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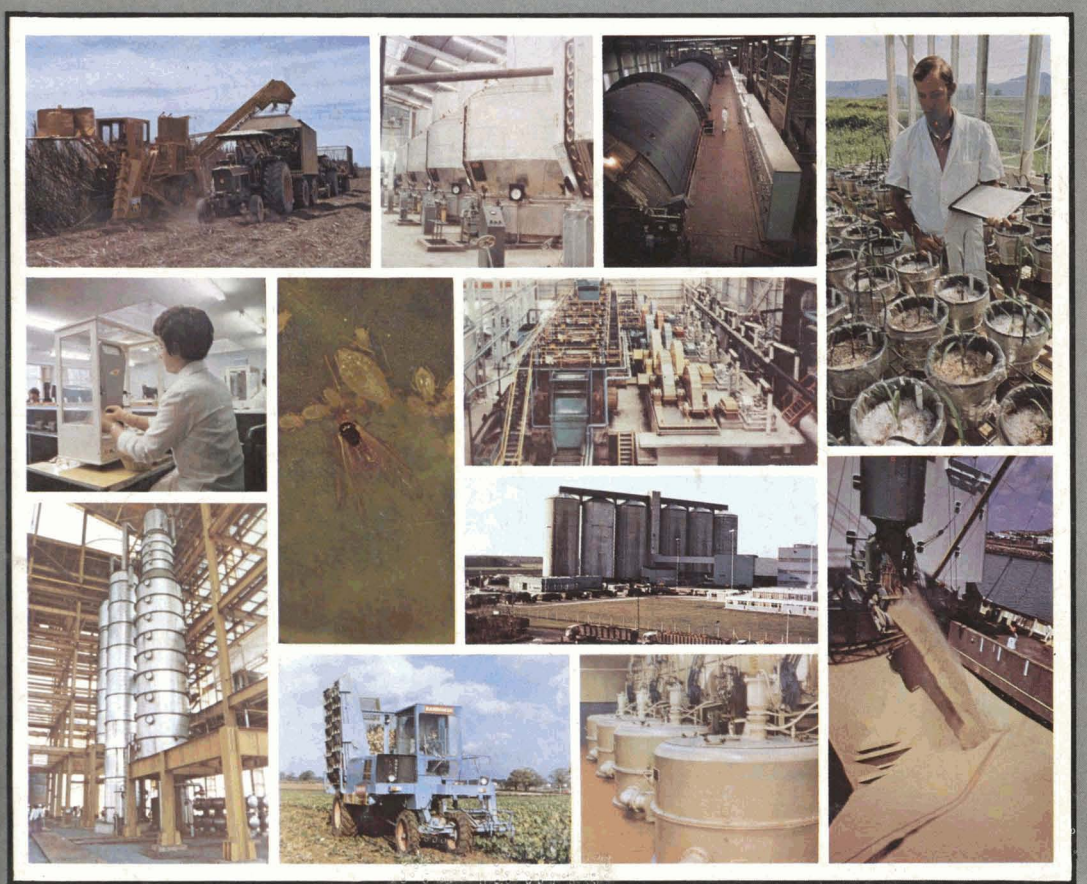

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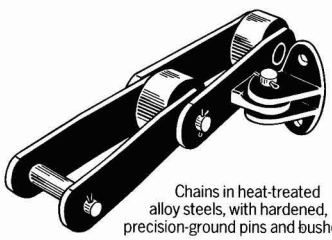

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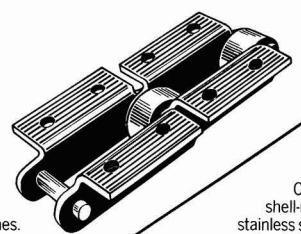

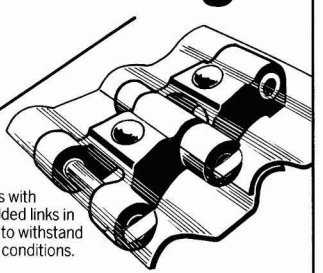

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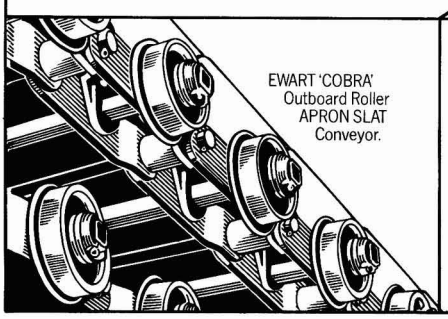

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NOTES AND COMMENTS

World sugar prices

With the imposition of import quotas by the USA, and reports of even higher estimates of production in the current Indian and Thailand sugar seasons, the LDP fell from £111 on May 28 to £104 on June 1 and continued to slide during the first half of the month, reaching £95 per tonne on June 15. The third quarter quota for US imports was set at a lower level than expected and this contributed to a depressed market.

The London Daily Price started to rise again on June 18, however, owing to what the market terms "technical reasons" connected with traders covering short positions, as well as reports of significant sales by India to China and Indonesia, and a level of £104 per tonne was reached on June 23. It eased again to £101 on June 25 but resumed its rise and climbed to £105 on June 30 and £111 on July 1. During most of the month, the premium for white sugar over raw remained steady at £28-£32, moving in parallel with the LDP. Towards the end of the month, however, the LDP(W) tended to pull further away and the premium rose to £42 on June 30, i.e. a price of £147 which compared with £133 on June 1.

Of course, when prices are falling, intending purchasers hold back, anticipating a further decline which comes about because of the lack of demand. When prices are rising, the same purchaser buys earlier in expectation of a higher price if he waits and the extra demand thus brings about the expected higher price.

E. D. & F. Man[1] comment: "The 1981/82 sugar year has so far proved to be one of contradictions and confusion. The past nine months have been notable for declining world prices in the face of limited actual availabilities of physical sugar. The relative physical tightness experienced during recent months has come about, in spite of a large statistical surplus, because substantial amounts of physical sugar have been withheld from the market, notably by the EEC stockpiling plan and the rebuilding of compulsory stocks by ISA exporting members. In India also a good degree of restocking seems certain. A further significant feature has been increased offtake by certain final buyers as values have continued to fall.

"Physical sugar has not, therefore, been in real exportable surplus during recent months. The surplus which has pushed the market to its present low levels has been a surplus of price-cover on the terminal market, as final buyers have postponed pricing physical sugar purchases. Basically the buyers' and speculators' perception of the physical situation has encouraged terminal selling and postponed terminal buying. In time these shorts will have to be covered and as current prices take effect and begin to influence the future supply/demand picture, the mood of potential buyers will change and result in more demand for forward price-cover than can be met without pushing values to substantially higher levels. Values would therefore seem to be at or near the bottom of the current cycle and should improve during the coming months."

ISA special stocks[2]

The International Sugar Agreement specifies that exporting members with basic export tonnages must set aside special stocks amounting eventually to a total of 2,500,000 tonnes, raw value. Apart from certain specified exceptions, members were required to establish their first tranche, amounting in total to not less than 1,000,000 tonnes, by June 30, 1982. The balance must be accumulated by December 31, 1983. Individual obligations are as follows:

	First tranche minimum*	Total
	—tonnes, raw value—	
Argentina	29,875	74,687
Australia	152,363	380,908
Austria	6,432	16,080
Bolivia	3,088	7,721
Brazil	160,788	401,970
Colombia	19,077	47,693
Costa Rica	1,968	4,921
Cuba	154,901	387,253
Dominican Republic	66,933	167,332
Ecuador	850	2,124
Fiji	18,335	45,838
Guatemala	15,333	38,332
Guyana	5,320	13,299
India	50,143	125,357
Jamaica	1,164	2,910
Malawi	2,340	5,849
Mauritius	10,786	26,966
Mexico	4,094	10,235
Mozambique	856	2,140
Nicaragua	3,621	9,052
Panama	10,320	25,801
Peru	16,601	41,502
Philippines	102,398	255,995
El Salvador	10,961	27,403
South Africa	56,625	141,562
Swaziland	6,185	15,463
Thailand	73,306	18,264
Trinidad	0	0
Zimbabwe	15,337	38,343
	1,000,000	2,500,000

* Although in general members are required to establish their initial tranches by June 30, 1982, the date has been deferred to December 31, 1982 in the cases of Guyana and Mauritius and to June 30, 1983 in the cases of Peru and El Salvador.

European sugar beet area 1982

F. O. Licht GmbH have recently published their third estimate of beet areas for European countries for the 1982 crop[3]. The total estimated area is a little more than 100,000 hectares below the second estimate made in April and this, representing only 1% of the total area, would indicate little change from previous assessments of beet crops and sugar production, as against those resulting from variations in weather conditions. The EEC figure is 10,000 ha smaller because of reductions of 2000 ha for France, Greece and West Germany and one of 5000 ha for Italy, offset by a rise of 1000 ha in the estimated Irish area. In the rest of Western Europe a fall of 8000 ha in the Spanish area and 21,000 ha for Yugoslavia is offset by an increase of 3000 ha for Turkey.

[1] *The Sugar Situation*, 1982, (352).
[2] C. Czarnikow Ltd., *Sugar Review*, 1982, (1600), 95.
[3] *International Sugar Rpt.*, 1982, 114, 337-338.

Further reductions of 1000 hectares forecast for Hungary, 18,000 ha for Poland and 70,000 ha for the USSR bring the total to 7,834,000 ha for the whole of Europe against the revised 1981 figure of 7,981,000 ha, i.e. a reduction of 1.84%.

US quotas and import fees

On June 15 the US Department of Agriculture announced a third quarter import quota totalling 420,000 short tons, raw value, considerably less than the 550,000-600,000 tons expected when the second quarter tonnage was announced. The individual quotas were as follows:

Argentina	18,060 tons
Australia	34,860 ,,
Belize	4,620 ,,
Brazil	60,900 ,,
Canada	4,620 ,,
Colombia	10,080 ,,
Costa Rica	6,300 ,,
Dominican Republic	73,920 ,,
Ecuador	4,620 ,,
Guatemala	20,160 ,,
Guyana	5,040 ,,
Honduras	4,200 ,,
Jamaica	4,620 ,,
Mauritius	4,620 ,,
Mozambique	5,460 ,,
Nicaragua	8,820 ,,
Panama	12,180 ,,
Peru	17,220 ,,
Philippines	56,700 ,,
El Salvador	10,920 ,,
South Africa	9,660 ,,
Swaziland	6,720 ,,
Taiwan	5,040 ,,
Thailand	5,880 ,,
Others	24,780 ,,
	420,000 ,,

Unused portions of quota from one quarter will not be carried over to the next, while the provision for "Others" is for smaller suppliers to be granted on a first-come first-served basis.

The Department is to set up a system of annual import quotas, beginning October 1, whereby the import controls will carry on after the third quarter but on an annual basis instead of quarters. No definite annual quota was announced but a tentative figure of 3,300,000 tons has been mentioned. It is planned to introduce a mechanism to ensure deliveries at required times instead of haphazardly and arrangements will also have to be provided for "tolling" or importation for refining and re-export.

On June 25 it was announced that the import fee for sugar would be reduced by 0.651 cents/lb with effect from July 1, to give new fees of 3.4193 cents for raw sugar and 4.4193 cents for refined sugar. The reductions reflect some strengthening of sugar prices in the US following the introduction of the quota system on May 5. The Secretary for Agriculture stated that, although the quota system reduces the volume of imports from foreign countries, those countries were now realizing higher revenues from their sugar sales on the US market.

The Egyptian sugar industry

Egypt is a member of the International Sugar Organization and, as such, has undertaken to provide statistics and information. Almost all the statistics published by the I.S.O. are estimates, however, indicating that Egypt has found difficulty in fulfilling this obligation. *World Sugar Journal* has now been able to secure authoritative data from the Egyptian Sugar and Distillation Company and the Ministry of Industry and has published these[4].

They reveal that, although it has been a declared objective to make the country self-sufficient in sugar, production has increased by only 93,000 tonnes in the five years to 1980/81 while consumption rose by 380,000 tonnes, necessitating a 49% increase in imports. The main problem has been a continuous decline in both cane and sugar yields, as shown in the table below, and this is attributed to the fact that the cane has not been replanted for a very long time, soil drainage is poor, an application of fertilizers has been lacking or untimely and there is a shortage of farm labour; in addition, the expansion of cane land has been into marginal areas of low productivity.

	Cane			Sugar	
	Area, ha	Production, tonnes	Yield, tonnes.ha^{-1}	Production, tonnes	Yield, tonnes.ha^{-1}
1971/72	57,536	5,132,890	89.21	661,722	11.50
1972/73	57,671	5,343,870	92.66	641,672	11.13
1973/74	59,834	5,287,823	88.37	672,601	11.24
1974/75	56,663	4,907,833	86.61	612,523	10.81
1975/76	58,725	4,706,820	80.15	566,542	9.65
1976/77	63,313	5,386,980	85.08	608,995	9.62
1977/78	71,796	5,803,126	80.83	640,053	8.91
1978/79	76,965	5,754,740	74.77	667,962	8.68
1979/80	75,369	5,862,018	77.78	661,614	8.78
1980/81	76,461	6,040,419	79.00	659,155	8.62
1981/82*	77,897	6,030,786	77.42	680,000	8.73

* Estimated

Consumption has increased markedly as a consequence of improved per caput income, relatively low retail prices and rapid growth in population of about 3% per year. Imports have grown, as shown below, most supplies coming from Brazil, Cuba and the EEC.

	Initial stocks	Production	Imports	Consumption	Exports	Final stocks
	tonnes, raw value					
1971/72	121,605	661,722	45,948	632,220	55,646	141,159
1972/73	141,159	641,672	72,469	635,795	39,608	180,197
1973/74	180,197	672,601	49,545	673,489	73,517	155,337
1974/75	155,337	612,523	124,216	729,084	49,462	113,530
1975/76	113,530	566,542	170,811	754,068	42,885	53,930
1976/77	53,930	608,995	180,992	768,719	41,671	33,527
1977/78	33,527	640,053	167,325	760,176	62,030	18,699
1978/79	18,699	667,962	384,438	912,964	47,400	110,735
1979/80	110,735	661,614	405,112	1,062,762	0	114,699
1980/81	114,699	659,155	459,760	1,121,374	0	112,240
1981/82	112,240	720,000**	631,369	1,343,369	0	120,240

** Including an estimated 40,000 tonnes of beet sugar

The Ministry of Industry drew up plans in 1981 to establish twelve new plants to produce sugar but no further details are available regarding their location, expected dates of operation or whether they are to process beet or cane. The first beet sugar plant started operations in June 1981 and is intended eventually to produce 100,000 tonnes of sugar a year.

[4] 1982, **4**, (11), 20-23.

British Society of Sugar Cane Technologists

First Technical Seminar, 1982

On April 6, 1982 the inaugural Technical Seminar of the B.S.S.C.T. was held at the Royal Commonwealth Society in London, under the Chairmanship of the President, Dr. M. C. Bennett, who welcomed members and quoted messages of good wishes from the Secretary of State for Trade and the Minister of Agriculture. In his introduction to the meeting, he referred to the earnings by British companies since 1970 of about £1000 million from the technology of sugar, aside from earnings from the manufacture of sugar and its by-products and in commodity trading.

About half of this sum has come from sales of sugar factory plant; British firms have built some 25 new factories and completed major expansions at a further 13. The balance has come from sales of agricultural machinery, agricultural and process chemicals, management and engineering services, consultancy, feasibility and planning studies and royalties.

Each of the five speakers would discuss a different area of British achievement in sugar technology while drawing the attention of members to the threat posed by (i) Government-subsidized finance for competitive suppliers, notably in the Far East, and (ii) the manufacture of sweeteners from corn which provided a feedstock in the form of starch at only a fraction of the cost of sugar in cane. Extensive summaries of the presentations appear below:

Project Planning

By B. Yates, J. Wilken and R. A. Yates

Project planning requires that all available resources (land, water, people and finance) be utilized in the best possible way so that the proposed project can be successfully implemented. Effective project planning is expensive, but this expenditure is small in relation to the waste of resources which could result from the installation of a non-viable project.

The broad objective of the project is normally identified by the client; for example, a country may wish to become self-sufficient in sugar. However, numerous alternatives could satisfy this objective. In order to make the most efficient use of all resources, project planning and development should progress though distinct stages as follows:

(i) project identification (or pre-feasibility study);
(ii) project preparation (or feasibility study);
(iii) location of finance;
(iv) preparation of detailed implementation plan and awarding of contracts; and
(v) implementation.

The basic objective and development proposals should be reviewed at the completion of each stage and modified as necessary. For example, detailed soil surveys undertaken in stage (ii) may reveal that the initial objective of, say, 100,000 tonnes/year should be reduced by 25%. In the extreme case it might prove necessary to abandon the project at some intermediate stage.

The project identification study can be done quickly and with economy. For a relatively simple assignment, a small team of, say, four consultants should be able to produce a report within two to four months after expending 200 to 300 man-days. They will have identified the options which could reasonably satisfy the objectives defined by the client. The options would be evaluated in a strictly broad-brush approach on both technical and financial grounds. The options would be ranked and appropriate recommendations made to the client. However, the client would decide which (if any) of the options should be further investigated as circumstances may change (for example, planned developments elsewhere are cancelled, or problems with foreign exchange may arise) and he may wish to place special emphasis on particular factors (such as regional development).

The selected option would then be subject to the more detailed (and more expensive) project preparation study. A relatively simple project would require an input of 600 to 1000 man-days, but this would be greatly increased if topographic surveys, soil surveys, the planning of irrigation and drainage/flood protection or similar time-consuming activities are necessary. Inclusion of aerial photography, mapping, cadastral, sociological and soil surveys can extend the total time required for report preparation from the basic minimum of four to six months up to in excess of twelve months.

This study would provide a clear, complete and authoritive report – a "bankable" document – which would be used for promoting the project, especially in respect of raising finance. The major British companies that are engaged in consultancy, such as Booker Agriculture International and Tate & Lyle, have traditionally offered (and indeed prefer) to implement and manage projects which they have designed. This is of great importance to potential financiers as it provides a form of corporate guarantee that the project is practical and realistic. Because of this, and because of increasing financial stringency applying to many Governments (who are or represent the client for most major sugar cane developments), it is becoming normal for the client to ask the consultant to extend his services beyond his traditional role to encompass the role of project promoter.

The typical sugar cane-based agro-industrial project is likely to be located in a remote, underdeveloped region. This implies that finance is required for items that are taken for granted in developed regions: main infrastructural works (roads, power supplies, etc), social infrastructure (housing, schools, hospitals, recreational facilities) and land development costs. In some instances part or all of these investments may be undertaken by Government (as they are national assets) or funded as Aid Projects or at concessionary rates (e.g. zero interest and 50-year repayment from the IDA). Alternatively, international lending agencies or other bilateral sources which prefer to invest in projects that provide socio-economic benefits would fund these investments which in general are not attractive to commercial sources. The whole range of commercial sources can be approached for the more normal investments; export-credit facilities (notably supported by the ECGD) provide a major source of finance for hardware. However, the long lead-time (typically at least six years) before full production

is attained is a disincentive to commercial finance for the total project costs.

Detailed project design (and the calling of tenders) is normally delayed until finance is, at least, identified in general terms; it is undesirable to carry out this work until the project is almost certain to be implemented. The implication of the above is that the project preparation report – the bankable document – is completed without the benefit of firm quotations. Obviously, the experience of the consultant is of great importance in estimating reasonably accurate total development costs. Individual components need not and should not be specified too closely, as managements will need to exercise their discretion at the time of implementation.

From the project preparation study onwards, the work is conceptually straight-forward, though there are significant problems: data (e.g. on yields and future markets) are rarely complete or reliable. The simultaneous optimization of all factors should justify sophisticated techniques such as linear programming – except that the base data are frequently too unreliable, so that sensitivity analyses, which indicate the effect on the project returns of altered values for the key data, are normally preferred.

The project identification study is often more complex conceptually. Ideally, the selection of possible sites is based on a general land-resource study (which is beyond the scope of this discussion, but which is within the scope of the major British companies active in the sugar sector). The simpler project identification studies would be required to match nominated production objectives to one or more pre-selected locations. A much broader study would be the "sector" study, which would identify future demand, specify the rationalization, rehabilitation and expansion required in existing units, identify new expansion areas, and coordinate all these data into a unified plan. One such study undertaken by Booker Agriculture International and Tate and Lyle (in conjunction with the Economist Intelligence Unit) was the Indonesian Sugar Study; this, in a "field work" period of six months, visited and inspected 56 existing factory areas and identified and inspected some 20 potential new areas (scattered over the Indonesian archipelago); the report, ten years later, is still a standard reference work and is being used as the basis for the current massive expansion of the Indonesian sugar industry. These companies, between them, have done similar exercises covering a major proportion of the world's sugar cane production.

In all of these studies, the complete range of relevant factors require investigation: the suitability of the land and climate; whether irrigation is justified; yields must be estimated so that land area can be calculated and, thus, the site-dependent land development costs estimated; the type of organization (estate or farmer, mechanized or labour-intensive) must be defined; the duration of the harvest season and the type of processing technology must be identified so that the appropriate factory technology can be specified; and, finally, it is necessary to ascertain whether the product can be sold at a competitive price. In all of this, not only the physical and financial but also the cultural, social, political and economic factors must be considered.

The work involved in project planning is considerable – and expensive. However the returns from a professionally planned and executed project far outweigh these costs, and in many instances such professional services are a prerequisiste of finance for the project being made available.

Sugar Estate Development

By A. W. MacGillivray and E. M. Johnson

Sugar estate development, for the purposes of this paper, is taken as all those activities which follow the acceptance by a client of a feasibility study, culminating in a fully operational sugar cane estate, but excluding the factory construction.

Although there is no such thing as a standard size project, typically the total capital costs (including the factory and social infrastructure) would fall into the range $100 to $200 million. Depending on the length of the crop and the factory capacity, the capital cost per tonne of sugar per year might fall between $1000 and $3000. Factors such as irrigation, mechanization and infrastructure will significantly affect these figures.

Financing. Project managers are frequently called on to raise funding for a new project. Typical investors would be international development agencies such as IDA, IFC, CDC, ADB, ADF, together with export credits for hardware.

Management contract. It is often a prerequisite of funding agencies that new projects should be managed by professional management companies during development and early operation. The management is likely to extend for 8-10 years because of the acute shortage of experienced middle management in many developing countries; to overcome this problem, intensive training systems are essential.

The contract should clearly specify the responsibilities of the manager, the client, consultants and contractors, and the interrelations of the various groups involved in the project. The manager's remuneration may be a flat fee or may be related to performance; in the latter case the parameters should be very clearly defined.

Development planning. The feasibility report will have laid the basis for the project plan. However, assumptions made at the feasibility study stage need to be verified, and the final development plan may vary considerably from the planning study. The implementation team should have the authority and flexibility to make such changes and variations in order to adapt to changing conditions.

The project budget will have been defined in total at the feasibility stage, and any changes made in the implementation plan should bear this in mind. Again there should be sufficient flexibility within the overall budget to permit changes to be made in the light of local conditions.

Implementation. Initial activities of the advance party will include initiation of agricultural trials and nursery plantings and the development of housing and infrastructure. Early contact with the local inhabitants in the project area is particularly important from a public relations point of view.

Development of a sugar cane project in a new area will require a substantial research program into cane varieties, pest control, soil characteristics and fertilizer requirements. Recruitment and training of staff and local labour should be carefully planned to meet the agricultural development program.

