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STUDY ON THE MARKET ASPECTS OF BY-PRODUCTS: DIVERSIFICATION OF THE SUGAR INDUSTRY*

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* The views expressed by the author in this document do not necessarily reflect those of the UNIDO Secretariat or those of the International Trade Centre UNCTAD/GATT (ITC). This document has not been edited.

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MAJOR BY-PRODUCTS AND THEIR MARKET POTENTIALS

(a) Introduction

The sugar industry has for many years attempted to increase its earnings by the sale and industrialization of the two major by-products of sugar-cane production, namely molasses and bagasse. The major derivatives that have successfully been commercialized from bagasse include pulp and paper, panelboard and furfural and its derivatives, while alcohol and alcochemicals, yeast, citric acid, monosodium glutamate, sorbitol and various amino-acids have been commercialized from molasses. Though it must be noted that the international trade in molasses itself has made a very significant profit contribution to the sugar industry, the use of bagasse as an energy source has made a considerable reduction in cost to the manufacturing cost of the sugar industry.

Concerning the commercialization of sugar by-products, many ventures have been unsuccessful. This has often been the result of poor planning, following an unrealistic feasibility study. The study has either not made a sound assessment of the availability or pricing of the essential raw materials or has not made an accurate analysis of the markets, both domestic and foreign.

In the case of the markets, it is important to have a large enough domestic or regional market for the facility to be able to stand on its own feet. To develop a facility that depends solely on export markets to be viable, very rarely works.

The purpose of this paper is to make a general overview of some of the international markets for by-products and to discuss some of the constraints that are encountered in developing these markets.

(b) Pulp and paper from bagasse

Bagasse is used for the production of a number of grades of paper, including printing and writing, newsprint, tissue, packaging materials and paperboard. Bagasse pulp is also a market pulp that can be traded internationally. However, to determine the market potential of bagasse-based pulps and grades of paper, it is first necessary to understand the major characteristics of bagasse pulp and then determine the potential markets for these products. In general bagasse-based pulps are similar to sulphite wood pulp in use and can be used preferentially for making those grades of paper where there is no requirement for high strength or tear. Hence the most usual export markts for bagasse-based paper have been for printing and writing papers, tissue, corregating medium and speciality papers. In cases where the paper grades are used for packaging, the Clupack process can be used to give added strength to the paper. Several mills in Latin America have exported bagasse-based newsprint. This product has, for many years, had a number of technical problems, on account of the short fibre of bagasse that requires additional furnish before it is considered viable. The international paper trade is still very sceptical about bagasse newsprint as an internationally traded commodity, on account of its tendency to tear on high-speed newsprint machines, unless the bagasse pulp used is blended with sufficient long fibre furnish.

In general most countries or firms considering new investment in pulp and paper do not regard bagasse as their first choice of raw material. It is only when a feasibility study of available fibre reveals that bagasse is the most economic solution that bagasse is considered.

The world pulp and paper capacity continues to grow, with paper and board capacity, according to the latest FAO survey of 1986-1991, predicted to grow

1.9 per cent annually and pulp capacity predicted to rise 1.4 per cent during this period. Given below is the FAO world pulp and paper capacity forecast for 1986-1991.

WORLD PULP AND PAPER CAPACITY FORECAST

(1986-1991, 1,000 tons)

	Capacity		Average growth rate (% yr)	
	1986	1991	1981-1986	1986-1991
WOODPULP				
North America	76 700	79 668	1.5	0.8
Japan	12 268	13 144	-0.1	+1.4
Western Europe	32 744	36 662	+1.3	+2.3
Oceania	2 708	2 890	+3.7	+1.3
Others	1 450	1 450	+14.8	0
Total developed economies	125 870	133 814	+1.4	+1.2
Africa	853	1 009	+12.5	+3.4
Latin America	6 528	8 612	+3.7	+5.7
Asia	2 244	2 540	+7.3	+2.5
Total developing economies	9 625	12 161	+5.2	+4.8
Asia	2 423	3 166	-2.8	+5.5
Eastern Europe	4 385	4 446	+2.5	-0.3
USSR	12 050	12 050	+2.1	0
Total centrally-planned economies	18 858	19 662	+1.5	+0.8
World total	154 353	165 637	+1.7	+1.4
PAPER & BOARD				
North America	85 702	91 550	+2.2	+1.9
Japan	24 617	26 771	+1.8	+1.7
Western Europe	58 209	65 343	+2.2	+2.3
Oceania	3 038	3 455	+4.7	+2.6
Others	1 986	2 046	+6.1	+0.6
Total developed economies	173 552	189 165	+2.0	+1.7
Africa	1 064	1 177	+6.6	+2.0
Latin America	12 483	14 007	+4.8	+2.3
Asia a/	8 835	10 118	+5.9	+2.7
Total developing economies	22 382	25 302	+5.3	+2.5
Asia	9 607	12 534	+0.3	+5.5
Eastern Europe	6 685	7 134	+1.4	+1.3
USSR	14 000	14 000	+2.3	0
Total centrally-planned economies	30 292	33 668	+1.4	+2.1
World total	226 226	243 135	+2.2	+1.9

Source: FAO

a/ Figures for Asia are divided by type of economy.

The survey shows that newsprint capacity is projected to grow from 32.2 million tons in 1986 to 34.6 million tons in 1991, while printing and writing paper will grow from 59.9 million tons to 69.7 million tons in the same period.

WORLD CAPACITY: PULP, PAPER AND BOARD
(million tons)

	1986	1991
PAPER AND BOARD		
Newsprint	32.2	34.6
Pr/wr	59.9	69.7
Other P&b	134.0	143.7
Total P&B	226.2	248.1
PAPERGRADE PULP		
Mechanical	37.7	42.5
Semichemical	9.7	9.8
Chemical	106.6	112.8
Total pulp	154.4	165.6
Dissolving	6.0	6.4
Other	13.9	16.5

Source: FAO

There are some 12.3 million tons of paper capacity planned to come on stream between 1988-1991 as well as 9.3 million tons of new pulp capacity. This new capacity includes the following:

Newsprint

Some 3 million tons of new capacity is expected to be on stream by 1991, with the majority of it in North America and Europe, while Japan will go through a rebuild programme. At this time none of the announced new capacity will use bagasse as a major raw material, though it is believed that several large projects using bagasse may well be developed in India in this time period.

Printing and writing papers

At least 6 million tons of new capacity is firmly committed for this time period, with 2 million tons being developed in North America and 2.2 million tons in Europe.

World markets for bagasse-based pulp and paper

The amount of bagasse-based pulp is very limited in terms of the total world market with only about 2.5-3 million tons a year of bagasse pulp being produced in a world production of 154.3 million tons. The majority of this pulp is used by the pulp mills that produce it for paper production and there is very little, if any, available as market pulp.

FAO's current survey lists other fibre pulp as 13.9 million tons in 1986, with 15 per cent of this coming from bagasse, 46 per cent from straw and 13 per cent from bamboo. It is expected to grow to 16.5 per cent by 1991.

The major use of the bagasse pulp will be for printing and writing paper as well as newsprint production. There are some 25-30 paper mills in the world that are producing about one million tons of printing and writing paper that can use a major proportion of bagasse pulp, while 20 mills are able to produce about 600,000 tons of bagasse-based newsprint. It is believed that India will substantially increase its capacity to produce newsprint from bagasse, following a very successful development at the Tamil Nadu Newsprint and Papers Limited in Pugalur, a mill which has an installed capacity for 50,000 tons per year of newsprint and 40,000 tons per year of printing and writing paper. The furnish is 85 per cent bagasse pulp and 15 per cent hardwood for the newsprint and 75 per cent bagasse and 25 per cent hardwood for the printing and writing paper.

In general bagasse-based papers have mostly been used in the country where they are produced, and have not to any extent been able to make any impact on export markets.

(c) Panelboard made from bagasse

Bagasse has been used for the production of panelboards for a number of years, though wood fibre still represents the major raw material used. The world production of wood-based panels has increased frm 41.9 million m^3 in 1965, 108.7 million m^3 in 1985, an annual growth rate of 4.7 per cent for the period. Given below is a breakdown by region of the production of wood-based panels.

Production of wood-based panels by FAO Economic Region

(million m^3)

	1965	1975	1985	Annual growth 1965-1975	Annual growth 1975-1985	Annual growth 1965-1985
World	41.9	84.4	108.7	7.0	2.53	4.77
Developed market economies	33.4	60.5	69.0	5.94	1.31	3.63
North America	18.7	28.7	36.4	4.28	2.38	3.33
Western Europe	10.8	22.7	23.8	7.43	0.47	3.95
Oceania	0.5	0.9	1.2	5.88	2.88	4.38
Others	3.4	8.2	7.6	8.80	-0.76	4.02
Developing market economies	2.3	7.8	16.5	12.21	7.49	9.85
Africa	0.4	0.7	1.4	5.60	6.93	6.26
Latin America	0.8	2.8	4.7	12.53	5.18	8.85
Asia	0.9	3.8	9.5	14.40	9.16	11.78
Other	0.2	0.5	0.9	9.16	5.88	7.52
Centrally-planned economies	6.2	16.1	23.1	9.54	3.61	6.58
Europe and USSR	5.7	14.8	20.3	9.54	3.16	6.35
Asia	0.5	1.3	2.8	9.55	7.67	8.61

Source: FAO Expert Consultation on Wood-based Panels, Rome, September 1987.

