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**Expert Group Meeting for the Latin American  
and Caribbean Region, in Preparation of the  
First Consultation on the Sugar-cane  
Processing Industry**

**Vienna, Austria, 8-10 December 1987**

**Background Paper**

**THE SUGAR-CANE INDUSTRY AND SUGAR CANE BY-PRODUCTS IN LATIN AMERICA\***

**Prepared by the  
UNIDO Secretariat**

1/92

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### Introduction

Following a decision taken at the second session of UNIDO's Industrial Development Board, held in August 1986, the First Consultation on the Food-Processing Industry with emphasis on sugar-cane processing will be convened in the biennium 1988-89. In order to identify the priority issues to be submitted for consideration at the Consultation, the UNIDO Secretariat is organizing regional and expert group meetings, one of which is the Expert Group Meeting for the Latin American and Caribbean region. This meeting is expected to advise UNIDO on the selection of regional priority issues for subsequent submission to the Consultation itself.

Latin America is one of the principal producers of sugar in the world (28.3% in 1986/87 with exports of 39.6%). The cane sugar industry in the region has occupied a privileged position within industrial activities carried out on this continent. In view of the importance of sugar for the countries of South America and the Caribbean, the present situation on the world sugar market may have serious consequences for their economies. It could also trigger off the "multiplier chain" and influence other branches of industry and agro-sectors. Added to the structural problems are the high stock volumes and prices which are below the stimulative production cost.

This information paper, prepared by the Secretariat, covers not only the general aspects of and data on the sugar-cane industry in Latin America but also presents some facts and figures on sugar-cane by-products which are viewed as promising alternatives for the development of the industry. Many export-oriented economies, especially in Latin America, have already started to analyse and introduce the production of sugar by-products and derivatives to diversify the market and acquire wider economic independence and stability. The information presented might be of interest to the participants and may serve as background for discussions and evaluation of the prospects for the development of the sugar-cane industry in Latin America at the Consultation.

I. The Sugar-cane Industry in Latin America

Production

1. Sugar is obtained from two main sources: beet and cane. Cane sugar represents about 63% of the world sugar output.

2. Since sugar-cane grows in tropical and sub-tropical regions, nearly all Latin American countries are producers.

3. The region's current production amounts to 29 mt. It is the number one producer in the world with a share of 28% of the world's sugar production and 50% of total sugar-cane output.

Table 1

Sugar Production  
(1000 tons raw equivalent)

	1986/1987		1985/1986		1984/1985		1983/1984	
World total	101845		98497		100433		98011	
Latin America total	28809		27011		29079		30429	
share	28.32		27.47		29.98		31.05	
Of which	<u>% world total</u>		<u>% world total</u>		<u>% world total</u>		<u>% world total</u>	
Cuba	7200	7.4	7347	7.4	8101	8.3	8331	8.3
Dominican Rep.	830	0.4	799	0.8	1043	1	1192	1.2
Mexico	4080	4	3994	4	3489	3.4	3297	3.3
Argentina	1119	1	1259	1.2	1317	1.3	1525	1.5
Brazil	9179	9	7371	7.5	8704	9	10211	10.5
Colombia	1317	1.3	1216	1.2	1367	1.3	1274	1.3

Source: F.O. Licht, 1987.

4. As can be seen from Table 1, the main producers in Latin America are also major participants in the world sugar market:

Brazil is the world's largest producer with an output of more than 9 million tons in 1986, which accounts for 9% of the world total.

Cuba, where sugar is the key sector of the economy, produces 7.2 million tons, 7.4% of world total.

Mexico and Argentina also produce significant amounts, namely 4% and 1% respectively of world output.

5. The amount of land planted in the region accounts for 7 million hectares and the production is processed in some 650 sugar mills and alcohol distilleries.

6. The sugar industry employs 2.5 million Latin Americans.

#### Characteristics of sugar cultivation and processing

7. Sugar-cane cultivation in Latin America is characterized by high costs of growth, harvesting and transportation.

8. Field work represents 60.8% of the total production cost:

The size of the areas devoted to sugar differs greatly, from 50,000 acres to 5 million and great differences can be noted in yields.

Varietal development is not widespread in Latin America; many commercial varieties are used.

Fertilizers are not used adequately; in the past five years the harvested area increased by 7% while cane productivity only increased by 1%. Sugar-cane has suffered from neglect.