Development of a new estate requires careful planning in the layout of fields and irrigation structures, so as to take account of cultivation methods and natural features. Establishment of estate housing to match recruitment is an important aspect of development. Parallel develop-

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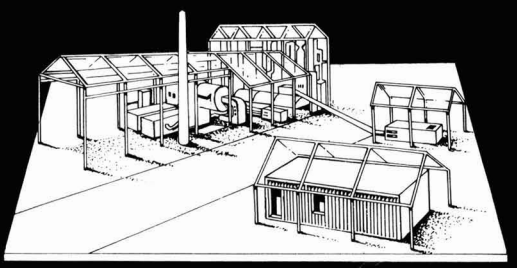

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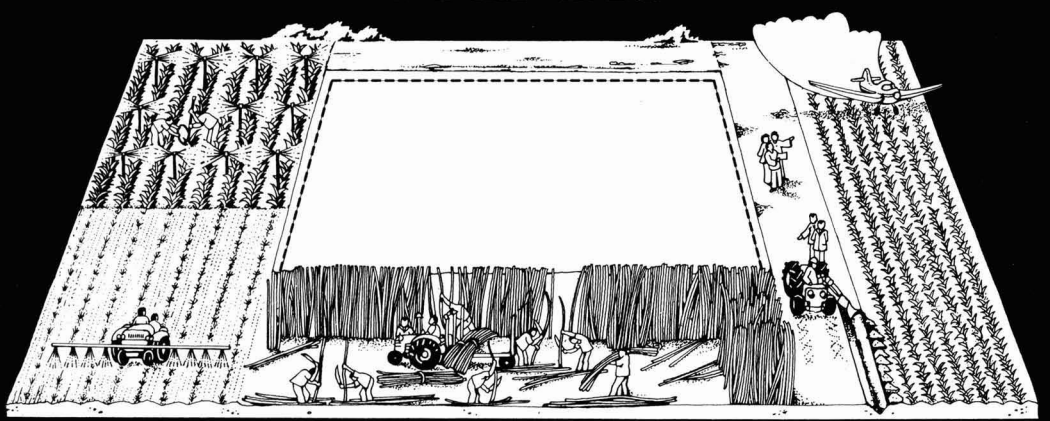

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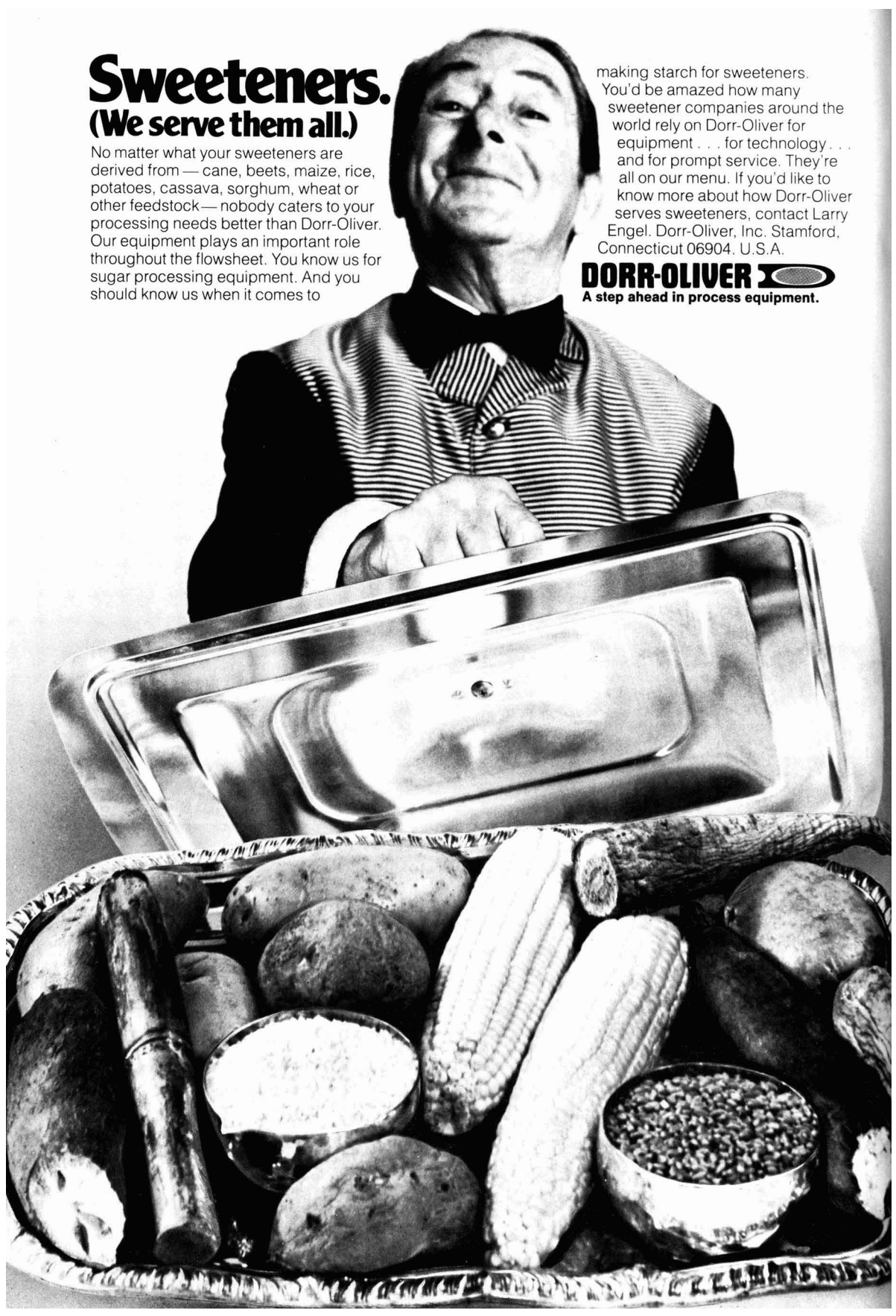
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ment of recreational facilities for all levels of staff is important in order to maintain morale. Services, particularly water supplies, need to be established unless ready access to a national grid is available.

Training. Any new project of this nature requires a substantial training input. In a developing country, basic skills will have to be taught in addition to the specialized sugar technology and engineering techniques required. In other administrative departments training in stores, accounts, and personnel management will be required.

Start-up of production. Particular problems are faced when production starts. First, there is a rapid build-up of activity in all departments, but especially in agriculture and factory. Personnel, training and accounts activities also increase substantially. Second, it is important not to neglect any remaining development work under the pressure to meet production targets.

Building Sugar Factories

By B. Newton and I. Carmichael

During the past decade, Britain has gained more contracts for cane sugar factories than any other nation; an independent survey of projects in 1975/80 showed that the two main companies — Fletcher and Stewart Ltd. and Smith/Mirrlees — shared 17% of the available market, amounting to new processing capacity of 50,000 tonnes of cane per day. The same period has seen the emergence of the Booker and Tate & Lyle groups as creators of completely integrated agro-industrial cane sugar projects. Both groups had for many years been involved in the management of sugar estates and factories but by the late 1960's it was clear that ownership of sugar assets in the developing countries was neither politically acceptable nor commercially sound.

At the same time, there was a demand for sugar plants as newly-independent nations struggled to satisfy growing food needs created by rapidly increasing populations and rising incomes. From this combination of skills and needs sprang a series of very successful projects — Nakambala in Zambia, Mumias in Kenya, Simunye in Swaziland and Juba in Somalia.

The advent of the governmental and para-statal buyer has produced a customer who is less informed technically and probably less interested than the owner-managers of the past. Simultaneous, and probably directly linked to this change, has been the increased involvement of the machinery supplier. The turnkey project has emerged, embracing civil design and construction plus mechanical and electrical installation and obtaining of financial support. Now, the contractor has to quote not only for the design, manufacture, supply and installation of plant but also to train large numbers of staff, construct large housing complexes and roads, etc.

However, when the market picks up again — and the emphasis is *when,* not *if* — it is fairly certain that we shall never again see attempts to create from scratch the giant schemes such as Kenana in the Sudan and Karim in Iran, or even of the size of Las Majaguas, Sennar and Asalaya. The downturn in the sugar cycle has on this occasion coincided with a severe world recession and the desparate shortage of money and lack of confidence have caused the delay or cancellation of many projects. The few which have proceeded have been the subject of fierce competition and, inevitably in such circumstances, prices have fallen. We are not likely to see a return to the easy money necessary to create new large projects based on the old European or US price levels.

The leaders in the attack on prices have been the Japanese, with India, Brazil and, more recently, Pakistan and Taiwan following suit and even in their turn attacking the Japanese price levels. It is true that, in most cases, goods supplied from Europe are superior in design and quality; however, the technology used in our industry cannot be described as high-level, and plants can operate satisfactorily with relatively low-standard but attractively-priced equipment. It is also a hard fact that some of the Asian and Brazilian goods are at least equal in quality to those of European suppliers.

If we are to survive and moreover to prosper, as we can, it is essential that we forget past experience and look afresh at the problems. We must concentrate more on identifying and meeting the needs of our potential clients. At the same time, we must also be aware of our competitors, examine our relative strengths and weaknesses and exploit to the full our competitive advantages.

The UK machinery suppliers have an excellent reputation throughout the sugar world for experience of operating in difficult geographic and economic conditions and willingness to stick to the task in the face of severe difficulties. Our general engineering reputation is underpinned by a small but important product line incorporating the entire range of specialist sugar plant and machinery. We can mobilize a cadre of personnel who have spent long periods of their working lives in the cane sugar industry; this gives great advantage in understanding the problems of the industry and of the environment in which it has to operate.

On the debit side, we now operate in Europe from a relatively high-cost base. While we can contain costs on some of our units, particularly mills, we can no longer supply vessels and tankage to the tropics at competitive prices, especially when freight costs are added. Even more worrying are the price differences on the major utility plant — boilers, turbines, generators, switchgear, etc. In some of these cases design problems arise owing to the adsorption of our traditional suppliers into larger groups meeting higher technology requirements than those of the cane sugar industry.

We do not believe that the competitive prices of Japanese suppliers stem from direct government subsidies but are more related to the structure and attitudes of the large industrial companies and trading houses. Profit expectations are lower and growth and market share are regarded as being more important. In the past few years, the reduction in Japan's national budget has increased the need for Japanese industry to obtain business in the export sector. But the credit regulations of Japan, although strictly applied, are essentially more flexible. It is, for example, possible for a Japanese company to purchase up to 40% of the project value outside Japan and still obtain full credit cover, so permitting purchase as cheaply as possible of simple items from Taiwan or Korea.

In our system it is very difficult to get non-UK goods covered in a package, and the latest problem we face is the OECD Concensus on interest rates which now permits Japan to offer lower rates than all its major trading competitors, including the UK.

The incursion of Indian manufacturers into the export market is relatively new. They receive considerable support from their Embassies and also specific monetary encouragement in the form of export rebates, marketing cost grants and preferential rates of interest for equity

investment in projects. The Brazilians operate almost entirely in the Latin American area; however, they again mobilize a great deal of political support from their government and are able to offer attractive financing terms and low prices. The Australians are new in the market and as yet their prices tend to be too high to be of great concern to us in straight competition. However, under the auspices and with the financial support of the Australian government, they have formed an organization for the promotion of the sale of Australian sugar technology, both machinery and consultancy services.

Our really successful projects have been those in which we were able to mobilize factory, field and general management in one complete package and benefits accruing from this approach have been considerable. It therefore seems a pity that the UK fails to create any form of coordinated attack on the market, to include commercial, financial and government interests. It is no accident that French companies get a high proportion of the contracts funded from EEC sources or that Japanese companies dominate those funded by the Asian Development Bank. Efforts put in by these countries at diplomatic and banking levels are fully coordinated to promote national interests.

We predict a continuing tight market with emphasis on lowering capital and operating costs in new plants. We anticipate competition for hardware from a number of sources with lower labour and material costs than the UK. With lack of finance and human resources in the developing countries to execute new sugar projects, there is likely to be increasing emphasis on availability of competent, all-round skills to plan and implement schemes. The UK is uniquely placed to meet these needs, but a better coordination of our total skills is essential if we are to expoit the comparative advantage we enjoy. Help must also be forthcoming from the financing institutions and government in regard to export credit rates so that other countries do not quote lower interest rates than we can provide.

New Technology

By S. I. Rankin

One of the most important objectives of the BSSCT is to attract young technologists to the UK sugar industry. New technology has an important role to play in achieving that objective and a summary of British achievement in process technology is reviewed here.

Basic research in the nature of colour bodies and the mechanisms of flocculation have resulted in two major technical successes which have found application in a variety of process steps in the production of raw, plantation white and refined sugar.

In the first instance must be cited the case of the Talofloc process for refining sugar, which has now been installed in nearly 100 refineries world-wide. It has been the subject of a Queen's Award for Technological Achievement and is so established in the sugar refining industry that, almost certainly, no new refinery project constructed in the last five years or currently under construction or planning is based on any other process method.

The steps through to the development of the commercial process that displaced traditional practice included fundamental work on the nature of colour in sugar solutions, identification of the type of chemical agents that could react with the colour bodies present and the establishment of a simple separation procedure. The end result was a compact, reliable process able to operate in the toughest of environments in a more cost-effective form than traditional practice.

The second instance relates to the identification of the role of primary and secondary flocculation in the removal of suspended matter from sugar syrups and juices. Derived initially from the need to remove the colour/chemical complex formed in the Talofloc process, flotation separation has found application in a variety of process streams in raw, plantation white and refined sugar.

In the case of raw sugar production, the technique is used firstly in factory raw syrup to improve raw sugar quality and yield, and secondly to clean up rotary vacuum filtrate, so enabling it to be passed on directly to the evaporators without being recycled through mixed juice. This improves yield by improving juice clarifier performance as the filtrate is high in non-sugars and constitutes some 15% of juice flow.

In the case of plantation white sugar production, the same applications just described are used but in conjunction with low level sulphitation. Because nearly all the suspended solids are removed, the effect of sulphur is enhanced to the extent that a white sugar can be produced of a quality approximating to refined sugar and acceptable to most domestic and industrial applications. The traditional disadvantages of plantation white sugars, associated with residual sulphur that makes shelf-life poor and puts off many industrial users, are overcome.

In the third instance in refineries, apart from the Talofloc process, clarification of other process streams such as recovery remelt or affination syrup show a benefit in either improving yield or allowing a new product line to be developed.

The steps through to commercial development in flocculation/flotation related to identification of the particular characteristics of the primary and secondary flocculating agents to ensure optimum compatability with the system in question. The characteristics of importance include molecular weight and charge density and by examining these and matching them with the nature of the particles present in the process syrups and juices in question, optimum performance was achieved.

These basic considerations were also critical in perfecting the design of short retention clarifiers which British engineers fine-tuned to permit operation within the short retention times sought by the industry.

In all these cases, considerable British innovation and development have resulted in considerable commercial success.

"Transformed sugar" has yet to achieve commercial success, but the future for it looks promising. In Brazil and Portugal, there is produced an amorphous sugar directly from syrup in which all the syrup is converted to sugar. There is no separation step and hence no recovery house. Traditional methods of amorphous sugar production are high temperature operations such that the product is high in invert sugar, making it unsuitable for long-term storage. New British technology has enabled this type of no-recovery crystallization to be developed to the point where a variety of existing syrups can be "transformed" to a microcrystalline solid without the high inversion associated with amorphous production and so without the storage problems. A wide number of applications are seen for this type of product and a further British success is hoped for.

In all cases, the purpose of the development and the resultant new technology has been to confer some advantage over traditional practice. This has been essentially of a cost-effective form either improving yield or quality or reducing capital or operating costs. The innovation has been market-led but achievement has not been without difficulty. Competitors watch the development work and then move in with cheap copies or attempts to copy, and for this reason the need for full protection by patent of inventions, is an integral part of any program.

The sugar industry is a low technology industry and generally the technical capabilities of factory and refinery staff are lower than, say, the petrochemical industry. New technology is required to compensate for this shortcoming. If the industry does not improve its level of technology then new technologists will not be drawn into the industry, new ideas will not be forthcoming and the gap will get wider. Career prospects for young staff will evaporate and the threat from alternative sweeteners will become stronger.

Both young and older technologists have a role to play. The younger members of the industry must not be afraid to examine every traditional practice and question as to whether it may be done by a better method; no matter how innovative, a wider range of concepts must be considered. The older technologists must lead the young and must recognise their responsibilities to support British industry, albeit without prejudicing any business ethics.

The basic theme in regard to areas of future development must be to reduce the capital required for projects, thus widening the potential market. Because of the economies of scale, projects now only become economical at the 7-8000 tcd levels where often neither the cane nor the market for the product exists. Admittedly, a factory or refinery can only be as good as its raw material but opportunities must exist in improving recovery, in enabling better quality sugars to be produced in the raw factories and in pollution control. Britain leads the world today in new process technology, and that position must be maintained.

Alternative uses of sugar

By W. Nicol

Over the last decade the British contribution to the alternative uses of sugar has been considerable. There has been active development of the chemistry of sucrose to produce derivatives of commercial significance. The challenge is there: the literature is full of success after success in using sucrose as a chemical raw material. The snag is that most of the brilliant chemistry is quite uneconomical.

However the advantages of using sucrose are many; it is safe, available, cheap, pure, and biodegradable but the economics of the chemistry need flair and vision. For example, Parker, Khan & Mufti found a way round the need for expensive solvents in making the fatty acid esters of sucrose. Their reaction product could be formulated as a detergent without further purification.

Only very recently has a new and surprising application for sucrose ester been found as the active ingredient in fruit preservation. This British invention is a formulation which when applied, as an enrobing film to the surface of fruit – bananas and pears for example – delays the ripening and thereby increases the shelf-life of the fruit. Recently the possibility of transporting bananas across the ocean without refrigeration has been explored.

Collaboration between Queen Elizabeth College, London, and Tate & Lyle has led to the identification of a new class of sweeteners typified by TGS which is 600 times sweeter than sucrose with virtually identical flavour characteristics. Such an exciting discovery has generated a great deal of interest around the world. The method of manufacture is quite complex but the intense sweetness is a major step towards cost-effectiveness. Instead of high intensity sweeteners being a threat to the sugar industry, the UK has shown how the sugar industry can respond in a very positive way.

British research teams have succeeded in not only making sucrose sweeter but have also achieved the converse of making it bitter or even tasteless. Apart from sucrose octa-acetate which does not have the required degree of water solubility or acid stability for use in soft drinks, sucrose benzoates and a chlorodeoxy derivative of sucrose which have recently been patented by Cadbury Schweppes and T & L respectively, have more suitable bittering characteristics for use in soft drinks.

Isomaltulose, an isomer of sucrose, but much less sweet, is said to be noncariogenic. It has been known as a minor constituent of honey but uneconomical to produce. At Reading, by the technique of immobilization of enzymes and a judicious choice of organism, a patented process has been developed which looks economically attractive.

Unfortunately, not all the sugar which finds its way into the food industry ends up in saleable products. There is inevitably some waste which is bad for two reasons. One, the sugar has been paid for, and, two, if discarded in the sewer, it causes environmental problems. A British scheme to recoup these losses has been developed and successfully installed. The advantage of this process over the normal effluent treatment plant lies in the value of the saleable by-product although its operating costs are higher. The capital investment of the yeast process is lower and needs less space.

Over the last decade there has been much interest in the conversion of sugar feedstocks to ethanol stimulated by the rapid rise in oil prices in the early 70's. This in turn stimulated the development and design of better processes of conversion of sugar to alcohol. The issues have been the reduction of capital and running costs through increased efficiency rather than the development of new processes. Effort has been directed towards design to minimize infection problems and towards continuous operation. The T & L system under development has gone a long way to achieving both.

In conclusion, the British contribution in studying alternative uses for sugar has been impressive. It is fair to say that we lead the world in this respect. The future is exciting and will hopefully encourage the younger generation to make a commitment to this diverse sector of the industry.

Malawi sugar production, 1981[1]. – With attainment of full-scale operation by the Dwangwa Sugar Corporation, which first went into production in 1979, the 1981 sugar outturn in Malawi reached 172,426 tonnes. The Dwangwa factory has a capacity of 3600 t.c.d. while that of the Nchalo factory, commissioned in 1966, is 5000 t.c.d.; combined capacity is some 180,000 tonnes of sugar per year. Both projects were designed by Lonrho Ltd. which both manages them and has a substantial investment. In 1981 they earned £30 million through the export of sugar which is now on a par with tea and tobacco as a major earner of foreign exchange, while fuel alcohol from molasses will help to contain the bill for oil imports.

[1] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 229.

Spent wash recycling for molasses fermentation

By D. S. DAHIYA, M. KOSHY, S. S. DHAMIJA, B. S. YADAV and P. TAURO
(Department of Microbiology, Haryana Agricultural University, Hissar, India 125004)

Introduction

Distillery effluent or spent wash constitutes one of the most recalcitrant industrial wastes. The nature of spent wash varies with the distillery; however, in general, its temperature on leaving the distillation unit is 90°C, it has a smell of burnt or caramelized sugar and is reddish brown to dark brown in colour having pH around 4.0 and average Biological Oxygen Demand (BOD) of 40,000 mg/litre and Chemical Oxygen Demand (COD) of 80,000 mg/litre. In most places, distillery waste cannot be discharged directly into irrigation water or used directly for irrigation owing to strict pollution abatement laws. A great deal of research work has been initiated at a number of institutions in India[1] and different methods have been suggested for spent wash treatment[2,3], but the methods so far suggested are found to suffer from one limitation or another. A common and easy method used for effluent treatment in India is anaerobic lagooning[4] but even this method requires much space and fresh water.

There are 127 molasses-based distillery units in India having total annual production capacity of 654 million litres of rectified spirit and generating some 15 times this volume of spent wash. There is thus an urgent need to develop suitable technology for disposal or reduction of this effluent and the present report describes work on recycling the spent wash in molasses fermentation. Depending on the number of cycles or the amount of spent wash used in each fermentation, it is thought that the total quantity of spent wash produced from each distillery could be reduced substantially.

Recycling of spent wash (vinasse) is not a new technique and has been recently attempted for dilution of fermentation raw material after initial removal of insoluble material such as colloids, clay, bagacillo, etc. and it is reported[5] that recycling ten times reduces the disposal problem by 90%.

D. S. Dahiya

M. Koshy

S. S. Dhamija

B. S. Yadav

Materials and methods

Organism: The sources and details of the yeast strains used in this investigation are given in Table I. These cultures were maintained on Yeast Extract Peptone Dextrose (YEPD)[6] agar slants by regular subculturing.

Table I. List of yeast strains

Culture No.	Yeast	Source
1	*Saccharomyces cerevisiae*	Switzerland
2	" " 522	California, USA
3	" *beticus* 519	"
4	" *cerevisiae* BY	Department Culture Collection
6	" " H-10-37	Casenheim, Germany
7	" " H-10-35	"
9	" " 523	California, USA
11	" " 729	Glens Osmond, Australia
13	" " 79 e I	France
14	" " M 912	"
15	" *bayanus* 88 X111	"
20	" *cerevisiae* R-113	New Zealand
21	" " R-114	" "
23	" " wine yeast	Kanpur, India
24	" " 288 C	Department Culture Collection
25	" " 2180-1 A	" " "
26	" " 2180-1 B	" " "
27	" " Distillers yeast	Kanpur, India
29	" " Bakers yeast	Geneva
32	" " ME-BNCYC	USA
34	" " Strain 21 NCYC	"
36	" " Strain 4228	"
37	" " Strain CC-9217-A NCYC	"
38	" " NSI Distillers' yeast	NSI, Kanpur
39	" " Distillers' yeast	Daurala Sugar Mills, Meerut, India
40	*Candida utilis*	Department Culture Collection
41	*Saccharomyces sSake*	
41	*Saccharomyces sake*	IFO, Osaka, Japan
42	" "	" "
43	" *cerevisiae*	Madras, India
44	" "	" "
45	" "	" "

Fermentation media: Cane molasses from Panipat Cooperative Sugar Mills, Panipat, India, was diluted with sterilized spent wash obtained from its distillery unit for preparing the inoculum and production media. The inoculation medium contained 150 g molasses per litre of spent wash (22° Brix solution); its pH was adjusted to 5.0 and the medium sterilized at 15 psi for 15 min. The unsterilized production medium contained 350 g molasses in one litre of spent wash unless otherwise stated.

Screening of yeast strains for fermentation of spent wash diluted molasses: For primary screening, 50 ml of the sterilized production medium, contained in 250 ml conical flasks, was inoculated with a loopful of the

1 Dahiya & Vimal: *Chemi Sphere* 1981, **40**, 5, 28-29.
2 Dahiya: Ph.D. Thesis, Kanpur University, Kanpur, India, 1976.
3 Koshy: M.Sc. Thesis, Haryana Agricultural University, Hissar, India, 1981.
4 Subbarao: *Paper presented to Seminar on Treatment and Disposal of Effluents from Sugar and Distillery Industries,* (Bangalore, India) July 24, 1976.
5 Fontes: *Brasil Açuc.*, 1980, **95**, 31-35.

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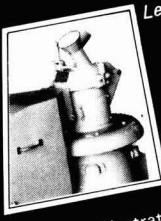
Cutter-Grinder

This is used to reduce cane samples into a fine condition to facilitate determination of fibre content, etc. The cut cane is retained in a receiving bin which is sealed to minimise windage and resultant moisture loss. The juice is evenly spread throughout the product.

Right: **Model 268B** will cut prepared cane or that which has come from a pre-breaker. It will also take full stalks including the tops and roots. The opening through which the cane is fed is 152mm. Power by 7.5kw motor.

Left: **Model 268BM** is identical to the Model 268B except that it has two smaller inlet funnels and will only handle stalks. Inlet diameter 55mm. It is fast in operation. It has a water inlet on top so that the machine can be flushed out at the end of tests while still running. This shows machine with receiving bin.



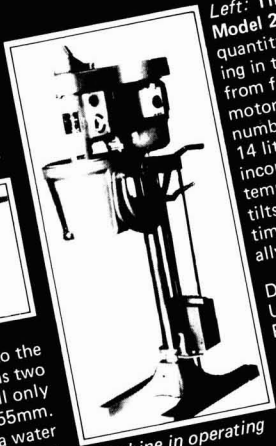
Right: Illustration of internal cutting arrangement. The cutters which are mounted on a vertical spindle perform a scissors action with the four hardened inserts in the head of the machine. Screen plates with holes of various sizes are available

DIMENSIONS: with receiving bin
Unpacked - 155 x 115 x 74cm Packed - 150 x 126 x 92cm
Cubic - 1.74m3 Weight Packed - 547kg

Wet Disintegrator

Left: **The Jeffco Wet Disintegrator Model 292** processes a measured quantity of cane and water resulting in the removal of sugar juice from fibre. It operates by a 2.2kw motor and is available in model numbers 291 - 9 litre and 292 - 14 litre capacity containers incorporating a water jacket for temperature control. Container tilts for easy emptying. Built in timer stops machine automatically at preselected time.

DIMENSIONS
Unpacked: 165 x 89 x 56cm
Packed: 173 x 104 x 57cm
Cubic: 1.02m3
Weight Packed: 337kg



Machine in operating position.

Container in filling position.

Container in emptying position.

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various strains under test (24 hr slants) and incubated. The progress of fermentation was visually monitored after 12 and 18 hr. Inoculum for secondary screening was prepared for each strain (Table II) in 50 ml sterilized inoculation medium by culturing for 12 hr and then transferring to 450 ml of the production medium contained in glass jars. Twenty ml samples were drawn from each jar at intervals of 0, 12 and 24 hr for alcohol estimation. All incubations were carried out at 30°C.

Table II. Ethanol production by different yeast strains

Strain No.	0 hour	12 hour	24 hour
	% ethanol v/v		
4	0.1	1.2	4.0
9	0.1	2.0	4.4
13	0.1	2.0	3.8
21	0.4	2.4	5.0
29	0.1	2.2	4.0
37	0.1	1.6	4.0
39	0.4	1.6	3.8
42	0.7	2.0	4.4
43	0.4	1.6	4.0
44	0.4	1.6	4.4

Production medium contained 350 g molasses in 1 litre spent wash.

