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STRUCTURE AND PERFORMANCE OF THE SALVADORAN SUGAR INDUSTRY

for

USAID/El Salvador

Prepared By CARANA Corporation

and

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UNITS OF MEASUREMENT EMPLOYED

Dimension & Unit	Abbrev.	Equivalents		
Weight		**LB**	**lb**	**kg**
Local (Spanish)				
Libra	LB	1	1.014	.460
Quintal	Q	100	101.4	46.0
Tonelada	T	2000	2028	920
U.S. (English)				
Pound	lb	.986	1	.454
	cwt	98.6	100	45.4
Hundredweight	t	1972	2000	907
Short ton				
Metric				
Kilogram	kg	2.174	2.205	1
Metric Ton	TM	2174	2205	1000
Area		**mz**	**ac**	**ha**
Local (Spanish)				
Manzana	mz	1.000	1.722	.697
U.S. (English)				
Acre	ac	.581	1.000	.405
Metric				
Hectare	ha	1.435	2.471	1.000
Volume		**GAL**	**gal**	**l**
Local (Spanish)				
Galon	GAL	1.000	1.005	3.768
U.S. (English)				
U.S. gallon	gal	.995	1.000	3.785
Metric				
Liter	l	.263	.264	1.000
Currency		**C**	**$**	
Local				
Colon	C	1.000	.125	
U.S.				
Dollar	$	8.000	1.000	

I. SUMMARY AND CONCLUSIONS

A. Introduction

CARANA Corporation was retained by USAID/El Salvador to assess the structure and performance of El Salvador's sugar industry and to provide information for use in the mission's policy dialogue with the Government of El Salvador (GOES), especially as related to privatization and price and trade liberalization.

The principal research questions, as defined in the Scope of Work, are listed below and identified by the relevant section of the report:

- Historical performance trends, including sugar industry responses to market forces (Section II for overall role of sugar in agriculture, Section III for market trends and implications, and Section IV for cane and sugar production and performance trends).

- Current state of the Salvadoran sugar industry (Section IV).

- Relevant policies and their impact, including quantification of results under alternative policy scenarios (Section V).

- Competitiveness of the Salvadoran sugar industry and implications for privatization (Sections I, IV and V).

The report has been structured in five principal sections. Section II presents a brief overview of the sugar industry in the context of the Salvadoran economy. Section III provides an analysis of product/markets, and emphasizes the point that policies affecting the future of the industry must be market rather than production driven. Section IV provides a detailed review of both the cane growing and processing components of the sugar system in El Salvador, including structure, current operations and techniques, and indicators of technical and economic performance. The final section reviews key policies that impact the sugar industry and quantifies the likely results in terms of revenues, costs and value added under four alternative scenarios. Appendices provide greater detail on the international sugar market (A), performance indicators by mill (B), field visits to the factories(C), and lists of equipment by mill(D).

B. Conclusions

1. Historical Performance

Sugar cane growing and processing in El Salvador has expanded erratically, but consistently over the last several decades. Growth of cane area (which almost doubled to 60,000 manzanas between 1970/71 and 1990/91, including a 40% increase over the past three seasons) is particularly notable compared to the stagnation or contraction of other important agricultural commodities, especially cotton and coffee.

In the 1960s, the re-allocation of the U.S. Cuban sugar quota was the main impetus for growth in Salvadoran sugar production. During the 1970s, further increase was driven by the growing national market for refined and white sugar that grew at a compound 8% annually between 1970 and 1980. In the 1980's, the national market languished, the U.S. sugar quotas declined and Salvadoran exporters missed opportunities to sell into the world market at price peaks. In an era of largely negative market signals, only government intervention sustained production. Some of the key factors have included:

- Heavy state intervention in pricing that resulted in a real wholesale sugar price for sugar as high as $28 per quintal (Q) in the early 1980's (in 1991 prices, or $20 in 1982 prices), during a time of stagnant national market conditions and low world prices. (Wholesale prices have since drifted down to a more realistic $14.30 per Q average in 1991 prices).

- State ownership of six mills (eight until 1986) through expropriation or construction, resulting in control of 64% of the 35,400 ton per day grinding capacity, and which in turn further sheltered the processing component of the system from market forces.

- Awards of domestic and U.S. market quotas to individual or groups of factories based on historical output, thus stimulating production even when surpluses are sold below cost on the world market, in order not to lose share of the profitable domestic and U.S. quota markets.

- A cane pricing system that disregards quality or marginal returns. As a result processors often pay more for cane than warranted by world market prices. Overall, the system protects cane growers from the market (with processors absorbing the losses) and allows marginal lands and inefficient growers to remain in production.

2. State of the Sugar System

On average, the Salvadoran processors can produce profitably for the domestic market (mill whites) and the preferential U.S. quota market (raw sugar). However, surplus production sold into the "world" market represents a loss at current costs to processors. The performance of the Salvadoran sugar system (including cane growing and processing) can be seen from the following key indicators:

- The yield of cane per area was only 59 T per mz in 1991, compared to 65 T achieved in El Salvador 15 years ago and levels of 70 T or more reached in neighboring countries.

- Sugar recovery, reflecting the sucrose content of cane and the efficiency of the factory process, presently averages about 160 LB per T compared to 200 LB ten years ago in El Salvador, and current recoveries of 230 LB in Costa Rica and 260 in Australia.

- Processing costs per ton of cane which show a wide range from C 65 to C 125 per T (compared to C 123 for Florida in 1988, one of the higher cost locations).

Sugar recovery has been affected most by unplanned burning of cane, some by guerrillas but also by cutters pressuring growers into harvesting (and growers pressuring mills into receiving their cane to avoid a total loss). This factor alone may result in as much as a 20% reduction in output per unit of land. The cost of cane delivered at the factory ranges from C 77 to C 115 per ton, compared to the 1991 fixed price of C 115. At this price, growers on good cane lands, and with low loading and hauling costs can make in excess of 30% net returns, while the least efficient are break-even or slightly unprofitable operations.

The condition and performance of the cane processing plants vary significantly. The six public sector mills include the newest facility (Jiboa, built in 1976), and several older facilities built between 1946 and 1983, often with second hand equipment (or cannibalized from other factories.) The condition of these plants varies significantly based on the original engineering and the level of maintenance and re-investment (which generally has been poor as reflected by down-time of 14-36%). However, some of the best factories are located in relatively poor cane growing regions (Jiboa, Chaparrastique) while others are poorly managed (La Cabaña). As a consequence, sugar recovery yields do not differ greatly . On average, the public sector mills have higher costs , poorer labor relations and more down-time than their private counterparts. The most

efficient of the five plants grouped in INAZUCAR (see Table 15) has costs 14% above the private sector average. Three of the four small INAZUCAR plants are losing substantial amounts of money. Three state-owned alcohol distilleries are uneconomic and beset by technical difficulties.

Private mills include two that were expropriated and then returned to their owners (El Angel and San Francisco). The former has difficulty accessing cane (due to its location on the outskirts of San Salvador) while the latter was returned in very poor condition. Izalco is considered the "flagship" of the industry and suffered the least during the 1980's, but its technical results are not particularly better. Ahuachapan is primarily a potable alcohol distillery jointly owned by the private processors.

3. Policies and their Impact

As indicated above, GOES policies have had a major impact on the behavior of the sugar industry. Although most agricultural and related macro-economic policies have been liberalized, sugar continues to be among the commodities with the greatest degree of government intervention (as is the case in many countries). The most important policies and their impact are summarized below:

- **Administered domestic sugar prices** - Sugar continues to be one of eight products whose price is set by the Government. Although administered prices fell sharply in real terms during the latter half of the 1980's, they are still substantially higher than the levels at which non-Central American sugar could be delivered to San Salvador if imports were permitted. An import tariff of 14% ad valorem would be required to sustain current administered prices given today's world market prices, some 20% less than the current nominal tariff of 35 percent.

- **Allocation of market quotas** - Since quotas for the high priced domestic and U.S. markets are assigned on the basis of historical production by each mill, each has an incentive to produce as much as possible, even at a loss for the world market, in order to retain its share.

- **Pricing of cane** - At this time, a fixed price is established for all cane (C 115 per T in 1991). This single price reflects neither different market prices (domestic, U.S. or world) or cane quality (sucrose yield). While the industry is considering some premium for quality, it is not addressing the more fundamental issue of different market prices. Not only does the system encourage

surplus cane production, but there is no concept by cane growers and processors of sharing in the risks and benefits of serving the various final markets.

- **Licensing of imports** - The Salvadoran sugar trade is presently protected with tariffs of 35%, and a restrictive licensing policy. Abandonment of the current licensing and the proposed reduction of the tariff to 10 %, would barely affect sugar system economics, subject to a regional agreement that protected El Salvador against the "dumping" of white sugar by its neighbors.

- **Molasses markets** - In 1990/91, the Salvadoran industry sold 23.5 million gallons domestically at prices only 53% of the world price, with the price differential equivalent to about 4% of total sugar/molasses revenues. This represents a subsidy to livestock and a loss of revenues to sugar processors.

4. Competitiveness and Implications for Privatization

Most of the sugar factories can sell profitably at the prevailing domestic and U.S. quota prices. Five processors with a total capacity of 4 million Q have costs below the price delivered to San Salvador for white sugar imported duty free.

However, costs of sugar production are generally above the marginal revenues from world markets. Even at the very optimistic World Bank projections of $14 per Q by 1995 and $16 by the year 2000, four of the five INAZUCAR mills would still lose money in the world market at current cane price levels and yields.

The principal implication is that reduced Government intervention likely will result in the shutdown of some processing capacity. If policy changes are made prior to privatization, this will happen naturally to the extent that some mills will be unable to find buyers. Conversely, the value of the most promising factories is likely to be enhanced by the prospect of operating at full capacity and by producing almost exclusively for the domestic and U.S. markets.

From a national perspective, the closing of two or three small mills would have a positive impact, especially if the cane pricing policy is changed to reflect quality and market conditions. This would allow marginal cane land to revert to other uses and reduce cane production and processing costs, while producing similar or higher amounts of sugar and generating higher revenues and value added.

The profitability of both cane growers and processors would be enhanced by the rationalization of overall capacity, largely by eliminating high cost producers.

Additional gains can be made through productivity improvements in both the agricultural and manufacturing phases (especially the former), as well as by closer ties between growers and processors. However, even with these improvements, sales into the world market are likely to exceed the marginal cost only if the price increases.

Privatization prior to significant policy shifts could have negative impacts. Not only would the value of the factories as going concerns be influenced by the current policy framework, but premature privatization could result in pressure to maintain existing policies, to the prejudice of the entire system.

II. INTRODUCTION

A. Study Objectives and Structure

The focus of this report is the sugar industry in El Salvador, and especially the impact of government policies and activities on that industry. The government of El Salvador (GOES), as a condition of a World Bank sectoral loan has committed itself to permit imports of sugar, allow the free trade of sugar in domestic markets and eventually privatize the sugar mills. The purpose of the study is to provide the information baseline and analytical tools that may be used by the GOES, to determine and assess options for the modification of policies and the guidance of a private sugar trade in the 1990s.

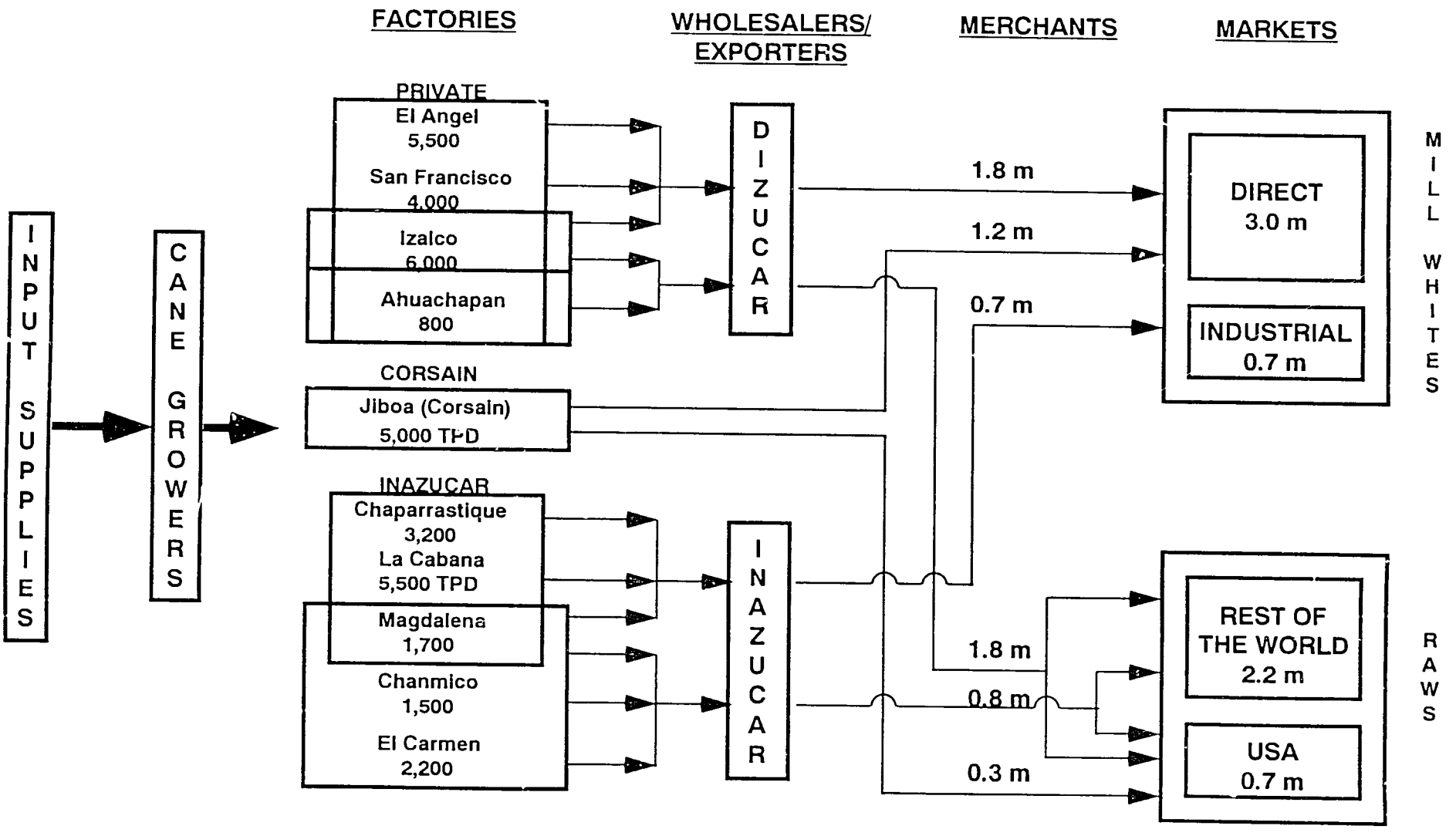
In particular, the study seeks to facilitate the GOES's efforts to map out alternative options for the virtual integration of El Salvador's sugar trade with the regional and world market, its withdrawal from management of the domestic sugar trade, and the end of government operation of sugar factories and alcohol distilleries.

The sugar system includes the domestic and international markets (for both sugar and sugar by-products, including molasses), the retail and wholesale distribution systems, sugar factories, cane production operations and the input supply system to cane and sugar producers. Figure 1 provides an illustration of the sugar system as it is structured in El Salvador.

Such systems are very dynamic in free, open markets, and competition between domestic and international components is based on economies of scale, specialization or other competitive factors. However, some of the unintended consequences of dynamic systems frequently attract government intervention as investment and employment adjustments are required. Such polices often take the form of quotas (that ensure a market share to even the weakest competitor), price supports or administered prices, subsidized inputs (including credit) or others, including nationalization. Since this pattern of intervention is pervasive throughout world sugar industries, the rationale for such interventions is further strengthened as each participant attempts to protect itself from foreign dumping.

Government interventions in sugar industries have several impacts. First, the system becomes increasingly isolated as producers' profits are protected, and tends to become less efficient as a result. Second, either sugar consumers or the national treasury (or both) must bear the cost of supporting industry incomes (which producers come to regard as social and political rights).

THE SALVADORAN SUGAR SYSTEM 1991



(Cane Grinding Capacity, T Per Day)

(Flow of Sugar, Q Per Year)

During the 1980s, opposition toward government intervention has grown worldwide as its costs have increased. National governments around the world have generally come to realize that open market systems are enormously more efficient and operate with fewer unintended impacts. This report is designed to examine the structure and operations of the industry in El Salvador, and to measure the potential impacts of increasing government withdrawal from the system, as well as the timing of this withdrawal.

A major purpose of the study is to match El Salvador's sugar system to the market opportunities available to it, with sugar alone the chief determinant of strategy (molasses and alcohol are sugar by-products and require separate strategies after the overarching sugar strategy has been determined).

The report proceeds in four sections following this introduction. Chapter III focuses on sugar demand, factors causing changes in domestic and international markets and the outlook for the coming decade. Chapter IV describes and evaluates sugar production in El Salvador (both cane and its processing) reviews the competitive position of Salvadoran producers and key issues affecting competitiveness and profitability. Chapter V assesses the implications of current and alternative government policies.

B. Sugar in the Context of the Salvadoran Economy

El Salvador is a nation of 5.5 million people, located on the Pacific Coast of the isthmus of Central America. Much of the country is rural, and the economy depends heavily on its agricultural sector which contributes 25% of GDP, about 40% of employment and more than two-thirds of export earnings. The sector is dominated by traditional export crops (coffee and sugar) but production of melons, shrimp, sesame seed and other non-traditional crops have become increasingly important in recent years.

El Salvador's total land area is just under 2.1 million ha with approximately 650,000 ha of arable land. Annual rainfall is around 2,000 mm with 90% of the total between the months of May and October. The variations in the average monthly temperature between 20°C and 30°C depend more on elevation than on season. The rainy season (May-October) is called winter, and the dry season (November-April) summer.

Soils are alluvial along the coast and in the valleys, with volcanic latosol types found at the higher elevations. The coastal plains (land below 200 meters in elevation) traditionally have been used to grow cotton, rice, corn and melons while land above 500 meters (in the Coastal and Central Mountain Ranges) is planted to coffee. In addition, a large amount of subsistence farming takes place in the mountainous regions, primarily on broken terrain (with mixtures of corn and beans frequently grown on slopes as great as 45 degrees).

More than two-thirds of the nation's harvested area normally is planted to basic grains, including corn, sorghum, rice and beans (Table 1). Nearly 860,000 T of corn and sorghum were produced in 1990/91, with about 80% of the total used for human consumption and the balance for animal feed (with corn accounting for nearly 82% of the total). Just over one-fourth is in coffee while less than 6% is in sugar cane and less than 2% in cotton.

In spite of the importance of basic grain production in El Salvador, coffee is the dominant crop. It is the second largest in area and by far the most important in value, accounting for 45% of total exports in 1990. Sugar is the second most important export crop and accounted for only $20 million in 1990, 3.5% of the total (Table 2).

Table 1

SALVADORAN CROP BY AREA, 1988/89 - 1990/91

	Coffee	Cane	Cotton	Corn	Sorghum	Rice	Other	Total
		(thousand manzanas)						
1988/89	217	43	19	405	175	20	3	881.0
1989/90	247	52	14	396	172	23	32	935.9
1990/91	247	60	10	405	187	22	55	984.7
Average	236.7	51.6	14.3	401.7	177.9	21.5	30.0	933.9
		(thousand hectares)						
1988/89	151	30	13	282	122	14	3	615.0
1989/90	172	36	10	276	120	16	13	643.0
1990/91	172	42	7	282	130	15	38	686.3
Average	165.0	36.0	10.0	280.0	124.0	15.0	18.1	648.1
Share:	25.5	5.6	1.5	43.2	19.1	2.3	2.8	100.0

Table 2

EL SALVADOR: PRINCIPAL AGRICULTURAL EXPORTS , 1988-90

	1988		1989		1990		1988/89	1989/90
	Value (m$)	%of Total	Value (m$)	% of Total	Value (m$)	% of Total	% Change	% Change
Coffee	357.9	58.8	228.6	45.9	258.9	44.6	-36.1	13.3
Cotton	0.3	0.0	0.7	0.7	1.3	0.2	133.3	85.7
Sugar	19.2	3.2	13.4	13.4	20.3	3.5	-30.2	51.5
Shrimp	16.0	2.6	10.1	10.1	14.4	2.5	-35.9	42.6
Total Exports (FOB)	608.8	64.6	497.5	50.8	580.3	50.8	-18.3	16.6

SOURCE: Central Reserve Bank of El Salvador

For more than a decade, El Salvador's civil war has limited agricultural production severely. Farms and other agricultural installations frequently were targets of guerrilla activities (especially in the eastern one-half of the country). Also, a number of highly controversial agricultural reform measures have been introduced. At least partly as a consequence, crop production declined during the 1980s. Coffee and cotton production were especially hard-hit, while sugar areas have been less affected.

Since mid-1989, the Cristiani administration introduced a number of important economic measures including:

- Elimination of price controls on 240 consumer products (mostly agricultural);
- Breakup of the GOES owned and sanctioned monopolies in the export of coffee, sugar and cotton;
- Reduction of most important tariff duties (from as high as 240% to less than 35%);
- Elimination of many non-tariff barriers such as quotas, import prohibitions and prior deposit requirements;
- Adoption of free market exchange rate system;
- Legalization and licensing of foreign exchange trading houses;
- Maintenance of real positive commercial bank loan rates;
- The major overhaul of the tax system, in an effort to broaden the tax base and lower rates;
- Reduction of the fiscal deficit by reducing real expenditure levels and increasing public utility rates;
- The implementation of anti-inflationary monetary policies; and
- The drafting of a plan to privatize the state-owned commercial banking system.

In 1990, economic growth was a war-time record 3.4% (inflation adjusted). Several factors contributed to the increase:

- Price de-regulation supported a 7.4% increase in agricultural activity, including record grain harvests and sharp increases in coffee and sugar output;

- New monetary disciplines held inflation to 19%;

- Expenditure reductions reduced the consolidated public sector deficit to 2.9% of GDP (down from 4.9% in 1989);

- Free market exchange rate incentives supported increases in merchandise exports of 17%;

- A new debt re-scheduling agreement increased international reserves by $60 million;

- Continued large inflows of dollars limited the foreign exchange decline to 15% (against the U.S. dollar).

As can be seen from Tables 1 and 2, these liberalized policies seem to have contributed to a reactivation of agriculture, and especially of basic grains. As will be further outlined in subsequent sections, sugar remains more protected than most commodities. However, over the medium to long term, liberalized policies in a country with a small land mass and high population density, are likely to contribute to increased land values and a greater focus on high value agribusiness or non-agricultural activities. This for example, has been the experience in Puerto Rico and Taiwan.

III. STRUCTURE AND EVOLUTION OF MARKETS

A. Sugar Markets

Figure 2 illustrates the changing shape of El Salvador's sugar markets over the last two decades. While total market size remained more or less constant, rarely dropping below 200,000 TM and never exceeding 300,000 TM, the relative proportion of the three segments varied dramatically. The domestic market consumes white sugar: until 1984 a mixture of refined and mill white sugar; thereafter only mill whites. It grew slowly throughout the period, and scarcely at all after 1986.

Both export markets, the U.S.A. and the "world" sugar market, take *raw* sugar. During the latter half of the 1970s and the mid-1980s, the U.S. market represented a substantial share of the total, over half the total in 1977 and 1979. El Salvador's sales to the "world" market occurred in the early 1970s and were suspended after 1976 for over a decade. The volume to be sold during 1991-1992 exceeds the U.S. volume.

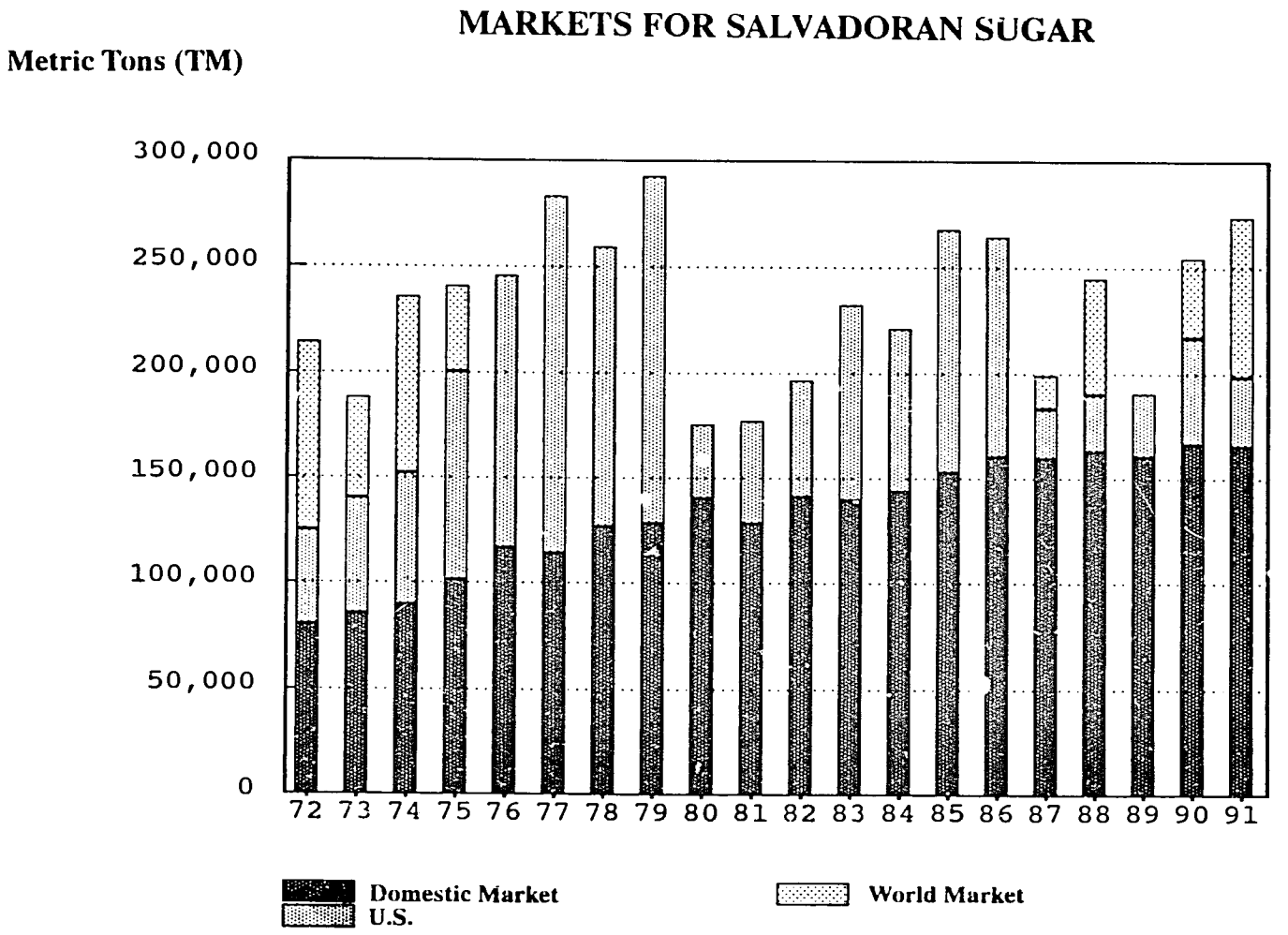
1. Domestic Market

El Salvador's domestic sugar market comprises two principal segments: direct purchases of granular sugar by households (the **direct** market), and sales to processors of beverages and food containing sugar consumed indirectly, (the **industrial** market). It appears there are few accurate data measuring the direct market. Official time series merely register domestic consumption as the difference between opening inventories plus production minus exports and closing inventories. Trade wholesaling organizations, through examination of their sales records, are able to determine the destination of their products, particularly to the small number of beverage and food processors. Thus the size of the **direct** market may be estimated by deducting the **industrial** volume from domestic "disappearance".

Independently of specific sugar data collected by the *Ministerio de Agricultura* (*Agricultura*), organizations such as the *Asociación Demográfica Salvadoreña*, under the auspices of the *Ministerio de Salud Pública y Asistencia Social (Salud)* collaborating with the *Instituto de Nutrición de Centro América y Panamá,* periodically conduct surveys of the nutritional status of Salvadoran citizens. Similarly the *Ministerio de Planificación y Coordinación del Desarrollo Económico y Social (Planificación)* determines a minimum sugar "ration" in order to compute the cost of the so-called *canasta básica*. Since the concern of both

Salud and *Planificación* are the lowest income groups, their surveys appear to register *per capita* levels of sugar consumption below computed *per capita* " "disappearance" figures.

Figure 2


MARKETS FOR SALVADORAN SUGAR
Metric Tons (TM)
300,000
250,000
200,000
150,000
100,000
50,000
0
72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
Domestic Market
U.S.
World Market

Until the mid-1980s, *Planificación* collected data showing the **grade** of sugar sold. After 1961, refined sugar began replacing mill whites in the domestic market. After 1980, the trend was reversed and, since 1985, after the refinery was closed, mill whites were the only white sugar supplied. (See Figure 3.)

a. The Direct Segment

The largest market segment, **direct** purchases of mill white sugar by households, (and some RHI[1] buyers), represents about 90 percent of the total. Granulated sugar is mixed into hot and cold beverages and used in baking. (No use surveys are available providing greater detail on the proportions).

Dividing the direct segment by the population, one observes daily consumption per capita declining from 79g in 1985 to 72g in 1991. A survev conducted in 1985 found 55g per capita per day in urban respondents, and only 50g in rural residents. A nutrition survey conducted by the *Asociación Demográfica Salvadoreña* in 1988 revealed *per capita* consumption levels ranging from 42 to 37g per day respectively for suburban adults and rural children. To calculate the cost of the *canasta básica, Planificación* uses a daily ration of 69g in the city and 57g in rural areas. These differences may be explained by skewed samples that include a disproportionate number of low-income people, by losses between wholesale volume and sugar actually consumed by citizens, or by a combination of both.