Machinery for land preparation, sowing and cultivation has grown in the region as a whole, but some countries remain far behind -

Oxen are still used for land preparation;

More than 70% of cane delivered to sugar mills is cut by hand;

Lack of skills among labour has led to improper use of machinery.

Transportation is undertaken by carts or wagons, pulled by tractors, and with trucks and rail, but ox-drawn carts are still widespread.

The pricing system in force in many countries does not offer incentives to producers for improving the quality of sugar-cane so that technological development remains limited.

Remarks on the sugar mills

9. In Latin America, techniques and equipment dating from the turn of the century co-exist with isolated advances introduced through technology transfers.
10. Very little can be done for diversification, competition, pollution and energy savings because of insufficient financial possibilities.
11. The machinery is often obsolete, energy is wasted and pollution from the burning of sugar-cane and its by-products is high.
12. The sugar industry is also known for its lack of organised maintenance based on preventive and more destructive techniques.

Consumption

13. Sugar is a very important element in the diet of the Latin Americans, since it is a significant nutrient in countries where nutrition is a serious problem.

Table 2  
Sugar Consumption  
(1000 tons raw equivalent)

	1986/1987		1985/1986		1984/1985		1983/1984	
World total	102791		100766		98430		96328	
Latin America total	18024		17397		16349		16095	
share	17.54		17.27		16.61		16.72	
Of which	<u>% world total</u>		<u>% world total</u>		<u>% world total</u>		<u>% world total</u>	
Cuba	787	0.7	913	0.9	761	0.7	748	0.7
Dominican Rep.	318	0.3	292	0.3	281	0.3	260	0.3
Mexico	3846	3.7	3717	3.7	3449	3.6	3230	3.3
Argentina	1053	1	1057	1	987	1	1341	1.4
Brazil	6946	6.6	6379	6	6009	6	5966	6.2
Colombia	1074	1	1066	1	1019	1	1002	1

Source: F.O. Licht, 1987



14. Consumption of sugar in Latin America amounted to approximately 18 million tons in 1986. Between 1970 and 1984, the consumption of the region grew at a yearly rate of 3.4%, i.e. from 10 million to over 16 million. The past two years confirm this trend. However the consumption growth lies below population growth which amounts to 7%.

15. In absolute terms consumption grew over 60% between 1970 and 1984 and if this trend continues, consumption could reach 26 millions tons by the end of the century, and practically all sugar produced would be for internal consumption by the year 2000.

#### Comparative figures

16. Latin America's actual per capita consumption amounts to 42 kg; the world average is approximately 20 kg a year. The region's rate of consumption growth is nearly 40% higher than that of the world total and the current regional consumption is double the world's per capita average.

17. The trend differs according to the size and development level of the country: Brazil accounts for more than 38% of the region's consumption and therefore plays a major role in the evolution of the growth rate. Its consumption increase between 1985 and 1987 was around 6.3%, the regional rate was 5.5%.

18. Latin America's consumption in world consumption has continued increasing: it was 14.3% in 1970, 17.7% in 1984 and should reach 19% by 1990.

19. The penetration of other sweeteners: caloric or non-caloric is very low in this region. Only Argentina produces significant quantities of high fructose corn syrup.

#### From an export-oriented to a domestic-oriented production

20. A very important point in the evolution of the sugar industry in Latin America is the recent shift from a traditionally export-oriented industry to one geared mainly towards domestic consumption.

21. In 1970, consumption represented 46% of the total production; in 1984 the share grew to 55% and in 1986 reached 66%.

22. Two reasons may explain this shift: the increasing internal consumption as a consequence of lower prices in the mid 1970s and the changes that occurred over the past ten years on the sugar market.

#### Trade

23. Sugar is the third major source of foreign currency for Latin America, after oil and coffee.

24. In 1986, the region exported more than 10 mt; it is the major producer in the world with almost 40% of the world sugar exports (see Table 3).

25. The region's first exporter is Cuba with more than 73% of Latin America's total and 24% of the world's total. Brazil follows, representing 12% of the region's total and 4.7% of the world's total.