In general, panelboard produced from bagasse has mostly been sold in the domestic markets of the countries that produce it. It is usually used in the building and furniture industries. Though in recent years the MDF (Medium Density Fibreboard) has had considerable success in export markets, and MDF made from bagasse in Thailand has been marketed in Europe successfully, MDF is now one of the fastest growing wood-based panels, since it is cheaper to produce than particleboard or standard fibreboard.

Initially in the 1960s and 1970s, a number of particleboard and fibreboard plants were built, using bagasse as the main raw material. However a number of them were closed down. The failure rate of these bagasse-based panel plants was often because of bad management, technical problems arising from failure to prepare the bagasse properly as well as lack of markets for the product, particularly when the products produced were not up to international market standards. However, since the success of the MDF plant in Thailand, a number of similar plants are being developed in Asia, particularly in the People's Republic of China, India and Pakistan, while in Latin America, MDF plants are being considered in Argentina, Brazil, Colombia, Mexico and Venezuela.

In general the foreign trade in all wood-based panels accounts for only a small proportion of world production, with only 13 per cent of particleboard and 4 per cent of fibreboard production entering international markets. The major part of the plywood produced enters world markets. Total trade in wood-based panels is given below, followed by a breakdown of international trade in particleboard and fibreboard.

Total trade in wood-based panels

(million m^3)

	Imports					Exports				
	1975	1980	1983	1984	1985	1975	1980	1983	1984	1985
World	12.4	15.7	16.9	17.9	18.8	12.4	16.3	17.4	18.0	19.0
Developed market economies	9.9	11.8	12.8	13.6	14.7	7.1	9.7	9.2	9.9	10.3
North America	3.1	2.4	3.4	3.5	4.0	1.5	2.3	2.4	2.7	2.8
Western Europe	6.1	9.0	9.0	9.5	9.9	5.2	7.0	6.5	6.9	7.2
Others	0.6	0.4	0.4	0.5	0.7	0.3	0.2	0.2	0.2	0.2
Developing market economies	1.2	2.7	3.0	2.8	2.7	3.0	3.9	5.7	6.0	6.7
Africa	0.3	0.5	0.6	0.5	0.5	0.2	0.3	0.3	0.3	0.3
Latin America	0.2	0.5	0.5	0.5	0.4	0.3	0.6	0.6	0.7	0.7
Asia	0.6	0.9	1.3	1.5	1.3	3.3	3.8	5.7	5.7	6.2
Centrally planned economies	1.2	1.2	1.1	1.5	1.4	2.4	2.7	2.5	2.1	2.1
Europe and USSR	1.2	1.1	0.8	0.8	0.8	1.6	1.8	1.6	1.4	1.5
Asia	0.0	0.1	0.3	0.7	0.6	0.8	0.9	0.9	0.6	0.6

Source: FAO Expert Consultation on Wood-based Panels, Rome, September 1987.

In 1987 ITC published a study entitled "Wood-based Panels: A study of major markets". This study, which is available on application to ITC, details the major world markets for particleboard, fibreboard and plywood, giving details of each market and the overall market characteristics.

World markets for bagasse-based panels

The potential to export bagasse-based panels from developing countries at this time is very limited. To date during the analysis of a number of markets, no trace of any foreign trade in bagasse-based panels could be found, though it was indicated by one manufacturer of panel plants that one firm in Venezuela and the firm that recently installed a bagasse-based MDF plant in Thailand were both exporting a limited amount of their production. At this time a number of the bagasse-based fibreboard plants in the Latin American and Caribbean region have closed or are closing as they are not competitive. The difficulty in treating the bagasse has been responsible for the additional amounts of adhesives that are being used in particleboard production, while the excess amounts of sugar that is left, causes a high level requirement of a biocide to keep away the insect life, particularly if the board is used for furniture production.

The development of a bagasse-based MDF production is most attractive as the extra cooking stage in the production process not only reduces the level of adhesive used but gets rid of any excess sugar in the bagasse, hence the net result is a panelboard with a reduced manufacturing cost at a higher quality specification. Hence it must be concluded that any sugar-producing country wishing to develop a bagasse-based panel facility must assume that the initial market for the product will be entirely a domestic one. It was pointed out in the recent FAO Expert Consultation on Wood-based Panels that one of the prerequisites for success in developing panel production was a good feasibility study that contained a realistic assessment of the market. It was found that many studies overrated the export potential in the markets of neighbouring countries. Hence to be really safe, it should be assumed that an export market can only be assumed, after the successful development of a domestic market. One mistake that must be avoided for estimating the potential domestic market is to assume that a need automatically means a market. There is a need for both low-cost homes and cheap furniture in many sugar-producing countries as well as in the region, but if there is insufficient money in that sector to purchase these items, a demand will not be developed.

(d) Furfural and its derivatives

The world market for furfural and its derivatives seems to be in decline. The world market appears to be about 204,000 tons in 1986, with some 75 per cent of the furfural produced being converted to furfuryl alcohol.

Furfural consumption in the United States totalled 120 million pounds in 1986, down some 100 million pounds from 1980.

The sole producer in the United States, the Quaker Oats Chemical Division of the Great Lakes Company, now only has one active plant with a capacity of 132 million pounds, having closed one of its plants.

After the United States, the Dominican Republic is the second largest producer, with a production capacity of 32,000 tons. In the first seven months of 1987, some 26,000 tons were exported.

Furfural consumption in the European Economic Community is not available, but the 1986 imports of 7,615 tons plus the European production of 9,000 tons in France, 14,000 tons in Spain and 8,000 tons or more in Italy would indicate a

European consumption of a little over 35,000 tons. The EEC imports of furfuryl alcohol indicate that about 30,000 tons of alcohol is produced; hence the furfural usage will lie between 35,000-40,000 tons.

The decline of furfural consumption in the United States is linked with the decline of furfuryl alcohol, which is used as a foundry resin binder intermediate. This market has declined in the United States as the foundry itself has declined.

Another major use of furfural has been as a solvent in the production of lubricating oils. In general this technology is not often incorporated into new plants, but the existing plants were not converted. The US consumption of furfural for this activity has been estimated to be about 16 million pounds in 1986.

Although the spot price of furfural in the United States during 1988 is in the region of 75 cents/lb according to the Chemical Marketing Reporter, the contract price of the major users is believed to be about 64-66 cents/lb.

The listed spot price for furfuryl alcohol in the United States is 72 cents/lb ex Omaha, Nebraska. The contract price is unknown. It is also claimed that the discount price offered for imported furfural from the Dominican Republic and from the People's Republic of China is much lower than the domestic contract price. However, this could not be confirmed.

Furfuryl alcohol consumption in Europe appears to have increased from 21,000 tons in 1983 to 30,000 tons in 1986.

The price of imported furfural in Europe is claimed to be $US 1,100 per ton c.i.f. Hamburg or Rotterdam.

The technology to produce furfural is readily available at a price. A plant to produce some 10,000 tons per year of furfural and 6,000 tons of acetic acid could be built on a turnkey basis for about $US 30 million, with the furfural process unit costing about $US 20 million and the offsites $US 10 million. A plant to produce 5,000 tons of furfural a year would cost a little under $US 15 million. These costs could be considerably lowered if the plant could be integrated into an existing sugar mill.

(i) <u>World production of furfural and its derivatives</u>

The world production of furfural was estimated to be in the region of 204,000 tons in 1986, with some 75 per cent of production being used to make furfuryl alcohol. The United States is still one of the major manufacturers of furfural with a plant capacity of 60,000 tons, the sole producer producing it from bagasse at Belle Glades, Florida and from agricultural wastes at Omaha, Nebraska and Cedar Rapids, Iowa, though a second potential producer was planning a 5 million pounds per year facility in Texas, to be expanded to 20 million pounds.

The Dominican Republic can produce some 32,000 tons per year, People's Republic of China, 30,000 tons, Spain 14,000 tons, France 8,000 tons, Italy 8,000 tons, Mexico 1,800 tons, Brazil 2,000 tons, Argentina 1,800 tons and the Republic of South Africa 7,500 tons. In July 1987 a Canadian group, Ethanol Energies Ltd., announced that they expect to build a plant to produce 130 million litres of ethanol per year, which would include a plant to produce 10,000 tons of furfural per year, which would be on stream in spring 1989.