Table 3

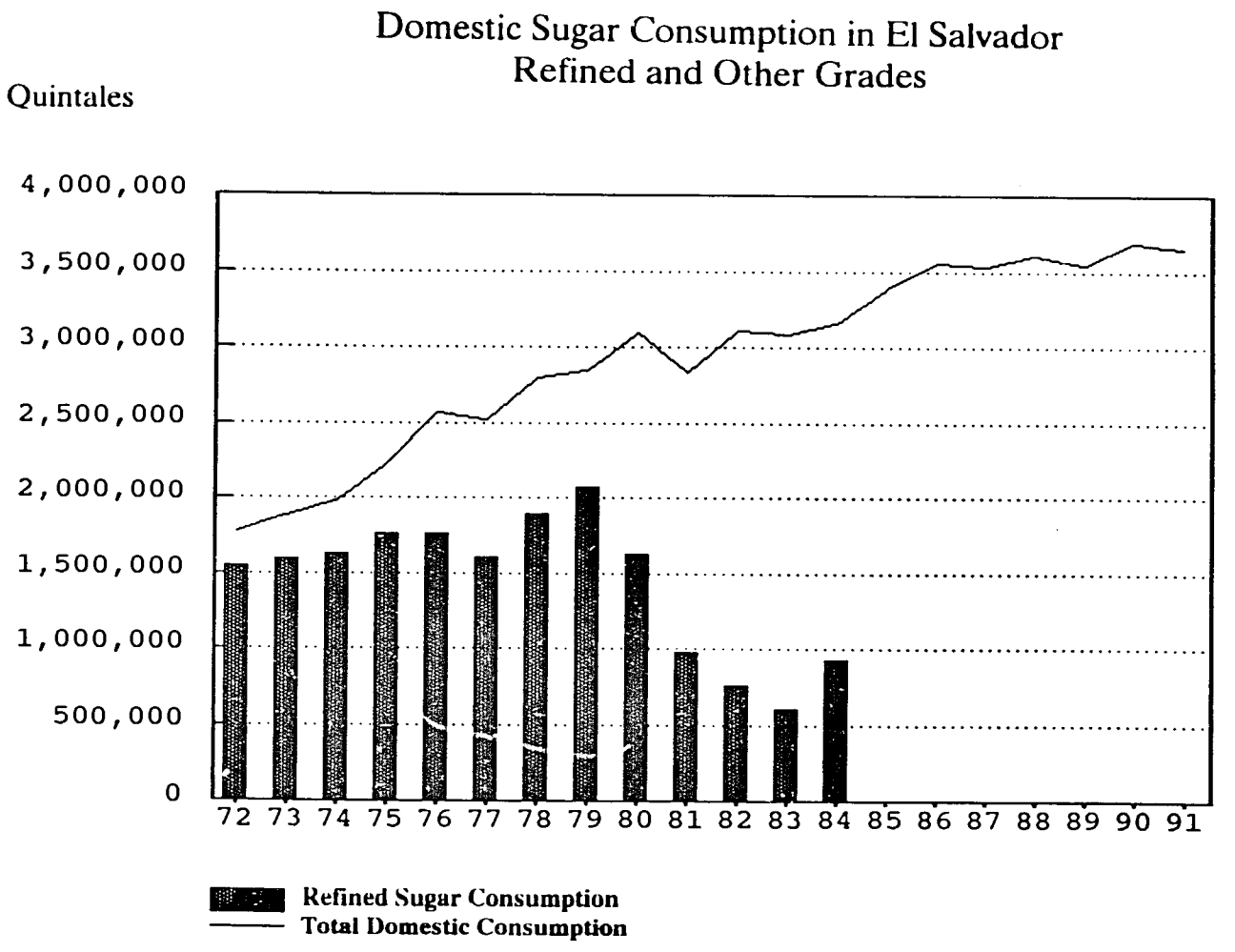
Segments of the Domestic Sugar Market, El Salvador. (Q)

ITEM	1985	1991
Total Market Size	3,400,000	3,700,000
Industrial Segment[2]	400,000	650,000
soft drinks		450,000
other		200,000
Direct Segment	3,000,000	3,050,000
grams per person per day	79	72

[1] "Restaurant, hotel and institutional".

[2] Assuming annual growth rate of about 10 percent.

Figure 3


Domestic Sugar Consumption in El Salvador
Refined and Other Grades
Quintales
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
Refined Sugar Consumption
Total Domestic Consumption

b. The Industrial Segment

The smaller but faster growing **industrial** segment is dominated by the bottlers of sweetened carbonated beverages, sales of whose product have increased in spite of declining *per capita* income. The carbonated beverage market leader has a 70 percent share, but has commercial links to another bottler with a 15 percent share. Until 1984, bottlers purchased refined sugar. Today they buy *mill whites* but the quality does not meet their specifications.[3] The principal problem is the aroma of molasses that would be transmitted to their beverages. Consequently, they are obliged to pass the sugar through a carbon filter. (It is alleged that the bottlers can perform this operation for less than the premium sugar processors want to charge for *refined* sugar: C 0.15 per Q.)

The remainder of the industrial segment comprises small bakeries, candy manufacturers, ice-cream makers and food processors. Quality requirements differ. An ice cream manufacturer requires an especially white sugar, while a candy manufacturer experiences problems making chocolates if the sugar has too high a moisture content. Interestingly the industrial consumers interviewed had each found a different supplier for the quality that best met their needs.

Assuming the current growth rate is continued, the industrial segment could rise from about 11 percent in 1991 to 16 percent by 1995 and 20 percent by 2000.

c. Refined Sugar

Three private sugar factories -- El Angel, Central Izalco and San Francisco -- are building "white ends" based on the *Talofloc* process. At times, it was suggested that the principal intention was to sell refined sugar to the "world" market. (Trends in the "world" market for white sugar are discussed below). At others, the claim was that refined liquor will be "blended" with raw syrup to produce a superior sugar for the Salvadoran market. Whatever the true intent, Jiboa, which already has a white end produces tiny amounts of refined sugar for the pharmaceutical industry only.

d. Regression Model

A regression model of the Salvadoran sugar market was built using as the independent variable annual consumption per capita. Total annual sugar disappearance was divided by population (see Figure 4), to calculate the *per*

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[3] The market leader requires sugar with 200 to 300 "base units" of impurities. Mill whites from some private mills are in the range 300 to 400. Inazucar's sugar has run as high as 800.

capita equivalent. The principal explanatory variables were annual change in the retail sugar price in constant U.S. cents per Q, (see Figure 5), and **gross domestic product** per capita (see Figure 6). Additional explanatory variables were **exports to the U.S.A.** in TM, and the world sugar price in constant U.S. dollars per TM, F.O.B. exporting country. In addition, the model incorporated a dummy variable for the year 1981. The data used ran from 1980 to 1989.

The equation, using rounded numbers, is as follows:

Variable	Coefficient	Standard Error
Constant	27,080	
Retail Sugar Price	-270	44
GDP *per capita*	60	16
World Sugar Price	-2.15	1.02
Exports to U.S.A.	-0.0106	.00626
1981 Dummy[4]	-2,058	511

As real GDP *per capita* dropped at the beginning of the 1980s and at the turn of the decade, so the administered sugar price, in real terms, was lowered so that *per capita* consumption stayed in the approximate range of 32,000 to 33,000g. Consumption rose abruptly as prices plummeted, then dropped as the price rose in 1987.[5]

Administration of the retail price represents the most significant government intervention in the sugar trade. First, it has sustained domestic consumption during a period of economic decline. Second, it has driven the price down to a point, probably unintentionally, where it is close to world levels.

The response of domestic consumption to the attractiveness of international sugar markets reflects the relative lack of concern by cane processors for Salvadoran sugar consumers. It seems likely that processors prioritize the U.S. market and, when prices are high, the "world" market. In 1986 the slack created by a low world price and a reduced U.S. quota was a domestic price cut and a jump in consumption.

---

[4] The year of the severest strife at the sugar estates in the wake of the preceding year's Agrarian Reform decree.

[5] Figure 5 shows that, during a period when the colon (C) was devaluing in relation to the U.S. dollar, the price was actually lowered by increasing it in nominal terms but at a slower rate than the currency's value fell.

Figure 4

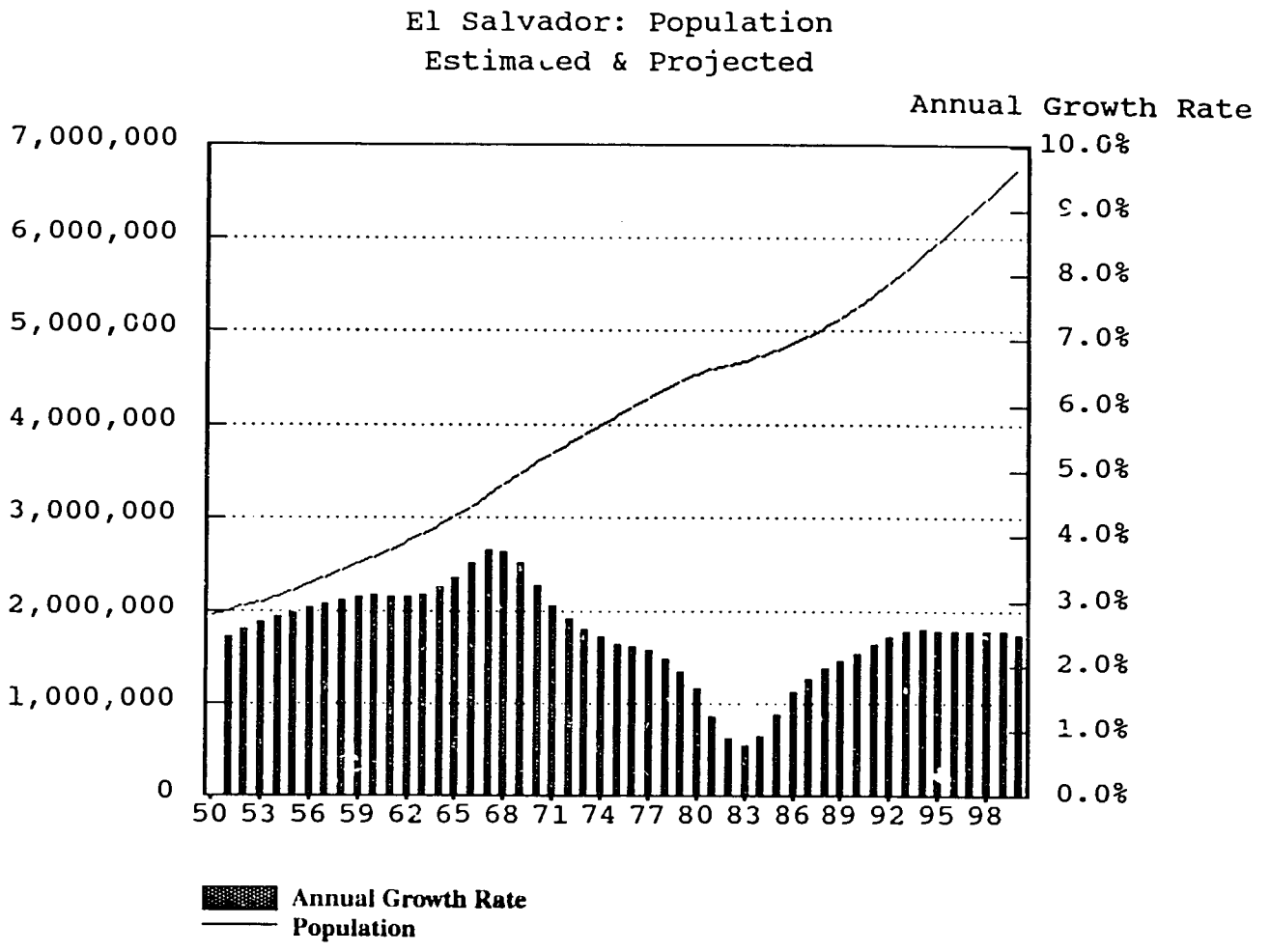

El Salvador: Population
Estimated & Projected
Annual Growth Rate
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
50 53 56 59 62 65 68 71 74 77 80 83 86 89 92 95 98
Annual Growth Rate
Population

Figure 5

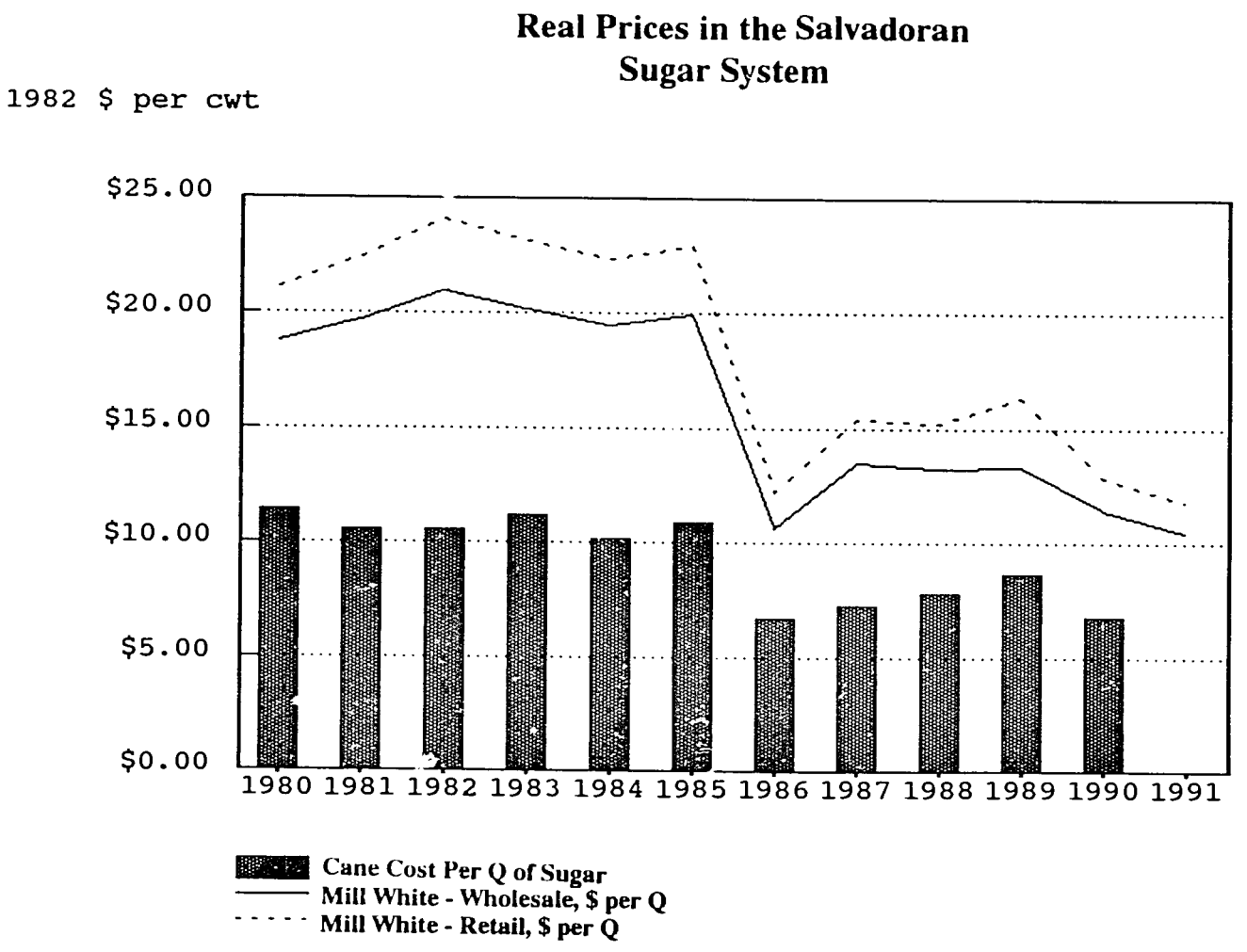
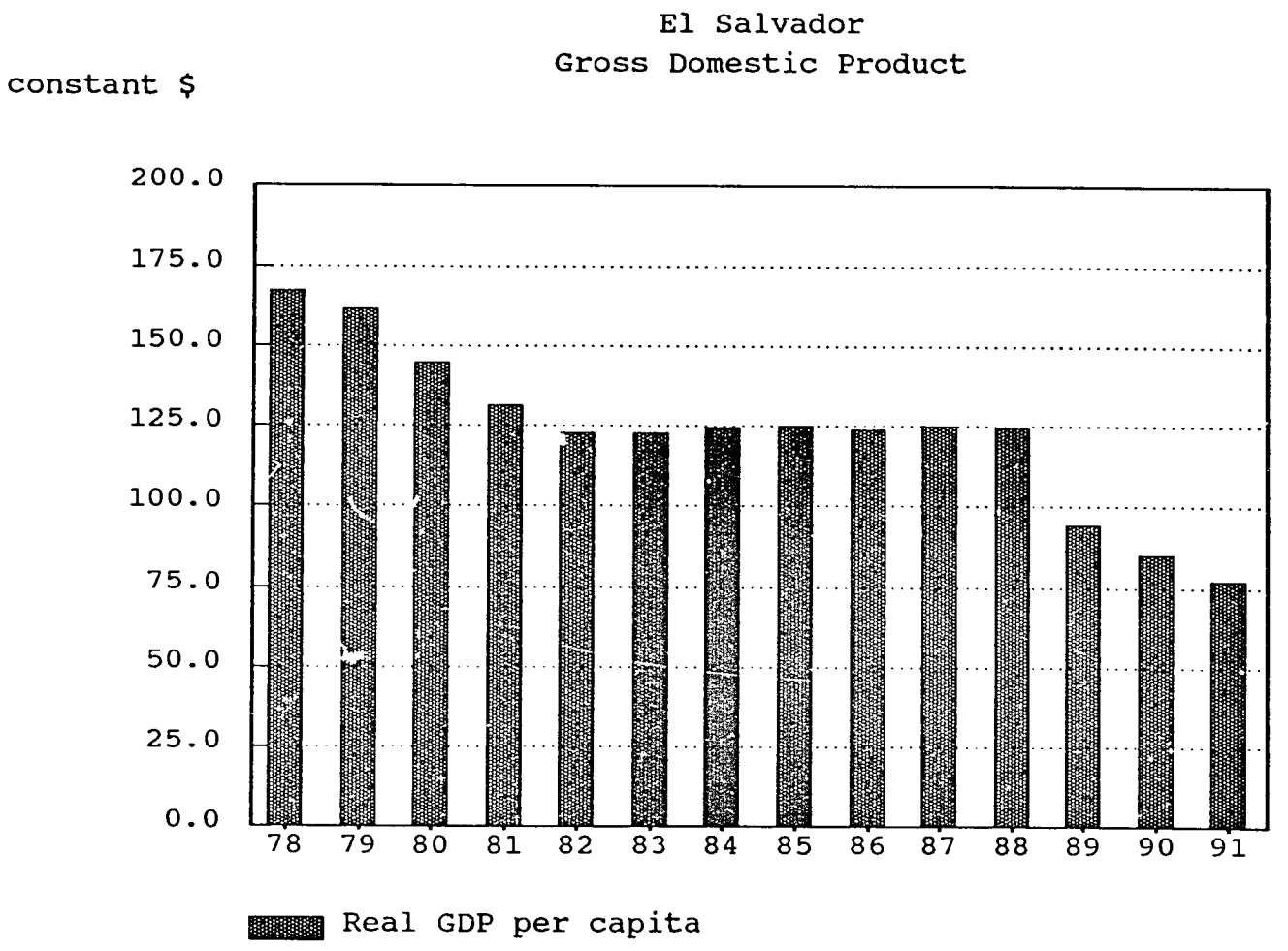

Real Prices in the Salvadoran Sugar System
1982 $ per cwt
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
Cane Cost Per Q of Sugar
Mill White - Wholesale, $ per Q
Mill White - Retail, $ per Q

Figure 6


El Salvador
Gross Domestic Product
constant $
200.0
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
78
79
80
81
82
83
84
85
86
87
88
89
90
91
Real GDP per capita

e. Implications

The size of the total domestic market depends on the national population, GDP *per capita* and the domestic sugar price. Future market size may be estimated according to a variety of assumptions. As is evident from the selection presented in Table 4, the range of projections of future market size is wide. The key issues are, **How much** (if at all) **will real** *per capita* **income rise over the coming decade**? and **What domestic price will prevail**?

Per capita income depends on population growth, the fortunes of a revamped Central American free trade area, and the world economic climate. The influence of the Government of El Salvador is probably greatest on the first of these variables.

The two main domestic pricing options are the **virtual integration** of the world and Salvadoran sugar markets and a continuation of the current **administered system**, particularly one that restricts consumers' access to non-Salvadoran sugar. Virtual integration is probably viable only if two conditions are met: a mechanism such as the "price range" is employed to even out short-term fluctuations in the world sugar price, and neighboring countries with overland access to El Salvador are prevented from dumping -- that is, selling in El Salvador below the price in their own domestic market, and preferably allowing Salvadoran exporters access to their markets. (The "price range" -- in Spanish, the *banda de precios* -- is a summary of the recent commodity prices from which the highest and lowest values, corresponding to price "peaks" and "valleys", have been excluded. A variable import tariff increases if current prices fall below the lower limit of the resultant range, and declines if they exceed the upper limit such that the landed cost of the commodity remains constant).

Table 4

Size of the Domestic Salvadoran Sugar Market, TM

	1991	1995	2000
Population Increase only	70,000	184,000	208,000
GDP per capita returns to levels of:			
1985	170,000	192,000	227,000
1980	170,000	195,000	235,000
El Salvador domestic price[6] equals world price:			
C 147 in 1995		160,000	
C 163 in 2000			207,000
GDP to 1980 level and real price of C 147 in 1995 and C 163 in 2000:		172,000	234,000

[6] In 1985 colones per Q.

2. U.S.A. Quota Market

The partial reallocation to El Salvador, after 1960, of the quota that the U.S. had hitherto granted to Cuba was a primary stimulus to Salvadoran cane growers and processors to expand capacity. Beneficiaries under successive U.S. Sugar Acts have received a generous price, currently some $.21 per LB. Except for a brief period in the mid-1970s and in 1980, the world price seldom even approached the U.S. level.

Since the U.S. divides its importable deficit proportionately among favored nations, El Salvador's pattern of sales closely reflects the U.S's needs.[7] (See Figure 7.) Following the first "oil shock" in 1973, when sugar began climbing steeply, the U.S. facilitated imports. Simultaneously, its domestic corn sweetener business began to replace cane sugar, particularly liquid sugar in many industrial applications. (See Figure 8 and Table 5.) As total sweetener consumption per capita rose only slightly, the total sweetener market grew in line with population growth. But domestic production of beet and cane sugar was also increasing. (See Figure 9.) The combined effect squeezed imports of sugar that dropped from a peak of 5.6 million TM in 1977 to 1.3 million TM in 1988. El Salvador's exports to the U.S. fell accordingly.

Table 5

Comparative Cost of Sweeteners Sold in the U.S., $ per Q

Sweetener	1979/1980	1986/1987
Raw Cane Sugar	13.90	18.30
Cane Sugar, White Value Equivalent	18.96	23.75
Beet Sugar, White Value	16.70	23.10
High Fructose Corn Syrup (dry basis)	12.20	15.86

SOURCE: Lord, Barry and Fry's USDA study, "World Sugar and HFCS Production Costs, 1979/80-1986/87"

The World Bank judges that the replacement of cane sugar by corn syrup has reached its practical limit. Henceforth, it is suggested, the increase in demand will be met with sugar. U.S. production costs, especially for sugar beet and cane in Louisiana and Hawaii, are relatively high. (See Table 6.) It sees U.S.

[7] Except during 1980 and 1981.

production leveling out, and imports staying at 2 million TM until 1995, and rising to 2.5 million TM by the year 2000. However, any shift towards integration of the various international sugar agreements and a lowering of tariffs seems likely to result in decreased U.S. production. **Consequently, increased U.S. consumption will probably be met with off-shore sugar. By the same token, the price premium will undoubtedly decline.**

Figure 7

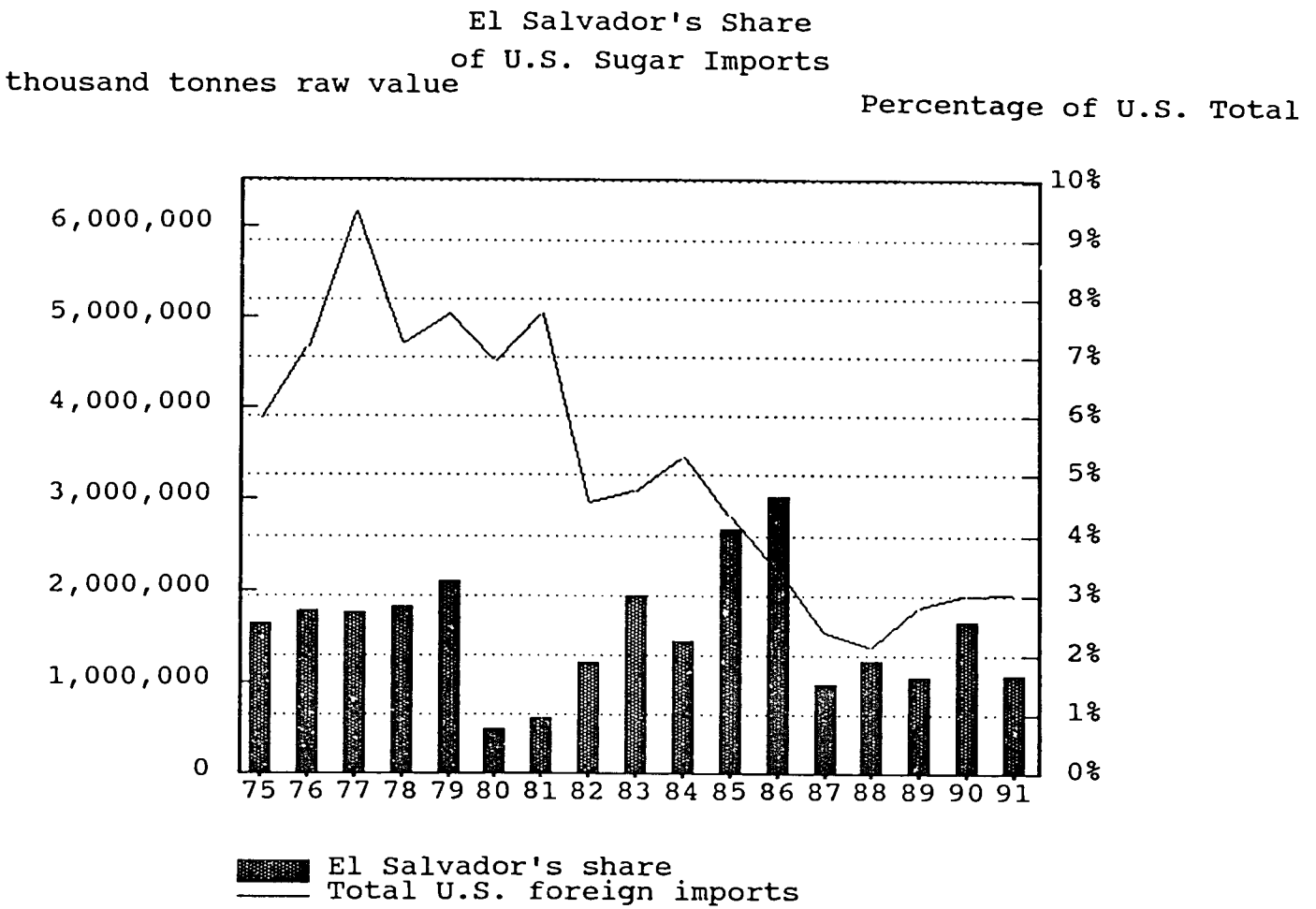

El Salvador's Share
of U.S. Sugar Imports
thousand tonnes raw value
Percentage of U.S. Total
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
El Salvador's share
Total U.S. foreign imports

Figure 8

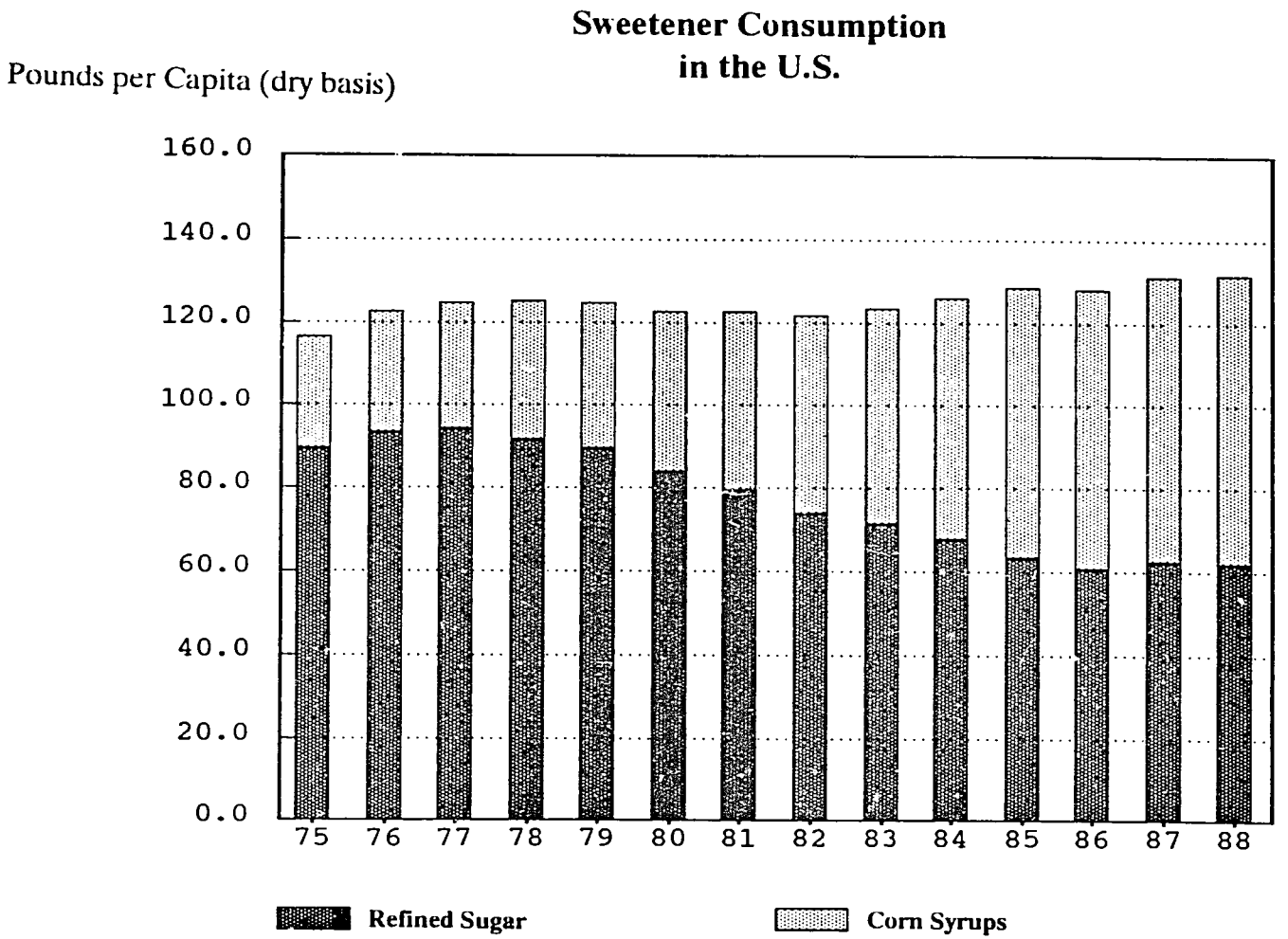

Sweetener Consumption
in the U.S.
Pounds per Capita (dry basis)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
75
76
77
78
79
80
81
82
83
84
85
86
87
88
Refined Sugar
Corn Syrups