Table 3

Sugar Trade in Latin America  
(1000 tons raw equivalent)

	1986/1987				1985/1986				1984/1985				1983/1984			
	Imports		Exports		Imports		Exports		Imports		Exports		Imports		Exports	
World	26711		27125		28358		28986		28409		30026		29121		30005	
Latin America	530		10692		566		12153		655		13970		1490		13482	
Total	1.98		39.62		1.99		42.01		2.3		46.72		5.11		45.04	
Share																
Of which:	<u>% world total</u>		<u>% world total</u>		<u>% world total</u>		<u>% world total</u>		<u>% world total</u>		<u>% world total</u>		<u>% world total</u>		<u>% world total</u>	
Cuba	0	0	6335	24	0	0	6947	25	0	0	7633	25	0	0	6840	25
Dominican Rep.	0	0	608	2.27	0	0	471	1.6	0	0	786	2.6	0	0	913	3
Mexico	0	0	276	1	0	0	174	0.6	0	0	22	0.07	405	1.3	15	0.05
Argentina	0	0	90	0.3	0	0	87	0.3	0	0	330	1	0	0	653	2.1
Brazil	0	0	1284	4.7	0	0	2606	9	0	0	3256	11	0	0	3012	10
Colombia	0	0	219	0.8	0	0	199	0.6	0	0	317	1	0	0	234	0.7

Source: F.O. Licht, 1987

26. Cuba dedicates the major part of its production to export, whereas Brazil as well as Mexico and Argentina which have larger absorption capacities, dedicate the major part of their production to consumption and the rest to export.

27. For smaller countries such as the Dominican Republic, Guyana and Belize, sugar accounts for more than 30% of the country's total exports.

28. The participation of the region in world total exports has continued to fall in the last 15 years - from 53% to 40% - while imports rose from 1% to 2%.

29. The destination of export has also changed as a consequence of the narrowing of the traditional markets. Sales to the United States, Japan and the EEC fell from 44% to 19% of total exports while those to the Soviet Union and China increased from 23% to 44%. The USSR is about to become the region's main customer with 35% of the total exports.

#### Consequences for Latin America's income

30. The income of foreign currency has been sharply affected. In 1974, 8445 million MTRU of sugar was sold to the free market for US\$5.511 billion. It was a very good year, and prices were high.

31. In 1985, the sales fell to 6.950 million MTRU, for a value of US\$1.079 billion.

32. As sugar is important to the economy of many Latin American countries, the problem is all the more acute for their trade balance in the context of lack of capital, of general financial difficulties and economic stagnation.

## II. Sugar-cane By-products in Latin America and in the World

### Presentation of by-products

33. In view of the current economic situation of the sugar-cane industry the search for alternative or supplementary activities within the industry is a reality which calls for minimizing the economic problems caused by the serious crisis of sugar oversupply on the world market. One of the ways to deal with this problem is the diversification of the sugar-cane industry, which means among others the rational use of available resources and by-products.

34. The use of by-products and the production of derivatives began several years ago in Latin America and in particular in member countries of GEPLACRA. Not all efforts have been successful; many of them are on the verge of achieving their objectives, some of them have failed and resulted in losses of investments and time. Nevertheless, within the current need to diversify the sugar-cane industry in Latin America and the Caribbean, a number of countries of the region continue to initiate and carry out programmes of this kind with short, medium and long-term targets.

35. Sugar-cane is a very valuable raw material with various potential fields of application. The purpose of its diversified use and the so-called industrialization is not only focused on the elimination of existing extra stocks and support of the world prices by cutting down export supplies, but also presents good opportunities for the whole economy of the region in general. The following considerations, published in the GEPLACRA papers, are of relevant importance:

- The development of by-products will make it possible to diversify the economies of the sugar exporting countries to eliminate their dependence on a single product.
- The growing scarcity of many non-renewable raw materials gives bagasse, one of the principal by-products, an advantage in the production of pulp, paper and fibreboard.
- By-products can be used as a source of export with which to earn hard currency.
- The scarcity of fodder in many countries makes molasses, pith, cane trash and cane top increasingly important as cattle feed.
- The direct use of sugar cane as a raw material may help to solve food problems.
- The by-products of sugar-cane are becoming a tangible and promising source of energy in some countries with an inadequate supply of oil.
- There are new possibilities opened up in the chemical industry to use the sugar-cane by-products for further steps of processing.

36. These outlines are based on the factual development of the sugar industry and the ad hoc manufacturing of by-products on an experimental basis.

37. Prior to the start of massive production of fuel alcohol in Brazil in 1975, the chemical industries had provided additional outlets for sugar in times of oversupply and depressed prices. In the late 1980s the low prices for sugar which then prevailed led to purchases of sugar by manufacturers of alcohol and chemicals as an alternative feedstock for their operations. Such transactions played a significant part in reducing the volume of excess sugar supplies but over the years the picture has changed with important implications for the sugar market due to the drop in oil prices, technological obstacles in the way of a massive introduction of "exotic" fuels, infrastructure problems, etc.