Since a number of plants were shut down in the 1980s in the United States, the actual world plant capacity is believed to be in the region of 250,000 tons.

The world production of furfuryl alcohol is not listed but the main producers are in Europe, which is believed to produce about 30,000 tons and the United States, which has a production capacity of about 45,000 tons, at Memphis, Tennessee and Omaha, Nebraska.

(ii) Foreign trade in furfural and its derivatives

The major world markets for both furfural and derivatives are in Europe, Japan and the United States. Given below are the exports of furfural and furfuryl alcohol into the European Economic Community (EEC) between 1983 and 1986.

Imports of furfural and furfuryl alcohol into the EEC between 1983 and 1986 (tons)

	1983	1984	1985	1986
Furfural from				
World	15 271	14 532	14 257	17 351
EEC	6 379	5 049	7 383	7 615
Non-EEC	8 892	9 483	6 874	9 736
People's Repubic of China	5 690	2 008	1 464	475
Spain	1 060	2 383	-	-
Yugoslavia	667	1 098	1 142	1 209
Dominican Republic	590	2 383	1 241	6 117
Confidential	-	3 261	1 243	965
Austria	-	-	-	750
Brazil	404	-	-	-
Furfuryl alcohol				
World	21 776	26 657	28 886	29 890
EEC	20 831	24 832	26 541	26 930
Non-EEC	945	1 825	2 345	2 960
Rep. South Africa	323	313	726	863
Hungary	236	496	-	-
United States	216	466	-	-
Switzerland	-			
Turkey	170			

Source: Nimexe.

The majority of exports from the Dominican Republic goes to the United States and to Japan. During the first seven months of 1987, some 26,000 tons of furfural were exported from the Dominican Republic.

(iii) Potential for the development of furfural production

In the early 1980s, a great deal was written about the potential for furfural development in developing countries with new plants listed for Bolivia, Colombia, Ecuador, Venezuela, Cuba, Puerto Rico, India, Pakistan, Côte d'Ivoire and Zambia. But most of these plants were not built and others who built plants were forced to shut them down for economic reasons.

There is still a production overcapacity in world markets, and demand can easily be met from existing capacity. However, it was announced in Canada that a new facility to produce 10,000 tons will be built. One reason may be that it is possible to make furfural more economically than in the past, and that new processes could allow substantial discounts to be offered.

(e) Ethanol and chemicals from alcohol

Over the past few years a large number of distilleries have been built to produce alcohol for alcoholic beverages and to blend with gasoline as a fuel.

Fermentation ethanol produced in the United States is now a cost-competitive gasoline blending agent, and will remain so, as long as it continues to receive an exemption from the Federal Government's gasoline tax. Sales of fermentation alcohol in the United States reached 860 million gallons in 1987 and are expected to reach 950 million gallons by 1990 and 1,150 million by 1992, with only a minimum amount of imports. The demand depends on the tax incentives, where the Federal rebate to blenders will reduce the net price by 60 cents a gallon.

These Federal tax exemptions have caused ethanol consumption to increase by 250 million gallons between 1984 and 1987. There are also a number of state incentives, which can vary state by state. However, without the state subsidy, production costs are too high and it is difficult to be commercially viable. The two major producers of fermentation alcohol are Brazil and the United States. Ethanol production in Brazil is predicted to remain at about 11.5 billion litres in the crop year 1988/89. Production over the last four crop years has been as follows:

Crop year	1987/88	1986/87	1985/86	1984/85
Alcohol production in billion litres	11.681	10.1403	11.797	9.251

Exports were one of the major profitable outlets for Brazilian alcohol, with over 360 million litres shipped in 1986, though the tariff now charged by the United States on Brazilian alcohol has reduced its competitive position. The United States is a major producer of fermentation alcohol from glucose, obtained from corn (maize), where a great deal of incentives for alcohol use have been justified in order to assist American farmers. The Caribbean Basin Inititive (CBI) was set up to assist manufacturers in the Caribbean Basin, and allows alcohol produced in the region to be imported in the United States, free of tariff. This also includes European wine alcohol, which is processed in Jamaica. It is interesting to note the economics of this operation. The wine alcohol is sold f.o.b. France for 40 cents/gal, and freighted to Jamaica for 12 cents/gal. It costs 15 cents/gal to process it, a further 2.5 cents/gal for the denaturent 0.5 cents/gal is added for shrinkage, and 5 cents/gal to ship to the United States from Jamaica, where it is sold for about 98 cents/gal. Alcohol production at the beginning of 1988 had reached 1,112 million gallons, and it was predicted that a further 100-140 million gallons would be added in 1988. Some of the major producers identified in the literature include:

		Plant capacity million gallons/year
Archer Daniel Midlands (ADM)	Decatur, Illinois	255
ADM	Peoria, Illinois	95
ADM	Cedar Rapids, Iowa	80

		Plant capacity million gallons/year
ADM	Clinton, Iowa	70
Pekin Energy	Pekin, Illinois	70
South Point Ethanol	South Point, Indiana	60
New Energy Co. of Indiana	South Bend, Indiana	60
A.E. Staley	Louden, Tenn.	40
Sheperd Oil	Jennings, La.	25
Tennol	Jasper, Tenn.	25
Kentucky Agriculture	Franklin, Ky.	25
Energy Fuels	P .rtales, New Mexico	10
Midwest Grain Products	Pekin, Illinois	40
American Diversified	Hastings, Neb. Hamburg, Iowa	20
Grain Processing	Muscatine, Iowa	60
High Plains	Colwich, Kansas	10
New Church Energy	New Church, Virginia	8

Source: ITC literature search.

It should be noted that when the State of Louisiana suspended state incentives, a number of producers in the State had ceased production.

In the United States 90 per cent of fermentation ethanol is used as a fuel component, 8 per cent for beverage use and 2 per cent for chemical and solvent use. It must also be seen that some 212 million gallons of synthetic ethanol are produced, for chemical intermediates (30 per cent), toiletries and cosmetics (20 per cent), coatings and solvents (15 per cent), vinegar (10 per cent), household cleaners (7 per cent), detergents (5 per cent), pharmaceuticals (5 per cent), printing inks (3 per cent) and 5 per cent miscellaneous. Prices for fermentation alcohol vary from $US 1.15 in Kentucky to $US 0.87 in Denver. Current synthetic price is $US 1.55 per gallon.

Alcohol production in sugar-producing countries:

Argentina produced some 259,248 million litres in 1986/87, up from 190,044 million litres in 1985/86. Pakistan is producing 155,000 litres a day from five distilleries attached to sugar mills, while alcohol production in Mauritius was 3,478,318 litres in 1986 and 3,547,454 in 1987.

It was announced this year that Codistil Nordeste will build two distilleries in Honduras, while it is claimed that a 50 million gallon distillery to be built in St. Croix, when completed in 1989, to supply alcohol for fuel blending in the United States, will be the largest distillery in the Caribbean.

From ethanol, a number of downstream chemicals can be produced such as acetaldehyde, acetic acid, acetic anhydride, 2-ethyl hexanol, ethylene glycol, and ethylene to mention a few. One of the main problems in developing these products is that they are all bulk petrochemical products, and the petrochemical industry, at the current crude oil prices, can produce them in such large quantities, at substantially lower prices. By necessity, agro-based plants are usually small or medium-sized, resulting in relatively higher capital cost per kilo of product produced. At the present level of oil prices, agro-based raw materials do not have sufficient margins to compensate for these higher costs. It is estimated that the oil prices will have to rise to between $US 30-35 per barrel before this technology will be commercially viable. This could happen by the mid-1990s.

Those countries with surplus agro-based raw materials will not normally have a large enough domestic market to justify the simple products such as acetic acid or ethyl acetate being developed. Hence export would be necessary, and this would be difficult in competition with products from Europe, the United States and Japan.

So unless the local market can absorb a level of demand equal to the break-even level of production of the plant, then development should not be considered.

Products for consideration include:

1. Acetic acid/ethyl acetate

This is a very simple process in a relatively small plant, where ethanol is first oxidized with air to produce acetyldehyde, which is then further oxidized with air to produce acetic acid. Part of the acid is then reacted with ethanol to produce ethyl acetate.

The process battery limit installation to produce 3,000 tons per year of acetic acid and 2,000 tons per year of ethyl acetate would cost in the region of $US 5 million.

2. Vinyl acetate/acetic anhydride

A plant to produce 8,000 tons of vinyl acetate monomer, together with 3,000 tons of acetic anhydride and 2,000 tons of ethyl acetate from ethanol was successfully developed in India and would cost about $US 16 million to build in Latin America. Celanese Corporation have such a plant in Mexico.