Figure 9

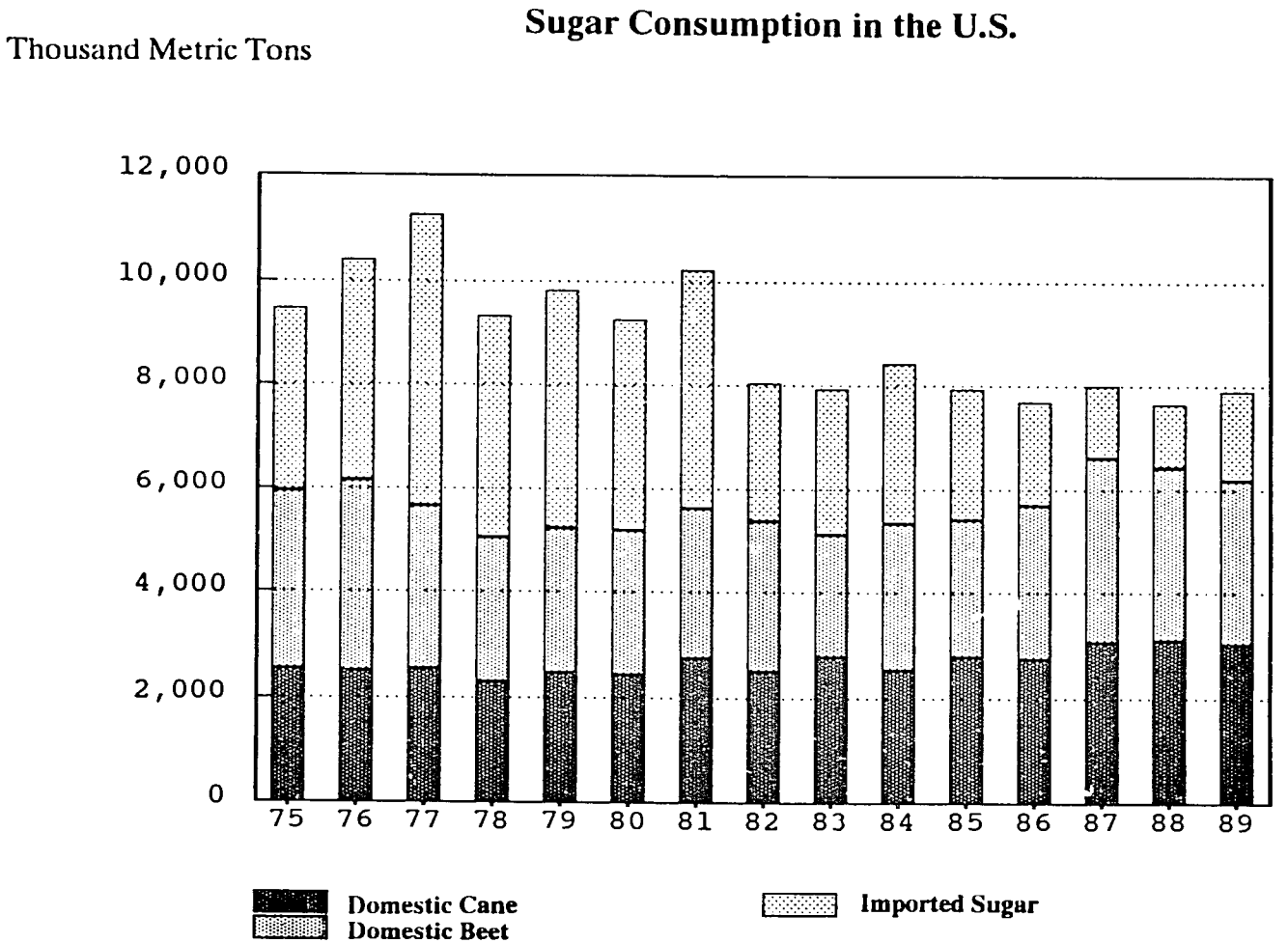

Sugar Consumption in the U.S.
Thousand Metric Tons
12,000
10,000
8,000
6,000
4,000
2,000
0
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
Domestic Cane
Domestic Beet
Imported Sugar

Table 6

Regional Sugar Yield Variations in the U.S., TM per ac

Year	Hawaii	Florida	Louisiana	Beet
1975/76	3.69	3.70	2.08	2.65
1980/81	5.25	3.50	2.12	2.65
1985/86	6.10	3.69	2.35	2.72
1990/91	5.97	3.67	2.59	2.77

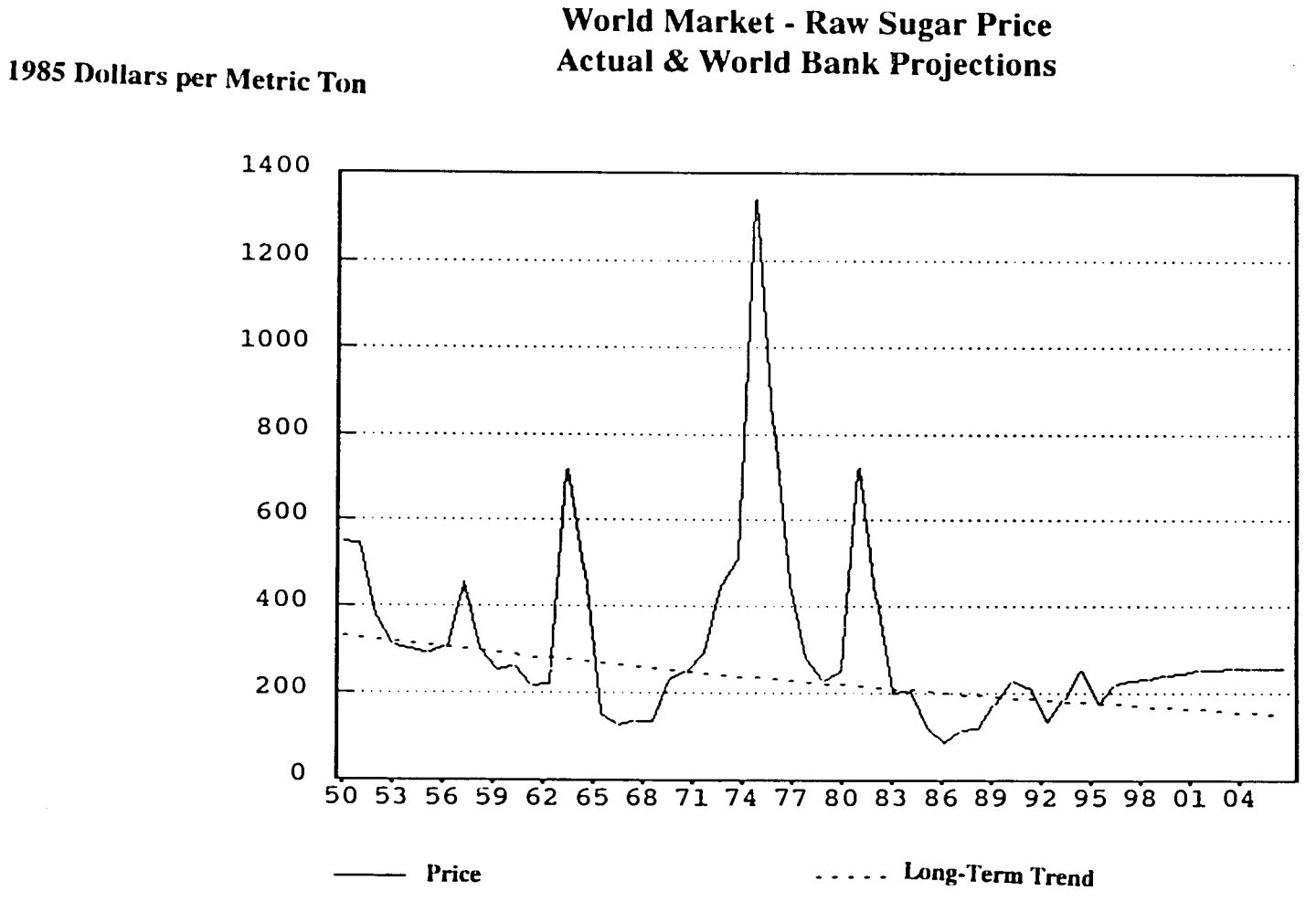
3. World Market

Appendix A summarizes the perspective on the "world" sugar market as reported in the World Bank's "Price Prospects for Major Primary Commodities 1990-2005: and F.O. Licht's "International Sugar Report" and "International Sugar and Sweetener Report". In summary, the market is characterized by over-capacity and large inventories. The developed economies continue to support their domestic sugar production with prices significantly above the costs of the most efficient producers and exporters, who correspondingly have idle capacity. At the same time, overall demand for sugar continues to grow with Asian developing economies -- particularly India and China -- accounting for an increasing share. This shift is thought to be responsible for a reduction in market volatility.

The World Bank forecasts that international sugar trade volume will grow at a compounded 2.3 percent between 1989 and 2005. It continues to believe that prices, in real terms (1985 dollars) will rise through the end of the decade, reaching $245 per TM by 1995 and 282 per TM by 2000. These levels are optimistically above the declining long-term price trend. (See Figure 10.)

Salvadoran exporters sold to the "world" market during the 1970s when the price was high, but abandoned it when the price dropped in 1976. Exporters favored the U.S.A. in the late 1970s, but the newly state-controlled sugar trade failed to take advantage of the "world" price rise in 1980 and did not sell into the world market until production exceeded the requirements of the domestic and U.S. markets in the late 1980s. As the later discussion of the dynamics of the relationship between cane growers and processors will show, presently the marginal cost of producing raw sugar for export to the world market exceeds the revenue.

Figure 10


World Market - Raw Sugar Price
Actual & World Bank Projections
1985 Dollars per Metric Ton
1400
1200
1000
800
600
400
200
0
50 53 56 59 62 65 68 71 74 77 80 83 86 89 92 95 98 01 04
Price
Long-Term Trend

4. Prices

As was noted during the discussion of the regression analysis of the size of the domestic sugar market, the nominal price in *colones* was increased periodically during the 1980s -- but at a rate slower than the *colon* lost real value. This section will discuss the relationship between various prices including wholesaler and retailer margins. The domestic price has now dropped to a level that is close to world level. The relationship between the world and domestic prices in the recent past and towards the year 2000 will be explored. Finally, the relationship between sugar and cane prices will be examined as a prelude to the discussion of processors and growers.

a. Wholesale and Retail Prices and Margins

Sugar processors sell directly to industrial customers and to wholesalers who supply the direct market. Wholesalers sell to retailers who in turn sell to consumers.

Figure 11 shows that industrial consumers prior to 1987 paid a lower price than wholesalers. In Figure 12 it may be noted that a small premium applies to the sales price of two pound bags compared to the same quality sugar sold in hundredweight bags. Over the last two years, private producers have sold sugar wholesale at a slight premium to INAZUCAR'S price as shown in Figure 13. Industrial consumers also revealed that processors sometimes invoice sugar at a flat C 115 per Q delivered to their premises **without** adding the cost of road freight.

Figure 14 depicts the retail margin. As prices dipped in mid-year, then rose at year-end, only to stabilize in 1991, margins widened, then narrowed, and since then oscillated very slightly. The persistence of virtually steady margins is indicative of minimal competition between wholesalers.

b. Salvadoran and World Prices

Figure 15 shows trends in Salvadoran and world prices over the last decade. The world price peaked in 1980, dropped to a valley bottom in 1985, then began climbing higher towards the end of the decade. Meanwhile the Salvadoran price, as has been mentioned above, remained level until 1985, then dropped to about half that level until the present. Obviously the two prices were completely unrelated. Nonetheless, the difference between the world and Salvadoran sugar prices has decreased over the past decade. The ratio of the Salvadoran wholesale mill white price to the world sugar price has dropped from 3.4 to 1.4 between 1982 and 1991. (see Table 7)

Figure 11

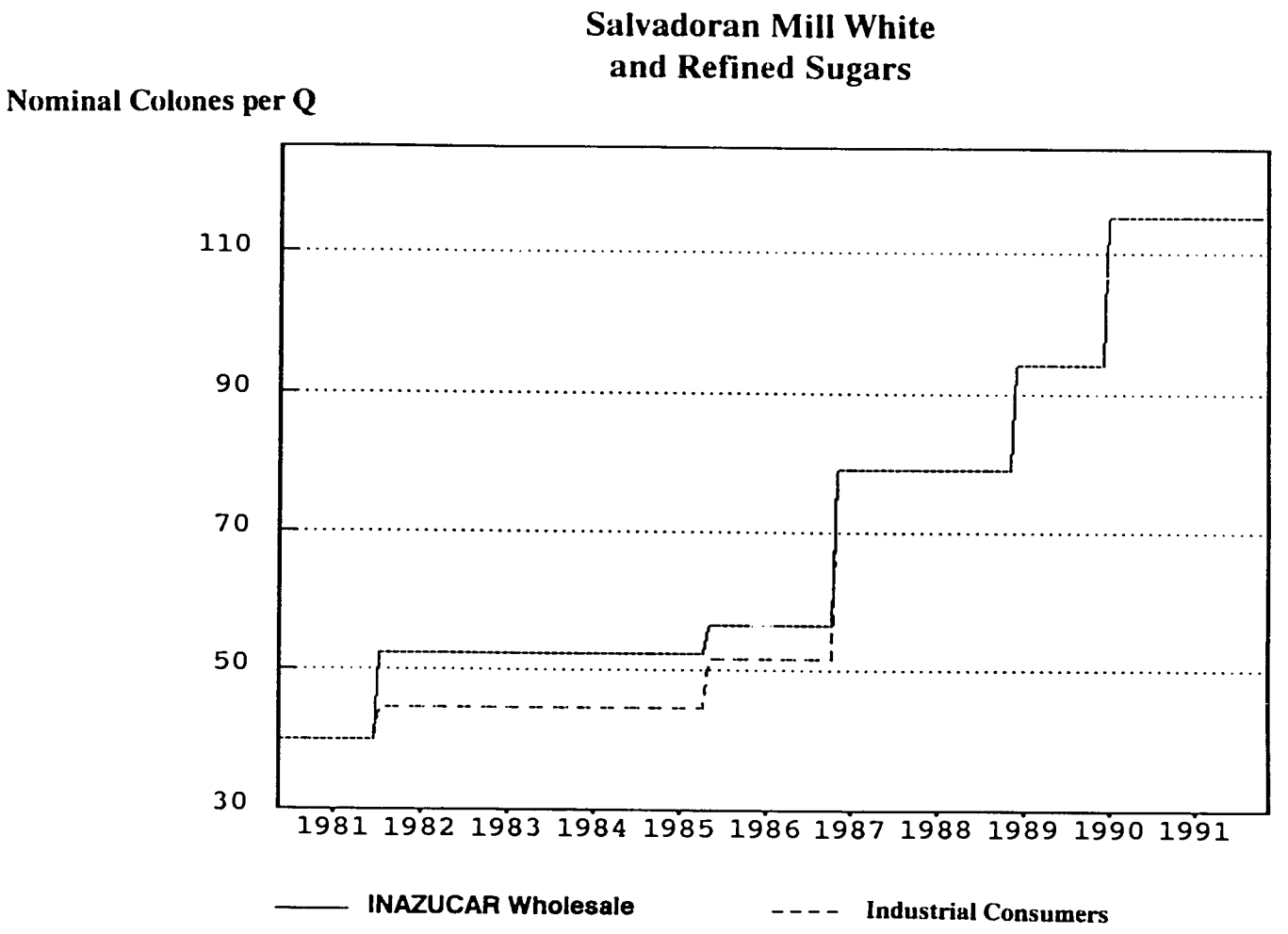

Salvadoran Mill White
and Refined Sugars
Nominal Colones per Q
110
90
70
50
30
1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
INAZUCAR Wholesale
Industrial Consumers

Figure 12

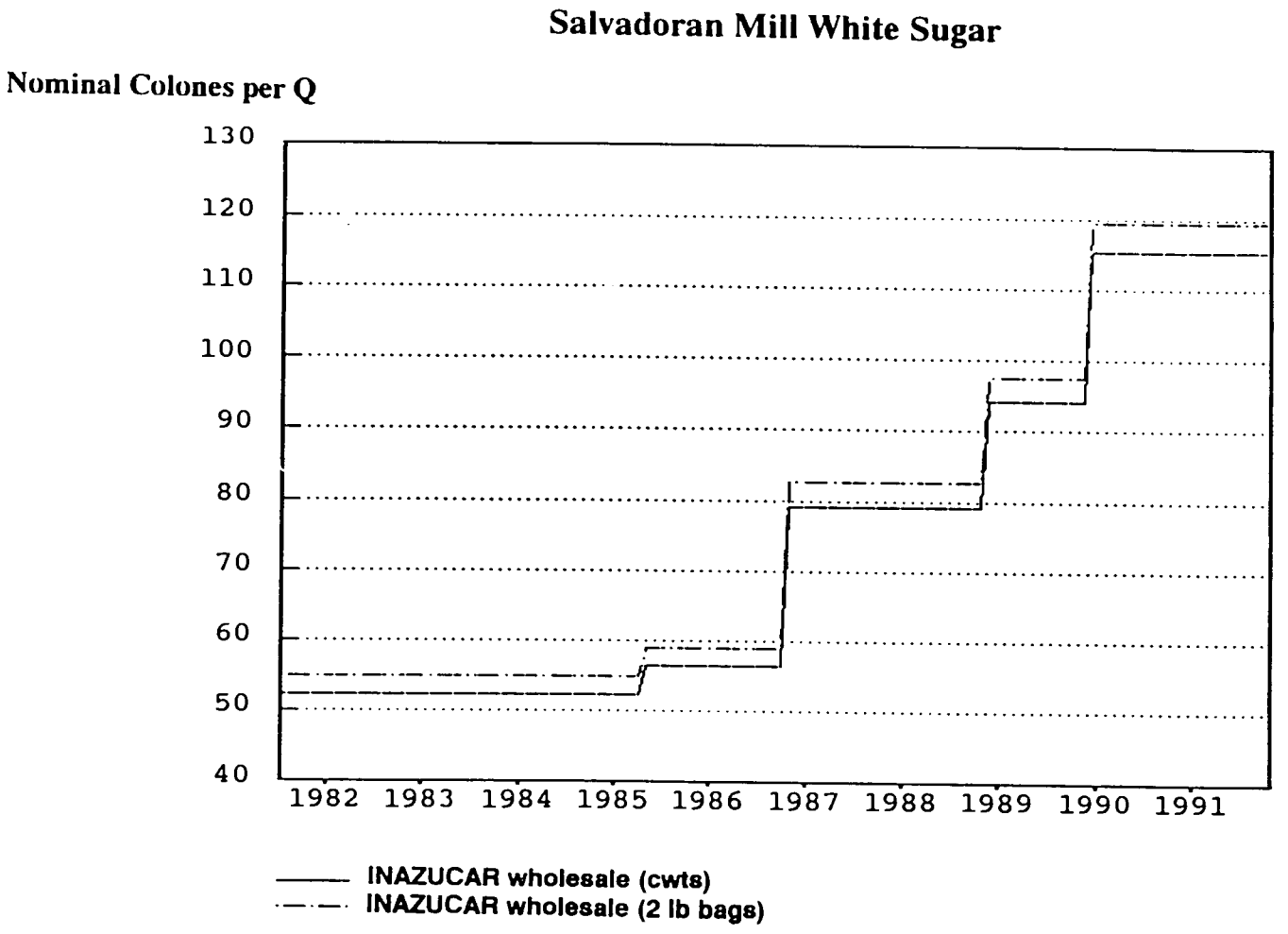

Salvadoran Mill White Sugar
Nominal Colones per Q
130
120
110
100
90
80
70
60
50
40
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
INAZUCAR wholesale (cwts)
INAZUCAR wholesale (2 lb bags)

Figure 13

Salvadoran Mill White Sugar Prices

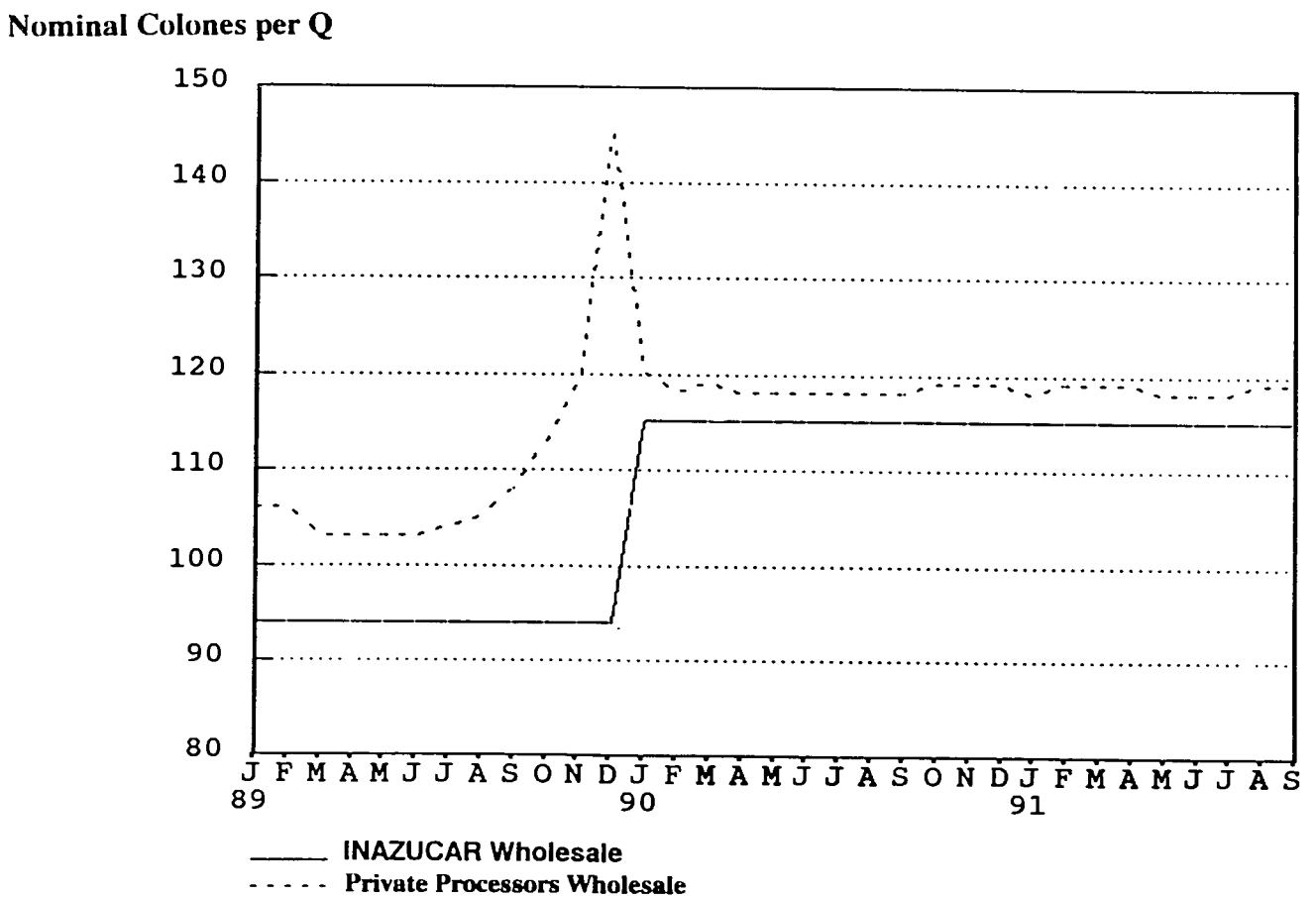


Figure 14

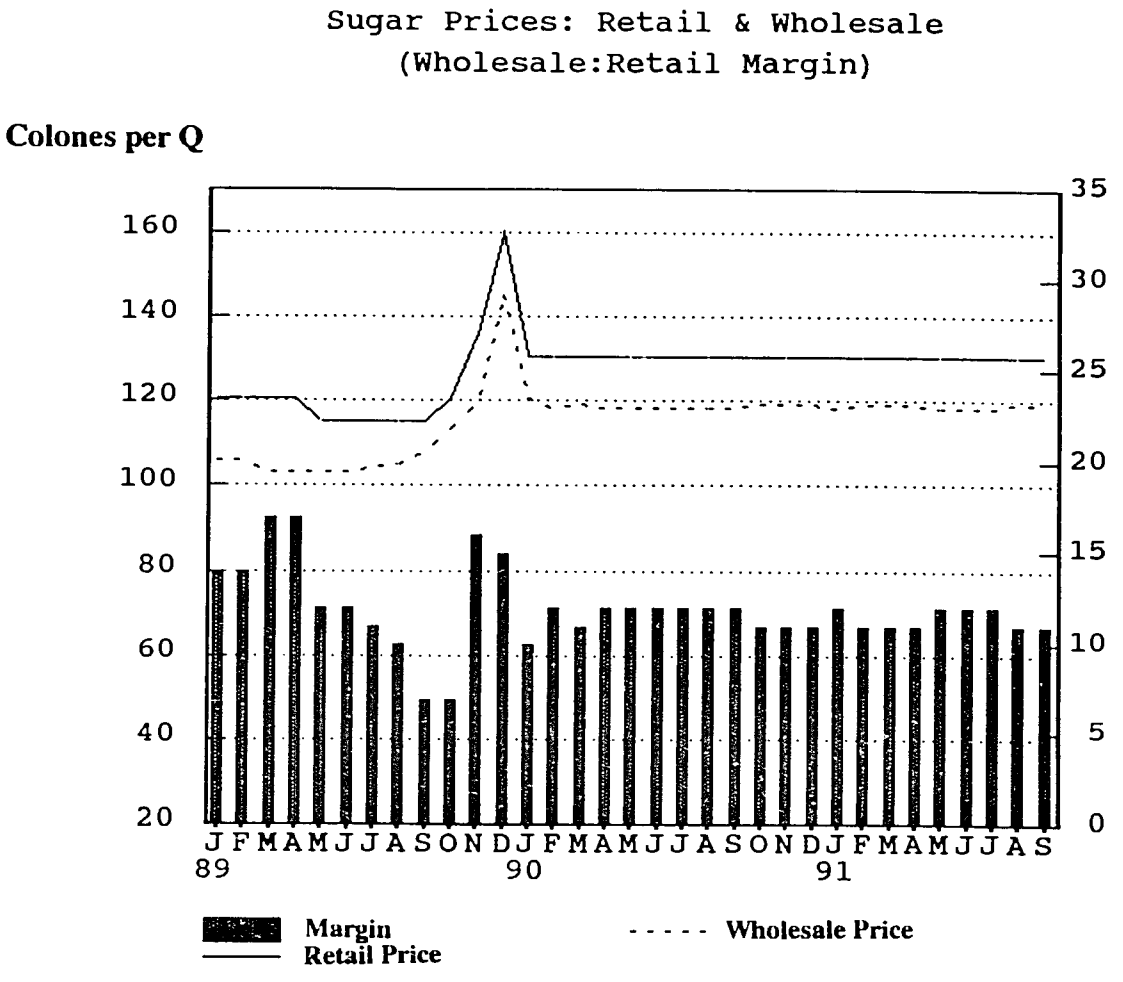

Sugar Prices: Retail & Wholesale
(Wholesale:Retail Margin)
Colones per Q
160
140
120
100
80
60
40
20
35
30
25
20
15
10
5
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
89
90
91
Margin
Retail Price
Wholesale Price

Figure 15

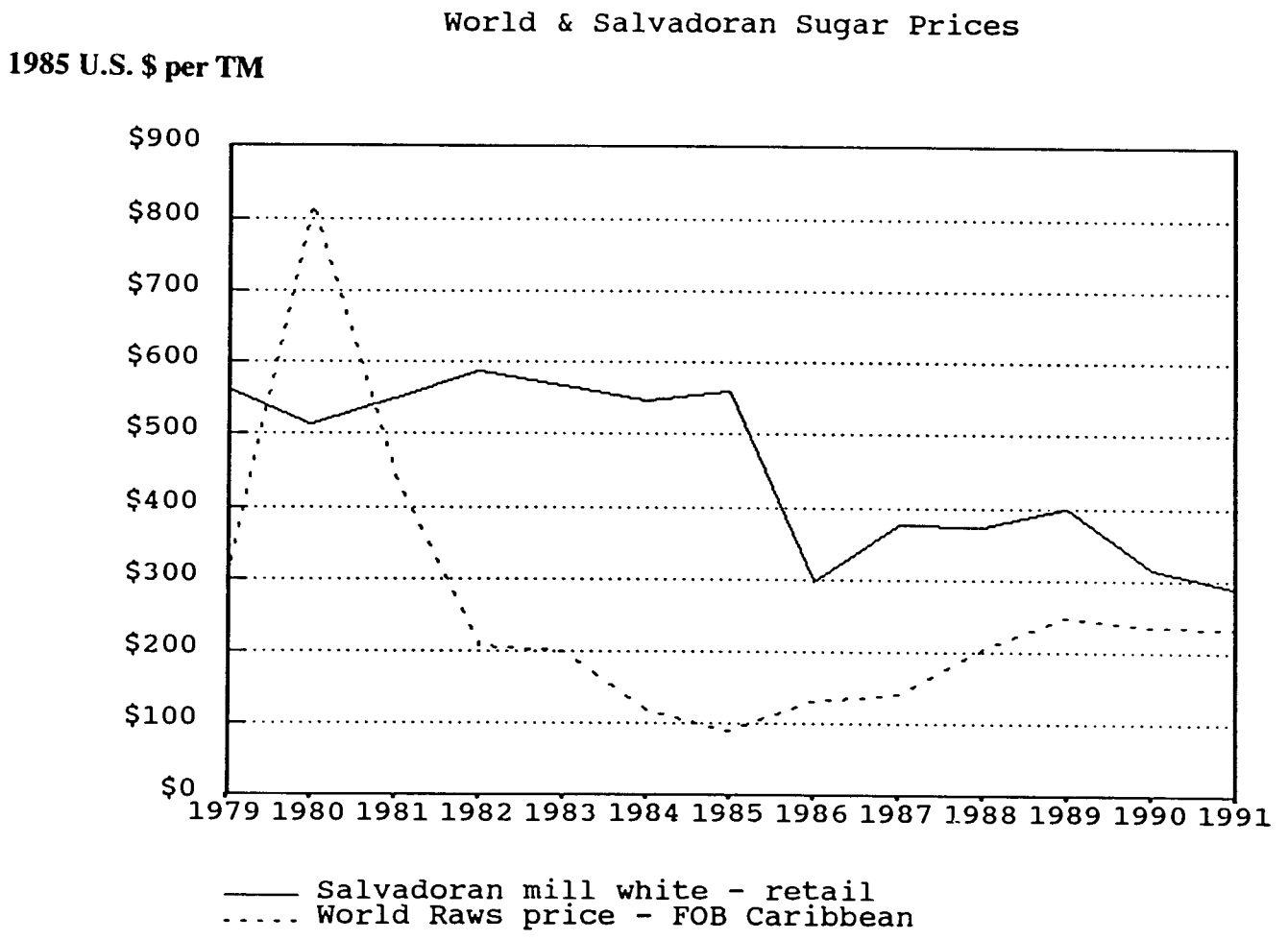

World & Salvadoran Sugar Prices
1985 U.S. $ per TM
$900
$800
$700
$600
$500
$400
$300
$200
$100
$0
1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
Salvadoran mill white - retail
World Raws price - FOB Caribbean

Table 7

Ratio of Salvadoran Wholesale Mill White Price To World Raw Sugar Price

Year	Ratio
1982	3.4
1986	2.8
1991	1.4

Thus, the current **domestic price** is within reach of world levels, but if the Salvadoran market were opened to imports of world sugar from outside Central America, the government would have to apply a tariff of 14 percent to sustain current price levels. The following section presents the sequential steps in the reasoning behind this estimate.