38. Nevertheless, this initial experience led to the conclusion that the diversification of the sugar industry is the only way to stabilize growth rates or at least to preserve the volumes of production in this sector of economy at a given level.

39. Until now, the main efforts of the sugar-producing and sugar-exporting countries have concentrated on several components of sugar-cane processing such as cane tops, bagasse, molasses and filter muds.

The potential use of by-products

Cane tops

40. Cane tops have always been used as fodder but on a very limited scale. 130 million tons are produced annually with about 28% dry matter, but most of it is left in the fields. Its value can be considered to be approximately \$10 per ton fresh.

Bagasse

41. The bagasse is the fibrous residue that is obtained in the milling station of the sugar factory during the extraction of juice. In comparison with other vegetable residues, bagasse as a fibrous material, has a series of properties with the greatest possibilities for industrial use, since large amounts are available (its production amounts to approximately 150 million tons yearly). From the industrial point of view, the bagasse can be divided into two fractions: the fibre (70% of the whole bagasse) and the pith (30%).

42. The fibre constitutes the industrially required fractions for the production of pulp, paper and particle boards.

43. The most extended uses of bagasse are as a raw material for the manufacturing of pulp, paper, particle boards, furfural and of course, as fuel in the boiler furnaces of the sugar mills, 1 t bagasse (dry basis) being equivalent to 0,34 t fuel oil. Bagasse can also be used for animal feed.

Utilization as fuel

44. Before 1973, when light crude oil was at lower than \$3 per barrel and electricity was US cents 2 per kWh, there was no incentive to use surplus bagasse as fuel. However, after the price rises of 1973 and 1979, the situation changed and even if the barrel of crude oil, after climbing to US\$34 has dropped since the beginning of 1986, the generation of electricity from surplus bagasse is an economic potential in most non-oil producing Third World countries.

45. The use of bagasse as a domestic and industrial energy source is one which can have good economic and social benefits. The following comparison of heat values illustrates the basis for this assertion:

Table 4

	(BTU) per pound
Bagasse (field moisture)	3,900
Bagasse (bone dry)	8,350
Peat	500 - 3,400
Wood (air dried)	3,500 - 4,500
Lignite coal	5,500 - 12,000
Charcoal	11,000 - 13,000
Bituminous coal	11,000 - 16,000
Anthracite coal	15,000 - 16,500

Source: World Bank

46. As a rough indicator, bagasse briquettes could be produced in some regions at about US\$ 30 per ton whereas firewood in many cane growing countries sells at US\$ 35-70 per ton. Charcoal could be produced at US\$ 55 per ton under the same assumptions and commonly sells for between US\$75 and US\$ 100 per ton.

47. Today, countries having a large sugar production per capita (say 500 to 600 kg) such as Fiji, Barbados, Mauritius, should be in a position to generate a fair percentage of their national electricity requirement from surplus bagasse.

#### Production of fibrous products

48. The main fibrous products are pulp and paper, particleboards and fibreboards.

#### Pulp and paper

49. The establishment of a paper industry has become an important element in the development programmes of many countries, due mainly to the problems they face in acquiring pulp since supplies of wood have been nearly exhausted in some areas.

50. More than 70 factories exist having a total production capacity of nearly 25 million tons per year. In addition, new installations are being projected to produce different kinds of pulp and paper.

51. The factories are located on each continent where sugar-cane is grown. More than 27 countries use bagasse for producing pulp and paper, most of which are in Asia and Latin America. Mexico, Peru, Argentina, Cuba, Brazil and Colombia are the largest producers in Latin America. In Latin American and Caribbean countries, there are 43 factories producing cellulose from bagasse, with an installed capacity of over one million tons annually. Of these 43 plants, 33 operate normally while the other factories are shut down for a variety of reasons such as lack of raw material, pollution problems, and economic difficulties.

52. The price of pulp and paper has risen recently, and it is forecast that pulp will be worth close to 600 dollars per ton in the future, which will cause difficulties for paper producers and pulp importers.

53. The pulp and paper industry based on bagasse has expanded considerably due to the rising prices of these products and the scarcity of renewable raw materials.

54. The world trend shows a considerable increase in the production of paper from bagasse in the last 20 years. Most sugar-cane producing countries have a need for paper, and new factories would meet their domestic market needs.