3. 2-ethyl hexanol/butanol

Another process that could be evaluated would be one to produce 2-ethyl hexanol from ethanol. The process steps go through acetaldehyde, crotonaldehyde and butyraldehyde to a final product of butanol and 2-ethyl hexanol. The normal petrochemical route uses the oxo process which starts from propylene and carbon monoxide to make butyraldehyde.

Butanol and 2-EH are important solvents. 2-EH is used as a raw material with phthalic anhydride to make plasticizers for polyvinyl chloride production. 2-EH can be nitrated to make 2-EHN, an additive that improves the cetane number of diesel oil, or even more important, can be used as an additive to allow a diesel engine to operate on ≈95 per cent alcohol. The cost of the process to make 2,500 tons/year of butanol and 9,000 tons per year of 2-EH would be about $US 17 million. A small additional cost would be incurred to develop nitration facilities to produce 2-EHN.

If ethylene is produced from ethanol a series of downstream products can be developed such as ethylene glycol, styrene, PVC, glycol and surfactants, using downstream processes similar to those used in the petrochemical industry.

The GEPLACEA bulletin in May 1988 made a very detailed report on sugar diversification in India, giving a breakdown of 69 plants in India that produce chemicals from ethanol, while the June 1986 bulletin presented alcochemistry in Brazil.

(f) Citric acid

The world market for citric acid in 1987 reached 400,000 metric tons, with demand for the product growing at some 20,000 tons per year. The 1987 consumption was broken down as follows:

	Metric tons
Western Europe	108,000
Eastern Europe	44,000
North America	150,000
Latin America and the Caribbean	30,000
Middle East and North Africa	15,000
Far East and Japan	35,000
Australia and Oceania	8,000
Other	25,000

Source: ITC estimates.

The current worldwide demand is mostly used in the food industry (at 75 per cent), where it is used as an acidulent, particularly in the beverage industry, and in the pharmaceutical industry, while industrial or technical grade citric acid is used for boiler descaling, in detergent additives and as a chelating agent. In the United States, the two latter applications, which involve a citric acid based liquid, now take up some 20 per cent of the domestic consumption, and are the fastest growing area, while the beverage usage has remained fairly static for the last few years at about 230-240 million pounds per year.

The world citric acid capacity is not published as a whole, but various estimates indicate it to be somewhere between 550-600,000 metric tons. From the various plant capacities given in the literature, the following has been established:

United States (4 plants)	Million pounds	Thousand metric tons
C. Pfizer Inc., Groton, Connecticut	100	
C. Pfizer Inc., Southport, North Carolina	100	
Miles Laboratories, Dayton, Ohio	50	
Miles Laboratories, Elkhart, Indiana	85	
Total US installed capacity	335	152

	Thousand metric tons
Hoffmann La Roche, Begium	60
Jungbunzlaur, Austria	60
Benckiser, Federal Republic of Germany	35
Sturgo Biochemicals, United Kingdom	25
Pfizer Ltd., Cork, Ireland	25
Miles Laboratories, Mexico	12
Miles Laboratories, Colombia	4
Miles Laboratories, Brazil	8
Quimica Mexicana	18
Biocor, Italy	25
Sirius Biotechnology, Australia	2
Japan (from 5 plants)	8
Israel	5

Cargill Inc. in the United States have announced that they are building a new 25,000 ton facility that will be on stream by the end of 1989, using glucose syrups as the main raw material.

There is also considerable production capacity in the socialist countries, with the People's Republic of China being a major producer.

Foreign trade in citric acid

In recent years, citric acid from a number of sources from both industrialized and developing countries has shown a good rate of growth in the major markets of the world. In the United States, over 49.6 million pounds of citric acid were imported in 1987, for an average c.i.f value of $32.5 million, while exports were some 13.32 million pounds, valued at $10.5 million. The major sources of US imports were Belgium, People's Republic of China, Federal Republic of Germany, Israel, Italy and Mexico. The European Economic Community (EUR 12) in 1986 imported 82,561 metric tons of citric acid and 10,568 metric tons of citrates, of which 32,763 tons of citric acid and 2,313 metric tons of citrates came from outside the Community, with 13,646 metric tons coming from the People's Republic of China. Imports of citric acid into Japan in 1987 totalled 12,796 metric tons, with China providing 6,145 tons, Ireland 2,446 tons and Austria 1,410 tons, according to Nimexe statistics. According to the Chemical Marketing Reporter discounts on the price of citric acid imported into the United States in the last few years has opened up this market to a number of exporters. Imported material is usually sold at a discount of 2-3 cents a pound. The price of citric acid in the United States is 83 1/2 cents a pound for truckloads of the anhydrous material for food or pharmaceutical use, while the technical grade material sells for about 76 1/2 cents a pound.

It was noted that in the United States, the market for the technical material was mostly handled by the domestic suppliers, particularly when liquid product was required.

Prospects for development of citric acid by sugar-producing countries

Every year, the major process engineering firms are requested to present offers for the construction of small citric acid facilities in sugar-producing countries. These requests are usually denied. There are a number of problems associated with citric acid development. The know-how to produce citric acid in a commercially viable way is held by a limited number of firms, usually international producers themselves, who want to keep the market commercially viable. If a country has a sufficiently large internal market, these firms will consider a joint venture, as has happened in several countries. Sometimes the international firm will use such a joint venture to supply the regional market. In the case that a sugar producer wishes to purchase technology to produce citric acid without a joint venture, it has generally not been possible to obtain the technology. It is also very difficult to operate a citric acid plant, particularly when sugar cane molasses is being used as the substrate. There are at least two firms that are offering the technology for citric acid, one in the Federal Republic of Germany and the other in Poland.

If an international export market is the goal, then the scale of economy of citric acid production will require a plant size of at least 15-25,000 tons to be able to produce a product that will be able to compete with the major international producers. If however a domestic market is the objective, and it can be protected by a tariff barrier, then a plant of 2,500-3,000 tons will be economical. Since the world consumption grows at a rate of 3-8 per cent per annum, then there will always be a possibility to consider a joint venture with an established producer.

(g) Monosodium glutamate (MSG)

The world market for monosodium glutamate is controlled by a small number of Asian firms from Japan and the Republic Korea, namely Ajinomoto, Acai Chemical, Kyowa Hakko Kogyo and Takeda Chemical Industries from Japan and Miwon and Mipoong from the Republic of Korea. MSG is an excellent seasoning that is used all over the world as a flavour enhancer. It does not have a particularly distinctive flavour of its own, but enhances the flavours present in the food.

MSG is manufactured in Europe and Asia, but not now in the United States, having since Stauffer Chemical Company ceased production in 1984, their plant had a production capacity of 45 million pounds. However the United States market is one of the largest in the world with a US demand of about 80 million pounds estimated by importers. In 1987, some 83 million pounds of MSG were imported into the United States, and 3.3 million pounds re-exported. Major exporters to the US include Brazil - 41.45 million; France - 4.48 million; Republic of Korea - 17.08 million; Republic of China, Taiwan Province - 16.52 million and Japan - 687,971 pounds. In recent years, Japan has ceased to export MSG, and the main Japanese firms, such as Ajinomoto USA Inc. no longer import from their parent company in Japan because of high labour costs and a weak dollar, but from their subsidiary in Brazil. It is even said, though not proved, that Japan has ceased to produce. Hence in 1987, Japan imported 13.742 million pounds of MSG from the Republic of Korea, 5.89 million; People's Republic of China, Taiwan Province 1.44 million; Thailand, 2.46 million; Indonesia, 2.84 million; and 0.61 million pounds from France. Ajinomoto are adding a new 18,000 ton plant to produce MSG for export, in Indonesia, which should be on stream by 1989.

MSG is produced in the European Economic Community in France, where Orsan have a plant capacity of about 30,000 tons, Italy about 15,000 tons and in smaller quantities in the Federal Republic of Germany and Spain. The imports into the EEC reached 18,323 tons in 1987, with 9,952 tons coming from other EEC members and 5,091 tons coming from outside the EEC.

The clever marketing policies of the producers have allowed the supply to always be equal to the demand, thereby being able to maintain prices at a reasonable level. Currently in the United States, the supply is fairly tight, and the prices have recently risen to 86 cents a pound for truckload quantities. The most recent price rise was attributed to inflation problems in Brazil. There is an increasing demand from Asian countries for product in the United States. The demand in the United States will increase to 90 million pounds by 1990, where it is thought that food processers consume 28 per cent of MSG demand, dry soups consume 26 per cent, institutions 25 per cent, spice blenders 12 per cent and flavour enhancers 9 per cent. The highest concentration of MSG is in soups. The autumn period is usually the highest for sales.

(h) Lysine

The manufacture of lysine, by fermentation of molasses, is one of the highest added value applications of by-product development. The lysine is produced by a very high technology fermentation process, which would have to be licensed from firms in Japan or the Republic of Korea at this time.