Effect of varying levels of spent wash on fermentation rate and fermentation efficiency: 350 g molasses was dissolved in one litre of diluent with different levels of spent wash as follows: (i) 1000 ml water (0% spent wash); (ii) 250 ml spent wash + 750 ml water (25% spent wash); (iii) 500 ml spent wash + 500 ml water (50% spent wash); (iv) 750 ml spent wash + 250 ml water (75% spent wash); and (v) 1000 ml spent wash (100% spent wash).

Effect of varying levels of spent wash on yeast settling: To determine whether dilution of molasses with spent wash would have any deleterious effect on the rate of yeast settling, 350 g molasses was diluted with one litre of tap water (0% spent wash) and with 250 ml spent wash + 750 ml tap water (25% spent wash) and 450 ml of the above media was allowed to ferment separately as usual for 30 hr and then, after thorough mixing, 40 ml of fermented broth from each treatment was centrifuged at 4000 rpm for 10 min to determine the cell mass in suspension. The fermented broth in suspension was then allowed to settle for 6 hr after which the sediment in the bottom 4 cm of the jars was collected by siphoning and centrifuged to separate the wet cell mass.

A Brix spindle hydrometer was used to determine the specific gravity of the solutions and the readings were corrected for temperature. Total solids and ash in spent wash was determined by standard methods. pH was determined using an Elico pH meter model LI-10.

Analytical procedures: Total reducing sugars and unfermentable sugars in molasses and spent wash were estimated by standard AOAC methods[7]. The ethanol content was measured by the method of Caputi *et al.*[8] and the fermentation efficiency was calculated as reported earlier[9].

Results and discussion

Screening of yeast strains for fermentation of the spent wash diluted molasses: Spent wash contains several constituents which may affect the growth of yeast. Table III gives the analysis of molasses and spent wash used in this investigation. A total of 31 different yeast strains (Table I) were screened for their ability to grow in and ferment molasses diluted with spent wash. All the strains except Nos. 11, 34 and 40 grew in and fermented this material; however, all were not equal regarding the rate of fermentation. From this preliminary study yeast strains No. 4, 9, 13, 21, 29, 37, 39, 42, 43 and 44 were selected for secondary screening. From Table II it can be observed that, among the strains tested for their alcohol-producing capacity, strain 21 fermented spent wash-diluted molasses fastest and produced 5% alcohol in 24 hr. In further studies, therefore, only this strain was used.

Table III. Composition of fermentation raw materials

	Spent wash	Molasses*
Colour	Dark brown	Dark Brown
Odour	Caramel	—
Total Solids	80,000 ppm	—
Total Ash	3.4%	13.0%
Brix (gravity)	10.35°	—
pH	5.0	5.5
Total reducing sugars	1.98%	51.8%
Non-fermentable sugars	1.02%	3.6%
Fermentable sugars	0.96%	48.2%

* Dhamija (Unpublished data)

Effect of nutrients addition on fermentation rate: Dahiya *et al.*[9] showed that strain 21 can produce about 8% alcohol from unclarified molasses solution containing 15% sugars in 24 hr in batch fermentation, whereas, in the present screening studies, only 5% alcohol was produced from a solution containing 14% reducing sugar. In order to see if the fermentation rate could be improved by addition of nutrients, nitrogen, phosphate or both were added to the production medium. It was found that the rate of fermentation as determined by the alcohol production rate was not affected significantly by the addition of either urea or phosphate although the final alcohol content after 24 hr was slightly higher in phosphate + urea treatment (Fig. 1). This was, however, still lower than in the molasses–only solutions as reported earlier[9]. This suggested that the medium contains adequate amounts of these nutrients and hence, in later experiments, neither urea nor phosphate was added in the fermentation medium.

Effects of varying levels of spent wash on fermentation rate and fermentation efficiency: The level of dilution with spent wash drastically affected the final amount of alcohol produced (Fig. 2). The alcohol content at 24 hr was 8.1% in the control and decreased with increasing level of spent wash in the medium. In 100% spent wash treatment, the fermentation was delayed and only 5.4% alcohol was produced in 24 hr. The fermentation efficiency and the productivity in various treatments is shown in Fig. 3; the fermentation efficiency was 94% in the control and decreased linearly up to 50% spent wash, while thereafter the decrease was more

6 Sharma *et al.: Indian J. Microbiol.*, 1980, **20**, 1.
7 "Official Methods of Analysis" 12th Ed. (A.O.A.C., Washington, DC) 1975, pp.577-581.
8 *Amer. J. Enol. Vitic.*, 1968, **19**, 60.
9 Dahiya *et al.: I.S.J.*, 1980, **82**, 203-206.

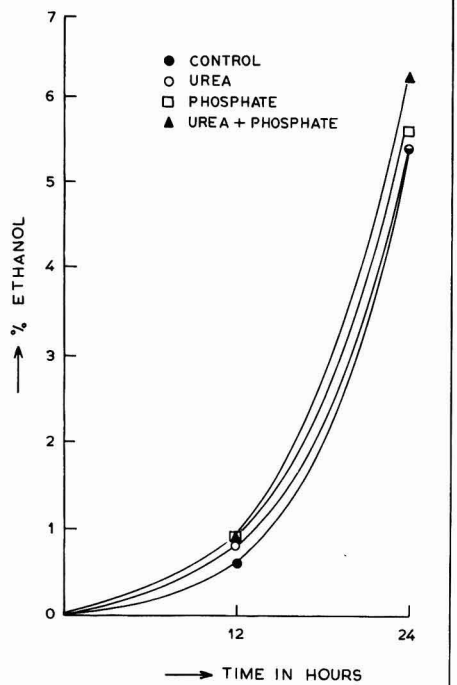

Fig. 1. Effect of nutrients on ethanol production using strain 21. Inoculum was prepared without nutrients, while the production medium was supplemented with 0.20% urea and 0.02% phosphate.

severe. At 100% spent wash, the efficiency at 24 hr was only about 74%. Fig. 3 also shows that the productivity (g ethanol/litre/hr) also decreased with increasing spent wash level.

Effect of varying levels of spent wash on yeast cell settling time: The amount of cell mass in suspension soon after complete fermentation was almost identical in both the treatments, indicating that the amount of growth in both treatments was very similar (Table IV). However, the amount of cell mass settled in 6 hr was less in the medium containing spent wash than in the control. At 25% level of spent wash, only 75% of the cells had settled in 6 hr, suggesting that the use of spent wash may create problems of cell settling.

Table IV. Rate of cell settling in spent wash-diluted molasses

Treatment	% spent wash	Wet weight for cell mass in suspension (g/40 ml)	Wet weight of sedimented cell mass (g)	% decrease in cell mass sedimented as compared with control
1	0	0.6	1.2	0
2	25	0.6	0.9	25

Fermentation medium contained 15% reducing sugars.

Conclusion

The most significant difference in the rate of fermentation occurred as a consequence of change in the ratio of spent wash to fresh water as a diluent, the fermentation

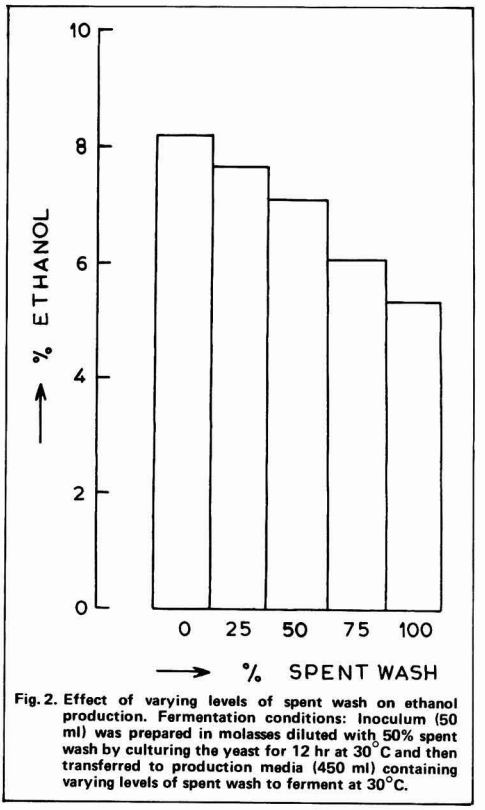

Fig. 2. Effect of varying levels of spent wash on ethanol production. Fermentation conditions: Inoculum (50 ml) was prepared in molasses diluted with 50% spent wash by culturing the yeast for 12 hr at 30° C and then transferred to production media (450 ml) containing varying levels of spent wash to ferment at 30°C.

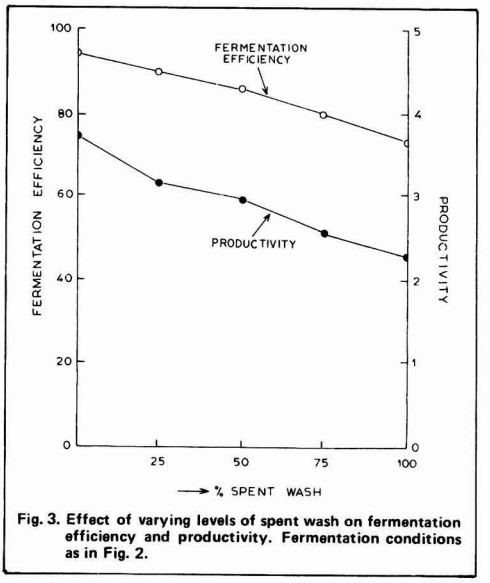

Fig. 3. Effect of varying levels of spent wash on fermentation efficiency and productivity. Fermentation conditions as in Fig. 2.

rate showing a deterioration with an increase in the level of spent wash. A ratio of 25:75 of spent wash to fresh water was close to the control but a ratio higher than

this significantly affected the fermentation rate. Use of a diluent with more than 25% spent wash may therefore not be economical with the available yeast strain since alcohol production efficiency cannot be sacrificed. What is needed then is a strain of yeast that will not only ferment spent wash-diluted molasses but also will ferment faster or at the rate equal to that in the control, i.e. water only as the diluent, if the method is to be adopted in the distilleries.

One problem that has been identified when using spent wash as diluent is that, even at the 25% level, it causes reduction in cell sedimentation. Normally, in distilleries, after the fermentation is complete, the wash is allowed to settle for about 4-6 hr before it is allowed into the distillation columns, this period allowing the settling of yeast cells. By using 25% spent wash in molasses dilution however, only 75% of the cells settle in 6 hr, perhaps because of the increased specific gravity of the broth (Table IV). This problem can be overcome, however, by the use of a centrifuge to recover the cells, which can then be used for recycling.

Summary

Use of distillery spent wash as a diluent in molasses fermentation has been attempted. The screening studies with different yeast strains revealed that strain 21 is capable of fermenting spent wash-diluted molasses solutions without any nutrient supplementation. Increasing concentration of spent wash in the fermentation medium, however, decreased the rate of fermentation and the fermentation efficiency. It was further noted that the cell sedimentation rate decreased with the increasing concentration of spent wash in the medium.

Acknowledgement

The cooperation of Mr. U. C. Sharma, Distillery Manager, Panipat Cooperative Sugar Mills, for supplying molasses and the spent wash is duly acknowledged.

Recylage de vinasse dans la fermentation des mélasses

On a essayé d'utiliser la vinasse comme diluant dans la fermentation des mélasses. En essayant systématiquement différentes souches de levure, on a remarqué que la souche 21 est capable de fermenter — sans supplément d'éléments nutritifs — des solutions de mélasses diluées à la vinasse. La vitesse et l'efficience de la fermentation étaient cependant réduites en augmentant la concentration de vinasse dans le milieu de fermentation. On a également observé que la vitesse de sédimentation des cellules étaient plus faible lorsqu'on augmentait la concentration en vinasse.

Schlempe-Rücknahme für die Melasse-Fermentation

Die Verwendung von Brennerei-Schlempe als Verdünnungsmittel bei der Melasse-Fermentation wurde versucht. In vorausgehenden Versuchen wurde festgestellt, daß Linie 21 fähig ist, mit Schlempe verdünnte Melasselösungen ohne zusätzliche Nährstoffe zu fermentieren. Erhöhte Konzentrationen an Schlempe im Fermentationsmedium vermindern jedoch die Fermentationsgeschwindigkeit und -ausbeute. Weiterhin wurde beobachtet, daß die Sedimentationsgeschwindigkeit der Zellen mit zunehmender Schlempekonzentration im Medium abnimmt.

Reciclo de vinaza en fermentación de melaza

Uso de vinaza como diluente en fermentación de melaza se ha ensayado. Estudios de selección con diferente razas de levadura han revelado que Raza No. 21 es capaz de fermentar melaza diluido con vinaza sin suplementación con nutrientes. Sin embargo, aumentación de la concentración de vinaza en el medio de fermentación disminuó la velocidad de fermentación y su eficiencia. Se ha notado también que la velocidad de sedimentación de las células se ha disminuido con aumento de la concentración de vinaza en el medio.

International Commission for Uniform Methods of Sugar Analysis

18th Session, 1982

Delegates from 27 countries met in Dublin in the Republic of Ireland from June 13 to 18 for the 18th Session of ICUMSA. Present were 118 delegates, as well as 31 accompanying persons. ICUMSA had been invited to hold its 1982 meeting in Dublin by Cómhlucht Siúicre Eireann, Teo. (Irish Sugar Company) and the first function was a Cocktail Reception in the Martello Room of Jury's Hotel on the evening of Sunday June 13, during the course of which Mr. J. E. Fitzpatrick, Chairman of the Irish Sugar Company, welcomed the guests.

On the following morning, the meeting began with an Opening Session, at which Miss M. O'Sullivan of the Irish National Committee of ICUMSA introduced Mr. M. Sheehy, Managing Director of the Irish Sugar Company. In his welcoming speech, Mr. Sheehy outlined the history of the sugar industry in the Irish Republic and emphasised its importance in relation to the overall pattern of Irish agriculture. He paid tribute to the contributions made by such international organizations as ICUMSA and expressed the pleasure felt by the Irish Sugar Company in hosting the meeting.

In his response, the President of ICUMSA, Professor E. Reinefeld, said how grateful ICUMSA was for the opportunity of holding its 18th Session in such a beautiful country with its long culture and history. For this, he thanked not only the Irish Sugar Company, but also the Irish National Committee of ICUMSA, under the leadership of Miss O'Sullivan. Professor Reinefeld recalled the contributions which had been made in Ireland by the late Mr. R. Carolan to the work of ICUMSA. He also drew the attention of the meeting to the fact that ICUMSA had celebrated its 85th birthday only a few days before the beginning of the 18th Session and said how happy everyone was to welcome to the Dublin meeting ICUMSA's Life Honorary President, Dr. A. Carruthers and Mrs. Carruthers.

Professor Reinefeld went on to report that, at the meeting of the Executive Committee held earlier in the day, applications for membership of ICUMSA from Colombia, the Dominican Republic, Honduras, Mexico and Panama had been approved. He welcomed these countries into membership and then asked the meeting to stand in silence for a short time in tribute to those who had worked so well for ICUMSA, but who had died since the 17th Session in 1978; these were Professor J. C. González Maíz (Cuba), Professor S. Zagrodzki (Poland), Mr. L. Condemarín (Peru) and Dr. W. Drewnowska (Poland).

After the Opening Session had been concluded, the meeting began discussion of the Referees' Reports. These Reports, which covered 30 Subjects, were dealt with not only on the morning of Monday June 14, but also during the afternoon and on the succeeding four days.

During the scientific meetings, a number of important Recommendations were adopted and it is hoped that a complete list will be published in this and other journals later in 1982. In accordance with the usual practice of ICUMSA, the Proceedings of the 18th Session will be published in book form, probably early in 1983. This volume, which will incorporate not only the full text of the Referees' Reports, but also the discussion and the Recommendations adopted, will be available for purchase from ICUMSA Publications, PO Box 35, Wharf Road, Peterborough, England, PE2 9PU.

On the evening of Monday June 14, all those at the meeting had the privilege of attending a reception offered by Bord Failte, the Irish tourist organization; this was held in the magnificent and historic setting of the Mansion House and the Deputy Lord Mayor of Dublin, Alderman J. Doyle, bade a cordial welcome to all present.

On Wednesday afternoon, June 16, there was no working session and the delegates and accompanying persons all enjoyed a bus ride through the countryside of County Wicklow, including a visit to the beautiful gardens at Powerscourt, home of the Slazenger family. The evening was taken up by a reception and buffet supper at Kilkea Castle, Castledermot, in County Kildare. An excellent meal there was followed by a fine display of Irish dancing, some tunes on the Irish harp, and a selection of well-known Irish songs.

Throughout the week, while the delegates were involved in the working sessions, the accompanying persons enjoyed a wide variety of well-organized entertainment, including tours of the Boyne Valley and the Vale of Avoca, a shopping tour and a fashion show.

The week culminated in a final banquet, offered by the Irish Sugar Company in the Killiney Castle Hotel, where everyone was made very welcome on arrival, not only by the hotel staff, but also by an Irish piper and a huge Irish wolfhound. The banquet was hosted by Mr. J. E. Fitzpatrick, Chairman of the Irish Sugar Company, an excellent meal was provided, and the guest of honour was the Minister for Agriculture in the Irish Government, Mr. Brian Lenihan, TD. In his speech, Mr. Lenihan paid tribute to many of the countries represented in Dublin and referred to the help which they had provided in establishing the Irish sugar industry in the 1920's.

In replying on behalf of the guests, ICUMSA's President, Professor E. Reinefeld, in a humorous and well-received speech, expressed ICUMSA's thanks to all who had been involved in providing not only a week of wonderful hospitality, but also an efficient organization of the scientific meetings. Especially singled out for thanks were the Chairman and many other personnel of the Irish Sugar Company and Miss O'Sullivan and the other members of the Irish National Committee of ICUMSA.

Professor Reinefeld expressed satisfaction with the scientific progress which had been achieved at the 18th Session under his leadership and thanked his predecessor, Dr. A. Carruthers, for having left the organization in such efficient working order at the time when, in 1978, he retired from the Presidency.

During the course of his speech, Professor Reinefeld announced the appointment of three new Vice-Presidents, namely Mr. L. Anhaiser (USA), Miss M. O'Sullivan (Ireland) and Dr. J. Tjebbes (Sweden). He also informed everyone that, in recognition of his valuable work for ICUMSA over many years, Mr. D. Hibbert (United Kingdom) had been made a Life Honorary Vice-President.

Professor Reinefeld's thanks also went to the Officers of ICUMSA, especially the General Secretary, Dr. A. Emmerich, and the Treasurer, Mr. R. T. Phillipson. The President and the other Officers would be continuing in office for a further four-year term.

Sugar production cost study

A new study into the costs of sugar production reveals just how parlous is the financial position of most sugar producing countries. Landell Mills Commodities Studies, (LMC), an independent economic consultancy based in London, has recently completed the latest in its series of detailed studies into aspects of the market for sugar and other sweeteners. The latest study, published in a five-volume report entitled "The costs of producing sugar and HFCS worldwide", presents a comparative review of the costs of sugar production (from both beet and cane) and of the costs of high fructose corn syrup production in the 1979/80 crop year. In all, the report covers 38 different cane sugar producing countries, 11 beet producing countries, and 11 HFCS producing countries, including all the world's main exporters, and including Cuba in the case of cane and Poland in the case of beet. The study was based upon a comprehensive description, using engineering analogies, of the various technologies employed at each stage of beet and cane cultivation, and at each stage of beet, cane and HFCS processing. These inputs were then multiplied by local prices to derive production cost estimates.

Some of the main conclusions from the study are indicated below:

The profitability of sugar production: There is no country or major sugar-producing region of a country that can cover its full costs at sugar prices of below 10 US cents per lb, in present circumstances. The same applies to HFCS producers. However, there is a select band — comprised entirely of cane producers — who, LMC's calculations reveal, can cover their recurrent costs at these prices. But these producers, important though they are, account for little over one-tenth of

world sugar output. Thus, over 85 million tonnes (raw value) of the sugar likely to be produced in 1982, would not even cover its recurrent costs, if it were to be sold on the basis of free market quotation.

The producers vulnerable to closure: The distribution of production costs among the many producers surveyed can be characterized as follows. The overwhelming share of output, of both beet and cane sugar, takes place at costs of up to 60% above those found for the lowest cost producers, in the range between roughly 11 and 18 cents per lb. On LMC's figures, almost three quarters of output occurs within this range. Such producers face difficulties at present world prices, but they should be able, on average, to cover their recurrent costs over the longer term. There exists, however, a sizeable group, mostly of small to medium-sized producers by world standards, whose costs of production range up to 5 times as high as those of the most efficient producers. Some of the high cost producers, whose production will always require substantial government support as long as present production techniques continue to be employed, are readily identified. Anyone familiar with Japan's domestic sugar industry, for example, will not be surprised at its presence in this group of high cost producers.

Looking at the world by regions, among cane producers two regions fare better than the others. Central/South Africa and South America appear, on average, to be comparatively low cost. However, Central America, including the Caribbean, has a sizeable number of high cost producers. In general, it proves difficult to establish any simple rules of thumb for determining whether or not a country is a high cost producer. Contrary to many people's initial expectations, high labour costs are not particularly noticeable (Japan notwithstanding) among the highest cost producers: in fact, one of the cane producers with the highest labour costs of all — Australia — was one of the most competitive producers in the survey. With respect to yields, too, the results of LMS's study are not entirely predictable. Thus, one discovers that yields of over 5 tonnes of sugar per hectare are by no means essential for a country to record below-average costs. Some low-cost South American and Asian producers have yields of under 5 tonnes per hectare, while Japan's yields are over 7 tonnes per hectare.

The most important single determinant of high costs in the sample of cane producers is the degree of capacity utilization, particularly at the factory stage. Sometimes this is low because the sector has gone into a seemingly irreversible decline: Puerto Rico is an outstanding example of this, and it may apply to other Caribbean producers (such as Trinidad, Barbados and Jamaica), too. In other cases, ambitious expansion programs have never been realized.

EEC production cost competitiveness: One result of LMC's study is to confirm that the EEC is, on average, lower cost than other beet producers. Also, it demonstrates that France's pre-eminence among the EEC's producers is not an aberration, but a fair reflection of a French competitive advantage. A wide variety of factors, including the length of the beet campaign, the level of land rentals and wage rates, affect the ranking of beet production costs. However, one factor proves to be much more important than all others — the yield of sucrose per hectare; and this is overwhelmingly to the advantage of North West European growers.

Beet versus cane costs: The cost advantage enjoyed by the EEC in a comparison with other beet producers does not apply when the comparison is extended to apply also to cane producers. LMC's calculations reveal that typical beet costs are significantly above those for cane. Indeed, in 1979, only France produced sugar at a cost below the average for the sample of cane producers. The sole respect in which beet performed better than cane was in having a substantially smaller range of dispersion of costs.

The impact of higher fuel prices: Looking ahead to a future in which energy costs can be expected to go on rising, LMC predicts that the cost advantage enjoyed by cane producers will continue to grow. Allowing fully for the repercussions of higher fuel prices upon the cost of chemicals, LMC's estimates indicate that a given increase in world oil prices will, in the long run, have approximately three times as great an impact upon beet costs as upon cane costs. Indeed, the cost advantages may prove even greater to cane producers as better use is made of by-product bagasse as a fuel.

The competitiveness of HFCS: In certain respects, those sugar producers whose production costs are calculated by LMC to be lower than the average can take comfort from their competitive advantage; but, the new factor of the inroads being made into sugar's industrial markets by HFCS threatens even low-cost sugar producers. The study has computed the costs of HFCS manufacture in all eleven countries in which significant production occurred in 1979/80. The key to these cost estimates turns out to be the domestic prices set for the maize used as the plants' raw material. In some maize exporting countries, such as the USA and Argentina, the value of the by-products obtained from HFCS production comes close to offsetting the costs of maize inputs. In these markets, HFCS was produced in 1979 at costs that would have placed them among the lowest cost one third of sugar production. Thus HFCS poses a real threat to sugar in these cases. Japan illustrates a different danger to sugar consumption — in which HFCS manufactured from imported maize undercuts high-cost domestic sugar.

The full report runs to over 700 pages and further details may be obtained from Dr. James Fry at Landell Mills Commodities Studies, 50/51 Wells Street, London W1P 3FD.

India sugar imports and exports[1]

	1981	1980	1979
		tonnes, raw value	
Imports			
Brazil	24,958	195,215	0
EEC	103,778	1,261	0
Korea, South	24,796	0	0
Philippines	8,613	0	0
USA	69,768	0	0
	231,913	196,476	0
Exports			
Bangladesh	0	10,804	17,780
China	0	0	22,149
EEC	0	26,406	27,525
Egypt	0	12,479	87,407
Indonesia	90,756	0	206,690
Kenya	0	0	44,568
Korea, North	0	5,672	0
Maldives	0	0	5,591
Nepal	0	1,621	0
Pakistan	0	0	21,176
Somalia	0	0	23,067
Sri Lanka	15,126	0	239,909
Sudan	0	12,479	12,965
	105,882	69,461	708,827

[1] *I.S.O. Stat. Bull.*, 1982, **41**, (2), 21.

An evaluation of DRIS based on leaf analysis for sugar cane in South Africa

By J. H. MEYER
(South African Sugar Association Experiment Station, Mount Edgecome, Natal)

(contd. from p. 205)

Reliability of predictions for macronutrients

Predictions of a yield response to N were found to be correct in 70% of the cases examined, based on the appropriate threshold values shown in Table V. The predictions when using the various DRIS norms were generally slightly better, ranging from 67% for the C set to 80% for the general set. In the case of P all the DRIS sets were clearly superior to the threshold value of 0.19% used alone. For K, however, there was very little difference between the two methods, although it was interesting to note that the norms developed in Florida gave the most reliable prediction of a K deficiency. The performance of the Florida norms was remarkably good when it is considered how the situation in Natal differs so much in terms of soil, climate and varieties from those which occur in Florida.