### Particleboard and fibreboard

55. The production of fibreboard and particleboard from bagasse has a sound commercial outlook provided that a sufficiently large local market exists for this material.

#### Particleboard

56. This product could be widely used, especially in the furniture industry. A close relationship exists between the furniture and the panel industries, and in some countries they operate as a single unit. Particleboard is used in kitchen furniture, wardrobes, desks and other household furniture.

57. For the Latin American and Caribbean region, particleboard production is mainly concentrated in Cuba, which has eight plants for manufacturing bagasse panels.

#### Fibreboard

58. Fibreboard is used mainly in the construction industry (for room divider panels, doors, thermal and acoustic insulation and for other decorative purposes after the surface has been adequately treated). It is also used in the furniture industry for cabinets, drawers, etc.

### Production of chemicals

59. Furfural is the most important by-product in this field. It is used as a raw material for the production of furfuryl alcohol, tetrahydrofuran and other derivatives.

60. World production doubled in the last decade. More than 90% of all the furfural produced is used in the industrialized countries, the main importer being the European Economic Community.

61. There are approximately ten factories in the world that produce furfural from bagasse, and others are planned in different countries. Generally speaking, there is a surplus plant capacity in the world for furfural and the production of furfuryl alcohol might have a better potential for countries with appropriate chemical expertise.

#### Filter cake

62. Filter cake is the waste from the filtration of juice in sugar production. The amount of filter cake obtained differs from one sugar mill to another and even within a single sugar mill, since it depends on many factors including the clarification system, extraction technology, and variety of sugar cane.

#### Molasses

63. This by-product has a broad spectrum of utilization.

64. In Latin American and the Caribbean countries the yearly production of molasses, taking beet and cane molasses together, is 37 million tons and export of this commodity has reached 7 million tons.

65. The major consumers of molasses are the United States, Japan and the EEC. These markets consume around 80% of the total world molasses supply. The price of molasses is characterized by great fluctuations on the world market. Nearly all the molasses on the international market come from sugar-cane. The sugar beet countries consume their own molasses.

66. The main industrial use of blackstrap molasses is in alcohol production. This industry exists in nearly all the sugar-cane producing countries. The production of potable alcohol from molasses is very important in many countries.

67. Industrial alcohol can also be obtained from molasses; most importance being placed on the production of ethanol.

68. Molasses can be used to make various other products such as lysine, yeast, citric acid and monosodium glutamate.

69. Molasses is also used in cattle-feed production.

Table 5

Products obtained from molasses

<u>Direct utilization:</u>	- Exportation - Fertilizer - Animal feed
	- Rum - Ethyl alcohol - Rectified spirits
<u>Distillery industry:</u>	- Anhydrous alcohol - Alcohol derivatives
	- Vinegar and acetic acid
<u>Other fermentation industries:</u>	- Butanol-acetone - Citric acid - Lactic acid - Glycerol - Yeast (baker's) - (fodder)
<u>Miscellaneous</u>	- Aconitic acid - Monosodium glutamate - Dextran - L-Lysine



### Yeast

70. Yeast production is a very ancient industry. Its technology is well known throughout the world. Among the best known yeasts are saccharomyces and torula yeast.

71. There are no significant technological difficulties involved in yeast production. Equipment traditionally used in the fermentation industry mainly comprises fermenters, stirrers, pumps and tanks.

### Lysine

72. Lysine is an essential amino acid used as an additive to animal feed. It is mainly produced in France, Czechoslovakia, Bulgaria, the USSR, Japan and Mexico. In the latter two lysine is produced from sugar-cane.

### Citric acid

73. Citric acid is obtained by fermenting molasses. It is used in food products and beverages as an acidifier, to bring out flavour and as a preservative.

### Monosodium glutamate

74. It is one of the best-known flavourings in the food industry, used in the form of a white crystalline powder. The main producer is Japan followed by the United States, France, Italy and the EEC countries. The technology for producing monosodium glutamate is rather sophisticated.

### Dextran

75. Dextran is a polymer of glucose with high molecular weight.

76. As a conclusion it can be said that some of these by-products have relatively small or saturated markets, other require substantial investments and are subject to economies of scale (e.g. pulp and paper). The important issue at this stage is that opportunities have not been adequately explored in many countries, and any evaluation of sectoral development should be taken into account when planning domestic food, feed and energy markets. Animal feed/litter, building materials, charcoal, fuel briquettes, electricity generation and potable and fuel ethanols appear to be the most promising for further evaluation.