According to Japanese sources, the total world market for lysine is in the region of 90,000 tons, and is totally dominated by three major producers and their subsidiaries, namely, Ajinomoto and Kyowa Hakko Kogyo of Japan and Miwon from the Republic of Korea.

The major markets for lysine are in the United States, Europe and Japan, where it is used to fortify animal feed rations for pigs and poultry. The use of lysine is strictly dependent on the price of other protein supplements that contain lysine such as soyabean meal and fishmeal. The price of lysine fluctuates according to the market conditions of protein supplements.

Take for example the North American markets. Until 1984 all lysine was imported from Japan or the Republic of Korea. In 1984, Biokowa Inc. opened a plant to produce 6,500 tons, followed by Heartland Lysine Inc. in Iowa with a plant, also producing 6,500 tons. It is now projected that production from these two plants will reach between 10,000 and 11,000 tons by 1992. At that time a similar amount of lysine will be imported to make a projected consumption of 20,000-22,000 tons. It is claimed that consumption in the United States has risen from 7,000 tons in 1980 to 19,000 tons in 1987.

Currently it is estimated that imported lysine in 1986 came 57 per cent from Japan, 26 per cent from Mexico, with the rest from France and Mexico. The lysine imports in 1986 had jumped to 28.2 million pounds, up from 23.2 million pounds in 1985, with 16.2 million pounds up from 11.2 million pounds coming from Japan. Fermentaciones Mexicanas reported that they are currently exporting 2,000 to 2,500 tons of lysine to the United States.

In Europe, lysine is produced by Eurolysine, a company with joint Japanese and French interests. Their production capacity is not published, but is estimated to lie between 30-40,000 tons. The production of this plant is supplemented by imports. It is estimated that the demand in the Community for lysine rose from 10,000-15,000 tons in 1983 to 20,000-25,000 tons in 1986 and then to 30,000 for 1988. The use of lysine in Europe is more directed at pig feeding, where difficult environmental legislation has caused pig farmers in particular to pay special attention to the efficiency of their rations. Hence most farmers now use a least cost control of the rations, based on a minimum cost lysine percentage. So depending on the cost of lysine in natural products such as soya or fishmeal, then synthetic lysine has been attractive when these products are priced too high. However when these commodity prices fall, then the use of lysine is restricted, unless the synthetic lysine producers are prepared to lower their prices.

Japan is believed to produce some 35,000 tons of lysine a year, with the Kyowa Hakko Kogyo plant producing at least 15,000 tons and the Ajinomoto plant listed at 10,000 tons. Sankyo, Tanabe and Toray are also listed as lysine manufacturers. In Japan the current lysine consumption is listed at 3,000 tons, with growth in lysine said to be static.

The Republic of Korea is another major lysine producer, with Miwon in Busan City, operating a 10,000 ton plant. It was claimed in the literature that a second plant with a 20,000 ton capacity would be on stream by the end of 1987.

Although little information about the production of lysine in the East European countries is published, Kyowa Hakko Kogyo have developed a joint venture in Hungary, to set up a 5,000 ton plant, to be on stream in 1989.

Potential for lysine development

The commercial success of lysine production has been dependent on keeping the production capacity at the same level as the demand. Since it would be difficult for a new party to develop production facilities, without a technology co-operation or joint venture with one of the main producers, the potential for development in this area will depend on a sugar producer being able to convince a potential partner of the commercial viability of their particular market.

It is fairly obvious that the demand for lysine will continue to expand, as the demand for animal feed continues to grow, and the development of a mixed feed industry in developing countries increases. What is really needed at the moment is a source of lysine technology that is independent of the two major producers. If that can be found, then the potential for the development of lysine production will be fairly good.

(i) Torula yeast

The international market for torula yeast is almost non-existent at this time, since in a free market, the production costs are much higher than the international market price, so that it could only be sold at a loss.

All protein supplements are sold on the value of their lysine content, and torula yeast has a lysine content somewhere between that of fishmeal at the high end and soyabean meal at the low end. So if for example fishmeal is priced at $450 per ton and soyabean meal at $200 per ton, then torula yeast would be valued at about $350 per ton by the purchasers of animal feed ingredients. However if the molasses necessary to produce it were valued at $50 per ton, then the torula yeast would have to be sold at a price in excess of $450 per ton to be commercially viable. So in recent years the price of molasses has been too high, while the prices of alternative protein supplements have been too low.

Very little production capacity exists in the world, outside of the socialist countries. In the European Economic Community, the only listed production is in Italy and Switzerland, with about 300 tons per year being produced for the extraction of RNA, while in the United Kingdom, a very small facility produces yeast for health foods, where it is sold as yeast tablets.

In the United States, a facility to grow torula yeast on ethanol was developed by Amoco Foods, an oil company, to provide yeast protein for the food industry, though it is believed that this facility has now been closed. It is also claimed in the literature that Provesta, a subsidiary of the Philipps Petroleum Corporation has an experimental plant that is producing torula yeast by solid or highly concentrated fermentation as a source of flavour additives, and feed for fish and racehorses. Although there are no plants to produce yeast, large amounts of brewers' grains and distillery slops are used by the feed industry, since they are available at a fairly low price.

The main torula yeast producer is Cuba, which has ten plants with a production capacity of between 120-130,000 tons, but in 1987 was producing between 40-70,000 tons, of which 20,000 was exported to socialist countries. It is also believed that a large production of torula yeast in the USSR has been developed, though this is not well documented.

Potential for torula yeast development

Torula yeast plants should only be considered in those countries that do not have easy access to cheap source of protein supplements, and have a reasonably well-developed pig or poultry production. There would be very little, if any, potential to export the torula to any free market economy country. A small facility that made a food grade item, which could be tableted and exported as a health food item may well have some potential.

TARIFF AND NON-TARIFF BARRIERS HINDERING DIVERSIFICATION

In general it is more the non tariff barrier that hinders diversification, since most of the sugar producing countries are able to export their sugar by-product derivatives into industrialized country markets. If they wish to export to regional markets they may have to pay heavy duties if they are not part of a regional trade pact. In general those countries that are receiving technical assistance for development, such as the countries of the Caribbean Basin Inititive, will be able to ship their sugar derivatives, such as ethanol, into the United States, without payment of tariffs, if the products are specified as free of duty. On the other hand other countries of Latin America such as Brazil, are not permitted to export ethanol to the United States, without payment of tariffs.

The major constraints to the export development of sugar by-products has been the lack of acceptance by the market, where the exporters have not been able to develop credibility. In the past, for example, various exporters of bagasse panel proved to be totally unreliable in terms of delivery and quality. Importers in the industrialized countries are looking for a constant supply of a certain quality. In some cases, those firms that have been able to do this have developed a good business. For example, the furfural supplies from the Dominican Republic are well priced to make market penetration, and the company shipping them have an excellent reputation for reliability. Citric acid and lysine from developing countries have a similar reputation. If the market development is professional, then a number of the constraints to export development will be overcome.

Quality control of the product is vital, since if the quality is inconsistant or is too low, then it will never be accepted. Delivery is also important, for if the suppliers are not able to meet delivery schedules, then the product would not sell. In order to develop a market, it is often necessary to discount the prices, until the product has built up a market share.

A lot of these problems stem from the fact that sugar is a seasonal crop that depends on the weather and other problems such as pests or diseases that threaten any agro-industrial product. Price is another major constraint, as the products must be priced for the market. For example, if torula yeast is to be developed for export, then it must be priced at a level that will allow it to compete with the major protein supplements. In a similar way the price at which lysine can be marketed depends on the price of lysine in soya and fishmeal. If this price falls, the lysine may have to be marketed at a lesser price in order to keep its share of the market.

Another barrier that must be watched is the levels of subsidies in some agricultural sectors, that may make it difficult for the by-products to compete.

PROGRAMME DEVELOPMENT FOR DIVERSIFICATION OF THE SUGAR INDUSTRY

(a) Introduction

It is agreed that a diversification programme is required by the sugar industry worldwide in order to improve its profitability. One prerequisite for a successful diversification programme is the absolute necessity to make a realistic feasibility study, which includes a sound analysis of the markets, both domestic, regional and international. This study, which must take a detailed and sound analysis of the raw material supply situation, should be prepared in such a way that it can be used to raise the necessary project finance to allow the project to be developed. The major weakness in the past in the field of sugar diversification, where there have been a number of failures in the projects that have been developed, has been caused by the failures in raw material supplies or the lack of real markets.

Feasibility studies are often optimistic, and in many cases not too objective, because they are often prepared by people who wish to sell equipment or wish to justify an expensive facility that they can operate. The equipment suppliers will often give optimistic assessments of investment costs, running costs, schedules for erection and labour requirements though the supply of raw materials, their quality and pricing is often done in a very cursory manner. But if there is no market or the plant cannot get raw materials, it cannot be operated, yet the project loans have to be paid off. This has been well demonstrated in a number of plants that were built to make bagasse paper or panelboard from bagasse, which have been forced to close.