Table V. A list of threshold values used in evaluating yield responses to treatment with various nutrients

Nitrogen				
Area	Crop age	Months of sampling	N% Plant	N% Ratoon
Northern Irrigated	4-6 months	Oct-Dec	2.0	1.8
		Jan-Feb	1.9	1.7
		March-April	1.8	1.6
Coastal Lowlands	4-9 months	Nov-Dec	1.8	
		Jan-Feb	1.7	
		March	1.6	
Midlands	5-12 months	Nov-Dec	1.9	
		Jan-Feb	1.8	
		March	1.7	
Other nutrients P: 0.19% K: 1.05% Ca: 0.15% Mg: 0.08%	Zn: 15 ppm Cu: 3 ppm Mn: 15 ppm S: 0.14%			

DRIS appears to be particularly useful for N, a single set of norms being equally reliable for predicting responses in the three regions, whereas five different threshold values are required for this nutrient. This implies that a diagnosis based on ratios is not significantly affected by factors such as stage of crop (plant or ratoon cane), month of sampling (between October and April) and region, all of which have to be considered in selecting one of the critical threshold values for N.

It can be seen from Table IV that the reliability of predictions when using the general set of norms, based on ratios involving five elements (N, P, K, Ca and Mg) is better than those obtained when using the A set, which was derived from the same N, P and K data. There may therefore be some advantage to be gained from including Ca and Mg results as well as those for the major elements when assessing the balance of nutrients in the plant and with respect to N in particular.

Reliability of predictions for micro-nutrients

The results in Table IV show that the threshold values provided more reliable predictions of the Ca and Zn requirements of sugar cane, but were slightly less reliable than DRIS for predicting Mg requirements. However, these results cannot be regarded as conclusive, because on some of the experiment sites the response to treatment with lime was due largely to the suppression of Al toxicity. In these instances positive Ca indices were invariably obtained, indicating the adequacy of Ca as a nutrient. On the other hand there were a number of trials when no response was obtained to treatment with lime, where DRIS indicated that Ca was the first or second most important deficiency.

In several of the trials there was no response to treatment with Zn, but the Zn indices were strongly negative, indicating a deficiency. The average value of 25 ppm Zn obtained from the University data bank is much higher than the leaf Zn levels found generally in the industry. This high value has probably biased the various ratios which involve Zn, thereby indicating Zn deficiencies when they do not exist. The norms involving Zn will clearly have to be revised before they can be used for advisory purposes.

Testing the reliability of DRIS norms in predicting order of nutrient requirement

(1) By comparing order of response with order of nutrient requirement.

According to the work of Beaufils[2] a diagnosis with the indices N = –7, P = – 5, K = – 3, Ca = + 5 and Mg = +10 implies the following order of requirement of nutrients: N P K Ca Mg. The results of 25 N-P-K fertilizer trials were used to assess the reliability of DRIS predictions of the order of requirement for N, P and K. Of the 25 trials, 24 were conducted in the South African sugar industry[15] and the other was a long-term N-P-K experiment conducted by the Zimbabwe Sugar Association at the Chiredzi Research Station[16]. For each trial the average responses obtained to applied N, P and K were ranked in decreasing order of magnitude and compared with the DRIS order of nutrient requirement. A comparison of the orders of response obtained for the six possible NPK combinations and the corresponding DRIS orders of requirement for

[15] Du Toit: *Proc. 10th Congr. ISSCT*, 1959, 432-441.
[16] Gosnell: *Ann. Rev. Expts. Rhodesia Sugar Assoc. Expt. Sta.*, 1971.

the five different sets of DRIS norms is given in Table VI.

Table VI. Comparison between order of response to applied N,P and K in 25 trials and apparent NPK requirement based on five sets of DRIS norms

N P K response class	No. of crops and leaf samples	Average response tc/ha			Predominant DRIS nutrient requirement					% Agreement between DRIS order of response and diagnosis						
		N	P	K	A	B	C	D	E	Nutrient order	A	B	C	D	E	Overall
> >					> >	> >	> >	> >	> >							
N K P	21	18.7	5.0	8.1	N K P	N K P	N P K	N K P	N K P	N K P	48	48	33	43	43	43
N P K	10	18.8	9.9	5.8	N P K	N K P	N K P	N K P	N P K	N P K	50	40	30	30	60	42
K N P	16	6.1	1.8	8.5	K N P	K N P	K P N	K N P	K N P	K N P	81	87	75	81	87	82
K P N	6	2.5	7.2	15.9	K P N	K N P	K N P	K N P	K P N	K P N	50	33	33	33	50	40
P N K	2	7.0	12.0	2.0	P N K	P N K	P N K	N P K	P N K	P N K	50	50	50	50	50	50
P K N	2	2.5	5.1	3.9	P N K	P N K	P N K	P N K	P N K	P K N	50	50	50	50	50	50
Overall Agreement (%)											58	56	46	51	60	54

Overall agreement between the order in terms of yield response and the DRIS order ranged from 46% for the C set to 60% for the E set of norms. The K N P order was generally predicted most reliably (82%). By contrast, the N P K and K P N orders of response agreed with the DRIS orders of nutrient requirement only on 42% and 40% of occasions respectively. Variations in reliability of predictions may have been due partly to the small differences in the values of the N/P, K/P and N/K values used to calculate the indices, but they are more likely to have been associated with the relatively small differences between the P and K and P and N yield responses in the N P K and K P N treatment combinations respectively.

The results of only two crops could be used to assess the P N K and P K N treatment combinations, and hence the reliability of predictions when the greatest response obtained is due to treatment with P has not been tested adequately.

(2) By progressive diagnosis and application of most limiting nutrient.

The reliability of the various sets of DRIS norms was also evaluated by means of a modified version of the Beaufils[14] progressive diagnosis technique, using data from a number of trials suited to this purpose. The procedure involves the identification of the treatment combination giving the lowest crop yield, and the selection of the nutrient in this combination shown by DRIS to be most deficient. The treatment combination which provides an application of this most deficient nutrient only is then selected, and the crop yield response noted. DRIS is then used again to identify the nutrient deficient in the new combination, and the process is repeated as many times as the treatment combinations allow.

The results of the plant crop in a 3N x 3P x 3K factorial trial conducted at Sezela[17] were used to conduct such an exercise, and they are given in Appendix II. For each of the 27 treatment combinations the yield responses obtained to treatment with the most deficient nutrient are compared with those obtained after treatment with one, two or three deficient nutrients according to the full progressive DRIS diagnosis, and also with the responses obtained when treatments were applied to overcome the deficiencies indicated by leaf analysis in relation to the threshold values for each nutrient element. When the sum of the three DRIS indices, ignoring signs, was less than 10, it was assumed that nutrition was balanced and that no further treatment was required. Similarly when percentages of N, P or K in the leaf exceeded the threshold values it was assumed that nutrition was adequate.

If the results for each of the 27 treatment combinations is regarded as a possible field situation to be treated according to DRIS or to nutrient levels in relation to threshold values, then the summated yield responses provide an opportunity to compare the effectiveness of the different procedures over a wide range of conditions. It appears that treatments made according to the full progressive DRIS diagnosis would have been most successful (366.6 tc/ha), and that the treatments based on threshold values would have been more effective (304.6 tc/ha) than those which supplied only the most deficient nutrient according to DRIS (263.6 tc/ha). Analyses of the data from several other NPK factorial trials led to a similar conclusion.

Reliability of DRIS in relation to age of the crop at time of sampling

The acceptable ages of the crop at the time of leaf sampling for nutrient assessment based on threshold values are shown in Table V. Beaufils & Sumner[8] concluded that DRIS could be used at any stage of crop growth, i.e. at any time of the year and at any crop age, to assess the nutritional status of the crop.

The results of this evaluation do not generally support this conclusion. The results of most of the trials investigated here indicated that the nutrient status of the crop could be predicted more reliably by DRIS (than by evaluation in terms of threshold values for each nutrient), more particularly when the crop was young than when it was old. For example, in a 4N x 2P x 3K factorial trial on a Makatini series soil at Pongola, DRIS N indices predicted an observed response to treatment with N only when the crop was between two and five months of age. When the crop was older, DRIS gave no indication that an N deficiency would have been corrected by treatment with N. The advantage of using DRIS when the crop is young was demonstrated for N also in an experiment conducted in the midlands (see Table VII). The response to N

17 Thompson: Private Communication (S. African Sugar Assoc. Sugar Expt. Sta.), 1954.

Table VII. Effect of increasing age on the reliability of a DRIS diagnosis for N

Kg N/ha	Yield tc/ha	At 3 months N%	At 3 months N index	At 5.4 months N%	At 5.4 months N index	At 9.5 months N%	At 9.5 months N index	At 11.3 months N%	At 11.3 months N index
0	126	1.87	− 4.2	1.80	− 9.3	1.43	1.7	1.59	− 3.1
25	141	2.14	− 1.5	1.97	− 6.0	1.51	5.2	1.62	− 2.8
50	147	2.15	− 0.2	1.86	− 7.3	1.49	3.8	1.61	− 2.3
250	150	2.57	4.4	2.06	− 3.0	1.73	6.8	1.74	0.2

applied in this trial correlated better with the DRIS indices when the crop was 3 and 5.4 months old than when it was 9.5 and 11.3 months old.

Further evidence that the age of the crop can affect the reliability of a DRIS diagnosis is presented in Appendix I. The data from 11 N-P-K trials show that the probability of predicting the correct order of response to N, P and K based on DRIS was much greater when the crop was less than four months old than at any later stage. The only instances where the reliability of DRIS remained good when the crop was older than four months was when a nutrient deficiency was severe.

Discussion

The superiority of DRIS over the system based on threshold values, particularly when the crop is young, is due partly to the fact that ratios generally vary less with increasing crop age than do the values for nutrients % dry matter in the leaf, and partly to the fact that DRIS takes the nutrient balance into account, including "synergistic" and "antagonistic" effects. The relatively smaller variations that occur in the ratios of N/P and N/K when the crop is between 3 and 5 months old, compared with N% dry matter, are illustrated in Figure 1, using data for ratoon cane cut in spring at Pongola. While N% dry matter declined by 45% over this period, the N/P and N/K ratios declined by approximately 10% and 20% respectively. However, not all ratios investigated were equally stable. Ca/P and K/P ratios, while fairly constant during the vegetative stage of crop development, increased markedly during the autumn and winter, and when the crop began to mature.

Diagnosis should be expected to change with time because the soil/plant atmosphere continuum is dynamic. For example the effects of season and increasing crop age on the N index for a crop of cane grown for 24 months in the midlands are illustrated in Figure 2. As the season progressed from the first spring to autumn, the N index indicated a change from deficiency to sufficiency, and P and Ca were then shown to be most deficient. As warmer conditions developed in the following spring and summer, the situation changed once again and N became the nutrient that was most deficient. In this instance DRIS correctly indicated a deficiency of N even when the crop was 15 months old. Complex relationships or interactions between pairs of nutrient elements in plant tissues have been described[18]. The influence exerted by one element upon another may be either synergistic or antagonistic but the direction of the interaction

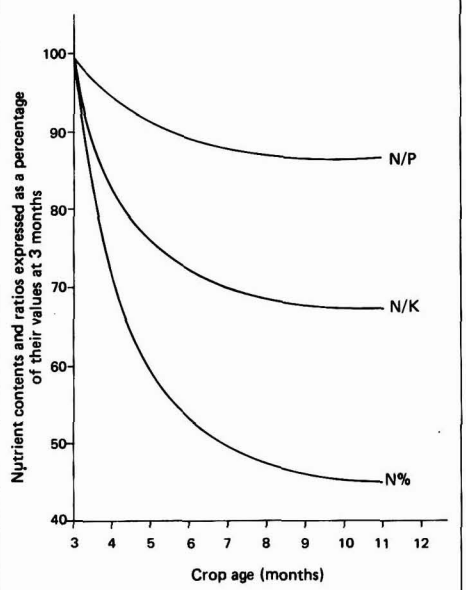

Fig. 1. Variation of third leaf N% and N/P and N/K ratios with age for ratoon cane at Pongola

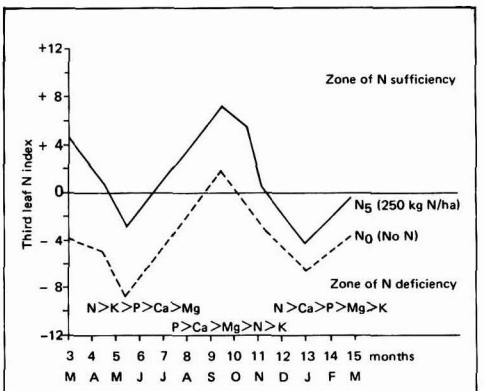

Fig. 2. Effect of age and season on changes in nitrogen indices

[18] Clements: *Hawaiian Planters Record,* 1941, **45**, 227-239.

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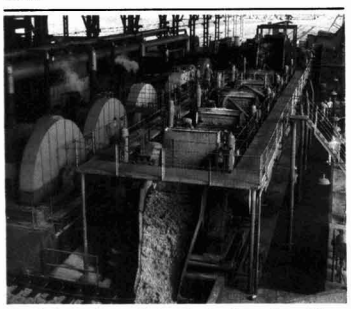

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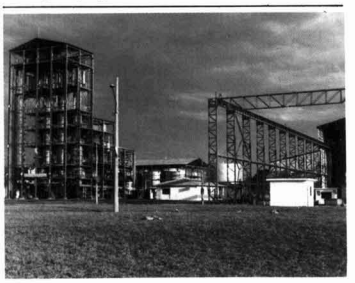

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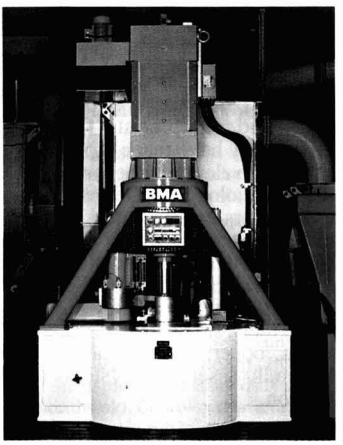

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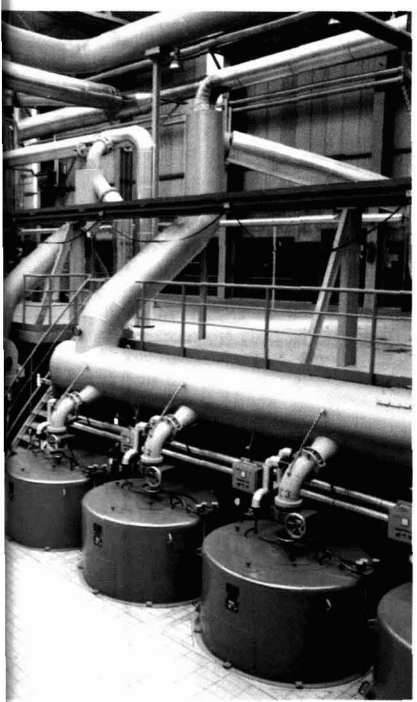

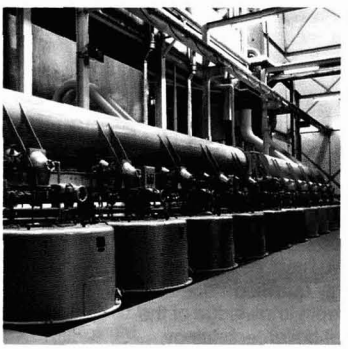

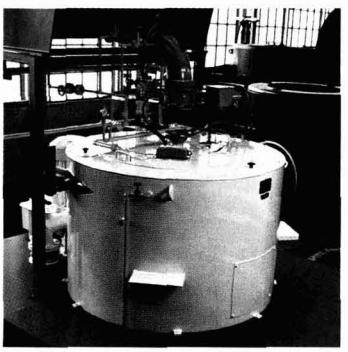

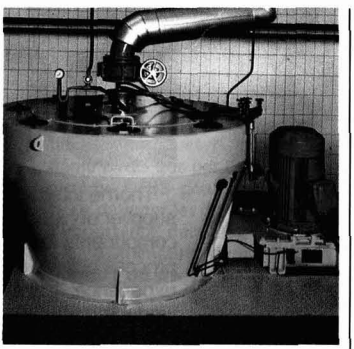

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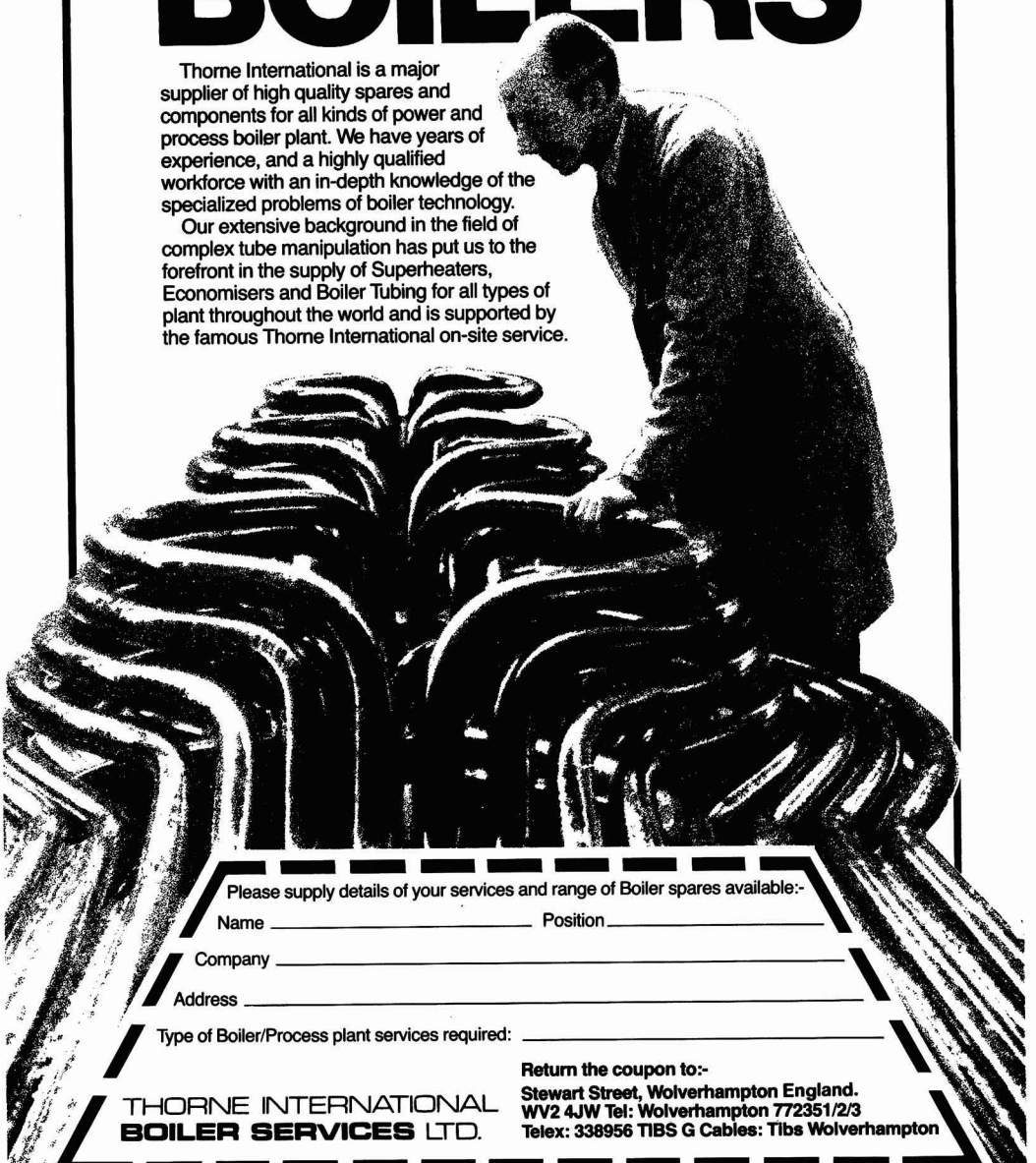

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is constant among many plant species[19]. Studies carried out by Evans[20] showed that antagonism between K and Mg was very marked in sugar cane grown in certain areas of British Guiana. The phenomenon was associated with Mg levels higher than 0.35% in the leaf blade. DRIS should permit such antagonistic effects to be detected when the crop is still very young. In several of the trials investigated, leaf Mg levels were found to be above 0.35% when the crop was young and the associated Mg indices were invariably highly positive (> +15). It was mainly in these trials that a DRIS diagnosis based on the "general" set of norms (using 5 elements) was found to be superior to the norms based on N, P and K only. Previous studies have shown the usefulness of DRIS in studying lime-induced antagonisms between Ca and K[7].

Conclusions

DRIS can be used to improve the value of the fertilizer advisory service offered by the Experiment Station. In general, imbalances of N, P and K can be detected by means of DRIS before a deficiency can be diagnosed reliably by means of threshold values. By taking leaf samples from the crop when it is only three months old, and perhaps even two months old after being cut in spring in the lowveld, deficiencies can be diagnosed and corrected for the immediate benefit of the crop.

Another advantage is that N, K and P can be ranked in order of importance, thereby identifying which nutrient the crop requires most urgently.

Items requiring further attention include a revision of the Zn norms; testing the applicability of the norms to different sugar cane varieties; and calibration of the norms in terms of fertilizer requirements. It will be possible in time to include a DRIS diagnosis, showing the order of nutrient requirement, in the FAS computer printout sheet for growers. This will provide a useful means of checking the balance being achieved when following a "whole cycle" fertilizer program. It will also help to deal more effectively with such problems as P fixation; early losses of N caused by leaching, denitrification or volatilization; and faulty fertilizer placement. DRIS soil norms are currently being evaluated.

Acknowledgements

Thanks are due to my colleagues at the Experiment Station for their advice and assistance in this investigation.

Summary

Cane yield data and third leaf analysis from 96 fertilizer trials have been used to establish whether DRIS can be used to improve the quality of the fertilizer advisory service offered by the South African Experiment Station. In general it was found that predictions of a yield response to applied N, P and K were more reliable when DRIS was used than when the nutrient threshold approach was used at an early rather than a late stage of crop development. The results suggest that imbalances of N, P and K can be detected earlier by using DRIS than by using the threshold approach. DRIS can be used fairly reliably to indicate N, P and K deficiencies in order of decreasing importance and the need for additional treatment identified at an early stage for a crop being sampled.

Une évaluation du système DRIS, basée sur l'analyse des feuilles, pour canne à sucre en Afrique du Sud

Les données du rendement en canne et d'analyse de la troisième feuille de 96 essais de fertilisants ont été utilisées pour établir si le système DRIS (Diagnosis and Recommendation Integrated System) peut être utilisé pour améliorer la qualité du service d'avis de fumure offert par la Station d'Expérimentation d'Afrique du Sud. En général, on a constaté que les prédictions d'une réponse en rendement aux N, P, et K appliqués étaient plus faibles avec le système DRIS qu'avec la méthode d'approche du seuil d'élément fertilisant, le système étant utilisé à un stade précoce plutôt qu'à un stade tardif du développement de la récolte. Les résultats suggèrent qu'un déséquilibre en N, P et K peut être détecté plus tôt par le système DRIS que par l'emploi de l'approche du seuil. Le système DRIS peut être utilisé avec une grande fiabilité pour détecter les déficiences en N, P et K dans l'ordre d'importance décroissante et le besoin d'un traitement supplémentaire d'un champ échantillonné peut être identifié à un stade précoce.

Bewertung des auf einer Blattanalyse basierenden DRIS-Empfehlungssystems für Zuckerrohr in Südafrika

Rohrertragsdaten und die Analyse des Dreiblattstadiums von 96 Düngungsversuchen werden verwendet, um festzustellen, ob DRIS (Integriertes System für Diagnose und Empfehlung) benutzt werden kann, die Qualität des Düngungsempfehlungsservice, der von der südafrikanischen Versuchsanstalt offeriert wird, zu verbessern. Im allgemeinen wurde gefunden, daß die Voraussage der Erträge nach N-, P- and K-Düngung bei Anwendung von DRIS verläßlicher war, als wenn Nährstoff-Schwellenwerte im Frühstadium oder auch im Spätstadium der Pflanzenentwicklung benutzt wurden. Die Ergebnisse lassen den Schluß zu, daß Störungen im Verhältnis von N, P und K bei Anwendung von DRIS früher erkannt werden können als bei Anwendung der Schwellenwerte. Mit DRIS kann verhältnismäßig zuverlässig und frühzeitig N-, P- und K-Mangel (in abnehmender Reihenfolge) bestimmt und die Notwendigkeit einer weiteren Behandlung des Feldes, von dem die Probe genommen wurde, festgestellt werden.

Un evaluación de DRIS, basado en análisis de hojas, para caña de azúcar en Sud-Africa

Dados de rendimiento de caña y de análisis de la hoja tercera de 96 experimentos con abonos se han usado para establecer si la DRIS (Sistema Integrada de Diagnosis y Recomendación) puede usarse para mejorar la calidad del servicio consultivo para abonamiento ofrecido por el Estación Experimental de Sud-Africa. En general, se ha logrado que predicciones de una respuesta en rendimiento a N, P y K aplicado ofrecen más confianza cuando se aplicó la DRIS que el camino de umbrales de nutritivos, a un etapa temprana más bien que a un etapa tardia del desarrollo de la cosecha. Los resultados sugieron que desequilibrios de N, P y K pueden percibirse más tempranamente por uso de la DRIS que por el camino de umbrales. La DRIS puede usarse con bastante de confianza para indicar deficiencias de N, P y K en su ordén de importancia decreciente, y la necesidad identificado de tratamiento adicional para una cosecha probada en un etapa temprana.