Since El Salvador has closed its sole sugar refinery, it can no longer import and refine raw sugar. Therefore, if due to catastrophe, it needed to meet its domestic needs with off-shore supplies, it would import refined or mill white sugar in bags. Refined sugar from Brazil, a low cost and reasonably accessible source, could currently be shipped from the port of Maceio at a price of about $295 to $300 per TM CIF Acajutla. Assuming the costs of landing the sugar and delivering it to the San Salvador markets were $22 per TM, the wholesale price would be the equivalent of C 115-117 per Q as shown below.

Table 8

Theoretical Price for Imported Bagged Refined Sugar

	$ per tonne	*converted to*	C per Q
CIF Acajutla	290		107
Acajutla to San Salvador	22		8
Delivered San Salvador	312		115

The current Salvadoran price for refined sugar is C130, while mill whites sell for C115, representing a premium for refined over mill white sugar of C15/Q. Thus the theoretical price for world market refined sugar delivered to San Salvador of C115, (see Table 8), equates to a mill white price of C115 minus C15, or C100/Q.

El Salvador would need to apply a 14 percent tariff to sustain existing white sugar price levels, as shown below.

Table 9

Illustration of Tariff Required to Raise World Market Price for Refined Sugar to Current Salvadoran Levels

	$/TM	*converted to*	C/Q
CIF Acajutla	290		107
Tariff: 14 percent	41		15
Acajutla to San Salvador	22		8
Delivered San Salvador	312		115

The world sugar trade quotes the world market price for raw sugar in U.S. cents per pound (¢ per lb) FOB Caribbean port, a price that applies to all raw sugar delivery ports including Acajutla. The World Bank predicts the world market price for sugar in 1985 dollars per TM (1985$/TM) FOB Caribbean port. For simplicity's sake, Tables 10 and 11 are expressed mostly in constant dollars standardized to the time of the report, that is 1991 dollars per tonne (1991$/TM). The extreme right-hand columns or column show the same information in *colones* per Q.

Thus far, we have considered current Salvadoran prices in relation to current world market price levels. But the World Bank optimistically predicts that prices will rise between now and the end of the decade. Tables 10 and 11 translate those forecasts into their equivalent levels in El Salvador. Table 10 illustrates the impact on domestic white sugar prices, and Table 11 on prices of Salvadoran raw sugar for export. In Table 10, it is assumed that the current premiums for refined over raw sugar are maintained.

Table 10

Salvadoran White Sugar Prices
Equivalent to Market Price (1991) and World Bank Forecasts (1995 & 2000)

Year	Raw Sugar FOB Maceio 1991 $/TM	Refined Sugar FOB Maceio 1991 $/TM	Refined Sugar San Salvador 1991 $/TM	Refined Sugar San Salvador C/Q	Mill Whites San Salvador C/Q
1991	180.5	265.00	312.00	115	100
1995	302.66	387.16	434.16	160	145
2000	348.37	432.87	479.87	177	162

Note: The difference between the "FOB Maceio" and "Delivered San Salvador" prices comprises ocean freight of $25, and port handling and road transport costs of $22, a total of $47 per tonne.

The equivalent price for mill whites of C100 per Q, referred to in Table 10, compares with a current price of C115. The Salvadoran government's goal is the virtual integration of the world and Salvadoran sugar trades. If the world market price were to rise in the way predicted by the World Bank, then the Salvadoran market could be gradually opened to imports while sustaining today's price levels. Therefore, in anticipation of a secular upward price movement, the government could consider permitting imports that would pay an initial tariff of about 14 percent declining to zero over a short number of years. Prices would no longer be set but would fluctuate according to movements in the world market.

El Salvador's situation as an exporter of raw sugar is much less rosy. Taking the current FOB price and those predicted by the World Bank for raws FOB Acajutla,and assuming the cost of delivery to the port is $22 per tonne, the value of raw sugar to a factory located in the general area of San Salvador may be computed as follows:

Table 11

Salvadoran Export Raw Sugar Prices
Equivalent to Market Price (1991) and World Bank Forecasts (1995 & 2000)

Year	Raw Sugar FOB Acajutla 1991$/TM	Raw Sugar Ex-Factory 1991$/TM	Raw Sugar Ex-Factory C/Q
1991	180.5	158.5	58
1995	302.66	280.66	103
2000	348.37	326.37	120

The equivalent value of C58 per Q for raws ex-factory compares with average costs of the cane alone of C69, so that, on average, every hundredweight of raw sugar exported to the world market currently loses the processor C11 plus the marginal costs of the transformation of the cane into raw sugar. The world price that would enable processors to break even on average is 1991 $310 per tonne of raw sugar FOB Caribbean, between the World Bank's bullish forecasts for 1995 and 2000. In other words, the true value of cane used to produce raw sugar for export is considerably less than the price currently paid for it.

Alternatively, if the average yield were to increase to the levels observed in 1980, the cost of cane per Q of sugar would fall to C67 and to C57 if the yield returned to 1970 levels. Such yield improvements appear insufficient to permit cane growers to sell at current levels to processors who export raw sugar at world market prices.

B. Molasses Markets

Molasses, or "blackstrap" molasses is the by-product of sugar-cane processing. Despite many possible uses in developing economies, access to a medium-sized port usually assures that the highest return may be earned by exporting to the world market. Figure 16 shows that the increased production of blackstrap molasses in El Salvador results principally from higher yields per unit of sugar. This is due to a reduction in the quality of cane and inferior processing efficiencies in some factories and will be discussed in the section dealing with the processing and growing components.

The Salvadoran molasses market comprises three segments: export, distillation and cattle feed. Figure 17 shows nominal U.S. dollar molasses prices for the three. Until 1986, the domestic distillers price was comparable with the international price while feed molasses was heavily discounted to processors. After 1986, both domestic prices fell to less than half the international price, but the additional discount for feed molasses was maintained until 1990.

The international price of molasses is determined primarily by its use as animal feed in developed countries. The relevant market for El Salvador is the U.S. Figure 18 shows the U.S. price for blackstrap molasses "free on vehicle" in New Orleans, LA, the standard delivery point. Apart from price "spikes" after the 1973 "oil shock" and the sugar price rise around 1980, the molasses price follows a long-term downward trend that leads to a 1991 value of about 1991 $73 per TM or 28 1982 ¢ per U.S. gallon.

Figure 16

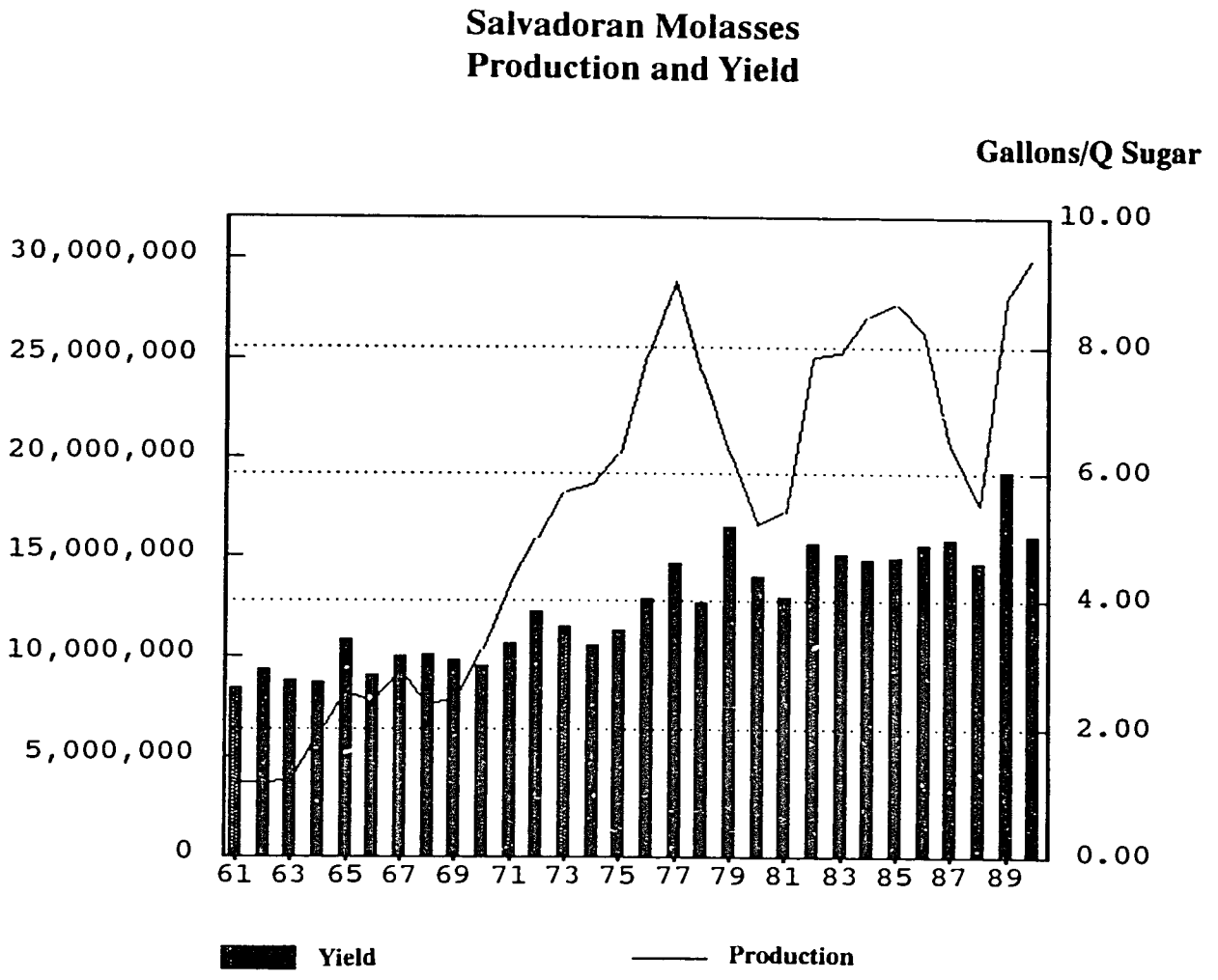

Salvadoran Molasses
Production and Yield
Gallons/Q Sugar
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
10.00
8.00
6.00
4.00
2.00
0.00
61 63 65 67 69 71 73 75 77 79 81 83 85 87 89
Yield
Production

Figure 17

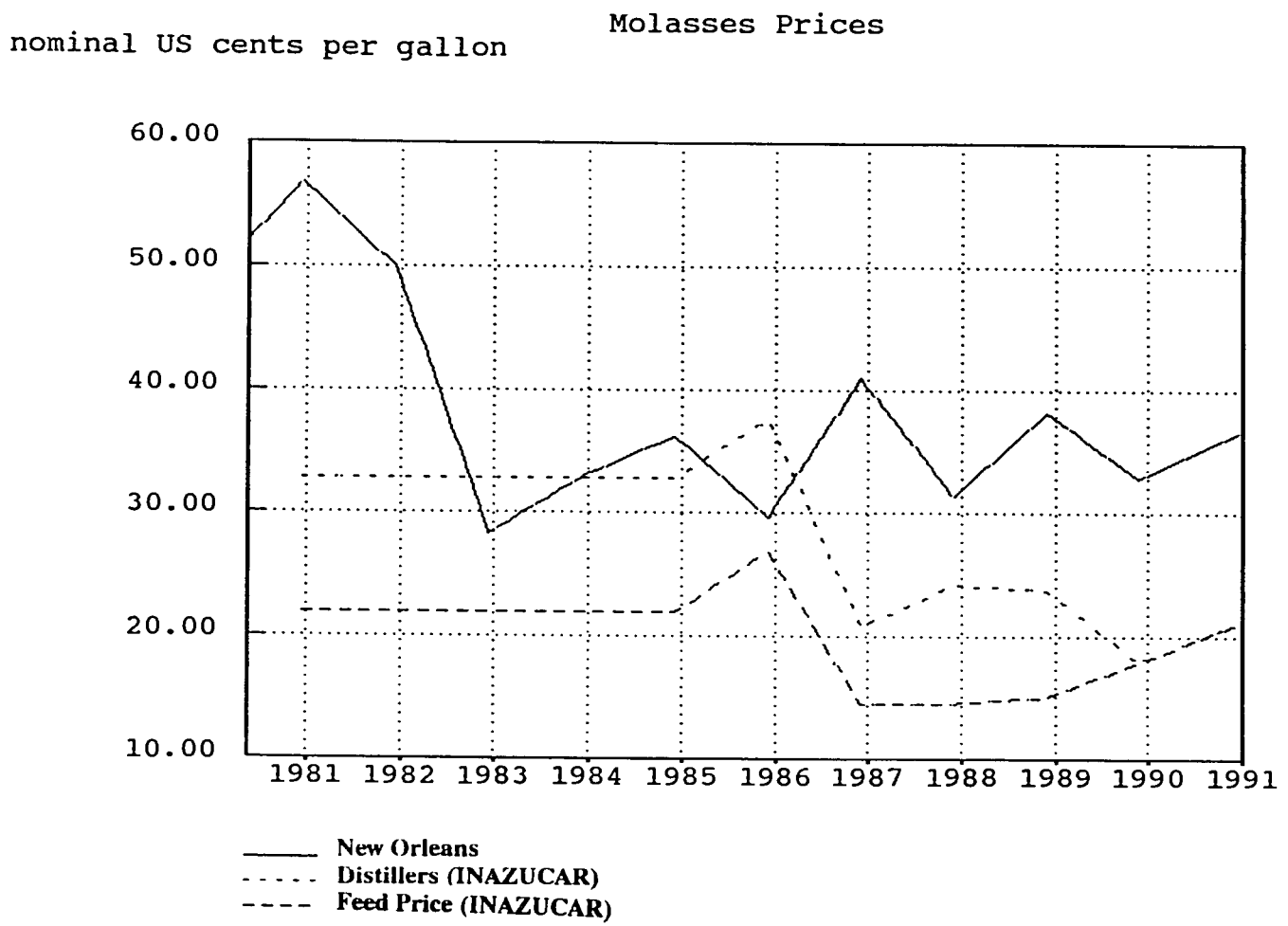
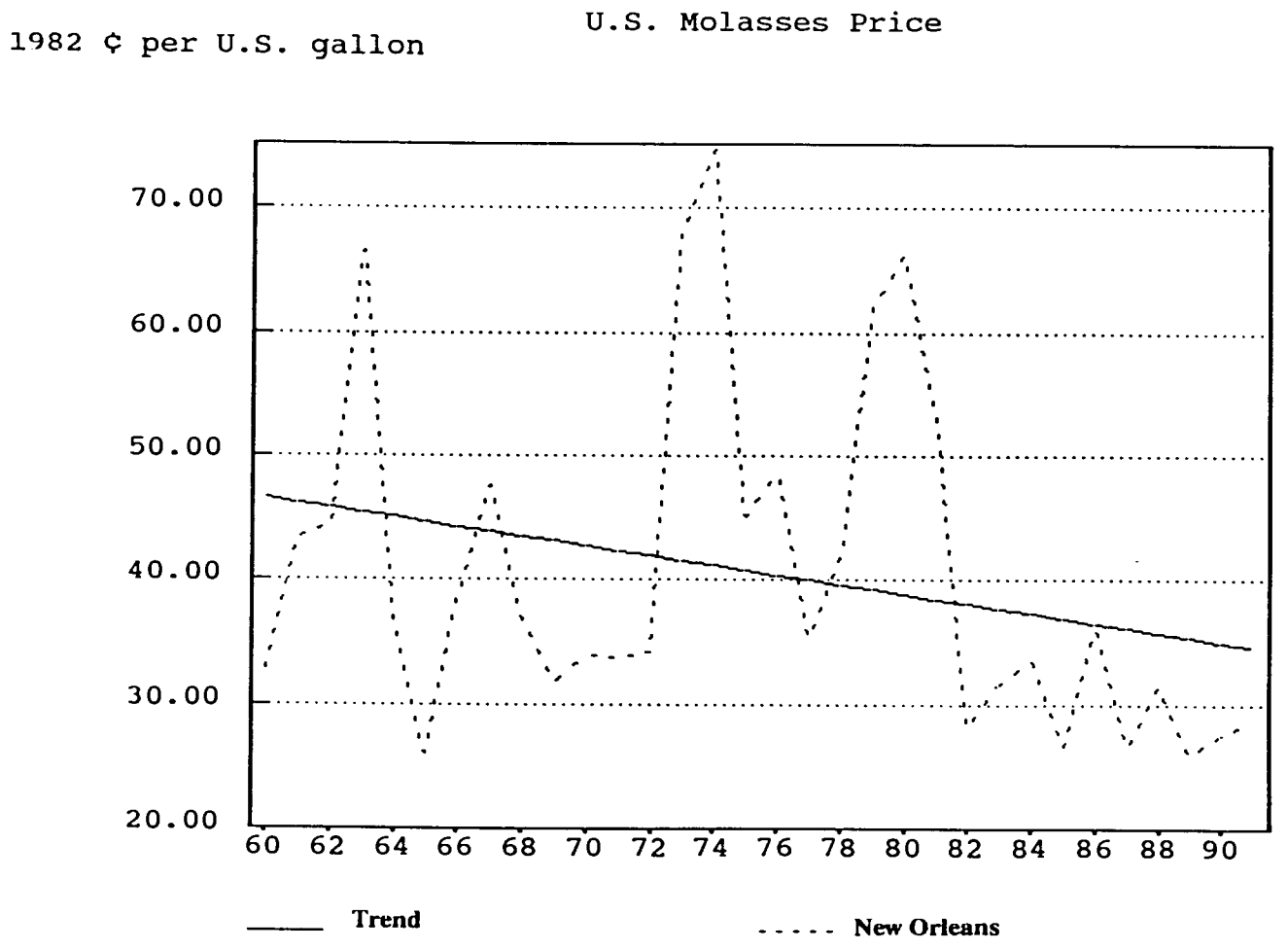

Molasses Prices
nominal US cents per gallon
60.00
50.00
40.00
30.00
20.00
10.00
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
New Orleans
Distillers (INAZUCAR)
Feed Price (INAZUCAR)

Figure 18


U.S. Molasses Price
1982 ¢ per U.S. gallon
70.00
60.00
50.00
40.00
30.00
20.00
60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90
Trend
New Orleans

C. Market Developments

In view of mediocre prospects for sales to the U.S.A. and a weak "world" market, Salvadoran exporters and government counterparts have approached two regional, sugar-importing nations, Mexico and Venezuela, with a view to negotiating bilateral agreements. In the short-term, El Salvador is handily positioned to supply Nicaragua with mill whites needed to replace sugar sold under preferential arrangements that persist from the *Sandinista* era. The general objective is to sell Salvadoran sugar at levels higher than the world price.

The proposal to Mexico involves swapping oil for sugar. Mexico's internal sugar price is said to be C 0.40 per LB due to very high local production costs. The status of discussions is not known but an attempt was made to sell mill white sugar to the Mexican government at $290 to 310 per TM FOB Acajutla. Allegedly due to pressure from Cuba, the sale was canceled. (It then became "available" for sale to Nicaragua.)

The bilateral arrangement with Venezuela is further advanced. An agreement for El Salvador to supply Venezuela with *raw* sugar has been signed with the executive branch of government, but requires the approval of the Venezuelan legislature if it is to become law.

In the case of Nicaragua, logistics favor El Salvador. Cargill recently offered sugar to the Nicaraguans in the range of $330 to $350 per TM. Salvadoran exporters quoted $320 delivered. Deducting truck freight of $44 per TM gives an ex-factory value of $276 per TM or C 101 per Q, a C 18 discount below the internal mill whites price. Assuming the difference between the cost of producing raw and mill white sugar is C 25 (the difference between their respective wholesale prices), selling mill white sugar to Nicaragua at C 101 per Q is equivalent to selling "world" market raws at C 76 per Q (compared to approximately C 58 for raws at current levels).

Bilateral deals are attractive and one can understand why Salvadoran exporters want to push their government counterparts to bring them to closure. Nonetheless there is little or no economic reason for Mexico and Venezuela to favor El Salvador in this manner. Rather it would form part of the nations' **political** efforts to cultivate Central America. In the case of Mexico, it may also run foul of the initiative to create a free trade area with the U.S. and Canada. Both efforts may be overtaken with the parallel initiative to recreate the Central American free trade area.

All Central American countries are sugar producers with market opportunities similar to those of El Salvador. They may be distinguished from one another in

terms of the size of their domestic markets, the level of administered prices, the size of their U.S. import quota, and the degree of integration between cane growing and processing. Integration of the regional sugar market is a possible goal of the free trade area.

As was suggested above, steps towards sugar trade liberalization need to be taken in a coordinated way in order to avoid predatory actions by one nation's exporters against another's. The structure of the world sugar trade forces all producing countries to "dump" sugar surplus of domestic and preferential markets by selling into the "world" market at the residual, and usually low price.

The calculation of the competitiveness of Salvadoran producers against imported refined sugar earlier in this section deliberately avoided consideration of neighboring countries as suppliers to avoid **circularity**. That is to say, Salvadoran exporters are in entirely the same position as their Central American counterparts in that they monopolize their domestic market and dump surpluses below cost.

If, for any reason, El Salvador were unilaterally to open its borders to sugar from neighboring Central American countries that did not open their domestic markets to El Salvador, then Salvadoran prices would probably fall to the level of "dumped" sugar, that is, at or below world market levels. The "dumping" price would probably be below the world price computed above based on Brazilian prices because FOB prices are the same for all exporting countries and so processors in neighboring countries would transport by road thus "saving" the costs of ocean freight and port handling.

Simultaneously Salvadoran processors would have to decide what to do with their (now larger) surpluses. Apart from U.S. quota, all market prices would now be similar or close to world market levels. At these levels, cane prices would drop drastically, probably reducing supply and ultimately bringing about the closure of several factories. Yet these grave consequences would result not from the operations of a free market but from an administered scheme designed to protect domestic processors and growers in El Salvador's neighbors.

Conceptually, therefore, the Central American **region** should be the unit of analysis for determining competitiveness *versus* sellers of white sugar. The calculation performed *vis-a-vis* Acajutla would apply, *mutatis mutandis* to the

whole of Central America. If the region-wide domestic sugar trade were permitted to operate on free market principles, virtually integrated with the world market through a mechanism such as the "price range" that tends to even out the "peaks" and "valleys" of price fluctuations, then the **question of competitiveness would arise in terms of grower-processor combinations at the sugar factory level.**

IV. STRUCTURE AND EVOLUTION OF SUPPLY

A. Key Indicators

The activity of supplying cane sugar and its byproducts to their respective markets has two distinct phases, cane production or the agricultural phase, and cane processing or the manufacturing phase. The two may be conducted by the same firm or as, by law in the case in El Salvador, by different ones. In each case, the profit of the operating firm or firms is the long term criterion for success. Where, due to imperfections or delays in the market mechanism, profits do not readily reflect a firm's situation, other results can serve as indicators.

Cane yield, the quantity of cane obtained per unit of area and time, is the chief technical performance indicator in the agricultural phase. In the Salvadoran sugar industry, yield is expressed as T per mz, per crop year. A second performance indicator, sugar recovery, spans both the agricultural and manufacturing phases. It is dependent on cane quality (sucrose content and purity of total soluble solids) as produced in the field, but also on the efficiency of the factory process. Nevertheless, recovery, expressed as LB of sugar per T of cane, is registered entirely as a processing result. A third key indicator, processing cost in C per T of cane processed, helps measure efficiency of the manufacturing phase.

A reasonable first impression of the present performance of the Salvadoran sugar industry may be gained by contrasting results relative to the above indicators with historic performance and results in other countries. For example:

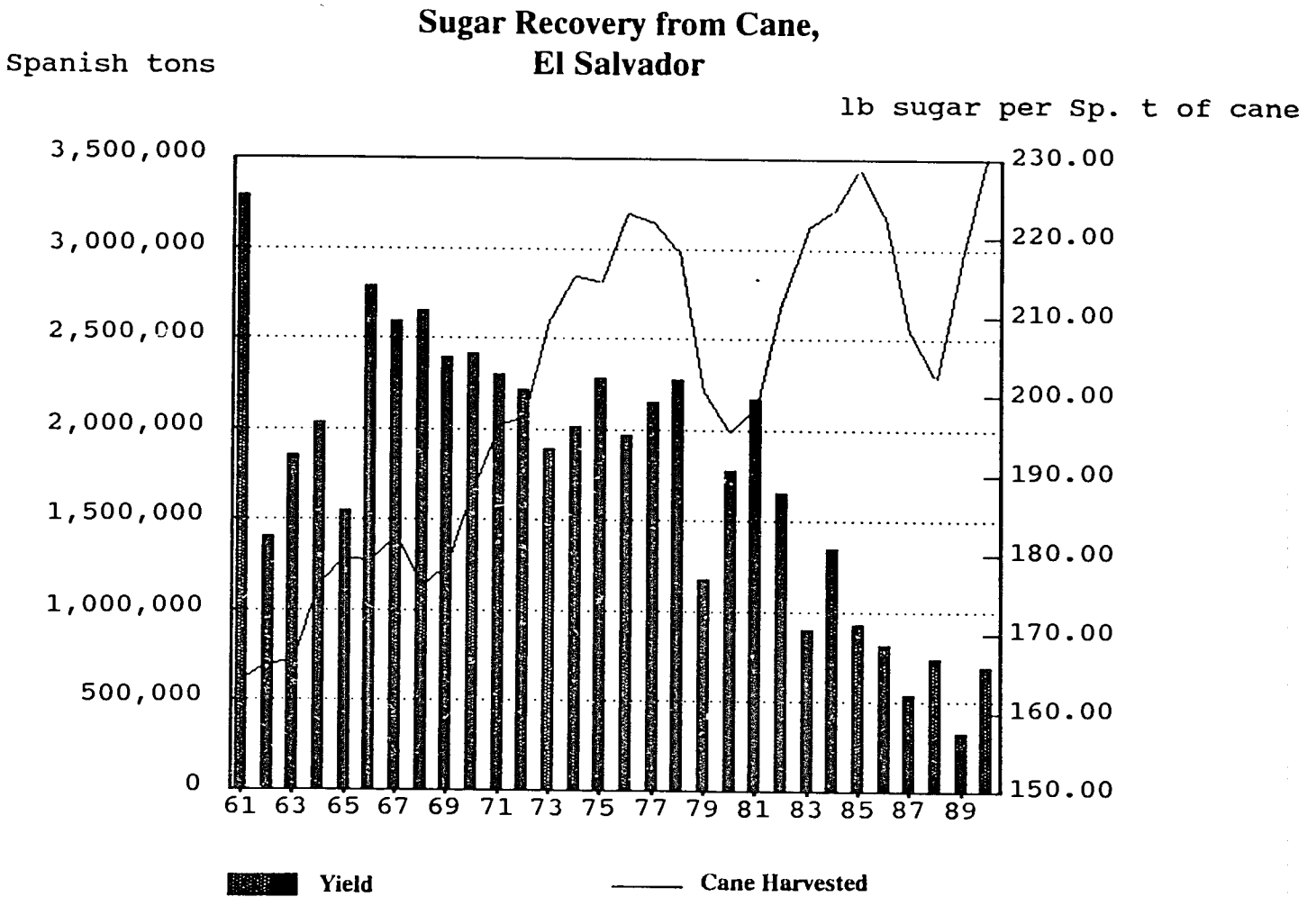
- The 1991 cane yield of 59 T per mz is lower than the 65 T attained in El Salvador fifteen years ago.

- The present Salvadoran sugar recovery average of 160 LB per T is low compared to the country's 200 LB only average ten years ago (Figure 19) and Costa Rica's 230 LB, not to mention the 260 LB attained in Australia.

- Although processing costs are the hardest to compare, because of regional variations in relative labor and capital costs, processing costs in El Salvador for 1990 range from C 65 to C 125 per T of cane compared to the 1988 figures for Florida and Louisiana of C 123 and C 133 respectively.

By analyzing various aspects of performance through their respective indicators, it is possible to widely assess the efficiency and competitiveness of the Salvadoran industry. Furthermore, judgements can be made as to the potential for improvement and the principal constraints.

Figure 19


Sugar Recovery from Cane,
El Salvador
Spanish tons
lb sugar per Sp. t of cane
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
230.00
220.00
210.00
200.00
190.00
180.00
170.00
160.00
150.00
61 63 65 67 69 71 73 75 77 79 81 83 85 87 89
Yield
Cane Harvested

B. Cane Production

1. Background Information

Sugar cane was originally grown at the intermediate elevations, mostly in the western half of the country. With the increase in cane area during the 1960s, after the reallocation of the Cuban U.S. quota, and following the price surge in the world market in the 1970s, cane also moved into the coastal plains. The decline of cotton during the 1980s has also brought cane production into new areas altogether, such as that around San Miguel.[8] In Figure 20, the present distribution of cane growing areas can be appreciated.

Most of the cane in El Salvador is grown under dryland conditions. In the Zapotitlan scheme, straddling the departments of Sonsonate and La Libertad, however, some furrow irrigation takes place. The system is fed by water pumped from a river and is operated in a supplementary way, to support plant cane and early harvest stubble during the dry period.

Prices for cane land are between C 7,000 and C 20,000 per mz, depending on soil quality and proximity to a mill. In the La Cabaña area, within three km of the mill, a price of between C 16,000 and C 18,000 per mz was reported, with a high of C 20,000 per mz near Chanmico.