The international community is well aware of the problems that developing countries have in project development and in many cases have been able to offer technical assistance. For example, in Africa, the African Project Development Facility is able to help African sugar producers prepare a project and to assist them in securing finance, either from banks or appropriate sources of finance. If on the other hand the World Bank is involved in the financing, then the first stage will be a World Bank funded feasibility study to define the project, followed by a funded engineering design stage. In Latin America and the Caribbean, the GEPLACEA Sugar Diversification Programme funded by UNDP is making a co-ordination of the project identification in each member country that wishes to participate. From these identifications, the various international donors, both multilateral and bilateral, will be able to offer financial assistance to those projects that are of interest to them. The last section of this paper discusses the role of the international agencies in this respect. A brief analysis of the monthly operational summaries of the major agencies revealed that many hundreds of millions of dollars are already committed to sugar diversification and rehabilitation.

It must be pointed out that the programme of sugar diversification will require a large amount of consultancy and engineering skills as well as a considerable amount of equipment, much of which may be manufactured in the region or country itself. Hence the first major benefit for the sugar industry will be a participation in this development, by selling know-how and technology.

Concerning the development of the feasibility study, a few brief comments:

Market studies assume that a market need is the same as market demand. There may be a big need for furniture in many sugar-producing countries, and it can be made from bagasse panelboard. However if the people in that country do not have sufficient money to pay for the furniture, then no market demand can be developed. One common fallacy is to assume that the product being developed can replace an existing one or would be accepted. For example, the world market for newsprint is very good, but bagasse-based newsprint will find it hard to compete with Canadian or Scandinavian newsprint. Or the product may not meet international market specifications, or that the supply is not reliable on a year-round basis. For example the pet food industry might use torula yeast, but it requires full assurances of a constant supply. Until it is established that a supplier can be relied on to provide a regular supply of product that meets the necessary quality specifications at the international (or less) price, then market development is difficult.

Another major problem in diversification is the scale of economy necessary for export development. For example, if it is decided to develop a citric acid plant for export, then the plant will have to be sized at about 15-25,000 tons. If, on the other hand, the plant is to produce citric acid for a domestic market such as Venezuela where the local market is about 4,000 tons, a plant of 5,000 tons could be developed that would be commercially viable from its domestic sales, and then the excess could be exported. It is usually necessary to have an export outlet in order to obtain foreign exchange to amortise the plant. Though in a competitive export market the scale of economy of production is very important to allow the product to be priced low enough as to be competive. For example, Chile exports a large amount of wood pulp to both developing and industrialized countries. By having a regular supply, which is discounted at about 20-25 per cent, it has made excellent market penetration.

One big problem occurs in developing countries, where a regional market is necessary, as it is found that considerable overestimating of the market potential is often made. If any significant market is developed, then exporters from other countries will offer similar products in that market at such attractive prices that it will be difficult to compete, or the domestic producers in that market will also try to compete. Though if a joint venture is possible with local traders or producers, then it is easier to hold one's market position.

It is also most important, as stated above, to have a sufficient domestic market to make production viable without an export market, so as to minimise the investment risk. It is usually found that many international funding agencies will only fund projects where the majority of production is for the domestic market.

The supply of raw materials is most easily assured if the project is directly integrated into the sugar mill. A good example was in Thailand with the MDF production at Khon Kaen where the MDF mill is integrated to a sugar mill. The bagasse is automatically conveyed from the sugar mill and depithed in the MDF mill. The pith is returned for incineration in the sugar mill and the bagasse for MDF production. In other facilities that have to buy bagasse for paper production, any problems of supply can force the mill to be closed. When the mill is not functioning, it is not earning revenue, but is still being forced to pay out its fixed overheads. One problem of an integrated facility, other than a joint venture, is the problem of a firm used to selling sugar, being forced into a new business area, say, selling panelboard. This can often be overcome by a joint venture. Say, for example, a furniture company sets up a joint venture with the sugar mill to make MDF at the mill, and then sets up the furniture manufacturing nearby.

It must be established in the feasibility study that adequate financing is available to ensure the success of the venture. This means that enough capital must be found for both working capital as well as investment capital, for many contingencies that can occur such as delayed start-up or lack of market penetration for a limited time.

(b) Improving existing products and developing by-products

The programme of sugar diversification must provide a series of alternatives to be analysed that will allow the industry to improve their profitability, by making a more positive contribution to their foreign exchange earnings and to utilize the land in the most economic way.

Often the best solution may be to take an existing production and either improve it or adapt it. For example, many sugar producers make rum, there is some potential for making increased revenues by organizing this industry more effectively by improved marketing, better transportation, improved quality or product adaptation. The packaging can often be improved.

Product adaptation can be seen in the field of furfural, where one producer is partially converting his factory to make furfuryl alcohol.

Consideration should also be given to developing existing sugar lines to produce sugar syrups and speciality sugars. The market for some brown sugars for health foods has been fairly good as it allows these sugars to be sold at fairly substantial prices. Liquid sugar and syrup development has been very successful in a number of industrialized countries, where it has been forced on the industry by the industrial sweetener buyers.

The desire to industrialize the two main by-products of sugar, namely molasses and bagasse, has been with the sugar industry for many years, and has been a successful development in many cases, even though it has not always benefited the sugar producers themselves. In many cases however the by-product development was forced to close down. Though some areas have been very profitable, such as alcoholic beverages and industrial alcohol, speciality chemicals such as citric acid, lysine, monosodium glutamate and furfural and derivatives. The reasons for the failures however can often be traced to poor management, lack of markets, failure of raw materials, outside influences, etc. In many cases a good feasibility study could have predicted a number of the pitfalls before they became unmanageable. Decisive errors, which may not be corrected, are often made at the earlier stages of development. The market potential of most of these by-products will often be domestic or regional.

(c) The development of alternative crops

If sugar cannot be produced economically on the sugar cane lands, then sugar producing countries should study the alternative of developing new crops. During the recent supply study that ITC has been carrying out this year for GEPLACEA, it is obvious that a number of Caribbean producers are looking at alternative uses of the land ranging from developing luxury homes in new tourist development areas to planting horticultural and agricultural crops. This is an area that needs a very detailed export evaluation and is one in which the International Trade Centre has considerable experience. Most of the crops that are currently being evaluated such as melon, pineapple, banana, tomato, palm oil, rice and citrus, are all crops whose export potential is followed on a regular basis. Hence, if any party is making studies of the feasibility to develop alternative products, one source of information could be ITC, who would also make available information concerning known traders and importers of that product.

The Hawaiian Sugar Industry has had some success in the development of replacement crops, particularly in the development of a macadamia nut production.

(d) <u>Exporting engineering services in the field of sugar and sugar by-product technology</u>

There is a considerable potential in many sugar producing countries to export the technology and know-now that has been developed. India, for example, whose sugar industry is not as well developed as in many other sugar producing countries, earns significant amounts of foreign exchange in the field of agro-industry development in the sugar industry. A large number of firms in the region have the competence to earn foreign exchange in this area. Let us consider co-generation, which will be discussed below. The development of electrical energy, by selling the surplus power generated by sugar mills into the national grid, is now of great interest to many governments in those countries tht have energy shortages, and the governments do not want to make large capital investments of foreign exchange. The original design of most sugar mills was made in such a way as to maximize the use of bagasse when it was burnt as it was regarded as a waste product that required disposal. Often the thermal balances in the mills were very inefficient. So if a sugar factory wishes to be involved in co-generation it will be necessary to make a complete thermal optimization of the entire facilities. This will only be of interest if the electricity can be sold to the power industry at commercial rates. It was noted during the supply study in the Caribbean that in some countries visited, the governments were offering attractive rates for co-generation, while in other countries there was no incentive to market the surplus power. However, a considerable amount of engineering work will be done on sugar diversification and energy generation. Traditionally this engineering has been purchased from outside the region, but now the countries of the region have this capability not only in the region, but in the sugar industry itself. So why not utilize this capability and earn money in the process!

There is also a good engineering industry in many of the sugar producing countries, which is able to offer both engineering and capital equipment necessary for the development of the various facilities discussed above.

The major international financing agencies, such as the World Bank, have already provided finance for this sector and the regional development banks such as the Inter-American, Asian and African Development Banks have all provided considerable amounts of project finance.

The International Trade Centre has a programme to assist developing countries export technical consulting services and has identified the agro-industry sector as a potential market for development by developing countries. The first stage in such a development would be a supply study on the availability of technology and know-how in the region and a breakdown of the various sectors of capability. A similar study could identify the main suppliers of equipment as a combination of goods and services is even more attractive.