[19] Emert: "The bearing of ion interactions on tissue analysis results, plant analysis and fertilizer problems" (Amer. Inst. Biol. Sci., Washington, DC) 1961, 236-243.

[20] *Proc. 10th Congr. ISSCT,* 1959, 473-508.

Appendix I. Effect of the age of the crop at the time of sampling on predicting the correct order of N,P and K requirements in 11 trials

Trial No.	Crop	Average response tc/ha				Sampling age (months)				
						< 4	4-6	6-8	8-10	10-12
		N	P	K	> >	> >	> >	> >	> >	> >
1	Plant	2.69	1.25	10.86	K N P	K N P	K P N	K P N	K N P	P N K
	Ratoon	6.09	7.29	21.65	K N P	K N P	K N P	K P N	K P N	K P N
	P	13.63	− 1.33	1.89	N K P	N P K	P N K	P N K	P N K	P N K
	1R	22.28	− 0.35	3.41	N K P	N K P	N P K	P N K	P N K	N P K
3	P	14.98	7.99	4.21	N P K	K N P	P K N	K P N	K P N	K N P
4	P	9.22	4,14	13.52	K N P	K N P	K N P	K P N	P K N	N P K
5	P	14.51	0.84	5.92	N K P	K N P	K N P	K P N	K P N	K N P
	1R	8.87	1.61	7.23	N K P	K N P	K N P	K N P	K N P	N P K
6	P	6.65	− 1.1	4.72	N K P	N K P	N K P	P N K	P N K	N P K
7	P	10.91	− 0.3	6.22	N K P	N K P	N K P	N P K	K N P	N P K
	1R	4.20	4.9	2.1	P N K	K N P	N K P	N P K	N K P	P N K
8	P	13.21	5.45	3.56	N P K	N K P	P N K	P N K	P N K	N P K
	1R	6.1	4.71	5.41	N K P	N K P	N P K	P N K	N P K	K P N
9	P	9.47	5.01	12.60	K N P	K N P	K P N	P N K	K P N	K P N
	1R	1.08	8.45	16.05	K P N	K P N	K N P	K P N	K P N	N K P
10	P	12.46	− 1.53	11.94	N K P	K N P	K P N	K P N	K P N	P N K
11	P	7.0	6.2	18.0	K N P	K N P	K P N	K P N	K P N	K P N
	1R	6.0	4.0	17.0	K N P	K P N	K N P	K P N	K P N	K P N
	Total number of diagnoses					18	18	18	18	18
	No. with entirely correct order					9	4	1	2	2
	No. with main deficiency correct only					13	11	7	7	10
	Remainder					5	7	11	11	8

Appendix II. Comparison of the threshold value and DRIS approaches to diagnosis of N, P and K requirements of cane sampled at 4 months

N	P	K	Yield		Leaf analysis			DRIS indices				Responses to treatments supplying limiting nutrients								
												DRIS deficient nutrient			Full Progressive DRIS diagnosis			Threshold values		
			Tons cane	Tons sucrose	N%	P%	K%	N	P	K	Order	Level	Yield tc/ha	Response tc/ha	Level	Yield tc/ha	Response tc/ha	Level	Yield tc/ha	Response tc/ha
0	0	0	84.4	12.0	1.67	0.13	0.90	13	−18	5	P>K>N	010	107.6	+ 23.2	110	108.6	+ 24.2	111	108.4	+ 24.0
0	0	1	71.6	9.2	1.42	0.14	1.17	− 5	−16	21	P>N>K	011	83.0	+ 11.4	111	108.4	+ 36.8	111	108.4	+ 36.8
0	0	2	81.6	10.3	1.61	0.13	1.20	− 4	−26	22	P>N>K	012	95.6	+ 14.0	112	103.0	+ 21.4	112	103.0	+ 21.4
0	1	0	107.6	13.6	1.57	0.19	1.11	− 5	− 1	6	N>P>K	110	108.6	+ 1.0	110	108.6	+ 1.0	110	108.6	+ 1.0
0	1	1	83.0	10.46	1.37	0.19	1.11	−13	3	10	N>P>K	111	108.4	+ 25.4	111	108.4	+ 25.4	111	108.4	+ 25.4
0	1	2	95.6	12.16	1.24	0.18	1.05	−16	4	12	N>P>K	112	103.0	+ 7.4	112	103.0	+ 7.4	121	119.0	+ 23.4
0	2	0	85.4	10.68	1.52	0.27	1.12	−18	19	− 1	N>K>P	120	108.4	+ 23.0	111	108.4	+ 23.0	120	108.4	+ 23.0
0	2	1	131.4	17.9	1.54	0.18	0.98	− 2	0	2	N>P>K	—	—	—	—	—	—	122	119.0	− 12.4
0	2	2	76.4	9.6	1.49	0.21	1.15	−12	5	7	N>P>K	122	119.0	+ 42.6	222	127.6	+ 51.2	122	119.0	+ 42.6
1	0	0	98.4	13.32	1.77	0.13	0.95	15	−21	6	P>K>N	110	108.6	+ 10.2	110	108.6	+ 10.2	111	108.4	+ 10.0
1	0	1	89.0	11.34	1.78	0.11	1.10	19	−39	20	P>N>K	111	108.4	+ 19.4	111	108.4	+ 19.4	111	108.4	+ 19.4
1	0	2	70.2	10.00	2.00	0.14	1.18	15	−28	13	P>K>N	112	10.30	+ 32.8	112	103.0	+ 32.8	112	103.0	+ 32.0
1	1	0	108.6	16.14	2.11	0.25	1.15	1	4	− 5	K>N>P	111	108.4	− 0.2	—	—	—	—	—	—
1	1	1	108.4	15.58	2.10	0.27	1.29	− 4	6	− 2	N>K>P	211	113.6	+ 5.2	112	103.0	− 5.4	—	—	—
1	1	2	103.0	14.40	1.99	0.23	1.26	− 2	0	2	N>P>K	—	—	—	—	—	—	—	—	—
1	2	0	108.4	14.46	2.04	0.31	1.06	− 5	20	−15	K>N>P	121	91.4	− 17.0	222	127.6	+ 19.2	—	—	—
1	2	1	91.4	11.46	2.27	0.31	1.28	− 3	11	− 8	K>N>P	122	119.0	+ 27.6	222	127.6	+ 37.2	—	—	—
1	2	2	119.0	14.06	1.94	0.32	1.13	−10	22	−12	K>N>P	123	119.0	0	222	127.6	+ 8.6	—	—	—
2	0	0	85.4	11.18	1.80	0.11	1.00	22	−36	14	P>K>N	210	124.8	+ 39.4	211	113.6	− 28.2	211	113.6	+ 28.2
2	0	1	113.4	15.70	2.01	0.13	1.05	21	−30	9	P>K>N	211	113.6	+ 0.2	212	101.0	− 12.4	211	113.6	+ 0.2
2	0	2	99.2	14.60	1.96	0.12	1.21	20	−40	20	P>N>K	212	101.0	+ 1.8	212	101.0	+ 1.8	212	101.0	− 1.8
2	1	0	124.8	16.92	1.16	0.26	0.93	9	11	−20	K>N>P	211	113.6	− 11.2	222	127.6	+ 2.8	211	113.6	+ 11.2
2	1	1	113.6	14.96	2.04	0.25	1.15	− 1	6	− 5	K>N>P	212	101.0	− 12.6	222	127.6	+ 14.0	—	—	—
2	1	2	101.0	14.34	2.94	0.24	1.13	1	3	− 4	K>N>P	—	—	—	—	—	—	—	—	—
2	2	0	107.6	14.88	2.04	0.32	0.97	− 3	25	−22	K>N>P	221	127.8	+ 20.2	221	127.6	+ 20.0	221	127.8	+ 20.2
2	2	1	127.8	17.58	2.04	0.33	1.16	− 9	21	−12	K>N>P	222	127.6	− 0.2	222	127.6	− 0.2	—	—	—
2	2	2	127.6	16.60	2.02	0.25	1.05	1	8	− 9	K>N>P	222	127.6	0	222	127.6	0	—	—	—
											Total yield responses for 37 crops			263.6			366.6			304.6

SUGAR CANE AGRONOMY

Effect of post-harvest burning on the quality of sugar cane stalks. T. Yamaguchi and N. Yabu. *Sci. Rpt. Fac. Agr. Kobe Univ.*, 1979, **13**, (2), 209-212; through *S.I.A.*, 1981, **43**, Abs. 81-969. — In unburnt cane stalks, there was little change in sucrose content up to two days after harvesting; analyses after four and six days showed a rapid decrease in sucrose content and a rapid increase in reducing sugars content. In stalks burnt after harvesting, the sucrose content (% fresh weight) gradually increased during six days while the reducing sugars showed little change. Post-harvest burning is considered useful for removal of cane trash without lowering the sucrose content.

Close row-spacing and sugar cane yield. J. E. Irvine and R. J. Matherne. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 157 *(abstract only)*. — Field plots with inter-row spacing of 61, 91 and 183 cm with a single drill, and 183 cm with a double drill were sub-plots of a split-plot design; the main effects varied in the manner of N fertilizer application, either as a solid or in aqueous solution. The cane variety CP 65-357 was planted in the autumn of 1976 on level land at Houma, Louisiana. Monthly observations began in May 1977 and included population counts, height measurements, leaf determinations, yield estimations and determinations of tissue nutrient levels. No significant differences were observed in response to spacing, and these included differences in plant populations, leaf area index, yield of biomass, and net cane and sugar per ha. Stalk populations were highest in June and declined until harvest in December; June populations for the 61-cm spacing peaked at 180,000 stalks per ha, compared with 92,000 for the standard 183-cm spacing. Leaf area reached a maximum in September, when the ratio of leaf to land area for the 61-cm and 183-cm single-drill spacings was 5.66 and 2.76, respectively. Yields increased steadily until the mid-December harvest, when sugar yields for the 61-, 91- and 183-cm double-drill and 183-cm single-drill spacings averaged 18.0, 13.3, 11.9 and 10.9 tonnes per ha, respectively.

Determination of nitrate and ammonium losses by lixiviation in a cultivated sugar cane field. S. Saldarriaga A., E. Paz-Vergara P. and E. Angulo A. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 161 *(abstract only)*. — An experiment was carried out in Cartavio in a soil varying from medium to moderately fine texture, located on the northern arid coast of Peru, which was planted with sugar cane cultivar H 32-8560, fertilized with 240 kg of N per ha and harvested at 21.1 months of age. It was installed with the purpose of determining the nitrate-N and ammonium-N quantities that are lost in the drainage water. After evaluating the results, it was found that there were greater nitrate losses than losses of ammonium. A method to determine the losses of the NO_3^- and NH_4^+ ions is presented. According to this method, it has been calculated that, within the base flow of drainage, there is an almost constant loss of 13.5 kg of N per ha per year, while losses arising from applied N fertilizer caused by lixiviation by irrigation are 8.1 kg of N per ha per year, which results in a total loss of 21.6 kg of N per ha per year.

Influence of nitrogen application methods and urea sources on the response of two sugar cane cultivars. S. Saldarriaga A. and M. Feijoō. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 161 *(abstract only)*. —.An experiment was conducted in a calcareous alluvial soil, located at Tuman sugar plantation, Chancay River Valley, on the arid northern coast of Peru. The purpose was to study the influence of three N application methods and two urea sources on the response of two sugar cane cultivars. After evaluating the results, it was found that the application of a top dressing on dry soil, immediately followed by irrigation, and incorporation of N in the soil significantly exceeded in cane yield and recoverable sugar the top dressing on moist soil. No significant differences were found between the Peruvian and European ureas.

Sugar cane yield in India in relation to climate. S. C. Srivastava and R. Srivastava. *Indian Sugar Crops J.*, 1980, **7**, 103-104. — Statistical analysis of the effect of climatic factors on cane yield showed a highly significant correlation between yield and mean monthly temperature coefficient of variation.

Intercropping of potato with autumn-planted sugar cane gives high profits in light soils. R. N. Verma and R. L. Bhoj. *Indian Sugar Crops J.*, 1980, **7**, 105-108. — Trials showed that, of a number of intercrops studied, potato plus autumn-planted cane gave the highest net profit per ha. Spring-planted cane did not perform as well as autumn-planted cane despite a higher germination rate.

Contribution of eco-biochemical factors in improving juice quality of sugar cane. O. Singh and K. Singh. *Indian Sugar Crops J.*, 1981, **8**, (1), 7-12. — Studies of the effects of ecological factors on juice quality showed that sunshine and minimum temperature during the ripening process were major factors contributing to increase in sucrose content, juice purity, protein content and pH and to decrease in the reducing sugars content, titratable acidity, gum content, soluble salts and flavonoids. Marked varietal differences were found in response to the ecological factors.

Response of sugar cane to application of nitrogen, phosphorus and potassium. —. Irfanuddin and R. G. Singh. *Indian Sugar Crops J.*, 1981, **8**, (1), 15-17. — Field trials over a 3-year period are reported in which the three fertilizers were applied separately and in pairs as well as in the form of a 150-175 $kg.ha^{-1}$ N-P-K mixture. The tendency was for the nutrients to increase cane and sugar yield but to reduce sucrose content.

Study of graded *vs.* usual straight furrow system (irrigation) with and without earthing-up in adsali sugar cane. J. D. Chougule. *Indian Sugar Crops J.*, 1981, **8**, (1), 21-22. — Trials showed that the graded furrow system, as used widely in Hawaii, gave 10 $tonnes.ha^{-1}$ more cane than did the conventional furrow system provided earthing-up was not used (otherwise the increase was insignificant); with the normal system, earthing-up reduced yield by 10 $tonnes.ha^{-1}$, while also adding to overall costs. The graded furrow system is also of benefit

in that it costs less than the normal system to lay out and does not require drainage to remove excess water.

Characterization of soils for irrigation in sugar cane – Campos RJ. N. R. Boni, C. R. Espindola and R. R. Aloisi. *Brasil Açuc.*, 1981, **97**, 284-287 *(Portuguese).* – Soil profiles, granulometric and chemical analyses were made of samples from soil classified in seven units totalling 1780 ha on an estate – Fazenda São Luiz – in the Campos area. The soils of the different units are described.

Capacity for use of the soils of Fazenda São Luiz (Cia. Açucareira Cupim, Campos, RJ). C. R. Espindola, N. R. Boni and R. R. Aloisi. *Brasil Açuc.*, 1981, **97**, 313-316 *(Portuguese).* – Soils from the title farm have been examined in regard to factors limiting agricultural use in order to discover their "capacity for use" and to formulate recommendations for land management. The principle limiting factors were: excessive soil moisture, edaphological drought, water retention capacity and soil fertility. Such aspects permitted grouping of the soils into six classes of "capacity for use" which are defined. About 70% of the area requires drainage to render the soils more suitable for cane growing.

Physical characteristics of soils of Cia. Açucareira Usina Cupim (Campos, RJ), relative to problems of land use and management. R. R. Aloisi, C. R. Espindola and N. R. Boni. *Brasil Açuc.*, 1981, **97**, 321-325 *(Portuguese).* Soils of the title estate have been examined for a number of characteristics (organic matter content, soil type, i.e. sand, silt and clay proportions, apparent and true density, coefficient of hydraulic permeability and available water). The data obtained show a great variability and indicate the need for more investigation and experimentation, particularly for drainage improvement, if the best use is to be made of the soils.

Pre-planting submergence as soil ecological alteration in sugar cane fields. S. W. Li and W. C. Liu. *Taiwan Sugar*, 1981, **28**, 80-84. – In Taiwan, reduced cane yield (particularly in ratoon crops) has become a major problem. In view of the beneficial effect of rotation with rice on plant cane yield, trials were conducted on flooding of cane fields before planting. Covering the soil with some 10 cm of water for 2-3 months increased yield of both plant and ratoon cane by comparison with the controls. Reasons for the effect have yet to be established. In some cases, application of bagasse at 50 tonnes.ha^{-1} or of green manure improved yields still further.

The adoption and improvement of planting whole-stalk seed cane in Huwei sugar factory district, TSC. Y. C. Kao and E. R. H. Hsu. *Taiwan Sugar*, 1981, **28**, 87-90. Because of the need to plant cane within a specified time and because of labour shortages, trials were conducted on hand or machine planting of whole stalks instead of two-budded setts. Results showed that, over the three years of the experiments, yields were much greater than with planting of setts; best results were obtained when the leaf sheath was removed prior to planting. The costs of the planting operation were halved by whole-stalk planting, while use of a mechanical planter equipped with a herbicide applicator was even more economical.

The effects of post-emergence herbicide treatments on sugar cane in South Africa. P. E. T. Turner. *Proc. 55th Ann. Congr. S. African Sugar Tech. Assoc.*, 1981, 99-105. – Post-emergence herbicides of more recent introduction in South Africa were tested for their phytotoxicity to cane, as indicated by leaf scorch and growth stunting, in both plant and ratoon crops. Results showed that most of the herbicides, sprayed individually or in combinations over the cane row, were no worse than Diuron + 2,4-D + surfactant (used as standard treatment) in their effect on cane; one exception was Dual + Ametryne + Paraquat which, in three out of five experiments, induced marked early stunting of the cane and caused a reduction in yields by comparison with the controls. Bladex Plus showed very small effects at all stages of crop growth and is therefore safer to use than the standard combination. In general, yield reductions were unlikely to result from the use of recommended rates of any of the combinations tested, provided the herbicides were applied when the cane was in an early stage of growth (or spraying of cane foliage was largely avoided). In instances where full cover applications are necessary, severe leaf scorch and early stunting can be expected, but yield reductions will be small if leaf height is below 400 mm at the time of spraying.

Use of a computer as a a management aid to crop prediction during time of restriction. O. P. Landrey, D. P. K. Schorn and R. D. Truen. *Proc. 55th Ann. Congr. S. African Sugar Assoc.*, 1981, 131-134. – In 1978 the South African sugar industry introduced sugar production restrictions in order to meet its obligations under the International Sugar Agreement; it was difficult to predict how long the restrictions would last and how severe they would be. The authors' company had to decide on a policy for the restriction period which would have least adverse effect on its ability to restore maximum production in the shortest period of time after lifting of the restrictions, i.e. the management needed to know the effect of fallowing of the land, reduction in fertilizer application, changes in the percentage of replanting and increase in the age of unharvested cane. To do this, a computer was used for the large volume of calculations involved in a crop prediction as well as for examination of the various options and projection of the results some years ahead. Details are given of the procedure used and of the results obtained, which demonstrated the value of the computer. While close agreement was established between predicted and actual yields for a section, e.g. to yield some 31,000 tonnes of cane, there was wide fluctuation about the mean for individual fields in a section.

Observations on the effects of frost on some sugar cane varieties. A. O. de Haas. *Proc. 55th Ann. Congr. S. African Sugar Tech. Assoc.*, 1981, 146-148. – Plants of 11 cane varieties were grown in pots during the winter at a site in the Natal Midlands, where cane is grown at altitudes between 750 and 1100 m and where it is commonly subjected to low temperatures during the winter. During the test period, the grass minimum temperature fell below 0°C on 40 nights. Proportionately fewer primary shoots survived the winter in the case of the more tropical varieties than in those usually grown in or recommended for the Midlands. A close relationship was found between shoot survival and both increase in shoot height during the winter and degree of necrosis of the spindle leaf. The relationship between shoot survival and attibutes observed early in the winter (chlorotic stripping and necrosis of the first leaf) was relatively weak.

SUGAR CANE MECHANIZATION

Mechanization of cutting and transport of cane. Anon. *Bol. Estac. Agric. Puerto Rico,* (237); through *La Hacienda,* 1981, **76,** (2), 44-45 *(Spanish).* — The fundamentals of mechanized cane harvesting are discussed and a survey provided of the types of cane harvester which have been used in Puerto Rico. The problem of lodged cane is briefly discussed.

Standards for cane tramway designs. S. Caltabiano. *Proc. Australian Soc. Sugar Cane Tech.,* 1981, 99-105. — A set of design proposals is presented to act as basis for minimum design standards for cane railway systems. Specific aspects considered include feasibility studies for new projects and bases of design for railway alignment and grading, drainage, bridging and trackwork construction.

Kenana uses world-wide expertise in field mechanization. R. J. Leffingwell. *Sugar y Azúcar,* 1981, **76,** (7), 19-20. An outline is given of cane transport and reception at Kenana Sugar Co. in Sudan. The transport units consist of a truck haulage unit and an Atvico skeletal semi-trailer carrying two 12-tonnes capacity containers. Of the cane, 75% is mechanically harvested. A continuous mechanical pick-up, chopper-loader loads the cane direct into the containers, obviating the need for trans-loading. Both loaders and harvesters are provided with air blowers.

Field planting of short sugar cane seedpieces in Louisiana. G. T. A. Benda, H. P. Fanguy, J. E. Irvine and R. D. Breaux. *Proc. Amer. Soc. Sugar Cane Tech.,* 1978, 40-48. — While seed cane is normally planted in Louisiana in the form of whole stalks, there is difficulty in obtaining uniform distribution of the cane in the furrow and the risk of planting cane crookedly when mechanical planters are used. Experiments were conducted with seedpieces 11-20 inches long, and showed that they gave a plant cane crop comparable in yield to whole stalks 5-6 ft long, provided the seedpieces were either cut by hand or by an Australian mechanical planter; cane pieces 9-14 inches long cut by a combine harvester did not give as good yields, apparently because of harvester damage to the pieces.

A new approach to mechanical stool eradication. E. N. Dicks, E. Meyer and G. C. Payn. *Proc. 55th Ann. Congr. S. African Sugar Tech. Assoc.,* 1981, 127-130. Four field experiments were carried out to compare the performances of (i) a shallow mouldboard plough, (ii) a conventional disc plough, (iii) a conventional chisel plough and (iv) a shallow rotary hoe in eradication of cane stools left over from the previous crop. At one site the soil was structured clay loam; at the other three sites it was a loamy sand. On the clay loam, the most effective method was (i) followed by disc or power harrowing; on the loamy sand, best was a rotary hoe operating at a shallow depth at 220 rpm and a forward speed of 2.6 $km.hr^{-1}$. On all soil types, Glyphosate sprayed at 10 litres. ha^{-1} on actively growing young cane in summer was successful in stool eradication, but was relatively costly.

Fuel consumption and productivity of trucks compared to tractors and trailers for hauling sugar cane. T. J. Murray and T. M. C. Boevey. *Proc. 55th Ann. Congr. S. African Sugar Tech. Assoc.,* 1981, 135-138. — About 75% of the cane grown in South Africa is transported to the factories by road. Recent increases in fuel costs prompted an investigation into the effects of changing vehicle size, load size and vehicle type on productivity and fuel consumption. Test results for trucks of carrying capacities in the range 5-40 tonnes are reported and compared with values obtained previously for tractors and trailers[1]. It was concluded that, within the scope of legal loads, both productivity and fuel consumption were improved dramatically by increasing load size; the tests also showed that trucks are very much more productive and fuel-efficient than tractors and trailers used as transport vehicles.

Harvesting in the wet. E. G. Spry. *Cane Growers' Quarterly Bull.,* 1981, **45,** 18-19. — Photographs illustrate the wet-weather harvesting equipment (full-track harvester, infield transporter and transloader) used by a cane farm in north Queensland under wet conditions.

Weight transfer reduces field damage. P. K. Makepeace. *Cane Growers' Quarterly Bull.,* 1981, **45,** 20-21. — Work carried out by T. Fuelling in a study of the effects of infield cane transporters on soil structure and cane productivity is reported. Maximum compaction occurs on soils with a moisture content below field capacity (no free water); at a higher moisture content, i.e. soil is boggy, tyres cause puddling, which breaks down the soil structure and reduces the air spaces in the soil. When the soil dries out, it sets very hard, causing a reduction in water infiltration rates and limiting the gas transfer needed for cane root development. It was found that pressure exerted by conventional roll-on, roll-off haul-out trailers exceeded acceptable ground pressures by up to 100% in some situations; however, ground pressure could be reduced to half the critical level by using specially designed high-flotation equipment, including large-diameter low-pressure tyres and a weight transfer system. Apart from reducing rutting of the inter-space and the level of compaction, such a system also decreases the horsepower required to transport the cane.

Mechanical damage to shoots from stalks of seed cane. P. N. A. Berto and L. G. Mialhe. *Brasil Açuc.,* 1981, **97,** 353-358 *(Portuguese).* — The damage to shoots from plant cane stalks of CB 45-3 cane following different procedures for sett production was examined quantitatively. The procedures included: (a) manual harvesting of the stalk followed by manual chopping into setts; (b) manual harvesting followed by sett cutting with a Martins PCM-02 machine; (c) mechanical harvesting and chopping with a Santal 115 cane harvester; (d) as (c) but with a Massey Ferguson 201 harvester, and (e) as (c) but with a Toft Robot 300. In all cases, the use of a mechanical harvester caused 12-15 times as much shoot damage, as measured by sand-box germination of the setts, as procedure (a), the MF 201 harvester causing the least and the Santal machine the most harm. Use of procedure (b) caused 4-6 times as much damage as (a). Visual examination alone provided an adequate estimation of damage.

[1] Murray *et al.: I.S.J.,* 1981, **83,** 368.

CANE PESTS AND DISEASES

Report on the 2nd Meeting of high-level experts on the control of sugar cane smut and rust. Anon. *La Ind. Azuc.*, 1981, **87**, 157-164 *(Spanish)*. – An account is given of a meeting in Cuba during March 31-April 3, 1981, in which experts from nine countries of Central and South America and the Caribbean discussed the two title diseases. A brief account is given of their history, symptoms, transmission and importance. The situation in the countries represented at the meeting is reported, as well as a brief survey of other diseases occurring in the host country.

Screening for resistance to ratoon stunting disease injury. The enzyme-linked immunosorbent assay. A. G. Gillaspie and R. W. Harris. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 157 *(abstract only)*. – See *I.S.J.*, 1981, **83**, 51.