About 60 percent of the approximately 60,000 mz on which cane is grown is in the hands of agricultural cooperatives, established in 1979 by Phase I of the agrarian reform program.[9] The other 40 percent is privately owned. The cooperatives may not be broken up, but individual members may join and leave at will. There are between 50 and 100 cooperatives growing sugar cane,

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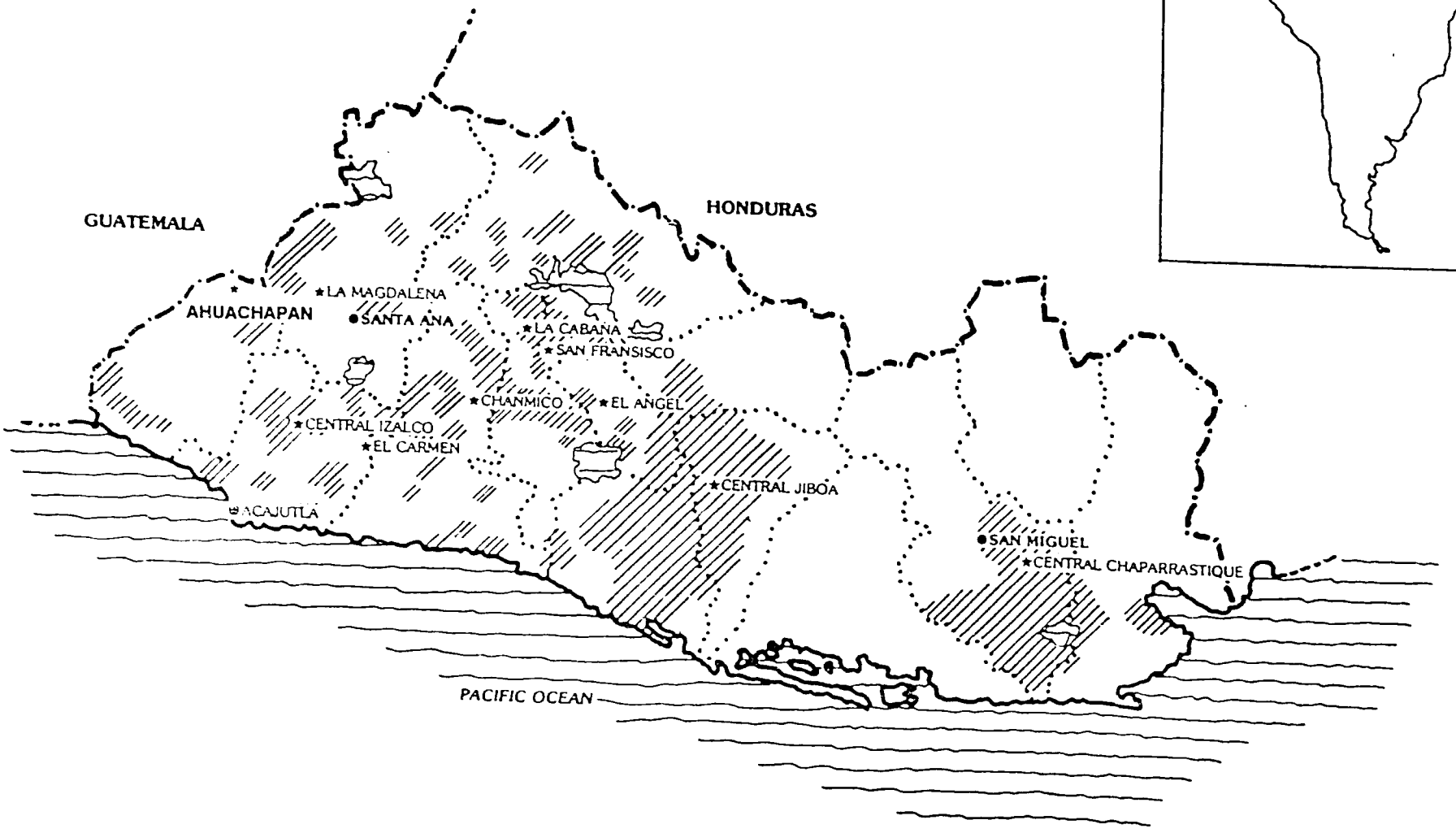
[8] The decline of cotton was caused by the market as well as by the appearance of armed insurgency, cotton being a crop highly susceptible to disruptive action. The shooting down of crop dusting planes and the burning of fields and gins during harvest were common occurrences. In addition, the transfer of complex production systems to agrarian reform cooperatives and the ensuing loss of qualified personnel contributed to make the cotton sector less competitive.

[9] Under Phase I of the agrarian reform program, all land holdings in excess of 700 mz were expropriated and turned over to agricultural cooperatives. The resulting change in ownership has affected nearly one half of all sugar cane land. Previously, the mills had owned about 20 % and the large independent growers about 30% of the area in cane. Under Phase II of the program, which so far has not been implemented, all holdings down to a maximum of 350 mz are to be expropriated. Under Phase III, ownership is to be given to all tenants of plots smaller than 10 mz. Expropriated lands have been compensated with interest- bearing (6%) 30 year government bonds in an amount equal to the declared tax base.

Figure 20

EL SALVADOR - Location of Cane Growing Regions, Sugar Mills and Sugar-Handling Port



★ Mills
● Towns and Cities

compared to about 2,000 to 3,000 private cane growers. The association of independent growers is PROCANA. Of late, the cooperatives also have created an organization, UNICANA.[10]

The mechanical equipment for cane production and transportation is owned in part by the cooperatives and independent private growers. Part of it is owned by the agricultural service firms contracted by the growers. These firms are generally operated by the sugar factories.

It is estimated that approximately 25,000 workers are employed in sugar cane production[11] and another 5,000 in processing, transportation, and ancillary services. This represents about 4% of total rural employment.

Labor unions do not exist in the area of cane production and harvesting. On the cane growing cooperatives, many but not all of the workers are cooperative members. There also are cooperative members who do not work on the cooperatives. Legal minimum wages for 1990/91 were C 11.50 per day in general work and C 16.20 in cane cutting. Actual wages vary from C 12.50 to C 22.00 per day.

2. Operations

a. Cane Growing

Sugar cane, in El Salvador, is planted in November and December, just after the end of the rainy season. Harvesting takes place over a period of five months, between mid November and mid April. Plant cane is cut at between 12 and 17 months of age, depending on the cane variety. Early varieties are ready in November, soon after the onset of dry weather. Medium and late varieties need a longer spell without rain to mature. Ratoons are harvested at exactly 12 months. The point at which they are ready to be milled, again, depends on the variety. Ideally, mature cane is programmed to be available for harvesting throughout the grinding season.

The agricultural yield of plant cane ranges from 85 to 120 T per mz. First ratoon figures are lower, ranging from 60 to 75 T. Yields gradually drop to anywhere

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10 The cooperatives, have lately been lobbying hard to have adjudicated to them the five INAZUCAR mills and Jiboa (of which the government is under pressure from the World Bank to divest itself).

11 Assuming 54 Man-Days per mz of cane per year and 60,000 mz, 3,240,000 Man-Days are required per year. At 130 days per worker per year, this represents approximately 25,000 workers.

between 40 and 55 T per mz for fourth ratoons. Although, in some stands, the yield decline is slower, renovation after the fifth cutting is considered desirable practice in El Salvador.[12] Fields that come up for renovation during the early part of the crop are plowed and replanted immediately. Fields coming up later are planted to an intermediate crop of rice or corn in May, once the rainy season has started. This crop is harvested in August, and the land is then duly prepared and planted to cane again in November.

There has been a trend to move away from such late maturing varieties as Pindar and the classical Puerto Ricans (PR-975, PR-980, PR-1000, PR-1013) which, together with B-34104, had substituted the noble canes and the first POJ and Mayaguez crosses about forty years ago. They are likely to be partially substituted by varieties from Canal Point (CP-722086, CP-721312), Queensland (Q-75, Q-96, Q-102), Mexico (MEX-68000, MEX-69200), and Jaronú (JA-6411, JA-6420), which mature considerably earlier in the Salvadoran crop.

In many commercial stands, there is a considerable degree of variety mixing. Unfortunately, these stands are also used as sources of seed material for new plantings, although conscious efforts are being made to control these cases of varietal pollution. The most serious disease to which cane varieties in El Salvador must be resistant is smut (Ustilago scitaminea Sydow). Variety work is presently done by the private mills, notably Izalco, and by INAZUCAR. *The Centro Nacional de Tecnologia Agricola* (CENTA) in San Andrés has recently been told to dedicate its resources to more expedient issues than the selection of cane varieties.

Among formulated N-P-K fertilizers, the most widely used is 15-15-15. Formula 16-20-0 has also been used. Plant cane is fertilized upon planting, ratoon cane at the start of the rainy season. The Nitrogen dosage of 157 LB per mz in plant cane is short of the benchmark restitution value of 2 LB per T of cane while, at 178 LB per mz in ratoon cane, it considerably exceeds that amount.[13] Herbicides applied include Diuron, 2,4-D, and Gesapax. One of the prevalent pests is the Neolabia or *Mosca Pinta*. Tamaron-600 from Bayer is applied to control it.

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[12] Reality differs somewhat from this professed goal, in as much as about one third (instead of one fifth) of all cane plantings are fourth ratoon or older.

[13] Nitrogen contents of 15% in formula fertilizer and 20% in ammonium sulphate are assumed.

b. Cane Harvesting

All cane in El Salvador is hand cut. A cutter is assigned a daily task for the completion of which he will receive approximately C 22.00. Presently, the average task works out to be between 1.8 and 1.9 T, resulting in a cutting cost of about C 12.00 per T. Most cane cutters finish their task around 9:00 a.m. In recent crops, an occasional lack of cane cutters has been reported by growers delivering cane to the La Cabaña mill. To talk about mechanical cane harvesters has, until recently, been "morally unacceptable". This situation is now changing, an active interest in such equipment being shown by some growers.

Normally, cane is harvested in El Salvador without being burnt. With the upheavals of the past 12 years, however, such "normalcy" has almost disappeared. Cane fields have been set afire on purpose by guerrilla fighters trying to disrupt the economy, by cane cutters trying to pressure growers into harvesting, and growers trying to pressure mills into receiving their cane, lest it be spoilt completely. Controlled burning, limited to cane that will be cut the same day, increases harvesting efficiency and is practiced by some growers. It may become part of normal procedure in El Salvador once the military situation calms down.

The uncontrolled burning of cane, sometimes months before its optimal point of maturity and when hauling is difficult to schedule, is the single most damaging influence on sugar production in El Salvador today. It may cause a loss of up to 20 percent in the production of sugar per unit area, as indicated by the average recovery drop from 200 LB per T of cane in 1978/79 to 165 in 1990/91.[14] This drop includes losses due to deteriorating cultivation and harvesting management and to a decline in mill extraction and boiling house retention. It completely leaves out any additional tonnage the cane plant did not produce due to untimely burning.

Cane loading is done by two systems. Where fields are large and reasonably flat, grab loaders load the windrowed whole-stalk cane (*caña larga*) onto sling-fitted trucks for direct hauling to the mill. Large growers, such as the cooperatives, have their own cane loaders. Mechanical loading, when performed by contract, costs about C 5.00 per T.

Where fields are too sloped for grab loader operation, cane is hand loaded. This presupposes that the stalks have been cut by the cane cutter into 2 to 3 feet

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[14] The starting point of this comparison is not particularly impressive to begin with. Costa Rica for example, consistently achieves average recoveries above 220 LB per T. This seems to indicate that not everything was well with the Salvadoran industry, even before the onset of its present difficulties.

lengths (*caña corta*) before being thrown into the swath. A loading gang, usually supplied by the transporter, carries the cuttings, bundled with a burlap tie, onto either a truck or a cane cart via an inclined plank. There, the unbundled cane is carefully stacked. Cane carts are used where fields are both inaccessible to trucks and close enough to the mill for tractor hauling.[15] Hand loading costs about C 15.00 per T and is normally bid as part of the hauling contract.

Cane transportation is mostly done in ten to twenty-ton trucks, which are loaded in the field in the manner just described. Transport is paid for per ton, but rates vary according to distance. Each factory normally receives cane from four to five "distance zones". Rates vary from C 10.00 per T for the closest zone to C 35.00 for the most distant, which may involve a 65 km haul. Road quality (and safety) as well as vehicle size enter into setting the specific rate. Other than the main public highways, there are very few solid roads for hauling cane. Most of the ton-kilometers are logged on dirt roads. Nevertheless, due to the lack of rainfall during the crop, a road grading job just before the start of the harvest is considered adequate.

Table 12 introduces the ten Salvadoran sugar mills and presents a summary of cane in 1990/91, broken down according to some of the characteristics indicated above.

3. Cost and Results

Table 13 summarizes the chief cultural practices and inputs employed in cane growing. It also shows the cost of each of the operations and the total cost per mz of plant and ratoon cane. The average for both, assuming one fifth of the cane area to be under plant cane, is C 3,173.25. Cane cutting, loading and transportation costs have been described for various conditions in the previous section. The total cost of cane delivered to the mill can thus be derived, and its range defined, based on the assumptions one chooses to make about the factors determining each one of its components. Such a short term cane cost range, jointly with grower margins, is exhibited in Table 14.

Cane production inputs are essentially fixed per area. Thus, variations in the cost of cane are due mainly to agricultural yield. Such yield is a function of climatic conditions, varieties, and proper cultural practices such as timely fertilization, weed and pest control, and proper renovation management. On the basis of past records it seems unlikely that the average agricultural yield will ever drop

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15 At Izalco, there even are 200 oxcarts delivering cane, although their use is based on a social and not an economic decision.

below 50 T per mz. On the other hand, the imminent improvements in crop management discussed above, allow the assumption of an average yield of 70 T per mz as a perfectly attainable level. Thus, 50 and 70 T per mz are assumed as the end points of a plausible range to determine the short term yield sensitivity of the cost of cane. In the long term, costs per mz are also bound to change, but this aspect is not considered here.

The cane cutting component is assumed not to change significantly in the short term and, therefore, is not assigned a range. It is assumed to be fixed at C 12.00 per T. In the long term, an industry-driven increase in labor demand will probably raise wages to the point where mechanical harvesting will become a viable or

Table 12

CANE RECEIVED BY SALVADORAN MILLS, 1990/91

Mill	Cane Area mz	Cane Yield T/mz	Total Cane m.T	From CoOps m.T	From CoOps %	Hand Loaded m.T	Hand Loaded %	Burnt Cane %
Jiboa(JBOA)			592	327	55.55		50.00	59.91
La Cabana(CABN)	8,800	51.59	454				3.00	92.30
La Magdalena(MAGD)	2,950	46.27	137	66	48.17	70	51.52	30.89
Chanmico(CHAN)	2,620	53.20	139			49	35.00	74.20
El Carmen(CARM)	3,200	58.51	187			64	34.40	88.37
Chaparrast.(CHAP)	4,000	55.54	222			144	64.70	83.04
Izalco(IZAL)	14,983	56.26	843	379	44.94	183	21.73	
El Angel(ELAN)			534				40.00	
San Francisco(SFCO)	6,783	60.04	407	197	48.32		1.00	71.90
Ahuachapan(AHUA)		50.00	68				40.00	
	60,770	58.95	3,583					

Table 13

COST OF GROWING CANE IN EL SALVADOR, 1990/91, C/mz

Components, Units	Plant Cane U.Use	Plant Cane U.Cost	Plant Cane Amount	Ratoon Cane U.Use	Ratoon Cane U.Cost	Ratoon Cane Amount
SUPPLIES						
Seed, T	10.00	109.55	1,095.51			
N-P-K Form. Fert., Q	4.66	73.86	344.17	4.50	80.54	362.44
Ammonium Sulfate, Q	4.33	43.99	190.47	5.50	41.76	229.70
Foliar Appl. Fertilizer						69.10
Insecticides			224.76			306.40
Herbicides			280.11			338.93
Fungicides						100.00
			2,135.02			1,406.57
LAND PREPAR., PLANTING						
Brush Clearing, Man-Days	13	11.88	154.50			
Chisel, Tractor-Passes	1	152.34	152.34			
Plow, Tractor-Passes	1	153.31	153.31			
Light Harrow, T.-Passes	1	107.24	107.24			
Heavy Harrow, T.-Passes	2	115.89	231.78			
Furrowing Plow, T.-P.	1	149.60	149.60			
Dist. & Cover, Man-Days	17	14.98	254.70			
			1,204.07			
CULTIVATION						
Reconditioning, Man-Days				5	15.49	77.43
Fert. Appl. 1, Man-Days	2	14.85	29.71	1	15.83	15.83
Fert. Appl. 2, Man-Days	1	14.85	14.85	1	16.48	16.48
Fert. Appl. 3, Man-Days	1	14.25	14.25			
Weeding 1, Man-Days	9	14.76	132.80	8	15.71	125.64
Weeding 2, Man-Days	6	14.80	88.80	9	15.22	137.00
Weeding 3, Man-Days	4	15.31	61.24			
Cultiv. 1, Tr.-Passes	1	122.97	122.97	1	116.37	116.37
Cultiv. 2, Tr.-Passes	1	70.00	70.00	1	66.43	66.43
Pestic. Appl., Man-Days	5	15.70	78.49	7	16.51	115.55
Supervision, Man-Days	4	18.14	72.54	2	16.61	33.21
			685.65			703.94
Direct Cost			4,042.74			2,110.51
Administrative Cost, 3%			120.74			63.32
Contingency, 5%			207.27			108.69
Interest Charges, 20%			870.55			378.22
Total Cost			5,223.31			2,660.74

Average for Plant and four Ratoons: 0.20 x 5,223.31 + 0.80 x 2,660.74 = 3,173.05

Source: Ministerio de Agricultura y Ganaderia, Estadisticas Agropecuarias
Survey of 234 Producers

Table 14

CANE PRODUCER MARGINS, EL SALVADOR, 1990/91, C/T
(DIFFERENT AGRICULTURAL YIELDS, LOADING SYSTEMS, AND HAULING DISTANCES)

REVENUE	115.00	115.00	115.00	115.00
Low Agricultural Yield Scenarios	1	2	3	4
Growing, C 3,173/mz @ 50 T/mz	63.46	63.46	63.46	63.46
Cutting, Manual @ C 12/T	12.00	12.00	12.00	12.00
Loading, Manual @ C 15/T	15.00	15.00		
Mechanical @ C 5/T			5.00	5.00
Hauling, 25 T.km/T @ C 1.00/T.km	25.00		25.00	
10 T.km/T @ C 1.50/T.km		15.00		15.00
COST OF CANE	115.46	105.46	105.46	95.46
PRODUCER MARGIN	(0.46)	9.54	9.54	19.54
High Agricultural Yield Scenarios	5	6	7	8
Growing, C 3,173/mz @ 70 T/mz	45.33	45.33	45.33	45.33
Cutting, Manual @ C 12/T	12.00	12.00	12.00	12.00
Loading, Manual @ C 15/T	15.00	15.00		
Mechanical @ C 5/T			5.00	5.00
Hauling, 25 T.km/T @ C 1.00/T.km	25.00		25.00	
10 T.km/T @ C 1.50/T.km		15.00		15.00
COST OF CANE	97.33	87.33	87.33	77.33
PRODUCER MARGIN	17.67	27.67	27.67	37.67

even necessary alternative. Harvesting costs will then enter a new order of magnitude, for which past experiences in Puerto Rico and Hawaii may serve as an indication. A similarly impending parallel to other regions may be the abandonment of all cane areas not suitable for mechanical harvesting.

The short run range of the cane loading cost is defined in terms of the present two alternatives, hand loading at C 15.00 per T and mechanical loading at C 5.00. In the long run, some of the observations made about cane cutting will also apply to the loading operation.

The data shown in Table 15 indicate that average hauling distances per mill range from 8 to 25 km. Based on these distances and considering some representative freight rates, C 25.00 and C 15.00 per T of cane were chosen to define the short term range of cane transportation costs.

These four components, three of which were assigned a range, resulted in a relatively wide total cost range of between C 77.33 and C 115.46 per T. Under the prevalent uniform cane price of C 115.00 per T, cane grower margins are seen to cover a wide range as well.[16] Growers with low yields and high loading and hauling costs are seen to lose money while others, at more favorable conditions, have the chance to make in excess of 30 percent profit on their sales.

C. Cane Processing

1. Background Information

There are ten operational sugar factories in El Salvador, with their locations indicated in Figure 20. Four of them are privately owned, representing over one half of the total installed capacity. The remaining mills are owned by the government. Prior to 1980, all sugar factories were privately owned. In that year, the plants, except Izalco, were expropriated under the agrarian reform program, along with the cane plantations. The factories were handed over to the Instituto Nacional del Azucar (INAZUCAR) which was charged with buying, at a fixed per-ton price, all cane produced by the cooperatives and the remaining private growers. It then was to process the cane and sell the products in the domestic as well as international markets. In 1986, El Angel and San Francisco were returned to their former owners. Ahuachapan was inoperative between 1980 and 1983 and thus escaped expropriation.

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[16] The price is fixed every year by the state-owned mills for cane placed at the mill yard. It actually represents an arbitrary distribution of proceeds from cane products between cane producers and processors.

Table 15

MAIN CHARACTERISTICS OF SALVADORAN SUGAR MILLS

A. GENERAL

Name (Abbreviation)	Year Est.	Present Ownership	Av. Haul (Max.) km	Capac. T/d	Pers. Crop	Special Features
Jiboa (JBOA)	1976	CORSAIN	(65)	5,000	630	White End
La Cabana (CABN)	1946	INAZUCAR	14.8 (70)	5,500	515	Distillery
La Magdalena (MAGD)	1967	INAZUCAR	8.2 (50)	1,700	402	
Chanmico (CHAN)	1954	INAZUCAR	8.0 (35)	1,500	369	Distillery
El Carmen (CARM)	1967	INAZUCAR	11.1 (65)	2,200	331	
Chaparrastique(CHAP)	1983	INAZUCAR	24.6 (65)	3,200	463	
Izalco (IZAL)	1962	Private		6,000	600	
El Angel (ELAN)	1900	Private		5,500		
San Francisco (SFCO)	1947	Private	17.6 (35)	4,000	475	Board Plant
Ahuachapan (AHUA)	1976	Private	(35)	800	260	Distillery
				35,400		

B. TECHNICAL

Mill	Cane Prepar. HP	Milling Train Rolls, W.	Milling Train HP	Electric Generat. KW	Steam Generat. T/h	Evapor. Surface m2
JBOA		12 x 84"		3,400	64	
CABN	1,500	15 x 78"	5,000	4,500	110	
MAGD		18 x 42"	1,300	1,000	50	
CHAN	600	12 x 48"	1,875	3,300	90	2,560
		3 x 56"				
CARM	600	12 x 60"	1,600	1,700	72	3,030
CHAP	600	12 x 66"	3,000	2,600	100	2,900
IZAL	1,900	12 x 54"	3,800	6,000	175	
		5 x 84"				
ELAN	1,300	15 x 66"	3,000	4,500	220	5,500
SFCO	970	6 x 60"	1,650	3,300	80	5,200
		9 x 52"				
AHUA		9 x 36"			32	

Up to 1989, the private mills were contracted by INAZUCAR to process cane for a fixed fee per ton. Since then, they are able to buy cane and sell sugar and molasses as independent agents, while INAZUCAR is strictly controlling its own five mills. The sixth government factory, Jiboa, is operated as a separate entity by the Corporacion Salvadorena de Inversiones (CORSAIN). The four private mills belong to an organization for joint marketing, the Asociación Azucarera de El Salvador.

To separate the sugar from the cane stalk and transform it into a non-perishable and transportable commodity, Salvadoran mills use conventional technology based on several operations of materials separation. Juice containing sugar and other soluble solids in solution is separated from the non-soluble solids, or fiber, by mechanical extraction in the mills. Suspended solids are separated from the mill juice, which has first been treated by heat and chemical agents, by decantation. Of the decanted or clarified juice, water is separated by evaporation. This results in syrup, a concentrated solution of soluble solids, the largest part of which consists of sucrose or cane sugar. To separate sucrose from the rest of the solids, crystallization is used. By maintaining the concentration of the syrup above the point where all of the soluble solids are able to remain in solution, part of the sugar is forced into the solid or crystalline phase. This separation is accomplished by pan boiling under vacuum. The sugar crystals and mother liquor or molasses of the resulting massecuite are separated by centrifugal action. The sugar is sent to the warehouse and the molasses, which still contains part of the sugar and all of the non-sugars in solution, is returned to the vacuum pans for further exhaustion. After the third boiling, it will yield no more sugar crystals and is referred to as final molasses.[17]

Table 15 shows a summary of the main characteristics of all mills. Accounts of the plant visits carried out in connection with this study appear in Appendix C, and detailed listings of the principal equipment in Appendix D. Some of the key features of each mill are summarized below:

- Jiboa was built for the government in 1976 as a turn-key job. Technically it is the most sophisticated of the Salvadoran sugar factories, but its nearest cane is located at 8 km. Half of its cane comes from hilly terrain, dependent on hand loading.

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[17] Bagasse, the solid output of the extraction process, contains all of the sugar cane fiber and some of the juice. It serves as the source of energy for the entire operation. The first step in utilizing this energy is the generation of steam. From it, mechanical energy is transmitted to the prime movers which drive the process, either directly such as knife and mill turbines, or indirectly such as electric power generators. The thermal energy of the exhaust steam leaving the prime movers is transmitted to the process vessels such as juice heaters, multiple-effect evaporators, and vacuum pans. From there, first condensate returns to the steam generators.

- La Cabaña is a well equipped conventional sugar house, the only one on which INAZUCAR spent any amount of money in the 1980s. It is surrounded by some of the best cane fields in the country but lacks forceful management. It competes for cane with San Francisco, 7 km away.

- La Magdalena was built with second hand equipment and is the site of some unusual but clever improvised engineering. It is located in the politically and socially quietest part of the country, a fact reflected in its low level of burnt cane and its recovery of nearly 200 LB per T.

- Chanmico is in a choice location with respect to cane and water and has some solid equipment, but was badly neglected through the 1980s. The mill is undergoing a thorough rehabilitation. Should El Carmen and El Angel have to fold, it could become the only mill for a large cane area immediately West of San Salvador.

- El Carmen is a collection of second hand equipment in a sorry state of repair. In spite of being favorably located with respect to cane, it may be the first of the INAZUCAR mills to stop operating in a free market environment.

- Chaparrastique is surprisingly well laid out and maintained, considering that its principal equipment has previously been operating at two other sites. However, San Miguel is not a traditional cane growing area, and Chaparrastique may always be hampered by poor cane quality.

- Izalco may be considered the flagship of the Salvadoran sugar industry. It has suffered the least during the 1980s and its social environment and grower relations seems to be in good shape. Given these favorable circumstances, it is surprising that its technical results are no better than they are.

- El Angel is located on the outskirts of San Salvador, surrounded by urban development. It is the only mill which last season had to close early for lack of cane. In spite of the poor outlook, its owners are resolved to carry on.

- San Francisco has a lot going for it: good cane land, part of which gradually is released back into production by the insurgents; and a record of solid sugar mill engineering. It has suffered badly, however, under state administration and is going through a phase of gradual rehabilitation.

- Ahuachapán is mostly an annex to its potable alcohol distillery, which it operates with its own as well as purchased molasses. It is located practically on the border with Guatemala.

Some of the mills are equipped for further processing of primary products. Sugar refining capacity exists at Jiboa and will soon be available at Izalco and El Angel.[18] There are distilleries to transform final molasses into ethanol at *Ahuachapán, El Carmen, Chanmico, and La Cabaña.* San Francisco operates a bagasse-based particle board plant, and at Jiboa, an extra boiler and turbo-generator are being installed to convert excess bagasse into marketable power. As there are periodic shortages of water at El Salvador's hydro-electric plants, and as excess bagasse is available at the sugar mills precisely during the period of low rainfall, the production and sale of electric power to the public grid also is considered by Izalco and San Francisco. At an estimated excess of 20kw of energy available for each T of cane ground, the sugar industry could eventually offer as much as 700 MW during the peak of the crop. The price agreed to by the public utility for 1991/1992 is C 0.30 per kwh, to be raised to C 0.38 during the 1992/1993 crop. The industry feels that in the long run it needs $0.07 (C .56) per kwh to justify the necessary investments. The sugar mills in Guatemala are presently receiving $0.06 per kwh.

Some mills have agricultural service departments, disposing of a variety of agricultural equipment. All mills have some transport capacity of their own which, during the crop, is expanded by renting or just brokering additional cane trucks. Vehicle maintenance facilities exist at all mills. Most mills also have some basic plate work and machining facilities. For larger mechanical jobs, involving casting and complex fabricating, they contract one of the two major shops in San Salvador.

Most of the sugar factories are unionized. In the privately owned mills, the unions are of the local or company type and seem to be quite reasonable in their demands. It is in the government owned mills that the unions are the most

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[18] Between 1962 and 1984, an independent sugar refinery, the Refineria Salvadoreña de Azucar, operated just North of San Salvador on the road to Apopa. The 600 ton-per-day oil-fired plant was owned jointly by most of the sugar companies. After the agrarian reform, its raw sugar supply was curtailed. At present, the installation is being cannibalized by the private mills.

powerful. The Sindicato de la Industria Nacional del Azucar (SINA) has imposed a base pay of around C 1,500 per month at each of the six government mills, in addition to rather stiff manning requirements.[19]

2. Operations

The Salvadoran grinding season starts after the end of the rainy period, in mid-November, and lasts for 120 to 150 days. In the western part of the country, the start is normally delayed until early December, because before that, most of the agricultural labor force is engaged in the coffee harvest. Factory work is realized in three eight-hour shifts, seven days a week. Table 16 shows some operating and production data. Together with information gathered at the mills, they allow some general comments on cane processing in El Salvador.

Cane is received at the mills during 20 hours, four hours at the start of each day being reserved for liquidating the cane pile in the yard. Cane is weighed, recorded, and unloaded, most of the time directly onto the cane table.[20] Mechanically loaded cane is not washed, and there are no data on dirt and trash content. Most cane tables, onto which the bundles of mechanically loaded whole-stalk cane are unloaded by hammerhead type cranes, have a perforated bottom. Dirt is carried out from under them either by wheelbarrow of by belt conveyor. Undoubtedly, the scarcity of water and the cost of any recycling of cane wash water contribute to this situation.

Short cane is unloaded into separate carriers, either by hand -- loading and unloading are part of the short cane hauling contract paid by the grower -- or via a rear end tipper and below-grade table, such as at El Angel. Jiboa was originally built for short cane only and has neither a table nor a crane to receive long cane. Cane is generally prepared for milling by two sets of rotating knives. Although Izalco and Chanmico have shredders, the extraction results do not bear out this advantage. Mill work throughout is characterized by high sucrose losses in bagasse. This is apparently not due to the lack of milling capacity, fiber loading exceeding 5 t per hour-foot only at El Angel. Also with respect to power installed for cane preparation and milling, the Salvadoran mills are well positioned, amply exceeding a thumb-rule level of 100 HP per ton of fiber per hour. One reason for the high losses, certainly, is the low rate of imbibition which, in turn, may be related to rather limited evaporator surfaces. Another

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[19] It appears that SINA, politically linked to the Christian Democrats presently out of office, is trying to make life hard for the ARENA management of INAZUCAR. Last year, there was a lengthy strike which reportedly did not yield the union any concrete gains, although it did hurt the mills. The union's popularity reportedly has been somewhat reduced since then.

[20] About three years ago, INAZUCAR planned the general introduction of cane quality control. Core samplers were installed at all mills but they never have been used.

reason may be the lack of cane washing. On the whole, however, there seems to be a demand for qualified milling technicians able to properly control such key conditions as settings, pressure, speed, feed of cane, application of imbibition, etc. on a continuous basis, and thus to ensure the quality of work for which the equipment was laid out.