## III. Production and Consumption of the Main By-products

### Bagasse

77. Bagasse is produced at the rate of approximately 150-200 million tons annually (with mill run basis and 50% moisture). The main producers are South and Central America with 116,310,000 mt in 1984 especially Brazil, Mexico and Cuba.

**Table 6**

**World Bagasse Production**  
(in 1000 mt)

	1975	1979	1980	1981	1982	1983	1984	1985
N-America	8,248	8,029	7,844	9,456	8,146	9,346	8,367	9,168
Europe	85	16	10	56	66	62	48	46
Africa	16,800	19,653	18,934	20,539	22,358	20,306	22,161	23,862
Centr. America	41,340	47,747	42,255	37,071	40,570	40,195	43,249	40,528
South America	35,878	39,129	42,993	53,313	59,083	68,484	73,061	76,806
Asia	42,210	52,466	42,996	55,226	71,024	66,193	63,701	65,270
Oceania	10,478	11,147	12,611	8,181	8,820	8,659	8,268	7,322
<b>WORLD</b>	<b>140,978</b>	<b>155,039</b>	<b>178,187</b>	<b>167,643</b>	<b>183,842</b>	<b>210,067</b>	<b>213,245</b>	<b>218,855</b>

Source : Energy statistics yearbook United Nations 1981, 1984 and 1985

78. Most of the bagasse is used to generate the steam and energy required by the sugar factories and approximately 8 million tons are available as surplus for paper, board, etc.

Paper

79. Bagasse is used for producing cellulose for the paper industry, which is a basic element in the development programmes of many countries, due to the problems some countries face in acquiring pulp, since supplies of wood have been exhausted in some areas.

80. About 27 countries use bagasse for producing pulp and paper, most of which are in Asia and Latin America where 43 plants are recorded with an installed capacity production of over 1 million tons annually.

Board

81. There are approximately 40 bagasse plants that produce fibreboard and particleboard in the world, of which 25 produce particleboard and 15 fibreboard. The production capacities of these plants range from 3,000 to 39,000 tons per year.

82. In Latin American and Caribbean countries there are 19 plants which produce boards from bagasse, 15 of which produce particleboard. Their total production capacity reaches 1,360 MT/D, ranging from 30 to 470 MT/D.

Furfural

83. Between 70%-75% of all the furfural produced in the world is turned in furfuryl alcohol which from the commercial viewpoint is the most important chemical derivative of furfural and is mainly used in the production of furan resins.

84. Around the world there are approximately 10 plants that make furfural from bagasse and others are being planned in different countries. In member countries of GEPLACEA production began in the Dominican Republic which between 1983 and 1984 produced about 340 MT through a discontinuous process which calls for 25 t of bagasse to produce 1 mt of furfural. Brazil has also been producing furfural since 1975 through this process and its production reached 2,395 mt and 2,940 mt of furfuryl alcohol in 1987.

Molasses

85. The world production of molasses fluctuates around the level of 36 million tons yearly and cane molasses is produced at the rate of 20 million tons yearly but only 6 million tons are exchanged on the international market with the remaining 14 million being consumed by the producers themselves.

86. The main producer is the Latin American and Caribbean region which produces nearly 13 million tons of cane molasses with Brazil in first place (5,339,870 t in 1986/87) followed by Cuba (2,320,000 t in 1984/85) and Mexico (1,425,000 t in 1984/85).

Table 7

World Molasses Production  
National crop years  
(in 1,000 tons)

	1984/85	1983/84	1982/83	1981/82	1980/81	1979/80
North America	1,755	1,752	1,663	1,789	1,737	1,785
West Europe	4,669	4,587	5,344	5,183	4,204	4,209
East Europe	5,017	4,803	4,985	4,311	4,234	4,637
Africa	2,507	2,261	2,507	2,335	2,122	2,180
Cent America	5,464	5,400	5,017	5,389	4,893	4,901
South America	7,571	7,509	6,942	6,612	6,909	7,320
Asia	8,331	8,306	9,330	9,493	6,674	5,225
Oceania	938	818	879	871	842	741
<b>WORLD</b>	<b>36,252</b>	<b>35,436</b>	<b>36,667</b>	<b>35,983</b>	<b>31,615</b>	<b>30,998</b>

Source: FO Licht 1985

87. Nearly all the molasses on the international market come from sugar-cane since the sugar beet countries consume their own molasses.