Known distribution of the imported fire and *Solenopsis invicta* Buren in Florida sugar cane fields: benefit or problem for the future. J. Prewitt, R. Brown, T. L. Carpenter, G. B. Powell and T. E. Summers. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 160 *(abstract only)*. – *S. invicta* Buren was found to have penetrated the interior of sugar cane fields during 1977. Mounds along edges of fields had been observed in 1976, but were not reported. The limits of observed infestations and the possible benefits of the fire ants as predators of the sugar cane borer and their effect as destroyers of benefical insect populations in sugar cane fields are discussed. The problems encountered by field personnel are reported.

***Field evaluation of insecticides for control of the white grub** Bothynus subtropicus* **in Florida sugar cane.** T. E. Summers, M. G. Bell, J. Prewitt, D. G. Holder and J. D. Stacy. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 162 *(abstract only)*. – Topical tests for acute toxicity to second- and third-stage larvae of *B. subtropicus* Blach. showed several insecticides, including Carbofuran, Ethoprop and Fonofos, to be effective when applied in this manner. Twenty-one common insecticides were subsequently included in field tests using one or more of the following methods of application: applied at planting time in the conventional method used for wireworm control; applied over the stubble as a drench, following harvest; metered into water being pumped into stubble plots; injected into a split opening made in the centre of the stubble row by mechanical coulter; and applied to the base of growing plants at or near the time of emerging female adults, with a thin layer of soil thrown over the material by a rolling tillivator. The last method, using light traps or attractant boards to determine the proper time of application, appears to be the most promising method of successfully using the short-lasting insecticides available in a total program, which also involves cultural and biological methods for the control of this and allied soil pests in the highly organic soil of Florida sugar cane fields.

Effects of sugar cane mosaic virus on sugar cane in south Texas. B. Villalon. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 163 *(abstract only)*. – The effects of sugar cane mosaic virus strain H on plant growth rate, height, stalk diameter and yields of plant and 1st ratoon crops of the commercial varieties N:Co 310, CP 61-37, CP 65-357 and CP 52-68 were compared in replicated field tests. Highly significant differences were found between healthy and mosaic-infected plants in all varieties with respect to plant height, stalk diameter, total weight, strip weight and factory calculated yields. Average yield reductions for all varieties was 5.74% in plant cane and 11.27% in 1st ratoon crops.

The effect of neem extracts on sugar cane webbing mite, *Schizotetranychus andropogoni Hirst.* O. P. Singh, O. Prakash and R. K. Tiwari. *Indian Sugar Crops J.*, 1980, **7**, 109-110. – The title pest has been found to cover the entire upper and lower surfaces of ratoon cane leaves, leading to chlorosis. A number of plant extracts were tested for their action against the mite, and an extract from seeds of the neem tree *(Azadirachta indica)* found to halve the pest incidence by comparison with the control.

Occurrence of sugar cane leafhopper *Pyrilla perpusilla* Walker on the mango tree, *Mangifera indica.* O. P. Dubey, R. K. Gour and S. R. Sharma. *Indian Sugar Crops J.*, 1980, **7**, 111. – Eggs of the leafhopper were found on mango trees adjacent to cane fields and were thought to have been laid when the adults migrated from the fields during post-harvest operations. A few days after hatching, the nymphs moved to nearby cane.

Screening of sugar cane clones for tolerance to the white grub. A. S. Patil, D. G. Hapase, P. R. Moholkar and B. P. Gajare. *Indian Sugar Crops J.*, 1980, **7**, 114. – The incidence of white grubs, particularly *Holotrichia serrata,* on a number of cane varieties and the plant mortality rate resulting from attack were recorded at two intervals after planting.

Resistance of a group of sugar cane varieties to *Meloidogyne incognita* Chitwood 1949. J. P. O'Relly L. and A. A. Razjivin. *Cuba Azúcar,* 1981, (Jan./March), 3-9 *(Spanish)*. – Ten varieties were tested for resistance to the title nematode. Only My 6422 was found to be resistant (10 nodules on the sample tested), while seven varieties were tolerant (11-20 nodules), one susceptible (21 nodules) and one highly susceptible (31 nodules). The nematode completed a biological cycle in all varieties, so that none could be considered immune; however, no significant differences were found between root weights or stalk lengths of the control and infested cane.

Some observations on the biology of *Epipyrops melanoleuca* Fletcher – an ectoparasite of *Pyrilla perpusilla* Wlk. in the laboratory. Y. P. Madan and R. A. Singh. *Indian Sugar Crops J.*, 1981, **8**, (2),18-19. Amongst laboratory observations on the title parasite of the leafhopper *P. perpusilla* are an average fecundity of 541 eggs per female, a hatching rate of 94.5% and a lifespan of only 26.7 hours for male adults and 32.0 hours for females. Incubation at 27-35°C (room temperature) averaged 11.3 days.

SUGAR BEET AGRONOMY

Ammonium and nitrate as sources of nitrogen for sugar beets. A. Ulrich and M. A. E. Mostafa. *J. Amer. Soc. Sugar Beet Tech.*, 1980, **20**, 553-570. – The effects of ammonium-N (applied as ammonium sulphate or nitrate) were compared with those of nitrate-N (applied as calcium or ammonium nitrate) in experiments in which beets were pot-grown for 6 weeks in a modified Hoagland nutrient solution containing nitrate as sole N source; one set of plants was harvested and the nutrient solution replaced by a N-free solution or one of the N solutions mentioned above. Plants were then harvested after 9, 12 and 15 weeks. Three weeks after treatment, those plants to which ammonium sulphate was applied were only half the size of those treated with nitrate, despite prevention of acidification of the culture solution by addition of $CaCO_3$ and despite the fact that at the time of the ammonium sulphate application the plants were large. This effect persisted in N-sufficient plants to the 12- and 15-week harvests, whereas in N-deficient beets the effect gradually diminished until, at the 15-week harvest, there was no difference in root size or quality between the various N sources. Hence, with prolonged N deficiency, ammonium and nitrate were equally efficient as N source, contrary to the prediction that the former would be more efficient than the latter. In the N-sufficient plants, nitrate (alone or combined with ammonium) gave much larger beets of higher sugar content and purity than did ammonium alone and gave a higher sugar yield than the N-deficient beets, despite a lower sugar content and purity. The early setbacks suffered by the beets treated with ammonium sulphate could be of economic importance, since any damage to the fibrous roots could induce nutrient deficiency and wilting in soils low in nutrient content and in available moisture.

Root and sucrose yields of sugar beet as affected by mid- to late-season water stress. J. N. Carter, D. J. Traveller and R. C. Rosenau. *J. Amer. Soc. Sugar Beet Tech.*, 1980, **20**, 583-596. – Experiments in Idaho, involving three irrigation water levels and two separate beet fields, showed that there was very little, if any, reduction in sugar yield as a result of stoppage of irrigation after the soil profile had been filled with water about August 1 (some 10-12 weeks before harvest), provided the soil contained at least 200 mm available water down to 150 cm. However, in the absence of rain or where the available water is less than 200 mm, a supplementary light irrigation about 1 month after the stoppage of irrigation might be of advantage. The use of such a restricted irrigation as indicated above could substantially reduce beet production costs in irrigated areas.

Recent solutions in the sector of beet mechanization. G. Baraldi. *Ind. Sacc. Ital.*, 1981, **74**, 37-43 *(Italian)*. A survey is presented of new machines and techniques employed in Italy for beet cultivation from seedbed preparation to harvesting and loading of roots.

Effect of nitrogen nutrition on enzymatic activity in the metabolism of sucrose in *Beta vulgaris* L. A. Bottacin, G. Cacco and P. Spettoli. *Ind. Sacc. Ital.*, 1981, **74**, 44-46 *(Italian)*. – The specific activities of neutral and acid invertases (NI and AI) and sucrose synthetase (SS) were determined in leaves of five sugar beet genotypes. Plants grown in a controlled environment chamber were watered with 7.5, 15 and 30 mN nitrate solution. AI showed higher values than NI and SS. ADP appeared the preferred substrate for SS from photosynthetic tissues. The middle nitrogen level gave maximum AI and NI activities but statistical analysis did not show significant differences relative to nitrate concentrations. On the contrary, the comparison between varieties demonstrated highly significant differences in the enzyme activities, which could represent physiological traits related to the different productive characteristics of the cultivars under examination.

Functional aspects of sugar beet responses to nitrogen fertilization. D. A. Analogides. *Hellenic Sugar Ind. Quarterly Bull.*, 1981, (45), 405-424. – Nitrogen trials carried out in Greece over the period 1970-79 are summarized and their statistical evaluation reported. Both root and sugar yields were accurately estimated by means of an exponential saturation-type equation fitted by transformed linear regression and a quadratic-parabolic model resulting from non-linear regression analysis. A quadratic model was also valid for calculation of sucrose content as a negative function of N dosage rate. The data examined showed that the upper limit of efficiency for N fertilization gradually fell during the 10-year period from 160 to 100 $kg.ha^{-1}$, indicating excessive fertilization eventually leading to an accumulation of residual N in the soil.

The effect of liquid manure on sugar beet quality on the basis of foreign experimental data. M. Nagy. *Cukoripar*, 1981, **34**, 41-45 *(Hungarian)*. – Trials conducted in various countries other than Hungary are discussed, and tables and graphs used to demonstrate the deleterious effect of liquid manure on beet quality and sugar content.

Difficulties in harvesting and processing beet as a result of late weed development in 1980. H. Bernardova and E. Wallova. *Listy Cukr.*, 1981, **97**, 122-128 *(Czech)*. The need for adequate chemical control of weeds where mechanization has replaced manual work is demonstrated by the difficulties experienced in 1980 in harvesting, storage and processing as a result of considerable growth of late-emerging weeds, details of which are given. New approaches to herbicide application include extended use of bandspread application at sowing and of post-emergence spraying with contact herbicides.

Beets need boron and manganese. I. M. Slotta. *Die Zuckerrübe*, 1981, **30**, 153-155 *(German)*. – B and Mn deficiency in beet is examined and application of foliar feeds discussed. It is pointed out that soil application of the two elements gives only partial success.

Weed beet – advice for June. A. Vigoureux. *Le Betteravier*, 1981, **15**, (154), 7-9 *(French)*. – Advice is given on the best means of eliminating beet bolters from the sugar beet crop in June.

CANE SUGAR MANUFACTURE

Studies on the foaming properties of raw sugar. H. T. Cheng, W. F. Lin and Y. C. Cheng. *Rpt. Taiwan Sugar Research Inst.,* 1981, (91), 41-51 *(Chinese).* — Investigations of raw sugar samples from Taiwan sugar factories showed that the extent of foaming differed between samples as a result of differences in soil and climatic conditions. In an attempt to identify the constituents responsible for foam formation, the protein contents of 361 samples of foaming and non-foaming solutions were determined and a significant correlation found between foaming degree and protein content, sugars containing less than 1000 ppm protein not foaming, while those with contents greater than 2000 ppm did foam. The presence of amylose would enhance the effect of protein and induce foaming if it was greater than 100 ppm in those sugars containing 1000-2000 ppm protein. For foam reduction, addition of proteinase or amylase to syrup is recommended.

Sucrose ester and its application for sugar manufacturing. N. Kawase. *Sugar y Azúcar,* 1981, **76,** (7), 29, 32, 34-35, 38. — A brief history of research on sucrose ester preparation is presented, with particular mention of the involvement of the author's company, Ryoto Co. Ltd., a subsidiary of Dainippon Sugar Mfg. Co. Ltd. Reference is made to the Snell and USDA process (for which Ryoto holds licences) as well as the MCI process developed by Ryoto and used for sugar ester manufacture since 1975. Types of sucrose esters, their surface-active properties and applications are described, with particular reference to their use in massecuite boiling. Laboratory experiments on molasses viscosity reduction by S-1570 hydrophilic and S-370 and S-570 lipophilic esters are reported, in which S-570 diester proved to have a remarkable effect, which reached a maximum at 60°C. Results from cane sugar factories and refineries confirmed the suitability of this ester when added to massecuite; both boiling and purging times were reduced, the purity drop increased and sugar recovery improved. Optimum dosing rates depend on local conditions.

Mill pinions and their associated problems. S. G. Clarke. *Proc. Australian Soc. Sugar Cane Tech.,* 1981, 249-254. Factors affecting the performance of mill roller pinions are discussed and suggestions made concerning their design and operation. While severe conditions experienced by pinions have led to the use of higher tensile steels in their manufacture, the author believes that the answer to the problem of pinion alignment lies in reversion to the earlier system of shrouding of the teeth and to provision of more teeth in order to ensure a smoother distribution of tooth loads. The extra teeth plus better alignment would reduce end thrust, regarded earlier as a disadvantage of shrouds. However, the changes in pinion design suggested are regarded as merely a stop-gap measure; the ultimate aim should be a better drive assembly.

Performance and operation of Inkerman's diffuser/milling train. N. W. Andersen and D. F. Smith. *Proc. Australian Soc. Sugar Cane Tech.,* 1981, 255-259. Further experience in the operation of the BMA cane diffuser-cum-mill system at Inkerman[1] is outlined, modifications to the system also being listed. Performance has proved highly sensitive to imbibition rates; at imbibition levels below 200% on fibre there is a marked increase in press water Brix and a corresponding low diffuser and overall performance. On the other hand, with correct operating procedures and with reasonably high levels of imbibition, extraction is high; the average figures for 1980, at a crushing rate of 240.85 tonnes.hr^{-1}, a fibre rate of 32.5 tonnes.hr^{-1} and imbibition of 218% on fibre, were a final pol extraction of 96.98%, a reduced final extraction of 97.23% (No. 1 mill extraction was 78.72%) and a final bagasse moisture content of 47.9%.

Performance measurements on the Inkerman mill diffuser extraction train. J. A. McGinn, T. L. Vidler, R. J. Zemek and W. N. MacCarthy. *Proc. Australian Soc. Sugar Cane Tech.,* 1981, 261-266. — Tests were conducted by the Sugar Research Institute on the Inkerman system during the 1977 and 1980 crushing seasons. From the results, relationships were established between diffuser extraction and (i) imbibition quantity, (ii) the percentage of open cells (POC) in prepared cane, and (iii) diffuser residence time. At higher POC values in prepared cane, imbibition quantity appeared to have the greatest effect on extraction. At a POC of 89 and imbibition levels of approx. 300% on fibre, extractions in the region of 98.3% are obtainable, while crushing rates of up to 300 tch (higher than design capacity) have been achieved. The steam consumption of the diffuser was found to be quite high, and the low-pressure steam consumption of a factory can increase by 3-7% as a result of diffusion, depending on diffuser operating conditions.

New results on the exhaustion of filter cake and its rational utilization. H. G. Ayala, J. M. Martínez C. and E. Salazar. *La Ind. Azuc.,* 1981, **87,** 150-156 *(Spanish).* Two alternative proposals have been studied. By subjecting filter cake to hydraulic pressure increasing incrementally to 50 $kg.cm^{-2}$, it was possible to recover 38.45% of juice on cake; 33.0% was recoverable up to 20 $kg.cm^{-2}$. The pressed cake is furthermore in a suitable form for pelleting for inclusion in animal fodder. The second proposal eliminates filtration; the clarifier mud is sent instead to a two-stage centrifuge installation with intermediate washing. The pol recovery is 96.566% of that in clarifier mud, against 81.021% for filtration alone and 88.127% for filtration plus pressing to 50 $kg.cm^{-2}$. The mud discharged from the centrifuge may be mixed with bagacillo and sent to the boilers.

The Tilby cane separation system. T. A. Anderson. *Proc. Amer. Soc. Sugar Cane Tech.,* 1978, 100-103. — Experience with a cane separation unit of the type designed by Tilby[2,3] is reported, and its advantages and future plans for its further development and application are outlined. The unit, installed at Pahokee in Florida in 1978, processed up to 15 tons of cane per hour; the suitability of the system in regard to by-products utilization is discussed.

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[1] Kelly & Porter: *I.S.J.,* 1979, **81,** 311.
[2] *ibid.,* 1972, **74,** 123.
[3] *ibid.,* 1981, **83,** 296-300.

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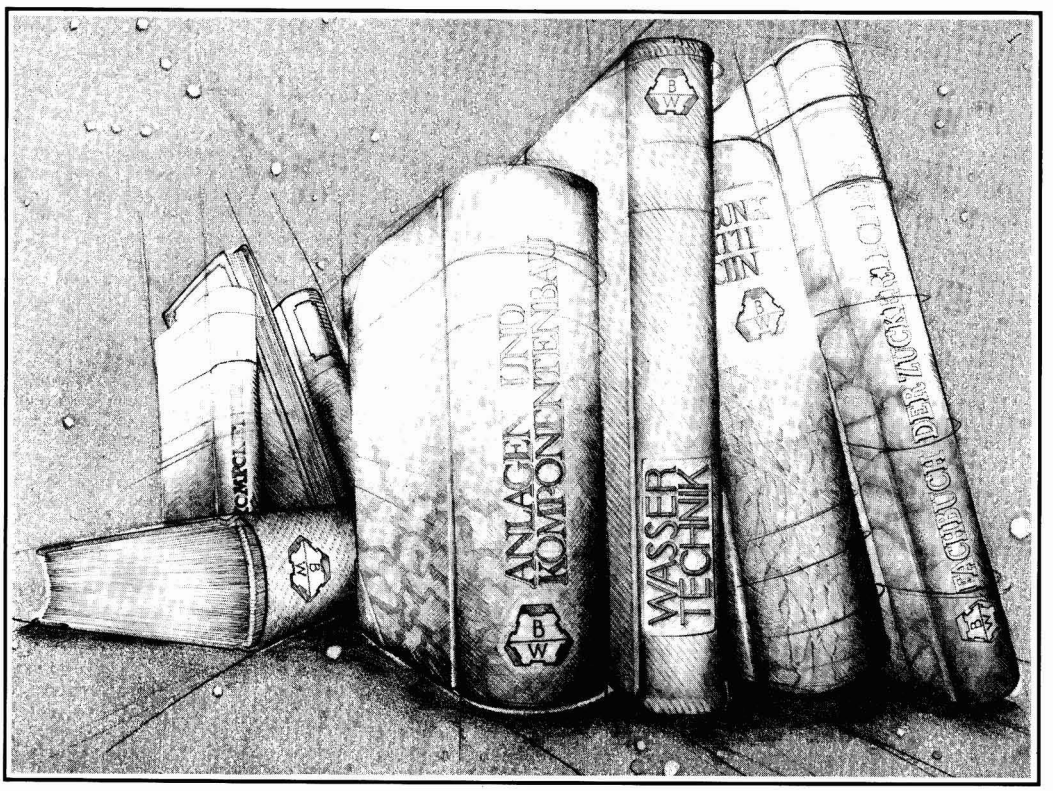

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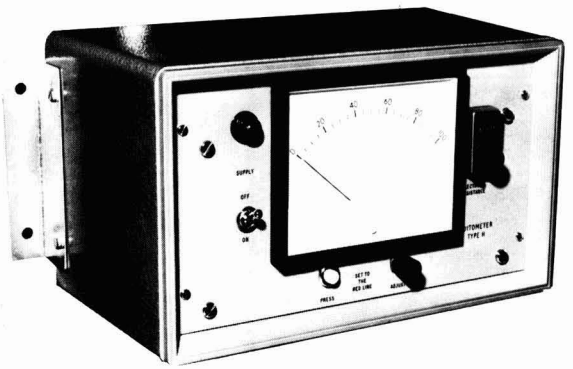

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Criteria for evaluating milling quality of potential varieties in Louisiana. B. L. Legendre. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 104-106. — Complete mill tests conducted on cane of 88 varieties in the CP series during 1973-78, with CP 52-68 or CP 65-357 used as standards in assigning varietal correction factors (VCF) to promising new varieties, showed a significant trend in recent years toward selection of varieties of higher fibre content and giving lower normal juice extraction and hence lower sugar yields. It was also found that VCF alone is not suitable as the sole criterion of milling quality of a given variety because of the potential abnormal behaviour of the standard variety, but it is valid for calculating the potential yield of recoverable sugar per ton of cane, while fibre content and normal juice extraction % cane are more suitable as milling quality criteria.

The use of dextranase in processing sour cane. J. A. Polack and H. S. Birkett. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 127-133. — Preliminary experiments on the possible use of dextranase to combat the adverse effect of dextran on cane juice processing are reported; the juice was obtained from stale cane (19 days old), and comparison made with processing of juice from "fresh" cane (actually 5 days old). Other tests were conducted on juice from frost-damaged cane. Addition of 100-200 g dextranase per 1000 litres of 36° Bx syrup and holding for 1-8 hours at 130-140°F allowed the syrup to be boiled, although at an apparently lower crystal growth rate, whereas no boiling was possible without treatment. Addition of 200 ppm dextranase to 36° Bx syrup, heated to 131°F, from frost-damaged cane and holding for 1½ hours also allowed crystal growth, but again at a lower rate, whereas no crystallization was possible without treatment.

Dynamics of pH control in the sugar house. F. Z. Llorens. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 134-138. Investigations conducted at Bryant Sugar House in 1977-78 are reported in which the effects of a number of variables on automatic control of pH during clarification were determined. Characteristics of the control loop studied were: the process load changes, i.e. changes and disturbances from external sources such as changes in the flow rate of incoming juice and in the quality of milk-of-lime; the reaction rate, i.e. the dynamics of the chemical reactions between the juice and milk-of-lime; time lags; and dead time (to be distinguished from time lags in that it consists of an actual physical delay rather than a retardation of the control means). The effectiveness of a control system is determined by the interaction of the above-mentioned factors. The control system is described with the aid of a diagram, and results (and conditions for which it is not suitable) are indicated.

A comparison of raw sugar boiling schemes. H. S. Birkett. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 139-147. The material and steam balances of a two-massecuite, a three-massecuite and a double-einwurf boiling scheme are calculated and the results used to compare pan requirements, centrifugal station requirements, vapour requirements, condenser water requirements, purity controllability and ease of graining for the three systems.

Economic study of bagasse dehydration. C. F. Miller. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 148-155. The various parameters involved in bagasse drying with the aim of increasing its fuel value and their interrelationships are discussed. From the analysis of the economics of use of a rotary dryer utilizing boiler flue gas, it is concluded that, depending on the amount of bagasse available and the local cost of fuel, power and labour, a bagasse dryer may be a justifiable investment for flue gases hotter than 400°F, and that the greatest return on investment is obtained by drying less bagasse to lower moisture contents, e.g. it is more economical to burn a blended mix of bagasse of 20% moisture and bagasse of 50% moisture content rather than burn bagasse all of which is dried to an intermediate moisture content between 20% and 50%. The higher the flue gas temperature, the greater is the return on investment, suggesting that a bypass duct around existing air preheaters to increase the temperature of the flue gas fed to the dryer may produce a greater fuel efficiency than the preheater.

The presence of ammonia and copper in condensates and boiler feedwater in Florida sugar mills. P. R. Arellano and J. S. Rauh. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 164 *(abstract only)*. — Determination of ammonia and copper were made on samples collected at several Florida sugar mills during the 1977-78 crop. High levels of incondensable gases and ammonia in evaporators, juice heaters and vacuum pans reduced their heat transfer efficiencies, caused corrosion of the copper tubing, and contaminated condensates and boiler feedwater with copper. The authors suggest increasing venting of the process equipment to reduce concentrations of incondensable gases and ammonia and maximize heat transfer efficiency. Lower ammonia levels will reduce corrosion of copper tubing. With less pitting of the tube surfaces, the tendency for deposits to adhere to the tubes is reduced, and this may retard the rate of heat transfer loss in such equipment. In addition, the resulting lower levels of copper in condensate used for boiler feedwater will reduce potential problems associated with copper in boiler water.

Design of long-tube juice heaters. J. Prieto. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 165 *(abstract only)*. When expanding the capacity of a sugar factory, space considerations have to be taken into account, and it has been found that, by using long tubes, juice heaters can be made to take up approximately the same floor area and still achieve the necessary increasing in heating surface. Other considerations taken in the design of these heaters are: pressure drop on the tube side; tube length; mechanical specification; and the periodical cleaning to remove scale. The results of the operation of seven units in two different factories have been good.

Study of the simulation of a raw sugar pan under automatic control. O. Mayo A., I. Cardoso C. and C. Alvarez P. *Cuba Azúcar*, 1981, (Jan./March), 43-55 *(Spanish)*. The authors present a mathematical model and a simulation of a raw sugar pan under real automatic control. A review is made of existing mathematical models which are taken as a basis for the proposed model. The only analysis made is that of the control loop by productivity of the feed flow to the pan, according to the control system applied at Central Espartaco. The system of differential equations constituting the model is integrated and solved by means of a program designed for an IRIS 10 computer. The results are within the range of values encountered in practice and may therefore be used for the analysis of different alternatives.

BEET SUGAR MANUFACTURE

The use of magnesium compounds in the sugar industry. J. Studnicky and A. Dandar. *Listy Cukr.*, 1981, **97**, 186-188 *(Czech).* — Laboratory tests were conducted on diffusion of stale beet using, as additives to the water, $Mg(OH)_2,4MgCO_3,5H_2O$, chemically pure MgO and $Mg(HSO_3)_2$, in an amount equivalent to 0.08% MgO on cossettes (w/w). The water was acidified with H_3PO_4 or H_2SO_3 to bring the pH to 5.8-6.2. The juice was then purified with MgO plus milk-of-lime without gassing. Results showed that thin and thick juice purities were higher than with conventional diffusion and purification, and their colour contents lower.