(e) <u>The utilization of bagasse as a fuel and the potential for co-generation</u>

The high prices of crude oil, which many of the sugar producing countries must import, using foreign exchange to pay for it, have made energy generation from bagasse an attractive proposition. There is always the argument that only surplus bagasse should be used and that half of the bagasse produced from the sugar mill is sufficient for energy production. In many mills in the region the thermal efficiency of the power houses are so low that this is not so. In order to optimize this, special bagasse-burning boilers can be used. If sugar derivative facilities such as furfural plants are built, the power consumption is very high and a complete thermal optimization programme is essential to ensure a viability of operation.

Next it is necessary to consider co-generation. The Government of India has publicly announced plans to improve the thermal efficiency of a number of the sugar factories to enable them to produce power for the grid. This is an attractive solution for a government as it minimizes the amount of foreign exchange spent to increase generating capacity. This whole concept, which is being discussed and developed in a number of developing countries, depends on the willingness of the goverrnment to pay a commercial price for the power. If they do not, then the mill makes no effort to optimize thermal output and increase generating capacity and efficiency. One of the main problems is not so much the lack of generating capacity, but the level of maintenance in the power generating capacity, but the level of maintenance in the power generating industry. Hence a well-run sugar mill that guarantees a continuous power input to the grid during the cropping season is a very valuable asset. Several international funding agencies are providing finance for this sector.

(f) Molassess as an item of international trade

Molasses is still a valuable item of international trade, and all export development using molasses as a raw material should be determined on the value of the molasses in the international market, bearing in mind that the more molasses that are taken out of international trade, then the higher will be the international price. Hence if the new facility is integrated into the sugar mill, then the processor will have some protection against rising raw material prices.

PRACTICAL EXAMPLES OF SUCCESSFUL DEVELOPMENT OF SUGAR CANE BY-PRODUCTS

Although there have been many failures, in the development of sugar cane by-product development, there have also been a number of successes.

Pulp and paper from bagasse

A number of the bagasse-based paper mills of India, Pakistan and several Latin American countries have been successful. For example, the Tamil Nadu Newsprint and Papers Limited mill in Pugalur, which produces 50,000 tons per annum of newsprint and 40,000 tons per annum of printing and writing paper from bagasse and hardwood has been a success. In the first analysis, it was found in India that there was a deficit of fibre for paper making, so bagasse was selected as the best economic raw material. The availability of sufficient hardwood pulp allowed a mix of bagasse and long fibre material to be used that produced a newsprint that was equal to the specifications to allow it to have the necessary tear factor for use on high-speed newsprinting machines. The quality produced would allow it to be exported worldwide and compete with Canadian and Scandinavian newsprint. Though it will only be used on domestic markets, since India is a net importer of newsprint; several new mills are to be built, modeled on this one.

Panelboard from bagasse

The Khon Kaen MDF plan in Thailand is another success story, as it is one of the few panelboard that use bagasse as a raw material and the panelboard has developed a good international market. However, it took some time to achieve this success, for when the plant first started up, the preparation of the bagasse was not sufficiently good as to allow the finished product to be acceptable in international markets. The MDF producer invested a further 35 million baht in the development of a bagasse preparation facility to allow the plant to produce a product of the desired specification. The product is now exported to several European countries.

For a fibreboard production for domestic use, there have been a number of small plants (10-15 tons per day), built in the People's Republic of China at a cost of $2-3 million that are able to provide the fibreboard required in the vicinity of the mill. In a similar way the mill has three lines that make packaging and writing paper, that have been developed at a similar cost.

Furfural and derivatives

Although the furfural operation in the Dominican Republic is a major success story, the smaller facility that has been built in Brazil and has added a furfuryl alcohol line is worthy of consideration. It is understood that a similar conversion is being developed in Mexico.

Citric acid from cane molasses

For many years, the major citric acid producers manufactured citric acid from beet molasses or glucose in the industrialized countries. Citurgia Ltd. in India, with the assistance of J & E Sturge from the United Kingdom, set up a facility in India to use cane molasses. It took some time to alter the micro-organism used to citric acid, and to get the importation of citric acid controlled to protect domestic industry. But this plant is very profitable, though it only supplies the domestic market.

Monosodium glutamate

Joint venture monosodium glutamate facilities in several Latin American countries have been very profitable. These joint venture partners from Japan and from the Republic of Korea have been able to control the size of supply and market development. The joint venture development of Ajinomoto in Indonesia has been so successful that Ajinomoto are developing a further plant of 18,000 tons capacity.

Lysine

The Fermentaciones Mexicana joint venture in Mexico, where Kyowa Hakko Koya provides the technology and is responsible for the international marketing, is very profitable and is expanded to match the market demand as it is developed. The Kyowa Hakko Koya Group has been very successful at keeping their supply levels at about the same level as market demand.

Fermentation alcohol

There are many distilleries in operation in many of the sugar-producing countries, manufacturing alcohol for beverage purposes as well as industrial and anhydrous grades. It is believed that the Bacardi Group is the most profitable. This is mainly because of their marketing abilities. There are some producers of anhydrous alcohol for gasohol use that are able to take advantage of the Caribbean Basin Initiative, to land their product in the United States on a tariff-free basis. The conversion of alcohol to alcochemicals is not usually profitable in international trade, but only where the chemical can be used locally and for logistics reasons or by protective measures, these chemicals do not have to compete with chemicals manufactured from petro-chemical feedstocks in industrialized countries. There are a number of alcochemicals manufactured in Brazil, India and Peru that are commercially viable.

NORTH-SOUTH AND SOUTH-SOUTH CO-OPERATION TO PROMOTE AND SUPPORT PROGRAMMES

The major development support for sugar diversification has come from a number of specialized international agencies. They have co-ordinated their efforts with many regional agencies and nongovernmental organizations such as GEPLACEA. The funding provided by the UNDP has allowed such organizations as GEPLACEA to promote and support their programme of sugar diversification in Latin America and the Caribbean. It has allowed them to get technical assistance from their own member countries as well as from industrialized countries. In Latin America, for example, three countries - Argentina, Brazil and Mexico - have formed a joint development group. Latinequip is an enterprise to support the structuring of a project, such as by-product industrialization, in Latin America, and wherever possible use Latin American goods and technical services in the development.

Since the major areas of investment in this field come from industrialized countries, and the major project financial support will come from the World Bank and the regional development banks, then the bulk of technical support and promotion will come through this group. However, this may well be augmented by support from technical groups from both developing and industrialized countries. For example, the Commonwealth Secretariat is providing technical experts to support the development of this activity from both groups. The experience in some developing countries will be invaluable. For example, the Khon Kaen Group have been assisting the development of bagasse preparation for MDF production in several new projects that are being undertaken by the European developers of the MDF technology. The Indian Group that provided the assistance in the Tamil Nadu newsprint plant hope to assist the development of more operations outside India. South-South technology and skills transfer will be most important in the industrialization of sugar by-products. It has cost the developing countries that gained this experience considerable amounts of money, so they are all hoping to get back part of their investment by marketing the skills they have gained. It must be stated here that this type of industrialization has a price and that any country that is not prepared to invest in diversification, or expects to get it for free, will have little chance of success in being able to compete in the market place. Though once the industry is operating, then technical support is always available.

The various organizations of retired executives in many industrialized countries will often be able to supply very experienced technical consultants to assist many of the development areas in sugar diversification.

Given below is a listing of firms tht have technology in various aspects of sugar diversification. This is not a complete list, but that of firms that have appeared in the literature in the areas specified. (See Annex)

ROLE OF THE INTERNATIONAL AGENCIES IN SUPPORTING SUGAR DIVERSIFICATION

The support of the major international agencies will be essential for any degree of successful development of sugar diversification. The major role of the international agenices will be twofold, to provide or to help develop project finance and/or provide technical assistance for product development, operation and exploitation of export markets.

Provision or development of export finance

Since in the majority of sugar producing countries there is a scarcity of foreign exchange that is needed for project finance, it is usually necessary for international financing agencies to co-ordinate the funding necessary for project development. A review of the current monthly operating summaries of the major multilateral funding agencies indicate that a number of sugar rehabilitation and diversification projects are already being implemented or are under consideration. Such projects include the following:

- Third Agricultural Sector Loan for Brazil to support sugar sub-sector reform ($US 300 million);

- Sugar sub-sector Adjustment Loan for the Dominican Republic to carry out reforms in the sugar sub-sector. Another loan in the Dominican Republic, co-financed by other bilateral and multilateral donors will be used in the power co-generation sector to increase the power generating capacity at a number of sugar mills to allow them to sell their surplus generating capacity to the national grid ($US 150 million);

- Guyana. An Inter-American Development Bank loan of $US 490,000 for a feasibility study of the most effective way to burn bagasse for co-generation;

- Philippines. A loan for $US 70 million is being negotiated with the World Bank for the rehabilitation of the sugar industry;

- A loan of $US 4 million was approved in 1987, for Barbados to diversify away from sugar by assisting the Government to develop a new strategy and to increase production of alternative crops. This is part of a loan of $US 5.8 million;

- A second sugar rehabilitation project obtained a $US 34 million loan in Jamaica to allow a financially self-supporting sugar industry to be developed in the public sector. This is part of a total project valued at $US 47.1 million.