88. The main molasses-consuming countries are developed countries, in particular the EEC, the United States and Japan. These 3 markets consume around 80% of the total world molasses supply.

Table 8

Molasses Imports in Selected Countries  
(in 1,000 mt)

	1982/83	1983/84	1984/85	1985/86
North America (USA)	1,725 (1,584)	1,533 (1,350)	1,783 (1,661)	1,500 (1,360)
EEC	3,609	3,702	3,172	3,161
Eastern Europe	150	90	98	114
Asia (Japan)	1,203 (915)	1,096 (814)	1,049 (769)	1,060 (780)
Other countries	85	136	55	65
<b>TOTAL</b>	<b>6,772</b>	<b>6,557</b>	<b>6,157</b>	<b>5,900</b>

Source: GEPLACRA bulletin vol IV N-3 March 1987

89. The EEC is currently the major importer of molasses, having replaced the United States a few years ago. Its imports have risen in the last ten years but have currently stabilized at approximately 2,5 to 3,0 million tons.

90. The United States also represents an important molasses market for the member countries of GEPLACRA. These accounted for 53% of the total American molasses imports in 1985 (60% in 1984) and that can be explained by the geographical situation.

91. Australia and South Africa are also two other main molasses suppliers of the United States.

92. Japan is another large molasses importer, with annual figures of nearly 700,000 to 900,000 t.

93. As far as exports are concerned, nearly 5,575,000 mt molasses were exported in 1985/86 (a decrease in comparison to 1982/83).

94. The most important exporting region is Asia, and particularly Indonesia, Thailand and the Philippines followed by the member countries of GEPLACRA with Brazil (500,000 mt cane molasses exported in 1985/86), Cuba (200,000 mt) and Mexico (178,000 mt).

Table 9

Molasses Exports in Selected Countries  
(in 1,000 mt)

	1982/83	1983/84	1984/85	1985/86
North America	425	501	451	397
South and Cent America	953	1,529	1,344	1,382
EEC	1,081	738	694	615
Africa	724	387	619	544
Asia	3,060	2,911	2,237	2,055
Oceania	316	301	442	332
Other countries	83	257	250	250
<b>TOTAL</b>	<b>6,642</b>	<b>6,624</b>	<b>6,037</b>	<b>5,575</b>

Source: GEPLACRA Bulletin vol IV N-3 March 1987

95. The prospects of the world molasses market are hard to predict given the lack of reliable statistics. However it appears to be a market with little growth in the United States and slightly more in the other principal markets such as the EEC, Japan and other Western European countries.

96. As far as the member countries of GEPLACRA are concerned, their own domestic consumption has been increasing, primarily for animal feed and more recently in the production of alcohol.

Fuel alcohol programmes in Latin American and Caribbean countries

97. Between 1977 and 1984, there was a seven-fold increase in world production of ethanol, primarily for fuel purposes. This has resulted for the most part from the shift in relative prices of petroleum and sugar.

**Table 10**  
**Summary of Ethanol Production Capacity**  
**(Million liters per year)**

	1977	1984	Construction	
			In progress	Planned
<u>Developed Countries</u>	<u>N/A</u>	<u>2,750</u>	<u>368</u>	<u>417</u>
of which - USA	38	1,643	360	367
<u>Developing Countries</u>	<u>N/A</u>	<u>10,850</u>	<u>574</u>	<u>2,449</u>
Of which - Brazil	1,210	10,000	508	686
- Other South American	-	309	40	880
- Central Amer./Car.	-	137	18	239
- Africa	-	88	-	128
- Asia	-	<u>470</u>	<u>8</u>	<u>516</u>
<u>TOTAL</u>	1,850	13,600	942	2,866

Source : Compiled from World Bank Working Papers.

98. In Latin America, Argentina, Brazil and Paraguay, have already initiated Fuel Alcohol Programmes. Bolivia, El Salvador, Guatemala, Panama, Peru, Dominican Republic and Uruguay are currently considering the possibility of setting up programmes of this kind.

#### Alcochemistry in Brazil

99. The case of Brazil is of particular interest because it has the largest and most comprehensive scheme for ethanol production and because its production costs are the lowest in the world, therefore constituting a "best case" analysis for substitution.

### The Brazilian National Alcohol Programme

100. The Brazilian alcohol industry emerged as a consequence of its huge industrial complexes for sugar production, which needed a rational outlet for molasses. In 1929, the Great Depression seriously affected the Brazilian sugar industry because it brought international sugar prices down to drastically low levels, forcing the Brazilian Government to intervene in this sector of the economy so as to curb the effects of the crisis. One of the first measures adopted made it compulsory to blend 5% alcohol with gasoline. Thus Brazil has been producing alcohol for fuel since the 1930's.