The heat economy of Goslawice sugar factory. E. Krupka and J. Szadkowski. *Gaz. Cukr.*, 1981, **89**, 2-5 *(Polish).* Information is given on the heat economy at Goslawice, where marked improvements in recent years have been brought about by installing a quintuple-effect evaporator of 4200 m^2 total heating surface. Details are given of the systems used to heat raw juice, cold-limed juice, 2nd carbonatation juice and thin juice as well as the vacuum pans. 1st stage raw juice heating is effected in a tubular heat exchanger using vapour from No.1 pan at 76°C. The condensate is expanded and used for 2nd stage raw juice heating, and the condensate from this is cooled and suitably acidified for use in diffusion. Fuel consumption at the factory has been reduced to 5.1% on beet and evaporator steam consumption to 33% on beet.

Hydraulic conveying of flume and carbonatation muds. W. Stefanski, W. Tichonczuk and B. Utrysko. *Gaz. Cukr.*, 1981, **89**, 5-9 *(Polish).* — The mass concentration of flume and carbonatation muds was determined at a number of factories as well as their granulometric and flow characteristics. Resistance to pipeline flow of the individual types of mud and of their mixtures was investigated at varying densities, and a mathematical method developed for its calculation on the basis of viscosity measurements.

Coordination of mass flow. S. Chmielewski, A. Rozycki and W. Matuszczak. *Gaz. Cukr.*, 1981, **89**, 9-11 *(Polish).* For automatic control of juice flow between individual process stations from diffuser to evaporator, a scheme was devised and tested during two campaigns at Dobre sugar factory. It is based on the use of buffer tanks and a system which, in simple terms, can be expressed as tank-control valve-station-tank; it utilizes, as the prime signal, the level of juice in the buffer tank after the evaporator. The scheme has worked satisfactorily and brought a number of benefits which are listed.

Storage of sugar beet with the help of forced ventilation. L. Bozhkov, D. Babev, N. Lambrev *et al. Khranit. Prom.*, 1978, (4), 11-14; through *S.I.A.*, 1981, **43**, Abs. 81-1017. — Comparative tests on beet storage with and without forced ventilation, performed in Bulgaria in 1976 and 1977, are reported. The economic effects of different ventilation arrangements are estimated, and a reliable ventilation control system based on Bulgarian components is outlined. It is recommended that the ventilation be provided by axial fans and subterranean semi-cylindrical movable air ducts. Ventilation decreased daily average sugar losses from 0.03-0.07% to 0.019-0.03%, total loss of beet weight from 4.4-7% to 1.4-2.7%, cell juice purity loss from 3.4-6.8 to 1.52-1.75 and the final reducing sugars content from 0.61-3.11% to 0.36-1.58%.

Economical utilization of energy resources. E. V. Mlodzyanovskii, V. S. Berezyuk and K. N. Savchuk. *Sakhar. Prom.*, 1981, (7), 22-27 *(Russian).* — Details are given of measures introduced at Turbov sugar factory whereby fuel consumption was reduced from 176 to 175 kg per tonne of processed beet. Principal modifications described involved the temperature gradient in the quintuple-effect evaporator, the use of condensate heat, lime kiln operation and CO_2 treatment for carbonatation.

Experience in operation of the North Caucasian sugar industry production group in regard to fuel economy. G. S. Stepanov. *Sakhar. Prom.*, 1981, (7), 27-29 *(Russian).* — The reduction in fuel consumption achieved by North Caucasian sugar factories since 1965 and means by which it has been brought about are discussed.

Our experience in saving materials and fuel-energy resources. S. I. Rud'. *Sakhar. Prom.*, 1981, (7), 30-32 *(Russian).* — Equipment and process modifications at Yares'kovskii sugar factory that have contributed to economies in materials and fuel are briefly surveyed.

A combined method of decolorizing sugar factory products. I. F. Bugaenko, T. N. Samoilova and V. V. Chopik. *Sakhar. Prom.*, 1981, (7), 32-33 *(Russian).* The method described is based on addition of a water-soluble anion exchange resin to the product, followed by addition of a phosphate to precipitate the resultant finely dispersed mud. Experiments conducted on thick juice and low-grade sugar remelt are reported; with the remelt, of 57°Bx and 52.7°St/100°Bx, best results (a colour reduction to 12.35°St/100°Bx) were obtained by adding 0.02% resin as a 1% solution followed, 3 minutes later, by addition of 0.001% (on Brix) of a $Ca_3(PO_4)_2$ suspension.

Recycling carbonatation mud to preliming. K. P. Zakharov, V. Z. Semenenko, R. G. Zhizhina and N. I. Zharinov. *Sakhar. Prom.*, 1981, (7), 34-36 *(Russian).* — Investigations showed that recycling carbonatation mud to preliming improved on the results (for carbonatation juice and thick juice) given by optimum milk-of-lime dosage and progressive treatment (followed by fractional cold and hot liming) when 20-25% of the total mud was returned (30-50% when substandard beet juice was being processed) and the total lime usage in purification was adequate. However, no benefit, particularly in terms of colour reduction, was derived when the lime consumption was too low (e.g. below 80% on raw juice non-sugars), and mud recycling could even have an adverse effect. Better results were given by 2nd carbonatation mud than by 1st carbonatation mud. The significance of mud particle electrical charge is discussed.

SUGAR REFINING

Practical aspects of changing from char to resin at Huletts. M. Cox. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 212-221. — The results of replacing the bone char station at Durban refinery with a decolorizing resin plant are discussed. Reasons for the change are indicated and various aspects of resin treatment and its effect on boiling are examined. The major problem remains effluent disposal. Various investigations are mentioned, including the evaluation of new resins, cleaning of fouled resin (for which sodium hypochlorite wash has proved highly effective in preliminary tests) and use of exhausted resin as a pre-treatment (found to be very promising). Performance data for five seasons from 1975 to 1980 show that use of resin has permitted maintenance of sugar quality in terms of colour, ash and reducing sugars while allowing a reduction in costs.

Sugar losses in refinery processes. B. C. Goodacre, K. J. Parker and R. H. Tilbury. *Sucr. Belge,* 1981, **100,** 95-103. — See *I.S.J.,* 1981, **83,** 57.

Mathematical models for a sugar refinery. P. García G. and V. González R. *Centro Azúcar,* 1980, **7,** (3), 109-117 *(Spanish).* — Application of a system of mathematical modelling with matrices to the first part of refinery processing (affination and separation of affined sugar) showed that calculated in- and out-flow quantities of materials were almost exactly the same as the actual values; the system is thus concluded to be applicable to the whole of the refining process.

A new plant for cube sugar processing. Anon. *Zuckerind.,* 1981, **106,** 434-436 *(German).* — A brief description, with photographs, is given of the new Chambon EMR-12 cube sugar press and packaging plant.

Packeting techniques and the packets and packeting material used in the sugar industry. M. Netolicky. *Listy Cukr.,* 1981, **97,** 115-119 *(Czech).* — A survey is presented of the various types of refined sugar produced in Czechoslovakia, with details of packeting equipment available, packet sizes and equipment capacities.

The performance of a fluidized bed refined sugar dryer. J. R. Fitzgerald, K. Taylor and G. W. Bestwick. *S. African Sugar J.,* 1981, **65,** 188-189, 191-192. — See *I.S.J.,* 1982, **84,** 84.

Monitoring and control of two remelt liquor evaporators with a Fox 3 process computer. M. Braeckman. *Zuckerind.,* 1981, **106,** 586-591 *(German).* — Details are given of the automatic control of two falling-film evaporators each of 50 $m^3.hr^{-1}$ used to concentrate remelt liquor at Tirlemont. Before evaporation the liquor is diluted to 68°Bx for decolorization purposes, but then has to be concentrated to 74°Bx in order that the throughput of the pan station can be maintained at a level which is 20% greater than previously. Reasons for the choice of the evaporators and the Foxboro computer system are given, and the training of staff to handle the system, the results obtained and the economics of the scheme are discussed. Brix of the liquor on discharge from the evaporators is kept constant at $< \pm$ 1%. By comparison with a steam consumption which would be at least 10.844 tonnes.hr^{-1} if the liquor were not pre-concentrated but fed directly to the pans at 68°Bx, the steam consumption in the two evaporators and used to heat the concentrated liquor from 70 to 76°C was 6.38 tonnes.hr^{-1}.

Economic considerations for conversion to coal burning. O. Brannen. *Proc. 39th Meeting Sugar Ind. Technol.,* 1980, 125-140. — A study was made of the economics of conversion of three boilers from natural gas and oil to coal firing. The various factors considered are discussed, and indicate that such a conversion would be economically unwise at the prevalent relative fuel costs, but that the decision would have to be continually reviewed with every price change in oil and gas.

The effect of high dextran content raw sugars on refinery performance. K. R. Hanson. *Proc. 39th Meeting Sugar Ind. Technol.,* 1980, 152-159. — The effects of dextran in raw sugar on operations at refineries of Amstar Corporation over a two-year period are reported, including the increase in remelt syrup viscosity, liquor turbidity and molasses losses, crystal elongation and possibly difficulties in filtration and fouling of heaters, evaporators, etc. Analysis of raw sugars has revealed a dextran content ranging from 20 ppm to 2150 ppm, with sugars from 19 countries containing less than 200 ppm and those from seven countries more than 700 ppm. Mention is made of the distortion of pol measurements caused by dextran, whereby the pol is raised by at least 0.10° for every 333 ppm dextran.

Entrainment separators for vacuum pans and evaporators. D. M. Humm. *Proc. 39th Meeting Sugar Ind. Technol.,* 1980, 190-215. — A review is presented of entrainment separator design and operating characteristics as part of an evaluation program carried out at Crockett refinery. The three chief factors governing these are collection efficiency, re-entrainment and pressure drop. Efficiency depends on the geometry of the separator and drop size distribution — the latter factor is very important, since all separators have a lower limit in drop diameter below which collection efficiency falls very rapidly. Re-entrainment occurs when the gas velocity becomes high enough to cause the collected liquid to be picked up again and swept out of the separator, so that re-entrainment velocities determine the maximum allowable gas velocity for the separator. Brief descriptions are given of the collection mechanisms commonly used, viz. inertial impaction, centrifugation and sedimentation, and of the three main types of separator — centrifugal separators and impingement types with zigzag baffles or with mesh pads. Results are given of tests on units of the two impingement types, performance of which was determined by means of a Technicon Auto Analyzer. The type with zigzag baffles was installed in pans and an evaporator, while the other type was installed only in a pan. When used within their design limitations, both separators proved highly efficient in limiting the sugar content of condenser discharge to 5 ppm or less (in most cases 2 ppm or less). The mesh pad was subject to fouling and so required frequent washing. The costs of the separators are indicated.

LABORATORY STUDIES

Colour studies in milling. P. Smith, N. H. Paton, H. R. Delaney and R. Ames. *Proc. Australian Soc. Sugar Cane Tech.*, 1981, 71-80. — An outline is given of the composition and properties of cane sugar colorants and colour precursors, and analytical techniques applied to identification of individual colorants and groups of colorants are briefly described. Comparison was made between the colour content (at pH 7) of products at two CSR factories, ranging from first expressed juice to sugar and molasses. Results showed that colour increased in the juices along the milling train as a function of the degree of extraction and consisted primarily of monomeric colorants, so that the higher the extraction efficiency the greater was the juice colour. However, the mixed juice and liquor colours at the two mills were very similar, but one factory (B) produced shipment sugar of 14% higher colour than did the other factory, the greatest difference between product colours being a 47% higher magma colour at factory (B). While measurement of absorbance indicated an apparent removal of high M.W. colorants during clarification, in fact there seems likely to have been some removal of colorants of lower M.W. and formation of more by hydrolysis of high M.W. colorants. During boiling and crystallization polymeric colorants had a greater tendency to be included in the raw sugar crystal, while most of the colour formation in low-grade massecuite occurred in the crystallizer.

Investigation of changes occurring in sugar beet during storage. VII. Investigation of sugar beet respiration losses. K. Hangyal, K. Vukov and C. Balla. *Cukoripar*, 1981, **34**, 52-57 *(Hungarian)*. — Three possible methods of determining sugar losses resulting from respiration of stored beet are based on measurement of oxygen consumption, on the amount of CO_2 released and on the quantity of heat given out during respiration. The last was used to determine losses during storage under favourable conditions. Results obtained agreed well with polarimeter readings.

Topography of the chemical composition of the sugar beet root. V. Investigation of changes in the topochemistry of stored beet under the effect of forced ventilation and Orthofaltan. J. Zahradnicek *et al. Listy Cukr.*, 1981, **97**, 128-134 *(Czech)*. — Changes in the distribution and content of sugar, amino-N, conductimetric ash, reducing matter, Na, K and Ca in beet stored with and without forced ventilation and (in the case of the ventilated beet) with Orthofaltan treatment, were determined in 1979-80. The control beets (without forced ventilation) were stored for 55 days, those with forced ventilation for 62 days and the other group for 50 days. The greatest changes occurred in sugar, followed by invert sugar and amino-N, while the total ash and ash constituents underwent only slight change. The use of Orthofaltan had a particular effect on the invert sugar content, which increased (particularly in the epicotyl) much more in the controls than in the other two groups of beet. Significant differences in composition were found both before and after storage as a result of root elongation and spread of girth.

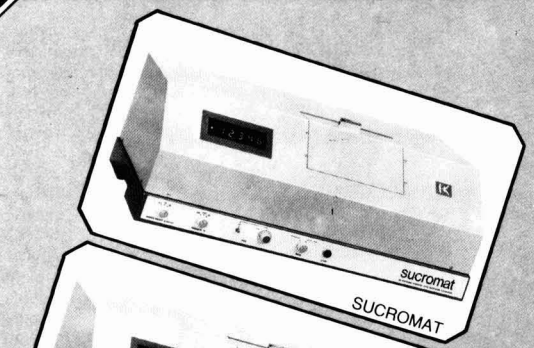
Relationship between certain white sugar physico-mechanical properties and moisture content. V. V. Kornaraki and L. Zh. El'-Diyab. *Sakhar. Prom.*, 1981, (6), 35-37 *(Russian)*. — Investigations of the effect of moisture content in the range 0-4% on white sugar coefficients of friction and the angle of repose are reported. Results showed that for a given granulometry, the relationships were not linear; the coefficients of friction initially fell and were then almost constant from 2% moisture, while the angle of repose initially increased and was then almost constant from 2% moisture.

Comparative study between spectrometers for the determination of colour in demerara, special crystal and granulated refined sugars. J. A. Weber. *Brasil Açuc.*, 1981, **97**, 221-225 *(Portuguese)*. — Comparative studies showed that a Brazilian spectrometer from Micronal, São Paulo, gave equivalent performance to the Varian 635 and Bausch & Lomb Spectronic 88 instruments and was in some respects superior.

Simultaneous determination of fructose, glucose and sucrose by the anthrone reaction. I. Abidin and H. G. Maier. *Chem. Mikrobiol. Technol. Lebensm.*, 1980, **6**, (4), 121-123; through *Anal. Abs.*, 1981, **41**, Abs. 2F19. — The sum of these sugars is determined by colorimetry with use of a reagent containing 0.325 g of anthrone in 100 ml of 72% H_2SO_4 or 0.2 g of anthrone in 100 ml of conc. H_2SO_4; measurements are made at 620 or 605 nm, respectively. In the presence of carboxylic acids, results with the latter reagent were 3 to 8% higher than for the sugars alone. With the former reagent, the absorption maximum after heating for 2 min was at 620 nm for fructose and at 590 nm for glucose; with time, the maximum for fructose shifted towards 590 nm and the absorbance of sucrose increased. The standard deviation with the second reagent was 0.5 $\mu g.ml^{-1}$.

Effect of ammonium salts on the physico-chemical properties of saturated sugar solutions. A. I. Gnezdilova, G. P. Remizov and V. M. Perelygin. *Izv. Vuzov, Pishch. Tekh.*, 1981, (3), 25-27 *(Russian)*. — The solubility of sucrose in aqueous solutions of ammonium chloride, ammonium thiocyanate and ammonium nitrate was determined at 40°C as well as viscosity and density of the resultant saturated sugar solutions. The results showed that increase in the molar concentration of the first two salts named above was accompanied by a fall in solubility and in viscosity, whereas cyanate generally had the reverse effect. The effect on density of increasing salt concentrations was less pronounced. The possible application of the viscosity-reducing action of the chloride and nitrate to factory technology is mentioned.

Dielectric phenomena in molasses. A. L. Lipin, E. S. Mints, P. M. Sargaev and N. V. Sedykh. *Izv. Vuzov, Pishch. Tekh.*, 1981, (3), 28-30 *(Russian)*. — With a view to automatic control of molasses biological treatment based on its dielectric properties, the dispersion of two dielectric parameters was determined as a basis for explaining the mechanisms of dielectric polarization and relaxation and their relationship with molasses composition. The two parameters in question were permittivity and the



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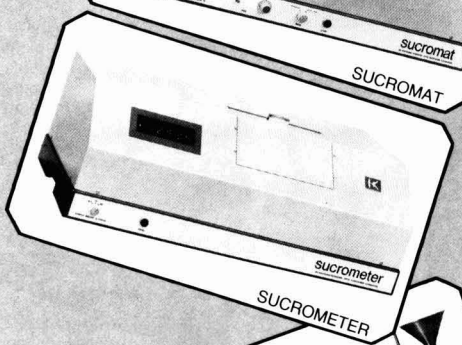

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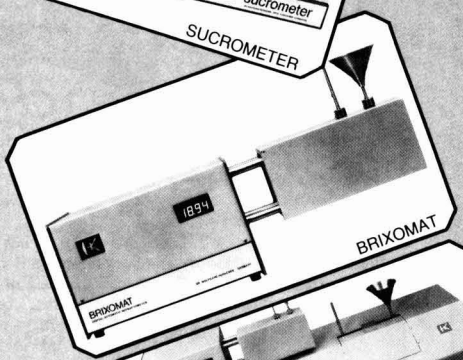

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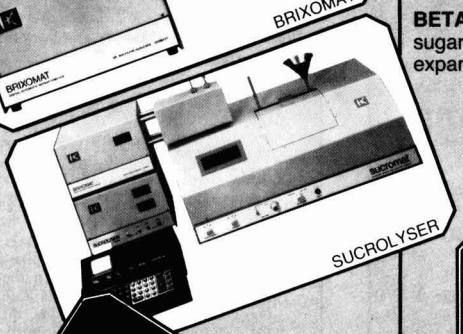
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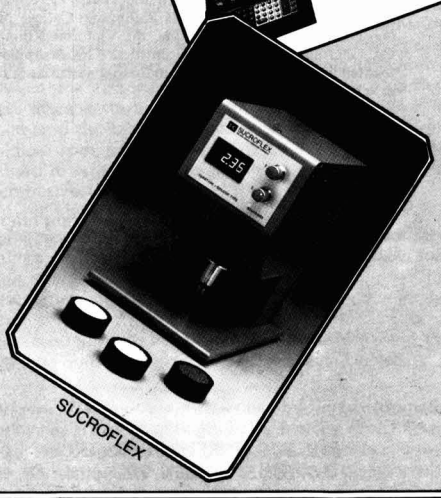

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dielectric loss angle, and measurements were made in the frequency range 0.5-100 MHz at 32°C. The results indicated that molasses is a strong polar dielectric and that colloids, micro-organisms, amino-acids and trace elements in it make the greatest contribution to the dielectric properties.

Analysis of mixtures of glucose, fructose and mannose by HPLC. H. van Olst and G. E. H. Joosten. *J. Liquid Chrom.*, 1979, **2**, (1), 111-115; through *S.I.A.*, 1981, **43**, Abs. 81-1097. — A high-performance liquid chromatographic method for the analysis of glucose-fructose-mannose mixtures, which are formed in the alkali-catalysed production of high-fructose syrup from glucose, was developed. The stationary phase was an unmodified silica, Lichrosorb SI 60, and the mobile phase was acetonitrile containing 0.1% water by weight. Separation was complete in 25 min.

Sucrose destruction: inversion loss determined by high-pressure liquid chromatography. M. A. Clarke and M. A. Brannan. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 107-120. — See *I.S.J. Supplement*, 1978, 7; *I.S.J.*, 1980, **82**, 255.

Deterioration of sugar cane: levels of dextran and total polysaccharides in process streams at two Louisiana sugar factories. E. E. Coll, E. J. Roberts and M. A. Clarke. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 121-126. Tests conducted during 1977 used a modified alcohol haze method to determine dextran and an enzyme-dialysis technique to determine total polysaccharides in mixed juice, syrup, *B*-molasses, final molasses and raw sugar. The methods used are described. Harvesting conditions were unusually wet throughout the season, although the first samples from each mill were obtained under dry field conditions. No frost-damaged cane was processed. Large increases in dextran between the mixed juice and syrup stages were found, although the increases could have been the result of dextran formation during clarification or of changes in molecular structure that affect alcohol haze development during analysis. A reduction in the dextran content was obtained during clarification of one series of slightly sour mixed juice samples of relatively high dextran content. Total polysaccharide during clarification was very good except for periods of high soil content in mixed juice; soil also interfered with determinations of the polysaccharide content in mixed juice samples. The polysaccharide content in syrups was closely related to field conditions. There was a marked difference in sample uniformity between the factories — probably the result of differences in cane storage and washing operations. Work in progress to determine dextran and total polysaccharides in juice from four Louisiana commercial varieties will be used to establish a base for minimum values expected from fresh cane.

High-pressure liquid chromatography (HPLC) and the analysis of sugars. L. E. Vidaurreta. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 163 *(abstract only)*. — This presentation covers the research done to date in the practical analysis of fructose, glucose and sucrose in sugar cane juice at the Chemistry Department and the Audubon Sugar Institute at Louisiana State University.

Analysis of sugar cane saccharides by liquid chromatography. J. Wong-Chong and F. A. Martin. *Proc. Amer. Soc. Sugar Cane Tech.*, 1978, 163 *(abstract only)*. The application of high-pressure liquid chromatography in the fractionation of sugar cane saccharides using cation exchange resins is described. Resolution of sucrose, glucose and fructose in cane juice samples can be completed in less than eight minutes, and the products of juice deterioration can also be detected with this procedure. Elution is carried out with water as the only solvent, and detection of the sugars with a differerential refractometer gives good reproducibility of the results. Muddy samples need only be clarified by centrifugation and deionized in a very simple procedure before injection into the liquid chromatography equipment. Samples containing as much as 15% mud have been successfully analysed by this procedure without adverse effects on the column packing material.

The determination of ash in bagasse. J. C. P. Chen. *Proc. Amer. Soc. Cane Tech.*, 1978, 165 *(abstract only)*. The determination of ash in bagasse constitutes a problem similar to that of the determination of pol or fibre in the cane. The main difficulty is not in the method of analysis but rather in the collection of sample and the proper way of sub-sampling so that the results of analysis can be reproduced. After a series of comparisons in parallel between two independent laboratories, using exactly the same procedure, and carried out by two conscientious chemists, a method has finally been developed with excellent reproducibility. The difference between two laboratories can be consistently within ± 0.5%.

Molasses exhaustibility studies based on sugars analysis by gas-liquid chromatography. P. W. Rein and I. A. Smith. *Proc. 55th Ann. Congr. S. African Sugar Tech. Assoc.*, 1981, 85-91. — Exhaustibility tests were carried out by concentrating molasses from a number of factories to 4000 poises (determined at 40°C), adding refined sugar, crystallizing at 40°C for 48 hr and analysing the separated molasses for sucrose and reducing sugars by GLC as well as by the Lane & Eynon method. Regression analysis of the results showed that purity of the exhausted molasses was strongly dependent on the non-sucrose:water and reducing sugars:ash ratios. Small but, in some cases, consistent differences in exhaustibility between factories may have been partly due to differences in the proportions of organic non-sugar components. A reference formula for purity has been derived and is intended for use with GLC sugars analyses; it takes the form: $GCP = 33.9 - 13.4 \log (F + G)/A$, where GCP = sucrose/dry solids purity, F = fructose % molasses, G = glucose % molasses and A = sulphated ash % molasses. Purity values calculated with the formula were substantially lower than those obtained with the target purity formula currently used in South Africa; this was attributed to a higher target viscosity, i.e. the viscosity to which the molasses was concentrated, than recommended by the SMRI, and significant overestimation of sugars by the Lane & Eynon method.

White sugar granulometry. Calculation of the weight % passing through a screen of given mesh size. G. Rens. *Sucr. Belge*, 1981, **100**, 243-246 *(French)*. — A method of calculating the weight % of a white sugar sample that has passed through a screen of given mesh size involves rather complex equations, which can be solved, however, by means of a computer. As an alternative, a graphical method based on the M.A. and C.V. can be used. Both methods are explained, and comparison is made between calculated and experimental results.

BY-PRODUCTS

Conditions for removal of volatile organic acids from molasses during heat treatment. V. N. Shvets and A. N. Ogorodnikova. *Izv. Vuzov, Pishch. Tekh.,* 1981, (3), 71-74 *(Russian).* — Since volatile organic acids in molasses have a negative effect on yeast growth and alcoholic fermentation, methods have been sought for their remval; one technique is heat treatment to suppress the action of contaminating micro-organisms and vaporize the volatile acids. The experiments reported in the present article were aimed at determining optimum conditions for heat treatment, and these were found to be a Brix of 50°, pH 6 and a boiling time, at 102-107°C, of 30-60 minutes. Under these conditions, alcohol yield rose independently of the yeast strain used. For most molasses these conditions are suitable for a volatile acid content greater than 1.45% by volume.

Fuels from sugar crops: status and prospects. E. S. Lipinsky. *Proc. Amer. Soc. Sugar Cane Tech.,* 1978, 158 *(abstract only).* — The development of liquid transportation fuels from sugar crop biomass at costs that are attractive in the marketplace is a formidable task. An integrated Department of Energy program which started in 1975 is making progress in reducing raw material costs through narrow-row spacing of sugar cane and sweet sorghum, the use of a Tilby cane separator, new methods of cellulose hydrolysis and improvements in fermentation processes. This paper presents a survey of new agricultural and processing technologies that relate to liquid fuel production. Potential impacts on sugar crop growers, processors and fuel consumers are discussed.