Juice scales are in place in only a few mills. Chemical juice treatment is applied before the first heating. For raw sugar production, only liming is used, while both liming and sulphitation is used for the production of mill white.[21] From the second half of Table 16, the type of sugar produced at each factory can be gleaned. Of the seven factories presently producing mill white, Jiboa is the only one not using sulphitation. This unsulphitated sugar is occasionally referred to as "Cristal". Of the other mills, some have connected the wooden sulphur columns before the liming tank, some after. The burners are of the tray type, the gas pipe being equipped with a cooling sleeve. Juice decantation and mud filtration is done in continuous multi-tray clarifiers and rotary vacuum filters.

Evaporation is done in quadruple or quintuple effect installations. The available capacities barely exceed one square meter per ton of cane per day, which is low by conventional standards. On the other hand, the absence in almost all factories of clarified juice heaters, shows that the operation is not particularly tight. Conditions such as exhaust steam pressure and effectiveness of the condenser water cooling circuit would have to be observed before additional comments can be rendered. It seems that most factories in El Salvador get by without having to stop for evaporator cleaning. They accomplish this by the use of swing bodies.

Due to the low syrup purities, a two-massecuite boiling system is used in Chanmico and El Carmen, the factories producing raw sugar only. An additional massecuite is used where mill white for domestic consumption is produced. This is the double-magma system, where all "C" sugar is mingled as a footing for "B" strikes, and mingled "B" sugar, in turn, is used as footing for "A" boilings. Due to the present low industrial yield of sugar on cane, no capacity problems exist in the back end of any factory. Some of them are quite well equipped to attain a better retention, should working conditions improve. Others are not. Ingenio Jiboa has a *Talofloc* refinery attached to its sugar house. Izalco, as well as El Angel are busy erecting similar stations, utilizing in part the let-up Salvadoreña

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21 As was seen in Section III, each mill receives a quota for export (raw) and domestic (mill white) sugar. To take advantage of the proximity of some of the mills to the export terminal of Acajutla and of others to the consumption centers of San Salvador, quota swapping takes place. Quotas are swapped, however, only within INAZUCAR and the Asociacion Azucarera respectively. Jiboa does not swap, having to haul its own export sugar to Acajutla, at C 3.44 per Q.

refinery. Also, part of this equipment is acquired by Ingenio San Francisco, for treating a melt made with part of its production of mill white. The treated melt, or liquor, will then be recycled to upgrade the syrup going into the commercial boilings.

Table 16

OPERATING AND PRODUCTION DATA OF SALVADORAN SUGAR MILLS, 1990/91

A. OPERATING CONDITIONS AND RESULTS

Mill	Total Cane T	Pol % Cane	First Juice Pur.	Fiber % Cane	Pol % Bag.	Sucr. Extr. %	Final Mol. Pur.	Sucr. Rete. %	Lost Time %
JBOA	591,702	12.06	75.09	13.12	3.56	90.61	34.01	74.51	14.06
CABN	454,025								15.27
MAGD	136,491								22.91
CHAN	139,388	12.16	81.05	12.88	4.20	90.17	40.32	72.85	25.37
CARM	187,282		77.78			87.73			35.71
CHAP	222,156		77.81			92.14			18.61
IZAL	842,987	11.61		12.65	3.60	91.79	34.73	79.02	6.41
ELAN	533,689								
SFCO	407,269	11.33	80.54	14.81	3.92	89.33	35.45	82.73	11.66
AHUA	67,620								33.64
	3,582,609								

B. PRODUCTION TOTALS

Mill	Sugar LB/T	Tot.Sugar Q	Ref. Q	Mill White Q	Raw Q	Mol. GAL/T	Molasses GAL
JBOA	170.80	1,010,709	3,599	784,950	222,160	9.60	5,680,009
CABN	152.50	692,550	-	692,550	-	8.26	3,750,241
MAGD	198.30	270,700	-	247,434	23,266	9.27	1,265,000
CHAN	164.25	228,947	-	-	228,947	8.77	1,221,904
CARM	152.21	285,068	-	-	285,068	9.02	1,688,516
CHAP	154.60	343,446	-	343,446	-	9.21	2,046,258
IZAL	166.51	1,403,678	-	335,924	1,067,754	7.88	6,645,199
ELAN	170.53	910,097	-	910,097	-	7.41	3,954,760
SFCO	167.46	682,000	-	682,000	-	7.56	3,079,190
AHUA	173.35	117,218	-	-	117,218	8.90	602,000
	165.92	5,944,413	3,599	3,996,401	1,944,413	8.36	29,933,077

All sugar destined to the domestic market is enriched with a Vitamin A preparation before leaving the factory. This treatment is based on an agreement between the mills and the Ministry of Public Health. A first stage treatment, blending the powdered pure vitamin preparation with sugar, is done centrally, at Ingenio La Cabaña. The second stage then takes place at the individual mills, where about 0.2 percent of this pre-mix is added to the sugar before it enters the dryer. Final Vitamin A concentration in sugar is about 6 parts per million.

Mill white sugar is weighed and bagged right after the dryer. The mill must store and release on a monthly basis the sugar to supply the domestic market during the entire year. Hardening in the bags does occur, but no operative sugar cooler was seen in any of the factories. Bulk export sugar is discharged from the centrifugals into a dump truck and weighed at the cane scales, on its way to the bulk warehouse.

Four distilleries were acquired by INAZUCAR in the mid-1980s. They were bought from Venezuela (CBT, based on French technology), at a time when questions already were being raised about the economics of producing alcohol for fuel use.[22] The plants were beset by technical problems from the outset. The distillery at El Carmen is located at about half a mile from the sugar factory, with boilers of its own. All distilleries are equipped for continuous fermentation and yeast recycling. Unfortunately, they have difficulties in using final molasses as a feed stock, due to excessive scaling in the columns. The slops evaporators furnished are seriously undersized and considerable slops disposal problems are experienced. With the exception of the plant at Ahuachapan, which today is privately operated and has gone into the manufacturing of potable alcohol, none of the distilleries will operate during the coming crop.

Steam is normally generated at between 200 and 250 pounds per square inch, (psi), most of it in saturated form. Capacity, on a basis of half a T of steam per T of cane, appears to be adequate for present power and processing needs. Major changes of pressure and volume, however, may be prompted by the greater requirement for live steam due to a nascent demand for co-generated power by the public grid, and for process steam due to more cristallizable sugar in cane delivered and a higher imbibition rate applied to improve present extraction.

Not all mills are self-sufficient in electric power. Magdalena, as can be seen in Table 15, has considerably less than 1 kw of generating capacity per T of cane per day. It has to buy power during the crop. On the other hand, Chanmico

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[22] The gasoline price in El Salvador as of October 1 was C 17 per gallon.

exceeds that value by more than 100 percent.[23] The Lost Time column in Table 16 shows a wide spread of values. The lowest losses belong to Izalco and San Francisco, two private mills, followed closely by Jiboa, run by the state but separately from INAZUCAR. The INAZUCAR mills have down times ranging from 15 to 35 percent. Ahuachapan can be considered an outlier. Due to its size and its link to the potable alcohol market, it is not directly comparable to the others. All state-owned mills were struck by SINA for about 10 days, or 7 percent of total time during the 1990/91 crop. The high additional losses at La Magdalena, Chanmico, and El Carmen appear to be directly related to the poor mechanical conditions of those mills. The lost time figures are mirrored in the processing costs per T of cane, presented in Appendix B, where La Magdalena and Chanmico lead the field with C 125 and C 115 per T of cane respectively. There is reason to believe that costs in some of the private mills run at little more than half of that.

The column Sugar Recovery, also in Table 16, singles out the other main economic determinant in sugar manufacture, the cost of raw material per unit of product sold. In Appendix B, it can be seen that La Magdalena, in spite of its poor operating cost, was probably saved from losing money in 1990/91 by the relatively low cost of raw material, associated with the reasonable industrial yield of the cane it received.

3. Cost and Results

In assessing costs and results, there are two parameters for which ranges have to be specified independently: the industrial yield of cane delivered; and the processing cost per ton of cane at the mill. The range used for the industrial yield extends from 160 LB to 210 LB of sugar per T of cane, implying raw material requirements of 0.625 and 0.476 T per Q respectively.

Processing costs, in light of the above discussion and the material presented in Appendix B, are assumed to range from C 65.00 to C 125.00 per T of cane. It is further assumed that the cost of cane equals C 115.00 per T.[24]

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[23] The reason for this situation is that under private ownership, mill employees living in the batey were supplied with power free of charge. After expropriation, company housing became public, with the right to free power attached. Even after the expansion of the village beyond being a sugar factory compound, Chanmico has not been able to shed its public power liability.

[24] Rather than being determined by the managers of INAZUCAR and Ingenio Jiboa, as in the past, the cane price will henceforth be set by the recently founded *Comision Salvadorena para el Desarrollo Azucarero*. The CSDA is made up of representatives of the Ministries of Economics and Agriculture, PROCANA, the private cane growers' association, and the private sugar millers.

With these parameters, a range for the total cost of sugar and its byproducts is automatically defined. For calculating the margin of the cane processor, the world market as well as the domestic market prices for the two main outputs, sugar and molasses, were used. It is unlikely that, in the short term, the marginal quintal of sugar will be produced for the U.S. preferential market.

Table 17 shows that, under such conditions, the cost of manufacturing one quintal of sugar and the corresponding amount of final molasses may range from C 85.68 (high industrial yield and low processing cost) to C 150.01 (low yield and high cost). With these costs, under three of the four selected scenarios the processor would have a positive margin in the domestic market. Under one scenario only, his margin would be positive in the world market.

Individual mill figures indicate a wide range between processing costs at the government-owned INAZUCAR plants and the two private factories for which cost data are available (Table 18). For the five publicly owned plants managed by INAZUCAR, average cost of processing is C 100.26 per T of cane. The most efficient factory's cost is more than 25% lower than average (and the least efficient, Chanmico, is 25% greater than average). However, the most efficient INAZUCAR plant's processing cost is nearly 14% greater than that of the two private plants.

Based on available information, pro-forma revenues (Table 19) as well as costs and operating margins (Table 20) were developed for each of the factories. These estimates imply that at least three of the four small INAZUCAR plants are losing substantial amounts of money annually.

D. Profitability Of The System

If the arbitrary divide between cane growing and processing margins embodied in the fixed price per T of cane is eliminated, it is possible to contrast the combined costs of cane and of sugar and its byproducts against the prices in existing product markets to determine the range of overall margins for the sugar industry. This is shown in Table 21. Sixteen scenarios have been specified by using two different costs of cane, two levels of processing cost, two different sugar recoveries, and two different markets.

Table 17

CANE PROCESSOR MARGINS, EL SALVADOR, 1990/91, C/O
(DIFFERENT MARKETS, INDUSTRIAL YIELDS, AND PROCESSING COSTS)

Domestic Market Scenarios		1	2	3	4
Sugar		119.00	119.00	119.00	119.00
Molasses,	0.625 T/Q x 8 G/T x C 1.60/G	8.00	8.00		
	0.476 T/Q x 8 G/T x C 1.60/G			6.09	6.09
REVENUE		127.00	127.00	125.09	125.09

World Market Scenarios		5	6	7	8
Sugar		80.00	80.00	80.00	80.00
Molasses,	0.625 T/Q x 8 G/T x C 3.02/G	15.10	15.10		
	0.476 T/Q x 8 G/T x C 3.02/G			11.50	11.50
REVENUE		95.10	95.10	91.50	91.50
Cane	0.625 T/Q x C 115.00/T	71.88	71.88		
	0.476 T/Q x C 115.00/T			54.74	54.74
Process	0.625 T/Q x C 125.00/T	78.13			
	0.625 T/Q x C 65.00/T		40.63		
	0.476 T/Q x C 125.00/T			59.50	
	0.476 T/Q x C 65.00/T				30.94
COST OF PRODUCTS		150.01	112.51	114.24	85.68

Domestic Market Scenarios	1	2	3	4
PROCESSOR MARGIN	(23.01)	14.49	10.85	39.41

World Market Scenarios	5	6	7	8
PROCESSOR MARGIN	(54.91)	(17.41)	(22.74)	5.82

Table 18

PROCESSING COSTS, SELECTED SALVADORAN SUGAR MILLS

Mill	Operating Cost	Overhead	Depreciation	Interest Charges	Total
	Costs per Type, m.C				
Jiboa	24,727	7,462	1,387	6,921	40,497
La Cabana	24,483	4,202	4,450	8,237	41,372
La Magdalena	12,013	1,960	758	2,919	17,649
Chanmico	13,514	1,494	2,203	3,062	20,273
El Carmen	13,333	1,655	717	4,140	19,845
Chaparrastique	15,179	2,749	2,039	6,827	26,795
INAZUCAR	78,522	12,060	10,167	25,185	125,934
Privates(2)	45,955	9,140	11,740	23,125	89,960
	Breakdown by Type, Percent				
Jiboa	61.1	18.4	3.4	17.1	100.0
La Cabana	59.2	10.2	10.8	19.9	100.0
La Magdalena	68.1	11.1	4.3	16.5	100.0
Chanmico	66.7	7.4	10.9	15.1	100.0
El Carmen	67.2	8.3	3.6	20.9	100.0
Chaparrastique	56.6	10.3	7.6	25.5	100.0
INAZUCAR	62.3	9.6	8.1	20.0	100.0
Privates(2)	51.1	10.2	13.0	25.7	100.0

Processing Cost per Ton of Cane

Mill	Total Cost, m.C	Total Cane, T	Unit Cost, C/T	Rel. U.C., % Privates
Jiboa	40,497	591,702	68.44	104.73
La Cabana	41,372	434,340	95.25	145.75
La Magdalena	17,649	153,905	114.67	175.47
Chanmico	20,273	161,470	125.55	192.12
El Carmen	19,845	218,286	90.91	139.11
Chaparrastique	26,795	360,000	74.43	113.89
INAZUCAR	125,934	1,328,001	94.83	145.11
Privates(2)	89,960	1,376,656	65.35	100.00

See also Appendices B-1 and B-2.

Table 19

PRO-FORMA REVENUES, SALVADORAN SUGAR MILLS, 1990/91

Total Sugar Made and Market Shares Allocated

Mill	Cane Ground T	Sugar Made Q	Share %	Domestic Q	US Quota Q	World Mkt. Q
JBOA	591,702	1,010,709	17.00	680,000	154,020	176,689
CABN	454,025	692,550	11.65	466,000	105,549	121,001
MAGD	136,491	270,700	4.55	182,000	41,223	47,477
CHAN	139,388	228,947	3.85	154,000	34,881	40,066
CARM	187,282	285,068	4.80	192,000	43,488	49,580
CHAP	222,156	343,446	5.78	231,200	52,367	59,879
IZAL	842,987	1,403,678	23.62	944,800	213,997	244,881
ELAN	533,689	910,097	15.31	612,400	138,709	158,988
SFCO	407,269	682,000	11.47	458,800	103,918	119,282
AHUA	67,620	117,218	1.97	78,800	17,848	20,570
	3,582,609	5,944,413	100.00	4,000,000	906,000	1,038,413

Total Molasses Made and Market Shares Allocated

Mill	Cane Ground T	Molasses GAL	Share %	Domestic GAL	World Mkt. GAL
JBOA	591,702	5,680,009	18.97	4,465,830	1,214,179
CABN	454,025	3,750,241	12.53	2,949,755	800,486
MAGD	136,491	1,265,000	4.23	995,807	269,193
CHAN	139,388	1,221,904	4.08	960,495	261,409
CARM	187,282	1,688,516	5.64	1,327,743	360,773
CHAP	222,156	2,046,258	6.84	1,610,241	436,017
IZAL	842,987	6,645,199	22.20	5,226,221	1,418,978
ELAN	533,689	3,954,760	13.21	3,109,837	844,923
SFCO	407,269	3,079,190	10.29	2,422,424	656,766
AHUA	67,620	602,000	2.01	473,185	128,815
	3,582,609	29,933,077	100.00	23,541,538	6,391,539

Revenues from Sugar and Molasses, C 1,000

Mill	Sug. Dom. (C 119/Q)	Sug. U.S. (C 168/Q)	Sug.World (C 80/Q)	Mol. Dom. (C 1.60/G)	Mol.World (C 3.02/G)	Total
JBOA	80,920	25,876	14,135	7,145	3,667	131,743
CABN	55,454	17,732	9,680	4,720	2,417	90,003
MAGD	21,658	6,925	3,798	1,593	813	34,787
CHAN	18,326	5,860	3,205	1,537	789	29,717
CARM	22,848	7,306	3,966	2,124	1,090	37,334
CHAP	27,513	8,798	4,790	2,576	1,317	44,994
IZAL	112,431	35,952	19,591	8,362	4,285	180,621
ELAN	72,876	23,303	12,719	4,976	2,552	116,426
SFCO	54,597	17,458	9,543	3,676	1,983	87,457
AHUA	9,377	2,998	1,646	757	389	15,167
	476,000	152,208	83,073	37,666	19,302	768,249

Table 20

PRO-FORMA COSTS AND OPERATING MARGINS, SALVADORAN SUGAR MILLS, 1990/91

Mill	Cane Ground	Cane Cost (C 115/T)	Processing Cost	
	T	C 1,000	C/T	C 1,000
JBOA	591,702	68,046	70.00	41,419
CABN	454,025	52,213	95.00	43,132
MAGD	136,491	15,696	115.00	15,696
CHAN	139,388	16,030	125.00	17,424
CARM	187,282	21,537	90.00	16,855
CHAP	222,156	25,548	75.00	16,662
IZAL	842,987	96,944	N.A.	N.A.
ELAN	533,689	61,374	N.A.	N.A.
SFCO	407,269	46,836	N.A.	N.A.
AHUA	67,620	7,776	N.A.	N.A.
	3,582,609	412,000		

Mill	Total Revenue C 1,000	Cost of Cane C 1,000	Operating Margin C 1,000	Processing Cost C 1,000	Profit (Loss) C 1,000
JBOA	131,743	68,046	63,697	41,419	22,278
CABN	90,003	52,213	37,790	43,132	(5,342)
MAGD	34,787	15,696	19,091	15,696	3,395
CHAN	29,717	16,030	13,687	17,424	(3,737)
CARM	37,334	21,537	15,797	16,855	(1,058)
CHAP	44,954	25,548	19,406	16,662	2,744
IZAL	180,621	96,944	83,677	N.A.	N.A.
ELAN	116,426	61,374	55,052	N.A.	N.A.
SFCO	87,457	46,836	40,621	N.A.	N.A.
AHUA	15,167	7,776	7,391	N.A.	N.A.
	768,209	412,000	356,209		

Table 21

OVERALL CANE PRODUCTION AND PROCESSING MARGINS, EL SALVADOR, 1990/91, C/Q

A. LOW INDUSTRIAL YIELD, VARIOUS CANE AND PROCESSING COSTS

Domestic Market Scenarios		1	2	3	4
REVENUE		127.00	127.00	127.00	127.00
World Market Scenarios		5	6	7	8
REVENUE		95.10	95.10	95.10	95.10
Cane,	0.625 T/Q x C 110.46/T	69.04	69.04		
	0.625 T/Q x C 77.33/T			48.33	48.33
Processing,	0.625 T/Q x C 125.00/T	78.13		78.13	
	0.625 T/Q x C 65.00/T		40.63		40.63
COST OF PRODUCTS		147.17	109.67	126.46	88.96
Domestic Market Scenarios		1	2	3	4
OVERALL MARGIN		(20.17)	17.33	0.54	38.04
World Market Scenarios		5	6	7	8
OVERALL MARGIN		(52.07)	(14.57)	(31.36)	6.14

B. HIGH INDUSTRIAL YIELD, VARIOUS CANE AND PROCESSING COSTS

Domestic Market Scenarios		1	2	3	4
REVENUE		125.09	125.09	125.09	125.09
World Market Scenarios		5	6	7	8
REVENUE		91.50	91.50	91.50	91.50
Cane,	0.476 T/Q x C 110.46/Q	52.58	52.58		
	0.476 T/Q x C 77.33/Q			36.81	36.81
Processing,	0.476 T/Q x C 125.00/Q	59.50		59.50	
	0.476 T/Q x C 65.00/Q		30.94		30.94
COST OF PRODUCTS		112.08	83.52	96.31	67.75
Domestic Market Scenarios		1	2	3	4
OVERALL MARGIN		13.01	41.57	28.78	57.34
World Market Scenarios		5	6	7	8
OVERALL MARGIN		(20.58)	7.98	(4.81)	23.75

The costs of cane are based on Table 14, the first one being an average of Scenarios 1 and 2, under the assumption that one half of the cane is being loaded manually and one half mechanically. The second cost of cane figure is based on Scenario 8. The levels of processing cost are the same as used in Table 17, C 65.00 and C 125.00 per T. The assumed sugar recoveries are 160 LB and 210 LB per T, implying the use of .625 T and .476 T of cane respectively per Q of sugar. The resulting eight costs represent a bundle of supply curves, their levels ranging from C 67.75 to C 147.17 per Q of sugar.

The revenues for one quintal of sugar and the corresponding amount of molasses at each of the two recoveries are taken from Table 17 as well. They cover domestic as well as world market prices. Together with these revenue levels, the above costs serve to derive the range of the combined cane producer and processor margins.

With a 70 T per mz agricultural yield, mechanically loaded cane, a 10 km hauling distance, a 210 LB per T sugar recovery, and a processing cost of C 65.00 per T of cane, the cane producer and the cane processor can jointly, make C 23.75 per Q of sugar, even in the world market. On the other hand, with a 50 T yield, hand loaded cane, a 25 km hauling distance, 160 LB of recovery, and a processing cost of C 125.00 they will jointly lose C 20.17 per Q of sugar, even in the domestic market.

E. Outlook

The outlook for the profitability of cane growing and sugar manufacturing in El Salvador is determined by the likely developments in technical efficiency and factor costs. Presently, both efficiency and factor costs in the Salvadoran industry are low. As long as the gains realized from efficiency increases will outpace the losses incurred through rises in factor costs, especially opportunity costs, the outlook is positive.

The biggest potential for an immediate efficiency increase lies in the improvement of cane quality through harvesting management. Such improvement depends chiefly on a joint effort of cane producers and millers to process all cane at its optimal commercial-sugar-per-mz yield. It requires the miller to transfer part of the recovery-driven processing margin increase to the grower. The grower, on the other hand, must be able to enforce his contracts with cane cutters and transporters. The increase is thus not so much a matter of technology (it is no secret that burning and harvesting cane out of cycle leads to sub-optimal sugar yields) but one of economics and the rule of law.

Assuming decreasing intensity of political tension and armed activity, improved agricultural extension efforts of private and government mills, and implementation of the impending quality payment system for cane, there is a good chance of a substantial rise in the efficiently of sugar production within the next two years, in the cane field as well as in the factory. Varietal renovation, another source of increased cane tonnage and sugar recovery, takes at least five years to be implemented across the entire cane area. Given the readiness of some growers to introduce early maturing cane varieties, which have peak yield and sugar recovery conditions that coincide better with El Salvador's grinding season than the present intermediate ones, an additional increase in factor efficiency may be expected over a five to ten year period.

Neither the factory productivity increases due to the improvement in harvest management nor those due to the replacement of varieties imply substantial additional inputs. Increases in technical efficiency, however, are usually obtained through the application of additional resources. While this is true for the agricultural phase, it is especially important in manufacturing where investments in properly qualified technical staff and additional capital equipment are required. Acquisitions of either have to be justified by the marginal product value. Given the quality equipment in several of the Salvadoran mills and the availability of technical know-how through consulting and assistance agreements, an increase in technical production efficiency through such additional inputs can be expected in any case. Improved management through privatization can also be expected for some mills.

In view of the potential for improved efficiency which can relatively easily be tapped, a positive outlook for the Salvadoran sugar industry seems to be justified in the short and medium term. Increases in factor costs should be absorbed easily, without any shift in the supply curve. This implies that, assuming the present structure of demand, the industry's output would remain at least at the present level. In the process, marginal land as well as marginal factories would go out of production, which is nothing but the continuation of an ongoing process.

The long term outlook is determined by the degree to which the continuing, development-driven increase in factor costs (especially the opportunity costs with respect to the potential use of land, labor and capital in other industries) will be absorbed by increases in factor productivity, especially once the initial efficiency improvements in the sugar industry have been made. By its factor endowments,

El Salvador is not suited for extensive agriculture. The level at which the sugar industry will be able to compete may eventually be reduced to only a fraction of its domestic market. Examples abound (Puerto Rico and Taiwan) where the forces of economics have dictated such a reallocation of resources. The long term outlook for the Salvadoran sugar industry must thus be classified as uncertain.

V. SUGAR POLICIES AND THEIR IMPACTS

A. Key Policies

The GOES has dramatically shifted several of its sugar policies in recent years, from total control of the expropriated industry in the early 1980s to somewhat more limited intervention today. However, six types of intervention continue to constrain industry decisions:

- Cane prices are fixed. Although prices have been established in recent years by the managers of INAZUCAR and Ingenio Jiboa (the six GOES owned plants), beginning next year cane prices will be set by the recently founded *Comisión Salvadoreña para el Desarrollo Azucarero (CSDA)*. While the established prices apply directly only to the GOES factories, competing private firms must pay the same price to compete for cane.

  The established cane prices were C 98 and C 115 per T for 1989/90 and 1990/91, respectively. Growers are pressing for higher prices for the 1991/92 crop, a decision that has not yet been made (as of (October, 1991).

  In addition to establishing rigid cane prices, this policy precludes the payment of premiums (or the application of discounts) for quality, foreign material or other cane characteristics that affect sugar yield. While the industry is considering a price scheme that will pay premiums (C 10-C 15 per T) for cane with higher sugar content, no such policy has been implemented.

- Sugar prices are fixed. Sugar is one of eight products that continue to be subject to price controls. The current structure is:

  - ex mill C 119 per Q;
  - wholesalers, C 122.25; per Q
  - retail, C 1.30 per LB (actual retail prices average about C 1.40 per LB in 1990 and much of 1991).

  - In addition, domestic prices for blackstrap molasses are normally established below world prices, thus establishing a subsidy for animal feed. C 1.60 per GAL v. C 3.00 per GAL

O Marketing is regulated by quotas. To insure equitable access to both the domestic and world market, each factory is assigned a domestic and U.S. quota share based on historical production. Factories advantageously located often fill quota requirements for other factories. Within either INAZUCAR or the Asociación, factories located near the port of Acajutla supply export sugar on behalf of those more distant, while factories located near internal markets produce mill white on behalf of those in more remote locations. Factories compensate each other after the end of the marketing season.

O Sugar imports are restricted. Licenses are required, and must now be recommended by the *Comision Salvadorena para el Desarrollo Azucarero* and issued by the Minister of Economy. Although crossborder trading sometimes develops when price differentials are great, legal imports are unknown.

O Production credit. Production credit is available on favorable terms (3 years), but at 22% market rates of interest. Producers must first have contracts with local factories, and then can apply to local banks. Loan repayments are deducted by the factory on the producer's behalf.

O Government ownership of six plants. While these plants operate in the general market environment in El Salvador, they do continue to enjoy benefits of government loans and, in some cases, to operate at levels of losses that likely would lead to closure of private plants.

O Domestic use of molasses. The Comisión Salvadoreña par el *Desarrollo Azucarero* regulates sales of molasses and as a result domestic prices are below world levels. In 1990/91, the industry sold 23.5 million gallons of molasses domestically at C 1 60 per GAL and 6.4 million gallons at C 3.02. The high local sales are a subsidy to the domestic livestock industry and a cost to sugar producers.

B. Impacts of Policies

1. Qualitative impacts

The current competitive situation in El Salvador varies widely across its three primary markets, as do revenues per unit:

- U.S. sales, with per unit revenues of C 168 per Q;
- Domestic sales, with per unit revenues of C 119 per Q;
- World market sales with per unit revenues of C 80 per Q.

For each of the ten factories, sales in U.S. markets are profitable and six are making money on domestic sales. However, at current prices none is making money on world market sales. At prices at the long-term level projected by the World Bank ($0.137 per lb FOB Caribbean) only four plants could sell profitably into world markets. **This implies that even if markets improve, the Salvadoran industry must increase its competitiveness if it is to prosper, limit sales to profitable markets where it is profitable, and increase net revenue.**

This is especially important if the U.S. preferential market is reduced, possibly through the current GATT negotiations, declining domestic sugar consumption in the United States or by U.S. policies that reduce imports in order to maintain markets for domestic producers.

Reviews of the sugar industry's economic structure indicate a positive total margin for producers and processors who sell at the 1990 average price and achieve relatively high sugar yields, low processing costs and high cane yields. **Even in current world markets, such a combination yields a net return of nearly C 24 per Q of sugar produced.**

Modification of several government policies that currently restrict the industry would improve the competitive position. These include:

- Fixed cane prices. The Salvadoran sugar industry is in fact an integral system incorporating both cane growers and processors. While cane producers can use political leverage to price cane, the real value depends on the value of the sugar and by-products it contains. As a result, cane prices should at a minimum reflect its quality, including sugar content.

- There is an additional dimension to cane prices; the value of each ton of sugar depends on where it is sold. At this time, more Salvadoran sugar is available for the high priced U.S. and domestic markets than can be sold, so access to these must be allocated. Cane prices should reflect such an allocation, either through cane prices that depend on average revenues, or through an allocation or auction system for cane quotas where prices for each component are reflecting the appropriate market prices.

O Fixed sugar prices. While this policy reflects direct GOES intervention, it appears to have little if any impact on sales or prices at this time. A review of prices of refined sugar in competing markets (in this case, Brazil), indicates that the current 35% duty would effectively prevent imported sugar from undercutting local prices. (See Table 22.)

Table 22
Landed Price, Brazilian Refined Sugar, El Salvador 1991.

Refined Sugar Imports

	Price Ranges:			
	35% duty		10% duty	
	$/TM			
FOB, Brazil	265	270	265	270
freight	30	30	30	30
handling, landing	22	22	22	22
duty	93	95	27	27
Subtotal	409.8	416.5	343.5	349.0
C/TM	3278.0	3332.0	2748.0	2792.0
C/Q	151	153	126	128

Even at a much more modest duty (10% ad valorem), significant amounts of imports appear unlikely since domestic prices of C 140 would be undercut modestly by import prices at C 126 to C 128 per Q. Thus, a shift in this policy would not be expected to diminish local sugar markets appreciably. As a result, the most important impact of the current licensing policy likely is the prevention of high quality imports and specialty sugars and the consequences such a restriction might have on processed food production for export. One likely indirect impact of the current policy is the encouragement of local investment in the production of better quality sugar, including investment in refining capacity at a few local factories; investment that is unlikely to succeed in the longer run once imports are more freely allowed.

- The GOES also fixes wholesale, ex-factory and retail sugar prices but these policies do not appear to be necessary or have significant impacts on either local prices or production. Local prices, in the absence of the policy, likely would be constrained by domestic production costs and the price of imported sugar. Average domestic production cost is about C 103.8 per Q, while the landed price of Brazilian refined sugar would be about C 152 per Q. In this context, the recent average domestic price of about C 140 does not appear unreasonable; it appears to reflect the ex-factory sugar price plus relatively small marketing costs. Thus, El Salvador would not appear likely to provide a very attractive market for Brazilian or other refined sugar.