101. Brazil adopted its national alcohol fuels programme, PROALCOOL, in 1975 in response to rapidly increasing oil import costs, as well as falling sugar prices. The objectives of this programme were the following:

- to increase the growth of sugar-cane and other biomasses for energy purposes;
- to reduce the dependence of import energy sources and feedstocks through large-scale use of local renewable resources such as ethanol;
- to reduce regional imbalances and improve the per capita distribution of income by expanding and increasing the nation's agroindustrial activities associated with the production of alcohol;
- to dynamize the capital goods sector through the increased demand for equipment to expand and build new distilleries;
- to minimize the costs of transporting feedstocks and energy sources;
- to reduce expenditures for imported oil, thus directly benefiting the balance of payments.

102. An output of 5 billion liters of alcohol was originally forecast for 1985. In 1979 the PNA was reformulated and a target output of 10,7 billion liters was set for 1985. Brazil is both the largest ethanol producer in the world and the country that has developed the alcochemical industry to the greatest extent at the world level. It now has 11 industrial complexes in which the following products are obtained: ethane, acetaldehyde, acetic acid, acetates, ethylic esters, ethylamines and ethyl chlorate.

103. It is estimated that the PROALCOOL Programme has created 600,000 new jobs (direct).

104. More than 60% of all Brazilian cars are nowadays fuelled by alcohol and about 90% of all new cars manufactured in Brazil run solely on alcohol.

105. This remarkable technological success is not without its problems. The basic issue remains the cost of alcohol in relation to oil-based fuels.

Statistical analysis of the Brazilian ethanol market

Production statistics

Table 11

Brazilian Alcohol Production from 1970/71 to 1984/85  
(1,000 liters)

SUGAR CANE CROP YEAR	ANHYDROUS (200 proof)	HYDRATED (185 proof)	TOTAL
1970/71 a)	252 397	384 841	637 238
1971/72 a)	389 984	223 084	613 068
1972/73 a)	388 891	292 081	680 972
1973/74 a)	306215	359 764	665 979
1974/75 a)	216 528	408 457	624 985
1975/76 a)	232 621	323 006	555 627
1976/77 a)	300 340	363 682	664 022
1977/78 a)	1 176 948	293 456	1 470 404
1978/79 a)	2 095 597	395 006	2 490 603
1979/80 a)	2 713 360	683 095	3 396 455
1980/81 a)	2 104 027	1 602 348	3 706 375
1981/82 a)	1 453 098	2 787 025	4 240 123
1982/83 a)	3 550 401	2 268 693	5 819 094
1983/84 b)	2 471 078	5 403 221	7 874 299
1984/85 b)	2 102 585	7 148 967	9 251 552
1985/86 b)	3 207 871	8 610 870	11 818 741
1986/87 b)	2 127 517	8 192 003	10 319 520
1987/88 c)	-	-	13 237 000

- a) June/May
- b) May/April
- c) Projection

Source : F.O. Licht

(Internationaler Melasse- und Alkoholbericht - June 1987)



106. As can be seen from the previous table, since 1977 production has been increasing very quickly. Over 60% of the entire cane crop is now channelled to distilleries.

107. The share of anhydrous alcohol in the total production is also increasing: it amounted to 73,9% in 1986. In 1986/87, for the first time, a backward movement was recorded due mainly to a drought during the preceding year.

#### Consumption and exports

108. In 1984, Brazil used about 75% of its ethanol output for domestic fuel purposes in a ratio of two-third pure alcohol and one-third in gasoline blends for older engines. In addition, 6,3% was used by the chemical industry and nearly 7% was channelled to other internal uses. The balance of just over 11%, or nearly one billion liters was mainly exported to the United States.

#### The perspectives for the Brazilian alcochemistry

109. The Brazilian alcochemical industry dates back over half a century and great progress has been made over the past decade particularly because of the Government policy to fix alcohol prices at levels equal to gasoline prices.

110. The economics of alcochemical processes compared to prices of petrochemical products are linked to the price of oil on the international market. That is, the rising prices of oil make alcochemistry more feasible and vice versa, when oil prices are low, alcochemical processes are no longer economically feasible. In short, the future of alcochemicals is linked with the behaviour of international oil prices.