Methods of alcohol production available to the cane sugar refiner. M. C. Bennett. *Proc. 39th Meeting Sugar Ind. Technol.,* 1980, 141-151. — Technical and economic aspects of fermentation and distillation techniques for alcohol production from refinery products (liquors, syrups, sweetwater and molasses) are discussed. While yeast recycle has the advantage of reducing the high costs of repeated propagation of fermentable substrate as well as cutting the fermentation time in batch processes, in continuous processes the amount of yeast that needs to be recycled in order to give a low residence time is so great that the advantage is more than offset by increased investment needed for the centrifuges used to separate the yeast and the power consumed in their operation. Mention is made of a Tate & Lyle continuous process that does not use centrifuges but does require a clarified feedstock to remove impurity particles, similar in size to yeast, that would otherwise accumulate during prolonged periods of operation. While most developments in distillation have been with a view to product quality, research is continuing on alternatives to the distillation method of alcohol separation from water, although such systems as liquid/liquid extraction, adsorption or absorption, reverse osmosis and ultrafiltration do have problems, such as solids suspension in the fermented wash which would adversely affect extraction solvents, adsorbents and membranes, while possibly being uneconomical and not achieving high alcohol concentrations without use of a final distillation stage. Research on improvements in fermentation include the use of immobilized yeast or replacement of yeast with another organism such as *Zymomonas mobilis,* which, however, metabolizes only glucose (although giving alcohol yields as high as 97% of theoretical). Examination of the costs of using refinery feedstocks shows that these would preclude raw sugar and affination syrup; molasses could be used under certain favourable circumstances, but no account is taken of gasoline blending costs nor of the profit requirement.

Disposal of molasses distillery waste with recovery of energy. A. Martini and G. Iaquaniello. *Ind. Sacc. Ital.,* 1981, **74,** 65-71 *(Italian).* — Energy, practical and economic aspects of vinasse disposal by concentration and use as a boiler fuel are discussed; it is concluded that the method is both useful and profitable.

The effect of additional admixing of waste gas to combustion air in pulp drying on energy consumption. H. Huber. *Zuckerind.,* 1981, **106,** 683-687 *(German).* While admixed flue gas must always have a higher temperature than the combustion air if energy savings are to be obtained (hence there must be a temperature gradient), other factors also affect energy savings, including the oxygen content of the flue gas component in the air-gas mixture (which varies in proportion to the air factor). Equations are developed for calculation of the amount of flue gas to add as a function of oxygen content, temperature gradient and air factor. Values are tabulated for flue gas oxygen contents in the range 0-12% by volume and oxygen contents in the air-gas mixture of 14,15 and 16%. The potential energy saving is also calculated.

Fermentative utilization of mixed juice and clarified juice. I. Determination of fermentation efficiency of ethanol production. J. D. Layoso. *Crystallizer,* 1981, **4,** (1), 12, 15. — The advantages and disadvantages of mixed juice and clarified juice as fermentation substrates are listed, and experiments briefly reported in which fermentation efficiency of clarified juice was much greater (90%) than that of mixed juice (61.4%). The relative costs of ethanol production are discussed on this basis and indicate the benefit of clarifying juice before fermentation.

Preliminary analysis of the possibility of utilizing vinasse as an energy source. C. A. B. Dias. *Brasil Açuc.,* 1981, **97,** 365-373 *(Portuguese).* — A study is described on the possibility of using vinasse as an energy source by anaerobic fermentation, separation of methane and CO_2 from the gases produced, using the former as a fuel and hydrogenating the latter to produce methanol as a fuel or raw material.

Treatment and agro-industrial utilization of vinasse. G. M. de A. Silva. *Brasil Açuc.,* 1981, **97,** 374-376 *(Portuguese).* — The treatment proposed involves cooling hot vinasse (and recovering the heat), liming to pH 11 and adding 200 ppm of phosphate, and settling the mud in a clarifier. The mud, containing organic matter from the vinasse plus lime, can be used as a fertilizer, while the clarified vinasse can be added to the cane wash water. Alternatively, the mud can be mixed with bagasse fines and filtered, the cake being used as fertilizer and the filtrate returned to process.

Cuba sugar exports, 1981[1]

	1981	1980
	—tonnes, raw value—	
Albania	12,143	17,069
Algeria	253,259	207,131
Angola	57,641	67,173
Bulgaria	249,851	234,112
Canada	375,985	263,508
China	573,246	512,095
Czechoslovakia	99,871	98,775
Dutch W. Indies & Surinam	2,057	2,183
Egypt	162,415	138,088
Finland	173,261	78,124
Germany, East	254,770	209,900
Guinea Bissau	2,131	0
Hungary	76,216	34,152
Indonesia	13,646	39,394
Iraq	178,184	277,840
Jamaica	8,872	1,081
Japan	354,593	267,082
Kampuchea	1,626	5,423
Korea, North	27,559	10,897
Libya	54,729	75,723
Malaysia	107,749	25,206
Mexico	138,126	401,122
Mongolia	4,697	4,720
Nicaragua	0	10,830
Poland	70,154	63,128
Portugal	154,405	131,377
Rumania	138,820	46,754
Senegal	27,560	0
Singapore	0	12,611
Spain	22,746	0
Sweden	24,647	0
Switzerland	3,072	3,640
Syria	108,714	133,999
Tanzania	0	11,383
Tunisia	14,354	32,904
Uganda	0	1,084
USSR	3,204,475	2,726,339
Vietnam	102,613	41,841
Yugoslavia	10,389	0
Other countries and donations	6,869	4,386
	7,071,445	6,191,074

US quota system ruling[2]. – The US Court of International Trade has dismissed a request by the US Cane Sugar Refiners Association for an injunction to block the imposition of quotas on US sugar imports[3]. The judge ruled that the administration had the necessary authority when it imposed quotas by the Presidential proclamation which is thus valid. The Association has decided to appeal against the judgement[4].

Antigua sugar industry revival setback[5]. – Antigua, which abandoned sugar production a decade ago, had hoped to get back into production with a 2500 tonnes output from a 780-acre cane area; this was subsequently cut to 1200 tonnes from 600 acres. The Caribbean Development Bank, which provided the original loan funding, is requesting a new study to determine the viability of the plant in the light of additional expenditure of EC$ 5 million proposed as necessary to get the mill working owing to under-estimation of the cost in the original project study.

ISA export quotas in effect[6]. – A number of countries indicated by the due date of May 15 that they would not be able to use their full export entitlement for 1982 and, since the prevailing price was under 14.00 cents per lb, the shortfalls which totalled 406,824 tonnes, raw value, were not redistributed. Further shortfalls were declared in June while Guatemala's quota was increased by 50,000 tonnes by the Hardship Relief Committee. As a consequence, the quotas in effect became as follows: Argentina 626,450 tonnes, Australia 2,829,874 tonnes, Austria 113,250 tonnes, Bolivia 114,470 tonnes, Brazil 2,798,095 tonnes, Colombia 241,825 tonnes, Costa Rica 86,335 tonnes, Cuba 2,403,094 tonnes, Dominican Republic 984,870 tonnes, Ecuador 1,499 tonnes, Fiji 292,224 tonnes, Guatemala 281,038 tonnes, Guyana 115,000 tonnes, India 700,000 tonnes, Jamaica 0 tonnes, Malawi 101,935 tonnes, Mauritius 157,907 tonnes, Mexico 0 tonnes, Mozambique 69,000 tonnes, Nicaragua 106,545 tonnes, Panama 150,000 tonnes, Peru 92,565 tonnes, Philippines 1,300,000 tonnes, El Salvador 29,928 tonnes, South Africa 878,080 tonnes, Swaziland 215,792 tonnes, Thailand 1,175,509 tonnes, Trinidad 0 tonnes and Zimbabwe 244,428 tonnes, giving a total of 16,449,678 tonnes, raw value.

Taiwan sugar exports, 1981[7]

	1981	1980	1979
		tonnes, raw value	
Hong Kong	3,385	678	10,227
Indonesia	0	13,153	0
Japan	89,275	156,864	121,849
Korea, South	163,929	202,363	205,654
Malaysia	0	12,455	0
Saudi Arabia	38,806	23,914	17,936
USA	0	0	25,733
Other Oceania	477	423	0
Other countries	0	0	605
	295,872	409,850	382,004

EEC price for ACP sugar in 1982/83[8]. – Representatives of the EEC and the ACP sugar suppliers met at the end of June and agreed to adopt a 9.5% increase over the 1981/82 level of price paid for raw sugar imported under the Lomé Convention. This increase is in line with the increase to be paid to the Community's beet and sugar producers, and will give a price of 426.30 e.c.u. per tonne.

CSR Ltd. 1981/82 report. – Exceptionally wet and cloudy weather at CSR's northern mills early in the crop year inhibited growth of cane and lowered its sugar content. Consequently, raw sugar production at the seven factories was about 4% lower than the previous year at 812,500 tonnes, from 6,200,000 tonnes of cane, about 24% of total Australian output. Profits fell from the exceptional $A 58.3 million of 1980/81 to $A 22.1 million, largely owing to the sharp downturn in world market prices for raw sugar. Revenue was sustained, however, by long-term export contracts of about one million tonnes per year and by the relatively stable domestic market which remained at about 697,000 tonnes. Refined sugar exports were maintained at 23,000 tonnes despite pressure from EEC white sugar in traditional markets. Capital investment at the raw sugar factories totalled $A 12.2 million, mostly to expand crushing capacity, while expenditure of $A 10.4 million at the refineries contributed to a reduction of 4% in energy consumption compared with levels of two years earlier. Sales by the New Zealand Sugar Co. Ltd. increased by 6000 tonnes to 154,000 tonnes. CSR Ltd., together with Bundaberg Sugar Co. Ltd. and seven other mill owners, are studying the possibilities presented by the Western Australian Government's announced intention to encourage a cane sugar industry in the Ord River area of that state.

US beet sugar factory closures[9]. – The Great Western Sugar Co. has announced that beet sugar factories at Ovid, Colorado, Bayard, Nebraska and Fremont, Ohio, will not operate in 1982. The company also announced that acreage in Colorado, Kansas, Wyoming and Nebraska will be cut by 37½%. The American Crystal Sugar Co. plant at Drayton, North Dakota, is also closed, reducing the beet sugar industry of the US to only 40 factories[10].

Record Pakistan sugar crop forecast[11]. – In 1981 sugar production in Pakistan reached 854,000 tonnes, tel quel, and in 1982 is expected to rise to a record 1.2 million tonnes. Domestic consumption is estimated at 850,000 tonnes, some 100,000 tonnes will be kept as a reserve and the government plans to export the surplus of 250,000 tonnes. However, not all this sugar may reach the export market since the domestic price is almost twice the world price and domestic sales are increasing.

Cuban cane harvester production[12]. – In 1981 the Cuban cane harvester plant located in Holguín Province fulfilled its target production of 600 KTP-1 machines. The plant was opened in 1977 and in the period up to end-1981 has produced 1661 machines; this has permitted mechanization of the cane harvest to reach 50%.

1 *I.S.O. Stat. Bull.*, 1982, **41**, (3), 10.
2 F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 311.
3 See *I.S.J.*, 1982, **84**, 193.
4 C. Czarnikow Ltd., *Sugar Review*, 1982, (1601), 100.
5 F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 311.
6 C. Czarnikow Ltd., *Sugar Review*, 1982, (1600), 96; (1604), 112.
7 *I.S.O. Stat. Bull.*, 1982, **41**, (2), 8-9.
8 C. Czarnikow Ltd., *Sugar Review*, 1982, (1603), 107.
9 *Sugarbeet Grower*, 1982, **20**, (4), 12.
10 *Zuckerind.*, 1982, **107**, 570.
11 F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 230.
12 *Cuba Economic News*, 1982, **18**, (127), 21.

Philippines sugar exports, 1981[1]

	1981	1980	1979
		tonnes, raw value	
Algeria	0	20,784	0
China	92,719	44,443	119,251
EEC	0	5,282	0
India	8,648	0	0
Indonesia	217,583	144,122	0
Iran	14,428	0	0
Iraq	38,083	102,228	85,109
Japan	121,227	377,101	350,482
Korea, South	157,519	244,479	159,906
Malaysia	19,899	21,716	11,265
Morocco	26,930	24,678	0
Portugal	22,059	0	0
Singapore	0	0	8,132
Sri Lanka	33,104	0	0
Thailand	0	26,669	0
USA	188,558	429,519	403,828
USSR	336,836	352,020	19,484
	1,277,593	1,793,041	1,157,457

New Indian sugar factories[2]. – At least four more sugar factories with an overall cane crushing capacity of 5000 tonnes/day are expected to be sanctioned soon for the state of Punjab, to be erected at Tarantaran and Ajnala in Amritsar district, Doraha in Ludhiana district and Fazilka in Ferozepore district. Another mill already sanctioned at Dablan in Patiala district was expected to start crushing in the next season. Cane production in the Punjab is now sufficient to supply ten factories and also 40 mini sugar mills each crushing 200-300 t.c.d. The total crushing capacity of existing factories is equal to only 19% of the cane supply, the remainder going to manufacture of gur, khandsari, etc. Cane yield has increased from 46 tonnes per hectare in 1972/73 to 76 tonnes in 1979/80, while the area devoted to cane is increasing rapidly.

South Africa sugar production, 1981/82[3]. – Sugar production in the 1981/82 season in South Africa amounted to 2,050,000 tonnes, tel quel, compared with 1,610,000 tonnes in the drought-hit 1980/81 season. However, the ratio of tonnes cane per tonne of sugar rose to 9.5 in 1981/82 from 8.73 in 1980/81 and was the poorest for about 30 years. Sugar production in the coming season is unlikely to be affected by the drought, which threatens almost to halve the country's maize crop. Natal sugar production areas have had good rains and, with reasonable rainfall throughout the season, prospects for the 1982/83 crop look quite good. Low current world sugar prices will not prompt a cut in South African sugar exports in 1982/83.

EEC rejection of Indian sugar sales request[4]. – The EEC has rejected the Indian government's request that it be allowed to sell to the EEC last year's unused sugar export quota for Common Market countries. The EEC had not accepted India's force majeure plea defending its failure to comply with the EEC sugar quota, totalling 25,000 tonnes, because India had, in fact, exported 61,000 tonnes elsewhere under commercial contracts. The Indian government is likely to appeal against the EEC decision.

Canadian corn sweetener plant[5]. – Canada Starch Company Ltd., the largest corn wet miller in the country and a subsidiary of CPC International Inc., has begun construction of a new plant at Port Colborn, Ontario, 25 miles west of Buffalo, New York, and this, when completed in September 1982, will be Canada's first facility for production of second generation (55%) high fructose corn syrup. The plant will serve the Niagara peninsula and the Toronto metropolitan area.

Bangladesh sugar expansion plans[6]. – At present, Bangladesh has 14 sugar factories under the management of Bangladesh Sugar and Food Industries Corporation, with a total capacity of 16,500 t.c.d., sufficient for a 1981/82 production of over 165,000 tonnes. The second five-year plan has as its target a sugar production of 250,000 tonnes by 1985 and to achieve this it is planned to replace 3 mills, modernize another 6 and erect a further 4 of 1500 t.c.d. capacity. Under a bilateral arrangement, Holland is rebuilding one mill and the World Bank will grant a $20 million loan to modernize three more. Pakistan is supplying a new turn-key 1500 t.c.d. mill at Natore in Rajshahi district, to be built by end-1984, and will give the necessary technical and financial assistance. No plans for the rest of the program have been announced.

Thailand sugar exports, 1981[7]

	1981	1980	1979
		tonnes, raw value	
Algeria	22,640	0	0
Canada	0	0	11,770
China	112,956	56,153	73,565
Indonesia	20,283	0	0
Iraq	0	0	9,980
Japan	107,326	112,919	678,602
Korea, South	116,970	15,417	90,744
Laos	805	0	0
Malaysia	45,249	18,261	116,969
Morocco	136,516	49,596	88,330
New Zealand	0	0	18,571
Singapore	16,524	28,274	45,708
Sweden	0	0	21,356
Tunisia	11,013	0	0
USA	281,624	81,637	11,527
USSR	282,952	97,443	43,182
	1,154,858	459,700	1,210,304

China sugar crops, 1981[8]. – According to official figures, China's sugar production in calendar year 1981 reached 3,170,000 tonnes against 2,570,000 tonnes in 1980. The figures include both cane and beet sugar and parts of the 1980/81 and 1981/82 crops, however, and the figures for cane and beet production are more significant. Beet production amounted to 6,360,000 tonnes, a record and somewhat higher than the 6,305,000 tonnes produced in 1980, although this showed a remarkable increase over the 1979 figure of 3,106,000 tonnes of beet. Cane production had increased gently over the previous few years to reach 22,807,000 tonnes in 1980 but last year saw a considerable increase to 29,670,000 tonnes.

Hawaii cane rust identification[9]. – Rust, the fungal disease attacking sugar cane which has caused considerable loss in the Caribbean area in recent years, has been observed in fields on the islands of Kauai and Oahu and, although there is no evidence for its presence on Maui and Hawaii, it is only a matter of time before wind-borne spores are carried to these islands. Most of the cane varieties grown in Hawaii were tested against rust in Jamaica and Florida in 1978 and showed resistance or tolerance; however, the presence of spores will pose a permanent threat and a varietal testing program is to be developed to test current and future varieties for resistance since use of tolerant or resistant varieties is the only known method of countering the disease.

PERSONAL NOTES

We regret to report the death on April 9, 1982 of **C. G. M. Perk** whose work on sugar technology has been published and reported many times in this Journal. Charles Perk was born in 1891 at The Hague, Holland, and studied mechanical engineering in Amsterdam where he graduated in 1911. He became assistant to the factory manager of Halfweg sugar factory in Holland in 1912, and the following year went to Java as an engineer and later chemist at Rewoeloe sugar factory. He became the manager of Tasikmadoe sugar factory in 1918 and in 1921 was appointed co-director of the advisory bureau for the Java sugar industry. In 1925 he became chemical and technical advisor to the N. I. Agriculture Co. Ltd. in Java, controlling 26 sugar factories, serving in this position until 1951 when he joined the staff of the Sugar Milling Research Institute in Natal, where until his retirement in 1970 he was consultant in the Division of Advisory Work and Factory Control.

We also regret to report the death of **H. A. Watts** on May 24 at the age of 87. Harold Watts, known familiarly as "Dicky" to many of his friends and colleagues, retired from Fletcher and Stewart Ltd. in 1963 after 50 years' service where he had been successively Chief Draughtsman, Drawing Office Manager and Technical Director. He accepted the role of unofficial guardian, adviser and confidant to many of the overseas apprentices and young engineers who trained at Derby and many of these engineers throughout the world will gratefully remember the sympathetic ear, patient counselling and sound advice which was freely given to them during their years at Fletchers.

[1] *I.S.O. Stat. Bull.*, 1982, **41**, (2), 32-33.
[2] *Indian Sugar*, 1982, **31**, 656.
[3] F. O. Licht, *International Sugar Rpt.*, 1981, **114**, 230.
[4] *Reuter Sugar Newsletter*, April 1, 1982.
[5] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 251.
[6] *Westway Newsletter*, April 1982, 9.
[7] *I.S.O. Stat. Bull.*, 1982, **41**, (2), 41.
[8] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 254.
[9] *Sugar y Azúcar*, 1982, **77**, (5), 19.

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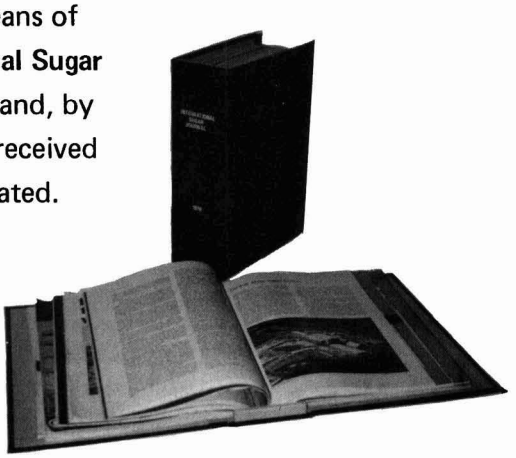

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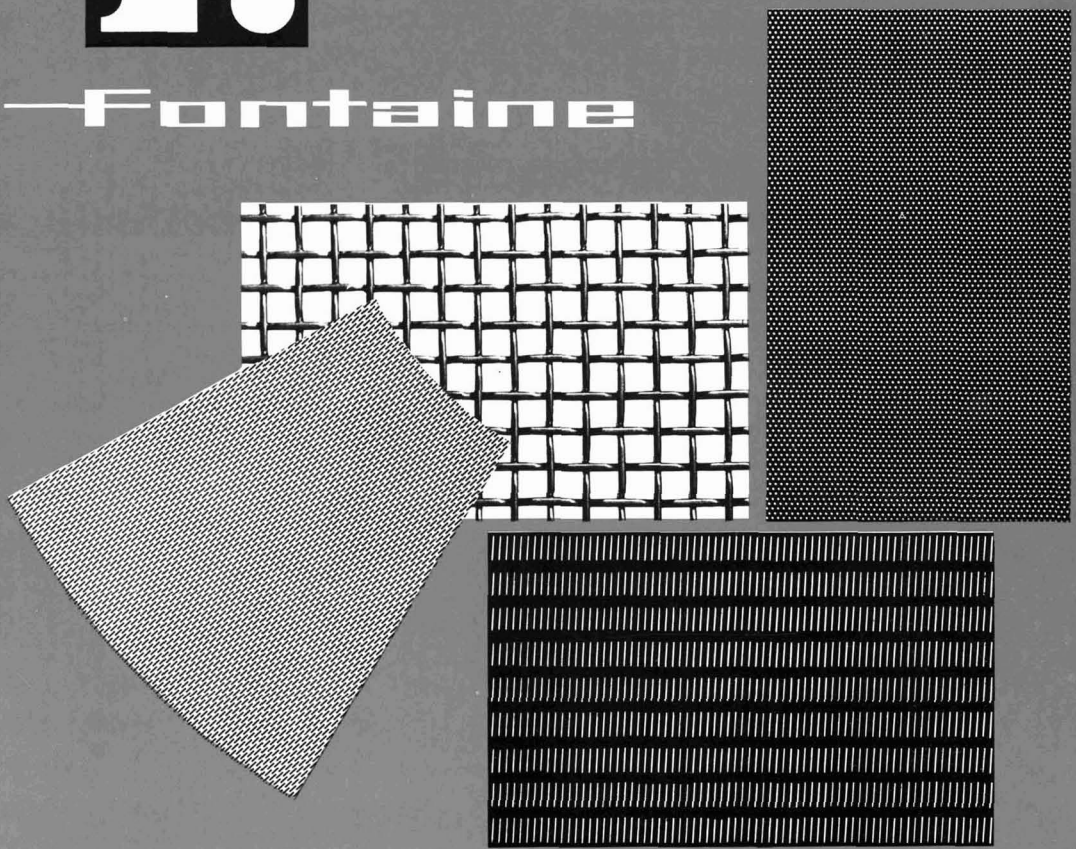

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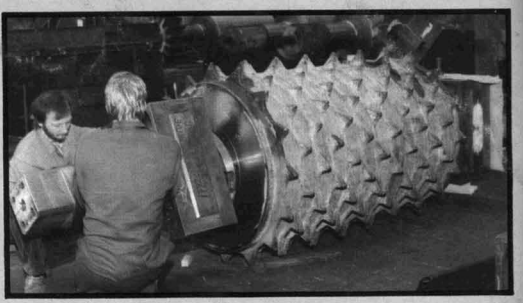

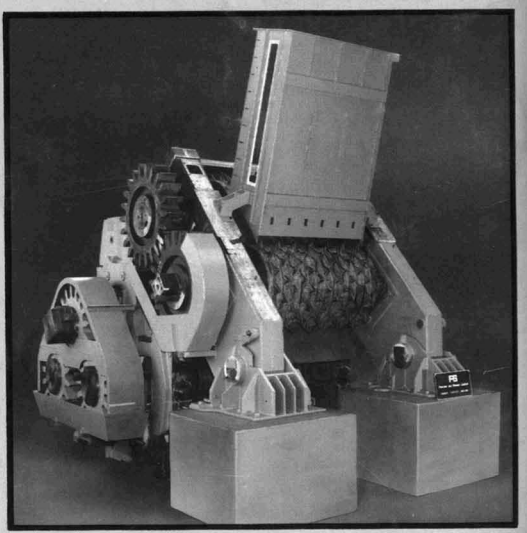

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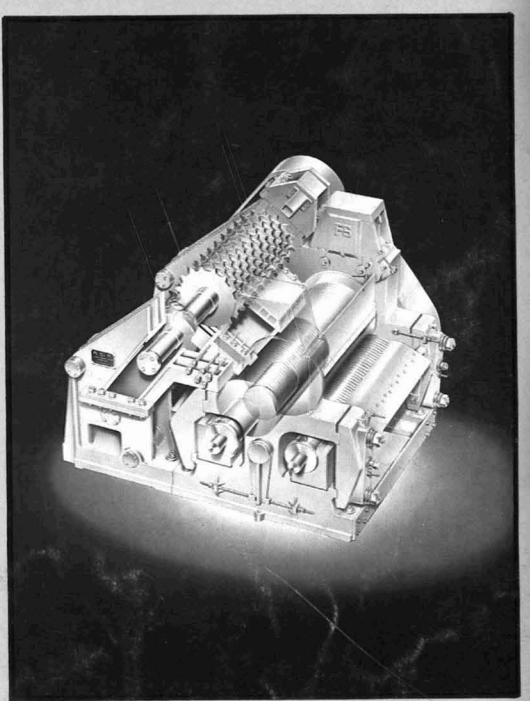

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