- Domestic and export market quotas. El Salvador's sugar quotas limit the total amount of sugar that enters the domestic market, and revenues from sales in both the domestic and U.S. markets are allocated among producers on the basis of historical production.

  While producers compete in a limited way for domestic markets on the basis of quality of product and services provided to buyers (transportation, scheduling, etc.), factories now compete for revenues primarily by expanding production (with excess sugar sold into the world market). As a result, factories expand or reduce production on the basis of price (rather than marginal revenue).

  The current policy also is costly since its limits competition for domestic markets, reduces quality of domestic products and limits consumer benefits.

- Domestic molasses markets. The Salvadoran sugar industry sold 23.5 million gallons of molasses domestically in 1990/91 at prices only about 53% of the world market level. This price differential cost the industry C 33.4 million, about 4% of total sugar/molasses revenues in 1990/91. While the differential is important to the domestic livestock industry, it represents a major revenue loss for domestic sugar producers.

- Government ownership of plants. The operation of six government-owned plants has several kinds of impacts on the domestic industry:

- Their continued operation at a loss increases government outlays and costs (attributable to annual losses as well as the failure to repay past debts)

- Their operation contributes to the continued operation of high cost cane producers;

- Government policies concerning their operation distort the industry's cost structure, raise average costs, and lead to the implementation of other policies that reduce opportunities for more efficient producers.

2. Quantitative Impacts

For the sake of quantifying the impact of government intervention on the Salvadoran sugar system, the 1990/91 economic results of Section IV were re-calculated under the following assumptions:

Abolition of the current allocation among mills of the country's domestic sugar market and U.S quota (according to previous levels of total production)

Abolition of all existing molasses trade regulations.

Continuation of the present fixed cane price, though enhanced by a premium for cane quality and an as yet unspecified value-added formula, both of which would pass on to cane producers a share of any processor revenue increases from better sugar recovery and export prices

The abolition of sugar market allocation is assumed to lead to the closure of some of the less efficient mills. It is difficult to predict which will be the plants thus affected, since some of the worst mills have the best access to quality cane and vice versa. Liberalization of the markets will help potential investors to identify the most viable plants.

The resulting mill closures will lead to a reduction of a cane produced on marginal lands. They will also bring about a reduction of the industry's average processing costs. Abolition of the molasses trade regulations will lead to a drastic decline in domestic sales.

In addition to these three policy-induced parameter changes, three policy-independent changes were assumed: an increase in sugar recovery from cane,

and increase in cane yield, and an increase in the world price of sugar. All three are extremely plausible under present Salvador conditions. Increases in cane yield and sugar recovery will undoubtedly occur with the changed political situation and the implementation of a quality based system of cane payments. A rise in the world market price of sugar has been predicted by the World Bank for the long run.

Four different scenarios were specified by the above six parameters. All other parameters are assumed to remain unchanged from the 1990/91 base line conditions.

In Table 23, a beneficiary matrix for El Salvador's principal sugar policies and their abolition is shown, using results of the four scenarios. The parameter value specifying the base line and each of the four scenarios are listed in Table 24. The results appear in Tables 25 to 26, and are summarized in Table 29.

Less interventionist GOES policies for sugar would mean a much more competitive industry, likely producing more sugar from fewer plants at lower cost and higher returns. In total, current GOES interventions are costly to cane producers and processors and to the government. These impacts include:

- Continued production at several high-cost plants that cannot compete in current markets, at an annual additional cost of C30.5 million (Sc. #1). A smaller, more efficient processing industry could realize an additional C140.2 million value added (Sc. #2).

- Continued low-quality, high-cost cane production on 11,094 mz of land at an annual extra cost of C39.6 million (Sc. #3). More efficient production on a smaller area could increase producers' value added by C62.3 million (Sc. #3).

- Annual costs to the GOES of about C30.5 million from losses in the operation of high cost plants (Sc. #1).

- Restrictions on molasses imports that constitute a C29.7 million subsidy for livestock producers at the expense of sugar processors (Sc. #1).

- Restrictions on refined sugar imports that limit access to refined sugar products and likely limit competition in the production (and possible export) of some sugar-containing products.

The allocation of markets among producers is the primary device that permits the continued operation of the least efficient, government owned plants. Other things being equal, that policy implies production cost increases of C30.5 million for the industry, and a reduction in value-added of C42.6 million. However, it continues cane production on 1,781 mz of land and implies a C12.1 million benefit for cane producers.

Similarly, export restrictions on molasses require the domestic sale at artificially low prices of a substantial share of the sector's molasses production. The removal of that policy would increase total domestic and export sales by C23.7 million. At the same time, the C29.7 million reduction in domestic sales imply a current subsidy to livestock producers that would be removed by such a change in policy.

Domestic production efficiency (cane yield, sugar recovery) is relatively low for several reasons, including the impacts of the war and conflicts between producers and processors. Many of these conditions are impossible to model. However, two scenarios were examined in which incentives for sugar and cane producers to increase productivity were assumed to result in increased cane and sugar yields. These are characterized as "lack of price incentives", although the scenarios actually reflect a considerably broader set of economic and social conditions that have been restricting investment and productivity across the industry. Key assumptions include a reduction in conflict, and more cooperative policies that reward producers for clean, well presented high-sucrose cane. Increased competition between producers works to reduce production costs, increase cane quality and increase sugar recovery throughout the industry. Yield and recovery increases would reduce processing costs or increase revenues by C122.7 million, while increasing processors' value added by C87.9 million as a result. Producers could convert 9,313 mz of land to other uses, reduce costs by C34.8 million and increase their value-added by C64.3 million (Sc. #1/Sc. #3).

Finally, sugar import restriction effectively prevent the importation of sugar (including refined sugar) into El Salvador. An analysis of price and cost trends indicate that administered prices in recent years have been relatively close to those that likely would have obtained had the market been more open. Assuming the current 35% duty, the landed price would be just over C1.50 per LB (compared with the current C1.40 per LB).

Table 23

BENEFICIARIES OF SELECTED POLICIES

CANE PRODUCERS	SUGAR PRODUCERS	GOVERNMENT	CONSUMERS	OTHERS
1. Market Quotas a. Holds 1,781 MZ in production; b. +C12.1 M in cane payment	a. Operate 4 high-cost plants; b. Increases proc cost C30.5 M c. Reduce proc value-added C42.6 M	a. Lost princ/int payments. b. Loss of potential taxes. c. Loss by govt owned plants of C30.5 M d. Lost foreign exchange	a. Minor direct impact	a. Increases returns to prod coops.
2. Molasses Export Restrictions a. No direct	a. Reduce revenue C23.7 M.	a. Lost taxes on revenues. b. Lost foreign exchange.	a. No direct.	a. Subsidy to domestic livestock production C29.7 M.
3. Lack of Cane Price Incentive a. Holds 9,313 MZ in production b. High cost production costs producers C34.8M c. Reduces producers value-added C64.3 M	a. Reduces proc revenues by C122.7 M b. Reduces proc value-added C87.9 M	a. Lost taxes on revenues b. Lost foreign exchange	a. No direct.	
4. Domestic Market Restictions a. Neg. directly to the extent the policy increases domestic prices it restricts domestic sugar use.	a. Protects domestic markets against imports; given price levels, the impact of this protection likely is small.	a. Reduced duty collections. b. To the extent sugar policies limit production and export of agricultural products, the policy reduces foreign exchange.	a. Small direct impact; Admin. domestic price is near competitive world levels (given the 35% duty). b. If duties were lower, the potential impact of the restrictive sugar policies would be somewhat greater. c. Restriction increases consumers costs and reduces availability of sugar, with negative impacts both on nutrition and income.	a. Restricts sugar availability, including the availability of speciality sugars for use by food processors/ exporters.

This implies that domestic sugar consumers have not been penalized heavily by the restrictions, either in terms of reduced sugar availability of higher costs.

However, El Salvador is a calorie deficit nation and the combined impacts of the restrictive sugar policies and the 35% tariff likely have negative impacts both on consumers' nutrition and their incomes.

At the same time, the nation's agribusiness sector may have been penalized indirectly by the lack of access to production or imports of high quality refined sugar. By requiring agribusiness and others to rely on local products, the quality of some sugar containing products may have been reduced and, as a result, access to some highly competitive export markets may have been prevented.

Table 24

Impact of Abolishing the Current Allocation of the Domestic Sugar Market and the US Quota among Mills and all Regulations of the Molasses Trade

Scenario Specifications

	Base Line	Scen. #1	Scen. #2	Scen. #3	Scen. #4
RATES & VOLUMES:					
Cane Prod., m.T/yr	3.583	3.478	3.478	3.478	3.478
Cane Yield, T/mz.yr	58.950	58.950	58.950	70.000	70.000
Sugar Recovery, Q/T	1.659	1.659	2.100	2.100	2.100
Sugar,Domestic, m.Q/yr	4.000	4.000	4.000	4.000	4.000
Sugar,US Quota, m.Q/yr	0.906	0.906	0.906	0.906	0.906
Molasses Yield, GAL/T	8.355	8.355	8.355	8.355	8.355
Mol., Dom., m.GAL/yr	23.542	5.000	5.000	5.000	5.000
PRICES:					
Sugar, Domestic, C/Q	119.00	119.00	119.00	119.00	119.00
Sugar, US Quota, C/Q	168.00	168.00	168.00	168.00	168.00
Sugar, World, C/Q	80.00	80.00	80.00	80.00	103.00
Molasses, Dom., C/GAL	1.60	1.60	1.60	1.60	1.60
Molasses, World, C/GAL	3.02	3.02	3.02	3.02	3.02
Cane, Delivered, C/T	115.00	115.00	125.00	125.00	130.00
COSTS:					
Cane Processing, C/T	76.45	70.00	70.00	70.00	70.00
Cane Growing, C/mz	3173.25	3173.25	3173.25	3173.25	3173.25
Cane Growing, C/T	53.83	53.83	53.83	45.33	45.33
C. Harv. & Haul., C/T	42.00	42.00	42.00	42.00	42.00
Cane Production, C/T	95.83	95.83	95.83	87.33	87.33

Table 25

Impact of Abolishing the Current Allocation of the Domestic Sugar Market and the US Quota among Mills and all Regulations of the Molasses Trade

Pro-Forma Results 1990/91, Scenario #1

	Base Line		This Scenario		Change
	Quantity, Units	Value, Million C	Quantity, Units	Value, Million C	Value, Million C
Area Harvested, mz	60780	-	58999	-	-
Cane Delivered, m.T	3.583	412.0	3.478	400.0	-12.1
Sugar, Domestic, m.Q	4.000	476.0	4.000	476.0	0.0
Sugar, US Quota, m.Q	0.906	152.2	0.906	152.2	0.0
Sugar, World, m.Q	1.038	83.1	0.864	69.1	-13.9
TOTAL SUGAR MADE, m.Q	5.944	711.3	5.770	697.3	-13.9
Mol., Domestic, m.GAL	23.542	37.7	5.000	8.0	-29.7
Molasses, World, m.GAL	6.394	19.3	24.059	72.7	53.3
TOTAL MOLASSES, m.GAL	29.936	57.0	29.059	80.7	23.7
SUGAR & MOL. REVENUE	-	768.2	-	778.0	9.7
CANE PAYMENTS	-	412.0	-	400.0	-12.1
CANE PROCESSING COST	-	273.9	-	243.5	-30.5
COST OF SUGAR	-	629.0	-	562.8	-66.2
VALUE ADDED,PROCESSING	-	82.3	-	134.6	52.3
per Q of Sugar, C	13.84	-	23.32	-	-
per T of cane, C	22.96	-	38.69	-	-
per mz, C	1353.65	-	2280.63	-	-
CANE PRODUCTION COST	-	343.4	-	333.3	-10.1
VALUE ADDED,PRODUCTION	-	68.7	-	66.7	-2.0
per Q of Sugar, C	11.56	-	11.56	-	-
per T of Cane, C	19.17	-	19.17	-	-
per mz, C	1130.10	-	1130.10	-	-
TOTAL VALUE ADDED		151.0		201.2	50.3
per Q of Sugar, C	25.40	-	34.88	-	-
per T of Cane, C	42.13	-	57.86	-	-
per mz, C	2483.75	-	3410.73	-	-

A) Assumed Policy-Induced Changes from Base Line:

1. Total Cane Production declines from 3.538 m.T to 3.478 m.T.
2. Average Processing Cost declines from 76.45 C/T to 70.00 C/T.
3. Domestic Molasses Sales decline from 23.542 m.GAL to 5.000 m.GAL

B) Assumed Technology- and Market-Induced Changes from Base Line:

None

Table 26

Impact of Abolishing the Current Allocation of the Domestic Sugar Market and the US Quota among Mills and all Regulations of the Molasses Trade

Pro-Forma Results 1990/91, Scenario #2

	Base Line		This Scenario		Change
	Quantity, Units	Value, Million C	Quantity, Units	Value, Million C	Value, Million C
Area Harvested, mz	60780	-	58999	-	-
Cane Delivered, m.T	3,583	412.0	3,478	434.8	22.7
Sugar, Domestic, m.Q	4,000	476.0	4,000	476.0	0.0
Sugar, US Quota, m.Q	0,906	152.2	0,906	152.2	0.0
Sugar, World, m.Q	1,038	83.1	2,398	191.8	108.8
TOTAL SUGAR MADE, m.Q	5,944	711.3	7,304	820.0	108.8
Mol., Domestic, m.GAL	23,542	37.7	5,000	8.0	-29.7
Molasses, World, m.GAL	6,394	19.3	24,059	72.7	53.3
TOTAL MOLASSES, m.GAL	29,936	57.0	29,059	80.7	23.7
SUGAR & MOL. REVENUE	-	768.2	-	900.7	132.4
CANE PAYMENTS	-	412.0	-	434.8	22.7
CANE PROCESSING COST	-	273.9	-	243.5	-30.5
COST OF SUGAR	-	629.0	-	597.6	-31.4
VALUE ADDED,PROCESSING	-	82.3	-	222.5	140.2
per Q of Sugar, C	13.84	-	30.46	-	-
per T of cane, C	22.96	-	63.97	-	-
per mz, C	1353.65	-	3770.89	-	-
CANE PRODUCTION COST	-	343.4	-	333.3	-10.1
VALUE ADDED,PRODUCTION	-	68.7	-	101.5	32.8
per Q of Sugar, C	11.56	-	13.89	-	-
per T of Cane, C	19.17	-	29.17	-	-
per mz, C	1130.10	-	1719.60	-	-
TOTAL VALUE ADDED		151.0		323.9	173.0
per Q of Sugar, C	25.40	-	44.35	-	-
per T of Cane, C	42.13	-	93.14	-	-
per mz, C	2483.75	-	5490.49	-	-

A) Assumed Policy-Induced Changes from Base Line:

1. Total Cane Production declines from 3.538 m.T to 3.478 m.T.
2. Average Processing Cost declines from 76.45 C/T to 70.00 C/T.
3. Domestic Molasses Sales decline from 23.542 m.GAL to 5.000 m.GAL

B) Assumed Technology- and Market-Induced Changes from Base Line:

1. Sugar Recovery increases from 1.659 Q/T to 2.100 Q/T.

Table 27

Impact of Abolishing the Current Allocation of the Domestic Sugar Market and the US Quota among Mills and all Regulations of the Molasses Trade

Pro-Forma Results 1990/91, Scenario #3

	Base Line		This Scenario		Change
	Quantity, Units	Value, Million C	Quantity, Units	Value, Million C	Value, Million C
Area Harvested, mz	60780	-	49686	-	-
Cane Delivered, m.T	3,583	412.0	3,478	434.8	22.7
Sugar, Domestic, m.Q	4,000	476.0	4,000	476.0	0.0
Sugar, US Quota, m.Q	0.906	152.2	0.906	152.2	0.0
Sugar, World, m.Q	1.038	83.1	2.398	191.8	108.8
TOTAL SUGAR MADE, m.Q	5,944	711.3	7,304	820.0	108.8
Mol., Domestic, m.GAL	23,542	37.7	5,000	8.0	-29.7
Molasses, World, m.GAL	6,394	19.3	24,059	72.7	53.3
TOTAL MOLASSES, m.GAL	29,936	57.0	29,059	80.7	23.7
SUGAR & MOL. REVENUE	-	768.2	-	900.7	132.4
CANE PAYMENTS	-	412.0	-	434.8	22.7
CANE PROCESSING COST	-	273.9	-	243.5	-30.5
COST OF SUGAR	-	629.0	-	597.6	-31.4
VALUE ADDED,PROCESSING	-	82.3	-	222.5	140.2
per Q of Sugar, C	13.84	-	30.46	-	-
per T of cane, C	22.96	-	63.97	-	-
per mz, C	1353.65	-	4477.73	-	-
CANE PRODUCTION COST	-	343.4	-	303.7	-39.6
VALUE ADDED,PRODUCTION	-	68.7	-	131.0	62.3
per Q of Sugar, C	11.56	-	17.94	-	-
per T of Cane, C	19.17	-	37.67	-	-
per mz, C	1130.10	-	2636.75	-	-
TOTAL VALUE ADDED		151.0		353.5	202.5
per Q of Sugar, C	25.40	-	48.40	-	-
per T of Cane, C	42.13	-	101.64	-	-
per mz, C	2483.75	-	7114.48	-	-

A) Assumed Policy-Induced Changes from Base Line:

1. Total Cane Production declines from 3.538 m.T to 3.478 m.T.
2. Average Processing Cost declines from 76.45 C/T to 70.00 C/T.
3. Domestic Molasses Sales decline from 23.542 m.GAL to 5.000 m.GAL

B) Assumed Technology- and Market-Induced Changes from Base Line:

1. Sugar Recovery increases from 1.659 Q/T to 2.100 Q/T.
2. Cane Yield increases from 58.95 T/mz to 70.00 T/mz.

Table 28

Impact of Abolishing the Current Allocation of the Domestic Sugar Market and the US Quota among Mills and all Regulations of the Molasses Trade

Pro-Forma Results 1990/91, Scenario #4

	Base Line		This Scenario		Change
	Quantity, Units	Value, Million C	Quantity, Units	Value, Million C	Value, Million C
Area Harvested, mz	60780	-	49686	-	-
Cane Delivered, m.T	3,583	412.0	3,478	452.1	40.1
Sugar, Domestic, m.Q	4,000	476.0	4,000	476.0	0.0
Sugar, US Quota, m.Q	0.906	152.2	0.906	152.2	0.0
Sugar, World, m.Q	1.038	83.1	2.398	247.0	163.9
TOTAL SUGAR MADE, m.Q	5.944	711.3	7.304	875.2	163.9
Mol., Domestic, m.GAL	23,542	37.7	5,000	8.0	-29.7
Molasses, World, m.GAL	6.394	19.3	24.059	72.7	53.3
TOTAL MOLASSES, m.GAL	29.936	57.0	29.059	80.7	23.7
SUGAR & MOL. REVENUE	-	768.2	-	955.8	187.6
CANE PAYMENTS	-	412.0	-	452.1	40.1
CANE PROCESSING COST	-	273.9	-	243.5	-30.5
COST OF SUGAR	-	629.0	-	614.9	-14.0
VALUE ADDED,PROCESSING	-	82.3	-	260.2	178.0
per Q of Sugar, C	13.84	-	35.63	-	-
per T of cane, C	22.96	-	74.82	-	-
per mz, C	1353.65	-	5237.70	-	-
CANE PRODUCTION COST	-	343.4	-	303.7	-39.6
VALUE ADDED,PRODUCTION	-	68.7	-	148.4	79.7
per Q of Sugar, C	11.56	-	20.32	-	-
per T of Cane, C	19.17	-	42.67	-	-
per mz, C	1130.10	-	2986.75	-	-
TOTAL VALUE ADDED		151.0		408.6	257.7
per Q of Sugar, C	25.40	-	55.95	-	-
per T of Cane, C	42.13	-	117.49	-	-
per mz, C	2483.75	-	8224.45	-	-

A) Assumed Policy-Induced Changes from Base Line:

1. Total Cane Production declines from 3.538 m.T to 3.478 m.T.
2. Average Processing Cost declines from 76.45 C/T to 70.00 C/T.
3. Domestic Molasses Sales decline from 23.542 m.GAL to 5.000 m.GAL

B) Assumed Technology- and Market-Induced Changes from Base Line:

1. Sugar Recovery increases from 1.659 Q/T to 2.100 Q/T.
2. Cane Yield increases from 58.95 T/mz to 70.00 T/mz.
3. World Sugar Price increases from 80 C/Q to 103 C/Q.

Table 29

Impact of Abolishing the Current Allocation of the Domestic Sugar Market and the US Quota among Mills and all Regulations of the Molasses Trade

Summary of Scenario Results, Million C

	Base Line	Scen. #1	Scen. #2	Scen. #3	Scen. #4
SUGAR REVENUE	711.3	697.3	820.0	820.0	875.2
MOLASSES REVENUE	57.0	80.7	80.7	80.7	80.7
SUGAR & MOL. REVENUE	768.2	778.0	900.7	900.7	955.8
CANE PAYMENTS	412.0	400.0	434.8	434.8	452.1
CANE PROCESSING COST	273.9	243.5	243.5	243.5	243.5
COST OF SUGAR	629.0	562.8	597.6	597.6	614.9
VALUE ADDED,PROCESSING	82.3	134.6	222.5	222.5	260.2
per Q of Sugar, C	13.84	23.32	30.46	30.46	35.63
per T of Cane, C	22.96	38.69	63.97	63.97	74.82
per mz, C	1353.65	2280.63	3770.89	4477.73	5237.70
CANE PRODUCTION COST	343.4	333.3	333.3	303.7	303.7
VALUE ADDED,PRODUCTION	68.7	66.7	101.5	131.0	148.4
per Q of Sugar, C	11.56	11.56	13.89	17.94	20.32
per T of Cane, C	19.17	19.17	29.17	37.67	42.67
per mz, C	1130.10	1130.10	1719.60	2636.75	2986.75
TOTAL VALUE ADDED	151.0	201.2	323.9	353.5	408.6
per Q of Sugar, C	25.40	34.88	44.35	48.40	55.95
per T of Cane, C	42.13	57.86	93.14	101.64	117.49
per mz, C	2483.75	3410.73	5490.49	7114.48	8224.45
AV. SUGAR VALUES, C/Q					
Market Value	119.66	120.85	112.27	112.27	119.83
MV - VA, Processing	105.82	97.53	81.81	81.81	84.19
MV - Total VA	94.26	85.98	67.92	63.88	63.88

a. Scenario 1

The inefficient plants close; other plants pick up as much of the slack as possible, but some marginal sugar land goes out of production. With remaining plants at capacity, area drops from about 61,000 mz to 59,000; production declines slightly (from 3.6 million T of cane to 3.5 million T). Cane prices to producers are unchanged.

Revenues increase in spite of slightly smaller sugar sales because molasses sales are freed and move primarily into the higher priced world market.

The sugar factories have slightly higher revenue; lower costs; higher value added. Cane producers have lower revenue and lower costs, so that returns per mz are unchanged (prices and costs are unchanged).

Sugar sales into the world markets are inefficient. (The cost of sugar is calculated by subtracting the molasses revenue from the total cane purchasing and processing cost). At C 80 per Q the world sugar price is likely to be below the marginal cost. If production could be fine-tuned, reductions in the money-losing world market sales would mean higher net revenues.

b. Scenario 2:

Same as Scenario 1, except that new sugar yield incentives are designed so that yield of sugar per ton of cane increases to about 2.10 Q per T, (a reasonable level by Central American standards.) The result is more sugar from the same number of tons of cane (and plants at cane crushing capacity), and higher revenues.

In this scenario, the initial cost of cane falls because a new cost-sharing scheme is introduced in which producers receive an initial payment of C $95 per ton (adjusted for sugar incentives) and a final payment based on the increase in value added relative to the baseline. Thus, the initial payment for cane is reduced from the baseline but the cane producers total revenue is increased by almost C $522 per mz.

Processing costs are unchanged from the previous scenario. Revenues are higher, value added to sugar and cane is higher. Marginal revenues on sales in the world market should continue to be below marginal costs.

c. Scenario 3

Much the same conditions prevail as in Scenario 2, except that the cane yields per area has increased. Since plant capacity is fully utilized, area is reduced. Cane delivered, sugar produced and revenues are unchanged, but cane production costs have declined. The value added per manzana increases.

d. Scenario 4

The same production assumptions as Scenario 3 apply. The world market price rises to the World Bank long-term estimate of, C$103 per Q ($0.137 per lb). Processing and production costs are unchanged: higher revenues mean that the world market price exceeds marginal cost.

The primary implication of this scenario is that only at higher world prices does it make economic sense for the industry to think of expansion; at about current prices (certainly at lower world prices), the economic incentive is to reduce production.

APPENDIX A

THE WORLD SUGAR MARKET[1]

1. General Perspective

Oversupply has resulted from an underlying weakness in demand caused by (1) the Persian Gulf crisis (2) USSR economic difficulties, and (3) the worldwide recession. There is a surplus of white sugar of 1 million TM (1 m TM), not including 455,000 TM stored by the EC. The result of the oversupply situation and consequent lower sugar prices will be:

- Fringe exporters, such as India, Poland and Argentina will cut back production; and

- Toll refiners, such as China, may find the artificially high white sugar premium less attractive and reduce activities.

The surplus of raw sugar is slightly less burdensome than the surplus of whites. Nevertheless, import demand is not expected to increase and production must be restrained to avoid buildup of stocks.

A price increase for raw and white sugars will only come from a decline in production.

The consumption pattern of sugar has changed over the last twenty years. Imports and consumption have declined in industrial countries:

- Trade protection in the U.S.A. and Japan has encouraged the technical development and market penetration of high fructose corn syrup (HFCS), displacing sugar;

- Dietary changes have encouraged the growth of non-caloric sweeteners in industrialized nations, now representing 10 percent of the U.S. sweetener market;

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[1] This appendix is based on The World Bank's, "Price Prospects for Major Commodities, 1990-2005", Washington, March 1991, and supplements for the first and second quarters 1991; and on F.O. Licht's, "International Sugar and Sweetener Report", Ratzeburg, May, 1991, and "International Sugar Report", Ratzeburg, July, 1987.

In contrast, imports and consumption have increased in developing countries:

- Per capita income has grown, especially in Asia, driving up demand in developing countries from 45 percent of world consumption in 1974-75 to 65 percent by 1988-89.

As a result, **the market influence of industrial countries has declined slightly in favor of developing countries**. This change in influence has lowered demand for raw sugar, and increased demand for white sugar since 1970.

Industrial nations have been unresponsive to world price fluctuations, but sensitive to price differentials between sugar and HFCS. Developing countries, however, have been more responsive to changes in price. With the emerging influence of developing countries, sugar demand has become income elastic, and may also become more price elastic. As a result of the change in elasticity, the market's tendency toward violent price booms and declines may moderate.

2. Raw Sugar

Consumption. Since industrial countries consume over 70 percent of raw sugar traded internationally, raw sugar demand is characterized by low price and income elasticities. Foreign exchange considerations do not determine the level of imports for these countries, except for the **USSR** which annually imports approximately 4 to 6 m TM.

The most stable importers of raw sugar are:

1) **EC.** The *Lomé Convention* sets imports at 1.4 m TM per year;
2) **U.S.A.** Although still the largest importer of raw sugar, the rise of domestic sweetener production has resulted in a decrease in imports. U.S. sugar imports dropped from 5.3 m TM in 1977 to 1.9 m TM in 1986. Sugar imports recovered somewhat during the years 1989/90 and 1990/91 as demand for HFCS reached the saturation point. This recovery may have been partly weather induced. Nevertheless, high domestic prices continue to encourage expansion in beet sugar production. (U.S. sugar legislation requires minimum imports of 1.1 m TM annually.)
3) **Japan.** Japanese demand decreased 458,000 TM between 1970 and 1986. It currently imports approximately 1.8 m TM annually.
4) **South Korea**. Imports average approximately 1 m TM annually.

5) **Malaysia**. Imports average approximately 800,000 TM per year.

Although China became a mainstay for the market at the end of 1980s, importing approximately 2.0 m TM per year, domestic production has expanded massively and tolling activities for export are expected to decline.

Supply. Major exporters of raw sugar are Cuba, Australia, Brazil and Thailand.

3. White Sugar

Consumption. Developing countries consume approximately 80 percent of the world supply of white sugar. Demand rose from 1970 until 1980 as gross white sugar imports increased from 6 m TM to 10 m TM, an annual growth rate of 6 percent. Growth was interrupted abruptly in the 1980s as imports plateaued in the 10 to 12 m TM range.

The white sugar market is more price elastic than the raw market. However, consumer sensitivity in developing countries to increases in retail prices has been modified on occasion by government intervention.

As white sugar production increased during 1990 and 1991, demand decreased due to the Gulf War and world recession. The Middle East had been the largest importer at 5.0 m TM annually in recent years. The embargo on Iraq and Kuwait, that began in August 1990, and the war resulted in a sharp contraction and lost consumption. Although Middle East imports increased after the war, they have not returned to normal as some countries continue to suffer economic consequences. Economic problems have also resulted in decreased demand in Mexico and Turkey.

Supply. The result of the decline in demand has been overcapacity and overproduction in the white sugar market. Inventories now equal 40 percent of annual consumption (4.8 months). This situation has been made more complex by the EC's carrying forward 1.076 m TM of white sugar for twelve months, the result of a 7.5 percent increase in EC production during 1989/90. The carry-forward created an artificial premium for white sugar, which rose from US $51.20 per TM in November 1990 to more than US $100.00 in January 1991. Toll refiners, such as China, and the more flexible exporters, such as Brazil and Thailand, took advantage of the high premium switching from producing raws to whites. White exports from Thailand increased from 420,000 TM in 1988/89 to 700,000 TM in 1989/90. Chinese exports of white sugar rose from 270,000 TM to 690,000 TM during the same period.

Several "temporary" exporters have appeared to contribute to the oversupply for 1990/91:

India Government production incentives plus good weather created a supply surplus estimated to be 520,000 TM.

Poland A 15 percent increase in production and a 25 percent decrease in domestic demand created a surplus of 221,000 TM and and estimated 500,000 TM for 1991/92.. The government has subsidized exports due to low world prices and heavy stocks. Measures have been taken to curtail production in the future.

Argentina 1990/91 exports are expected to rise to 420,000 TM from 129,000 TM the previous year. It is thought that this level will drop since production costs and taxes are rising, the *austral* is overvalued, and international prices are declining.

4. Trends and Outlook

Consumption. From and estimated 110 m TM in 1991 consumption is expected to grow to 132 m TM by 2000, a growth rate of about 2 percent annually. Declining consumption in the industrial nations will halt and reverse in line with the slowing rate of market penetration of HFCS. Consumption in the developing world will increase the most.