Bilateral donors have also made very important contributions in project financing in this area, with a number of the major sugar by-products plants being developed in recent years being co-financed by bilateral donors. The Commonwealth Development Corporation, for example, has taken a number of equity positions in East Africa in the sugar field. The USAID are also actively involved in financing sugar rehabilitation, with projects being developed in Barbados, Dominican Republic and other countries of the Caribbean Basin Initiative (CBI).

Attention is also being given to countries that need assistance in developing projects to the point when project finance is sought. In Africa, for example, the Africa Project Development Facility was set up by the African Development Bank, Interntional Finance Corporation and the United Nations Development Programme to assist African entrepreneurs in promoting medium-sized projects. It works with the entrepreneurs to prepare a project and to secure financing, either from banks or appropriate sources of finance.

Provision of technical assistance or support

Another important function of the international agencies is to provide technical assistance and support. There are a large number of agencies providing these services and in many cases developing countries are confused by the vast amount of assistance being offered. The United Nations specialized agencies have a number of specific agencies that offer specialized services, which include:

(i) United Nations Industrial Development Organization (UNIDO) based in Vienna that has a number of sections specialized in offering technical assistance to the key areas of sugar diversification and sugar rehabilitation. The mandate of UNIDO in this area is to promote and accelerate the industrialization of such key areas as developing bagasse-based paper, alcohol and alco-chemical development, biotechnology, etc. They do this through general surveys and studies, project identification, preparation, evaluation, design, implementation, establishment of pilot plants, maintenance and repair, etc. The development in Cuba of their bagasse paper-making facilities has been made possible by such technical assistance.

(ii) International Trade Centre UNCTAD/GATT (ITC) based in Geneva could provide assistance in export development to those developing countries that are considering sugar diversification into products and services that have potential to be exported. The ITC has already worked with GEPLACEA in making a survey of a number of selected items that are produced from sugar cane and the various by-products of the sugar industry. They are also able to help identify markets for other agro-industry products other than sugar in such a programme. Once a supply of these products is available, further assistance in identifying potential buyers and then being introduced to them can often be arranged. The ITC already has a large amount of experience in the export development of most of the goods and services available from the sugar industry and those industries into which sugar diversification is planned.

(iii) Food and Agricultural Organization of the United Nations (FAO) based in Rome is primarily responsible for the development of agricultural crops and the management of these commodities. The Agricultural Services Division has experience in a number of areas of crop development, while the Plant Protection Section is able to offer assistance in this area. The FAO Investment Centre could provide assistance in developing alternative crops. They have access to finance for the development of feasibility studies necessary to initiate such development.

Outside the United Nations system, there are a number of international groups that have been active in the sugar rehabilitation and diversification field.

(iv) Commonwealth Secretariat's Industrial Development Unit based in London have provided technical assistance to this sector under funding provided by the Commonwealth Fund for Technical Co-operation (CFTC). They have provided experienced international consultants to study the potential for sugar diversification of the sugar industry in a number of ACP (African, Caribbean and Pacific) countries such as Jamaica, Trinidad and Barbados, as well as other Commonwealth countries such as Bangladesh.

(v) Centre for the Development of Industry (CDI) based in Brussels is an agency that is funded by the European Economic Community to assist setting up production in ACP countries, under joint venture, franchising, or licencing arrangements, with local businessmen. They regularly advertise in The Courier magazine of the European Community various proposals from EEC firms interested in setting up production in ACP countries. In the March/Arpil 1988 issue of The Courier, for example, there is an offer from a firm in the Federal Republic of Germany that offers technical assistance, know-how and equity participation in bakers' yeast and vinegar production. This type of participation can be most valuable where export markets are concerned and the international partner can provide an access into these markets. (It should be noted that UNIDO provide a similar joint venture service from a number of major industrialized countries and share a joint venture in Zurich with ITC that looks at joint venture participation in developing countries, where export markets are required.)

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- Licht F.O. International Molasses Report, Ratzeburg, Federal Republic of Germany, weekly.
- Official Board Markets published by Magazines for Industry, 111 East Wacker Drive, 16th Floor, Chicago, Illinois 606601, USA, weekly.
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ANNEX

International firms that are able to supply technology and assistance in sugar diversification

Alcohol and alcochemicals

Speichim
Tour Franklin
100-101 Terrasse Boieldieu
Puteau, Cedex II
92081 Paris-La Défense
France

Vogelbusch GmbH
Blechturmgasse 11
1050 Vienna
Austria

Nobel Chematur
Box 430
S-691 27 Karlskoga
Sweden

Dedini SA Particip.
Assess A Presidencia
Avenue Limeira 222
13400 Piracicaba-SP
Brazil

Agrima Project Engineering and Consultancy Services
N.K. Mehta House
178 Backbay Reclamation
Bombay 400 020

Citric acid

Mannesmann Anlagenbau AG
Theodorstr. 90
Postfach 30 07 41
D-400 Düsseldorf 30
Federal Republic of Germany

Miles Inc.
Biotechnology Products Division
Elkhart IN 46515
USA

Standard Messo Verfahrenstechnik GmbH
P.O. Box 100204
Sonnenwall
D-4100 Duisburg 1
Federal Republic of Germany

Chas Pfizer Inc.
235 East 42 Street
New York, NY 10017
USA

Sturge Biochemicals
John & E. Sturge Limited
Denison Road, Selby
North Yorkshire YO8 8EF
United Kingdom

POLIMEX-CEKOP Ltd.
ul. Czackiego 7/9
00-950 Warsaw, Poland

Furfural and derivatives

QO Chemicals Inc.
Subsidiary of Great Lakes Chemical Corp.
823 Commerce Drive
Oak Brook, Illinois 60521
United States of America

Furano Hispano-Alemana SA
Apt. 281, Torragona
Spain

Sulzer-Escher Wyss Ltd.
P.O. Box
CH 8023 Zurich
Switzerland

W. Rosenlew Ltd.
P.O. Box 51
Sf 28101 Pori
Finland

Monosodium glutamate and lysine

Ajinomoto Co. Inc.
5-8 Kyobashi I-chome
Chuo-ku, Tokyo 104
Japan

Kyowa Hakko Kogyo Co. Ltd.
6-1, I-chome
Ohtemachi, Chiyoda-ku
Tokyo, Japan

Seoul Miwon Co. Ltd. (MSG only)
7 Panghak-dong
Tobong-gu, Seoul
Republic of Korea

Miwon Co. Ltd.
52-1 Kayang-dong
Kangso-gu, Seoul
Republic of Korea

Bagasse-based paper

Technip
Tour Technip La Défense 6
Cedex 23 92090
Paris La Défense
France

Beloit Corporation
448 Hubbard Avenue
Pittsfield, Massachusetts 01201
United States of America

Tamil Nadu Newsprint and Paper Ltd.
Kagithapuram
Velayuthampalayam P.O.
Trichy District
India

Seshasayee Paper (SPB) Projects
and Consultancy Limited
109 Nungambakkam High Road
Madras 600 034
India

Peadco Division
WR Grace Natural Resources Group
2 Galeria Tower
Dallas Texas 75240
United States of America

J.E. Atchinson Consultants
Two East Avenue, Suite 212
Larchmont, New York 10538
United States of America

MEMA
12 Churchside
Vigo Village
Meopham, Kent
United Kingdom

Bagasse-based panelboard

Bison-Werke, Bähre & Greten GmbH
Industriestrasse, P.O. Box 1380
D-3257 Springe 1
Federal Republic of Germany

Elten Engineering BV
(Bagasse cement boards)
P.O. Box 15
NL 3771 AA Barneveld
Netherlands

Schenck AG
Postfach 4018
D-6100 Darmstadt I
Federal Republic of Germany

G. Siempelkamp GmbH & Co.
Maschinen und Anlagenbau
Siempelkampstrasse 75
P.O. Box 25 80
D-4150 Krefeld 1
Federal Republic of Germany

Sunds Difibrator AB
Boards Division
S-851 94 Sundsvall
Sweden

Energy conservation and crop diversification

Pacific Marine Resources
Central Pacific Plaza
220 South King Street, Suite 900
Honolulu
Hawaii 96813
United States of America

Fintrac Consulting Limited
Cuckfield House
High Street
Cuckfield
Haywards Heath
West Sussex RH 17 5EL
United Kingdom

Booker Agriculture
International Limited
Bloomsbury House
74-77 Great Russell Street
London WC1B 3DF
United Kingdom