Asia represents the major opportunity for import growth, due to a current "low" per capita consumption, the fact that one half of the world's population lives in Asia, and high projected population, and income growth. Growth in income is projected for the 1990s to be 6.6 percent in East Asia and 5.1 percent in South Asia, encouraging consumption and import growth in Indonesia, the Republic of Korea, Malaysia, Pakistan and the Middle East. (From 1980 to 1988, high income growth in China, India, Thailand and Pakistan, the Republic of Korea and Indonesia coincided with a 67 percent increase in sugar consumption. World sugar consumption increased only by 17 percent for this same period.) India is expected to become a major importer by 2005 as it reduces government support for domestic producers. China, however, is expected to rely increasingly on domestic production and refining of raw sugar.

Imports are not expected to increase for the USSR as yields of the domestic production increases. Eastern Europe is not expected to increase consumption since per capita levels there are already relatively high. (Consumption generally does not increase over per capita consumption levels of 40 to 50 kg.).

The World Bank projects the following growth rates:

Minimum annual consumption growth rate	1.7 percent
would result in world consumption of	128 m TM by 2000
implying an increase of	19 percent or 20 m TM
with a 2 % annual population growth rate	
consumption would rise to	131.7 m TM by 2000
implying an increase of	22 percent
with the average population growth rate	
of the 1980s consumption would go to	135 m TM by 2000
implying an increase of	25 percent.

Close Competition of Sugar. Government intervention in industrial countries to protect the HFCS market is more likely to affect consumption growth than prices. HFCS constitutes 40 percent of the U.S. caloric sweetener market, displacing 3.5 m TM per year of sugar imports during the 1980s; it makes up 30 percent of the Japanese market. Further penetration will be limited without government encouragement outside the U.S.A. and Japan. The EC has strictly limited output. Crystallization of HFCS has not yet been achieved commercially. HFCS costs are currently above world market levels. However, there is little hope for reduction of the import restrictions in the U.S.A. and Japan that have both promoted HFCS.

Although non-caloric sweeteners do not substitute readily for sugar, they currently constitute 10 percent of the U.S. sweetener market. Aspartame dominates the non-caloric sweetener market in industrial countries.

Production growth is expected to slow, in line with consumption growth, to the year 2000. Production growth in developing nations is expected to fall more than in the industrial nations, and is expected to increase in the EC, Australia, the USSR and Eastern Europe. In addition, production growth is forecast for certain developing countries: the Peoples Republic of China, Thailand and Brazil.

Exports are expected to grow by an average of 2 percent per year. The five largest exporters, Cuba, the EC, Australia, Thailand and Brazil, now share 62 percent of the total market, and are expected to control 70 percent by the year 2005. However, southern African nations will also experience major growth in exports, while Fiji's overseas sales will grow in line with field and factory yield increases.

Imports are projected to increase as growth in HFCS consumption levels off, and as developing nations provide a source of growth. A resurgence of import demand in the U.S.A. is expected with the saturation of the HFCS market, and so Argentina, the Caribbean and the Philippines will experience some export growth.

5. Producer Profiles

EC Increases in supports during the mid-1970s and 1980s resulted in a change of status from an importer to a large exporter. Continued price supports, even covering fixed costs, are expected, after price booms, to encourage production. Strong growth in exports will make the EC the largest exporter, surpassing Cuba by 1994.

U.S.A. Production has increased due to high support prices and falling prices for other crops since the mid-1980s. Production is expected to stabilize at current high levels.

Japan Consistent and large increases in prices during the mid-1970s and 1980s led to production increases, although price and production increases have declined since the mid-1980s.

Australia In a slightly protected market, output has increased in this low-cost producer. Production controls have, however, limited the expansion rate. It is expected to maintain its current production growth rate, with the expansion following price booms, and strong export growth.

Developing countries have increased production most rapidly, but overall will see the larger declines in production. Certain developing nations will experience **export** growth:

Thailand Thailand is an efficient low-cost producer, with the ability to respond quickly to world price increases and export opportunities since there is no rigid

	control of production nor constraint of profitable exports. Strong export growth is expected to make Thailand the third largest exporter, surpassing Australia in 1995.
Southern Africa	Production in Swaziland, Zimbabwe and Mauritius has grown in response to export opportunities. Exports from these countries are expected to grow at 28 percent a year.
Egypt and Morocco	Production has increased in line with consumption growth to limit dependence on imports.
Caribbean & Philippines	Production has declined with the loss of preferential access to the high priced U.S. market. Recent reinstatement of lost import quotas to the U.S. will keep production constant at current levels.
China	Changes in government controlled prices have caused surges in output. China has increased production to higher levels of self-sufficiency, to provide security of supply and reduce the risks of paying out foreign reserves to maintain imports.
India	This is a decline in the proportion of sugar that producers must sell at a discount to state-run outlets. Increased returns from sales to private traders are encouraging growth at a declining rate. Further price increases as protection are not expected. However, efficiency is increasing in milling.

In Central and South America:

Brazil	Production has increased significantly, but has been limited by government production controls that restrict the rate of growth of this low-cost producer.
Mexico	Production has increased significantly.
Cuba	Production increased during the 1970s, but yields have been flat since the 1980s. Production is expected to decline in line with reduced demand from

	Eastern Europe and the USSR, and access to those markets. Cuba will provide more sugar to the world market at lower prices.
USSR & Eastern Europe	Low yield and shortages of processing capacity have limited growth. Technology transfer from Western Europe is expected to increase yields by 2 percent annually.

6. Price Outlook

The World Bank expects the world sugar market to the year 2000 to be characterized by a series of booms and slumps. Price booms will stimulate production that will lead to over-supply, then government intervention to protect producers, followed by prolonged periods of price decline.
However, the *boom* and *bust* scenario may be modulated by changing market behavior. With the declining influence of the industrialized nations that were unresponsive to price, the market may behave differently, and boom price scenarios may decrease in intensity. The increasing influence of developing countries that have been more responsive to changes in price, may moderate price booms. However, although **consumers** in developing countries are responsive to increases in retail prices, they are often unresponsive to world prices because of government intervention. Nevertheless, competition for supplies of sugar of importers could remain strong if rising world prices coincide with strong income growth in developing countries that typically have fewer alternative sweeteners available.

In addition, the behavior of producers may temper production shortages and price booms:

EC	EC countries could respond quickly to high prices and so moderate emerging shortages since their agriculture is unrestricted by government controls in the supply of C sugar to the world market. However, they are generally high-cost producers and grow sugar beets in rotation with other crops that are less risky to produce because they are highly subsidized.
Brazil	Large amounts of cane could be switched from ethanol to sugar production -- though, as the years pass, domestic dependence on ethanol production could increase.

Price. The World Bank projects that the price for raw sugar will rise to 1990 US $0.15 per lb[2] by 1995, and to 1990 US $0.13 per lb by 2000. Over the entire 20 year period projected, there is an estimated 65 percent chance of prices falling in the range of 1990 US $0.101-0.202 per lb., a 2.5 percent chance of the average annual price slipping below 1990 US $0.068 lb., and the same chance of price exceeding 1990 US $0.28 per lb The average price over 20 years is projected at 1990 US $0.155/lb., comparing it with the average world price since 1951 of 1990 US $0.184 per lb

Policy reforms in OECD countries the virtual elimination of protection in the U.S.A., Japan, the EC could significantly increase the average world price and reduce its variability and the character of the market. With the long-run world price rising by an estimated 33 percent and its variability being reduced by around 28 percent. This change could lower production of sweeteners in those countries eventually creating a shift in production of sweeteners away from high-cost, highly protected producers to low-cost exporting countries.

In addition, relaxation of production controls in Australia and Brazil could lower world prices: an average 25 percent increase in Brazilian exports to the year 2005 in response to rising world prices could lower the world price by around 2 percent and result in lower EC exports.

7. Conclusions

Consumption growth will slow to average 2 percent annually. Most of the growth will be in developing nations consuming white sugars. There will be slight growth in consumption in industrial nations importing raw sugars.

The rate of growth in production will slow in line with the growth rate in consumption, particularly in developing countries. Meanwhile production in the protected markets of industrial nations will continue to increase.

The average price projected for the next twenty years, 1990 US $0.155 per lb., is lower than the actual average price for the past twenty years, 1990 US $0.184 per lb

Finally, the historical volatility of the sugar price may be moderated by the behavior of the consumers in developing countries, who are more sensitive to price, and by producers better able to expand or contract output with changing demand.

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[2] Using the GNP deflator.

APPENDIX B

1. PROCESSING COSTS OF INAZUCAR MILLS - COLONES

	La Cabana	Magdalena	Chanmico	El Carmen	Cha'tique
Crop (5 Mo.)					
Prod. Supplies	937,850	202,000	155,544	473,360	530,000
Electric Power	356,181	416,000	148,351	152,985	400,000
Fuels & Lubric.	1,204,876	497,680	327,346	504,214	788,750
Maint. Supplies	2,559,792	350,000	476,105	366,402	550,000
Contract Serv.	188,500	100,000			250,000
Wages & Salaries	4,834,316	3,315,200	3,460,352	2,789,655	5,117,676
Payroll Benefits	3,827,442	2,405,300	2,621,980	2,877,408	2,249,053
Subtotal	13,908,957	7,286,180	7,189,678	7,163,934	9,635,479
Off-Crop (7 Mo.)					
Electric Power	352,889	112,500	253,804	145,734	140,000
Fuels & Lubric.	537,440	117,500	95,064	172,460	288,500
Parts & Supplies	5,637,971	1,815,000	1,889,255	3,327,579	2,470,925
Contract Serv.	682,329	350,000	425,000	572,748	225,000
Wages & Salaries	1,681,170	1,365,000	1,745,623	1,239,604	1,630,671
Payroll Benefits	1,682,430	966,400	1,915,148	711,239	782,600
Subtotal	10,574,229	4,726,400	6,323,894	6,169,364	5,543,696
Overhead (12 Mo.)					
G & A Supplies	369,030	380,500	371,866	139,550	368,200
G & A Salaries	2,579,548	950,200	632,051	1,080,330	1,666,856
G & A Benefits	672,082	203,100	129,729	202,984	419,585
Insurance	242,000	175,000	210,000	171,000	120,000
Contract Serv.	132,200	68,000		4,000	27,000
Labor Rel., PR	100,100	131,000	107,815	27,000	6,500
Local Taxes	107,017	52,000	42,900	30,000	141,300
Subtotal	4,201,977	1,959,800	1,494,361	1,654,864	2,749,441
Operating Costs	28,685,163	13,972,380	15,007,933	14,988,162	17,928,616
Depreciation	4,450,000	758,000	2,203,000	717,000	2,039,000
Interest	8,236,762	2,918,632	3,062,094	4,139,544	6,826,989
Total	41,371,925	17,649,012	20,273,027	19,844,706	26,794,605
Cane Estimate, T	434,340	153,905	161,470	218,286	360,000
Proc. Cost, C/T	95.25	114.67	125.55	90.91	74.43

Based on Mill Budgets for 1991/92

APPENDIX B

2. PROCESSING COSTS OF SELECTED SALVADORAN MILLS - COLONES

	Jiboa	Private Mills (2)
Production, Maintenance, Repairs		
Prod. Supplies	2,445,000	1,051,219
Electric Power	305,400	394,219
Fuels & Lubric.	1,534,000	4,483,773
Maint. Supplies	3,394,800	
Spare Parts	8,600,000	12,022,967
Contract Serv.	2,877,500	318,832
Wages & Salaries	12,575,000	17,921,008
Payroll Benefits	6,390,000	9,763,365
Subtotal	24,726,900	45,955,383
Overhead		
G & A Supplies	689,600	3,039,304
G & A Salaries	2,107,000	
G & A Benefits	1,401,200	
Insurance	1,386,000	2,654,617
Contract Serv.	853,600	2,714,381
Labor Rel., PR	308,700	
Local Taxes	716,000	731,404
Subtotal	7,462,100	9,139,706
Operating Costs	32,189,000	55,095,089
Depreciation	1,387,200	11,739,950
Interest	6,920,500	23,124,505
Total	40,496,700	89,959,544
Cane Ground 1990/91, T	591,702	1,376,656
Processing Cost, C/T	68.44	65.35
Projected Cane, 1991/92, T	816,000	
Proj. Proc. Cost, C/T	49.63	

Jiboa cost figures are based on the 1991/92 budget.
Private mill costs are actual 1990/91 figures.

APPENDIX C

FIELD VISIT REPORTS

1. Ingenio Jiboa

Jiboa was built for the government by Fletcher & Stewart in the mid seventies, as a turn-key job. As a part of CORSAIN, it was planned to provide a modern processing facility for cane growers in the hilly San Vicente area, where previously only "panela" had been produced. It also was planned to process cane from the coastal plains in La Paz. The mill is located halfway between these two areas, the nearest cane being 8 km away.

Cane from San Vicente is cut into three feet pieces and hand loaded, while whole-stalk cane from Las Paz is loaded mechanically. The latter also is lower in sucrose and purity. Jiboa does not have a crane or cane table to handle whole-stalk cane. Storing, reclaiming, and feeding to the main carrier is done by front-end loaders. Cane transportation is hampered by distances as well as guerrilla activity. Both problems are reflected in the transportation cost.

There is a permanent work force of 193, which is increased to 630 during the crop. In addition, there is a technical and administrative staff of 60. The SINA labor union is very strong at Jiboa, its actions apparently in part being politically motivated.

Much of the mill equipment is of non-standard design, which leads to extended ordering times for spare parts and the need to keep large inventories.

Jiboa, being the only sugar factory in CORSAIN, does not pool its U.S. or domestic sugar quotas with other mills to save on transportation costs. It is transporting raw sugar to Acajutla by truck at C 3.44 per quintal. It also is trucking sugar to Nicaragua, by way of Honduras.

Jiboa is actively pursuing "Co-Generation", the generation of electric power in excess of the factory's operating needs and the sale of that power to the public grid. A new boiler and a condensing turbine are scheduled to go on stream during the next crop, thus converting available excess bagasse into revenue. In the past, fear of guerrilla actions against the national power network has caused the mills to be cautious about this innovation. A co-generation consultant, Pedro Walte, the long-time factory superintendent at San Francisco, has been retained.

As an installation, Jiboa is the prize property among the six government sugar factories. With all its operational problems, it reportedly made C 21 million last year. Its privatization separate from the INAZUCAR mills is being advocated by various interest groups. INAZUCAR, obviously, opposes this separate solution. A valuation of Jiboa was done in late 1990 by John W. Siemer, formerly General Manager at American Factors' Pioneer Mill in Hawaii.

2. Ingenio La Cabaña

La Cabaña sugar mill is located about 40 km due North of San Salvador, in the plain between the volcanic coastal range and the continent's central mountain range which rises into Honduras. The central plain between the two mountain ranges, crossed by the Lempa river contains some of the country's best agricultural land. It belongs to the traditional sugar cane region. Both the La Cabana and the San Francisco mills are located here, only 7 km from each other. Part of the central valley is occupied by the lake formed by the Cerron Grande hydroelectric dam. When the level in the lake is low, as happens at present, the exposed area is cultivated. The land North and East of Guazapa had been abandoned for several years due to the fighting. It now is gradually coming back into production.

The normal yearly rainfall around La Cabaña is around 2,250 mm, concentrated between May and October. This year, there have so far only been 1,800 mm. Nevertheless, the cane looked strong and healthy. Plant cane yields of 110 T per mz are normal, with yields dropping by about 10 T per mz every subsequent harvest until levelling off around 70 T per mz. A pest which is causing some trouble in the region (it can reduce tonnage by 25 percent) is the Neolabia, a leaf hopper which attacks the leaf veins and causes fungi to invade the plant tissue. Control of Neolabia consists in spraying Tamaron 600 (Bayer), which has to be applied early in the day, when the bugs are moving about. Lately, there has been a problem with Bayer lowering the strength of its product without the users being aware.

During harvest time, some growers are running into the problem of finding sufficient cutters for their cane. Cane is cut by "Tarea", a task staked out for each cutter by the overseer. The average per task at La Cabaña turns out to be around 1.8 tons. The task is paid at C 22.00. Some people will agree to cut two tasks per day. Even then, they are home before lunch. There is no formal law against the import and use of mechanical cane cutters, but politically it is deemed to be highly inexpedient. Given the beginning scarcity of labor, however, some growers are pursuing information about mechanical harvesters. Land is priced at between C 16,000 and C 18,000 per manzana.

Of the roughly 500,000 T La Cabana grinds per crop, 200,000 T are grown within a 3 km radius of the mill. Another 60,000 T come from within 10 km, another 40,000 T from within 15 km, and the remaining 200,000 T are drawn from as far away as 50 km. Complaints were heard about the mill's cane receiving policy, where transportation and scheduling favors are given to far away growers threatening to send their cane to San Francisco at the expense of the more "captive" growers adjacent to the mill.

There exists a consensus, inside and outside the government, that the state run sugar mills should be privatized. With respect to La Cabana, some of the growers have formed a group interested in taking over the mill. This group controls about 300,000 tons of cane per year and includes two co-operatives (120,000 T), the "parcelarios" (100,000 T), and independent growers (80,000 T). The parcelarios are growers with service ties to the mill, who acquired their parcels of land from the de Sola family, the original owners, before the agrarian reform. Two major co-operatives which, reportedly are hard to get along with, are not included. The take-over aspirants are worried by the talk about a blanket transfer of ownership of the government mills to the agrarian co-operatives.

Up to the agrarian reform, the mill was owned by the H. de Sola group which, afterwards, was called in to manage it for some time. There is a permanent staff of 120 people, which during the crop is expanded to 450. La Cabaña is an impressive installation -- evidently, money has been spent on the industry even after government takeover. The principal installations are listed in Appendix D. A new mill tandem was installed in 1988. The fact that the extraction is no better than it is may, among other things, be due to the scarcity of experienced personnel, a post-reform condition reported at several of the factories visited. According to management, they are experiencing capacity problems at the clarifiers. The amply and well laid-out boiling house goes back to a project of Jose Lima. The double-magma boiling system is used for the main product, mill white sugar. There is a project to install syrup sulphitation, but without any subsequent filtration. There is a bagasse baling plant which is in use.

The closest the 120,000 liter (l) per day distillery ever came to its planned 14 million l per year was 2.2 million l in 1990/91. Problems are caused by the use of final molases for feed stock (heavy equipment incrustation -- plant specifications called for "miel virgen"), the lack of cold water for the condensers, and the lack of capacity and operational dependability of the slops evaporator that was part of the purchase. The purchase by INAZUCAR of four French designed, Venezuelan built anhydrous (hexane) distilleries, which is responsible for close to one half of INAZUCAR's C 380 million of accumulated debt, apparently was more of a political than a business deal. The plants themselves went through the following steps of "musical chairs":

- A 60,000 l per day unit was installed at El Carmen.
- It was moved from El Carmen to Chanmico while, at El Carmen a new 120,000 l per day plant was installed.
- La Cabaña received another 120,000 l per day plant, while a 75,000 . per day facility went in at Ahuachapan.

There is a permanent staff of 120 which, during the crop, is increased to 450 persons. Some details on operating costs are reported in Appendix B.

3. Ingenio La Magdalena

This sugar mill is located near Sta. Ana, about 60 km West of San Salvador. La Magdalena is the westernmost of El Salvador's sugar factories, not counting Ahuachapan, which is in the same area and, in its small way, competes with La Magdalena for cane. This part of the country, presumably because of its elevation, has a slightly cooler dry season than the rest, which helps the ripening process of the cane. It also is less plagued by guerrilla fighter activity which allows more normal grower relations and harvest planning. Both of these characteristics are reflected in an industrial yield of around 200 pounds of sugar per ton of cane which, though not spectacular in itself, is clearly superior to the rest of the industry.

Before the agrarian reform, La Magdalena was owned and operated by Lic. Gino Giammattei, presently President of INAZUCAR. In 1967, Giammattei had bought the old La Laguna mill in San Salvador from the Deininger family and mounted it as La Magdalena.

Access is one of La Magdalena's problems. The pavement ends at Chalchuapan, from where a 6 km dirt road, with considerable grades and only the most rudimentary surfacing, carries the traffic of all products and supplies, including a good part of the cane.

The factory is laid out on two sides of a small stream which divides the mill and fabrication, on the one side, from the boilers, spray pond, and bagasse and molasses storage, on the other. Needless to say, the layout is not strictly based on right angles. Other noteworthy aspects of the factory are the sulphitation by Multi-Jet condenser, a battery of belt-and-pulley driven centrifugals, and molasses storage in brick-lined pits, covered by corrugated steel roofs. Some details on the principal equipment are reported in Appendix D.

The operation is characterized by recurring shortages of bagasse, which force La Magdalena to use the oil burners on its boilers. Total personnel during the crop amounts to 410 persons, while the permanent staff is about 140. Some operating cost details are reported in Appendix B.

4. Ingenio Chanmico

This sugar mill is located at Sitio del Nino, about 15 km West of San Salvador.

Before the agrarian reform, Chanmico was owned by Mr. Wolf von Hundelshausen, past president of INAZUCAR. His father had been the representative for BMA equipment for all of Central America, which certainly shows in Chanmico. This mill is competing for cane with El Angel as well as with El Carmen. Comparing its logistics with the former, and its technical installations with the latter, it has a better than even chance of survival.

Details on the principal equipment are reported in Appendix D. Unlike some of the other mills visited, Chanmico does not have any machine shop to speak of, nor does it operate and maintain any agricultural equipment for its cane growers. The sugar house operation is based on the two-massecuite boiling system, shock seeding being used on low grade strikes. Filter cake and also boiler ash is hauled away by the cooperatives. The mill has an ample supply of fresh water in the adjoining Chanmico Lake. Cooling water overflow is applied in irrigating the surrounding cane fields. The distillery has not operated since the 1987/88 crop, which was its only season. Some operating cost details are reported in Appendix B.

5. Ingenio El Carmen

This sugar mill is located near Armenia, about 40 km West of San Salvador in the Pacific foothills of the coastal mountain range, within sight of the Izalco volcano. The terrain around the mill itself is quite broken, but the area becomes flatter towards the sea. Some remarkable features noted on the drive down from San Salvador included the extent to which fields planted to a mixture of corn and beans reach up the rather steep hill sides and the number of small brickyards operating along the roadside, flanked by stacks of cord wood and offering their ware by the truckload. The approximately one mile of road linking the mill yard to the San Salvador/Sonsonate highway consists of a dirt track full of gullies and potholes, with some remnants of pavement showing here and there.

Before being taken over by the government in 1980, the mill and part of the surrounding cane land was owned by the Giammattei family. It is not hard to believe the comment heard at the mill that, El Carmen had been built from equipment of mills going out of business. Today, the mill belongs to INAZUCAR, while the former Giammattei plantation, and the land of about a dozen other formerly private growers are operated by the same number of agrarian cooperatives. They supply about 70 percent of El Carmen's cane, while about 60 smaller producers, untouched by the agrarian reform, supply the rest. The cooperatives, at the same time, also supply cane to the sugar mills of Izallco and El Angel. Cooperativa del Zunza operates the formerly mill-owned lands.

Cane is planted in November, one month after the end of the rainy season. Between 10 and 15 tons of seed cane are used per manzana. Plant cane is harvested after 12 months in short-cycle varieties, and after a longer period if the variety requires. Harvesting takes place from mid-November to mid-April. Programming of ratoon harvesting seems to be rather rudimentary. The cane department of the mill tries to influence the growers' harvesting schedules by providing field analyses of cane. Fields to be replanted (ideally after the fourth ratoon, but in practice often a lot later) are plowed up in April and planted to corn in May. The corn is harvested in August, the field being prepared for cane planting in October, re-entering the cane cycle in November. Intermediate crops other than corn are also used, except beans which have to be planted in August so they can be harvested in November, at the start of the dry season.

Normally, cane is harvested in El Salvador without being burnt. However, with the upheavals of the past 12 years, regarding land ownership and public safety, such "normalcy" has almost disappeared. Cane fields are set afire on purpose

both by guerrilla fighters trying to disrupt the economy and by growers trying to pressure the mills into receiving their cane, lest it be spoilt completely. During the last crop at El Carmen, only 15 percent of cane was delivered unburnt, while crusher juice purity averaged a mere 79 percent.

Large growers, such as the cooperatives, have their own cane loaders. For growers without loaders, El Carmen (which has three loaders) provides this service at C 4 per ton. Transport of cana larga to El Carmen is provided either by the growers, independent transporters, or by the mill. During the past crop, El Carmen charged an average of C 12 per ton for hauling. There are independent haulers who will load hand cut cane and transport it to the mill at C 25 - C 30 per ton.

At the time of the visit, the start-up of the crop had been scheduled for November 18. The mill tandem was still completely dismantled, as one housing, one large gear, and several rollers and couplings had not yet returned from Metalurgica Sarti in San Salvador. The progress of repair work was seriously hampered by the lack of electrical power. As there is no emergency power generator, work is directly affected by the daily four-hour power cut-offs scheduled by the public grid to cope with the low water levels at the country's hydro-electric dams. Any welding, hoisting, grinding or work in enclosed areas was limited to the afternoon hours, with work stopping at 4 p.m.

Several operational aspects are noteworthy. Cane is stored on an unpaved yard and reclaimed by a front end loader. No cane washing takes place. The 60" mill tandem is fed by a 48" cane carrier. Bagasse left over from the last crop was extremely coarse. The two clarifiers are located high enough to permit filter operation without the pumping of mud, which is good. No clarified juice heating takes place. El Carmen produces raw sugar only, its domestic market quota being filled by INAZUCAR mills more distant to the Acajutla terminal. The boiling house layout imposes considerable lateral gravity transport of massecuite. The loose boiling of strikes this requires works against a good sugar retention. Some of the receivers were half filled with massecuites from last year's crop. In the absence of a sugar scale, sugar is transported to the warehouse by truck, passing over the cane truck scale to be weighed on the way. Details of equipment and installations are reported in Appendix D.

On inspecting the factory operating reports, the following aspects were noted:

- Factory performance is based on gross cane, no discount being applied for extraneous material. This undoubtedly contributes positively to the agricultural and negatively to the factory yields reported. Extraction at the mills is 88%, with 7

percent imbibition. Bagasse of 4 percent sucrose is being sent to the boilers. Raw juice quantities, about 77 percent on cane, are based on flow meter values. There is, of course, a direct relationship between the excess of bagasse and the small amount of dilution water added at the mills. The retention, in the boiling house, of about 88 percent seems to be largely determined by the low purity material entering the factory. Final molasses purity is in the upper t!..ties.

- Lost time for the last three crops ran at 20%, 20%, and 35%, respectively. In theory, there is a scheduled 12 hour maintenance stop every two weeks. Apparently the labor union is exerting considerable pressure in the direction of overstaffing. Fringe benefits are around 90 percent of base pay. There is a permanent work force of 107 which is increased to 331 during the crop. A scheme is in operation under which off-crop work is provided for a large portion of the crop personnel

At about half a mile from the El Carmen sugar factory, is the El Carmen alcohol distillery. It is not operating, and there are doubts as to whether it ever will. It was built by a Venezuelan company as a turn key project in the 1980's, as part of the governments gasohol program. During its years of operation, it was supplied with bagasse and molasses from both the El Carmen and Izalco sugar factories. It is a self-supported open-air 120,000 l per day plant which apparently never reached its nominal capacity. Its boilers are equipped with oil burners. It has at least two large alcohol storage tanks (they look like 5,000,000 l units) and several tanks for molasses. The down-river area has, reportedly, been seriously affected by the discharge of slops. The distillery's access roads are in as bad, or worse, conditions as those of the El Carmen sugar mill.

6. Ingenio Chaparrastique

Located at San Miguel, about 70 km East of San Salvador, Chaparrastique, which started grinding in 1983, is the third incarnation of a factory which previously has been operating in two different places. It started as Ingenio Sta. Barbara in the upper Lempa valley. It belonged to the Bustamante group and was built in the early sixties, most likely in response to the assignment to El Salvador of part of the Cuban U.S. quota When parts of the upper Lempa valley were flooded by the Cerron Grande power dam in the mid seventies, the mill was transported to Mapilapa, near San Salvador, as Ingenio San Esteban. It started operations there in 1976. With the agrarian reform in 1979 it passed into the hands of INAZUCAR. In view of a lot of land in the East going out of cotton production and of an excess of processing capacity for the cane available near San Salvador, the decision for a second transplant of the factory was made.

In spite of such a tumultuous past, Chaparrastique is a well laid out and well appointed sugar factory. Details of its installations are reported in Appendix D. Its spaciousness and ease of access for maintenance of most major equipment are noteworthy. Its great challenge resides in improving the quality of its cane supply. San Miguel is not a traditional cane area, and times have not been in favored of the development of optimal cultivation routines and the selection of the most appropriate varieties. Details on operating costs are reported in Appendix B.

7. Ingenio Izalco

Ingenio Izalco is located at Sonsonate, about 60 km West of San Salvador. Ingenio Izalco, which belongs to the Regalado group, was established in 1964, shortly after part of the U.S. Cuban sugar quota had been reassigned to El Salvador. At that time, the Regalados also owned the San Isidro mill which, along with their cane lands, was lost to the Agrarian Reform in l980. San Isidro has since been shut down. Presently, Izalco owns only about 350 mz of land, the legal maximum for sugar mills. Of the roughly 10,000 mz producing the 850,000 tons of cane per year ground by Izalco, 52 percent belongs to Agrarian Reform Cooperatives and the rest to independent growers.

Originally, most of Izalcos cane came from the higher lands around Sonsonate. Beginning with the expansion of the mill during the high world market prices of the mid seventies, lower lying coastal lands were brought into production. Cane from those areas, which today account for 60 percent of the mill's supply, is higher in tonnage but lower in sugar content than cane from the traditional areas.

Izalco will be the first mill in El Salvador to introduce quality payment for cane this coming crop. At an average of 80 T per manzana and at the present flat cane price of C 115 per ton, a cane grower is able to clear about C 3 - 4,000 per mz. Under the new system, the grower will continue to receive every fortnight the flat C 115 per ton, plus information about the recoverable sugar content of his shipments during that period, as determined by the new core sampling apparatus. At the end of the crop, he will receive C 0.65 for every pound of sugar delivered by him in excess of 175 pounds per ton of cane.

Izalco is providing agricultural extension services to all its cane producers. There is heavy emphasis on new varieties with a higher sucrose content and earlier maturity dates. In addition, Izalco carries all agricultural operations of cane production for the owners of about 3,500 mz. This service is provided on a cost-plus-ten-percent basis by the mill's agricultural department.

Details of the factory itself are reported in Appendix D. Basically, the factory produces raw sugar for export, filling its own export quota as well as those of El Angel and San Francisco. These mills, in exchange, produce plantation white sugar for Izalco's quota on the domestic market. Izalco's domestic sugar for industrial users is, however, produced at the mill itself. Izalco is in the process of installing a refinery for part of its output, the necessary equipment for which is partly brought in from the former Refineria Salvadorena. Output of the refinery is intended for regional niche markets, such as Mexico, Venezuela, and neighboring Central America. There are 720 people working during the crop and 285 during the off-season.

8. Ingenio El Angel

This sugar mill is located near Apopa, about 20 km straight North of San Salvador. Sugar cane has been grown in the Apopa area since colonial times, when "panela" constituted the only commercial product. A centrifugal sugar factory was built on the present site around the turn of the century. In 1968, the Borja group acquired El Angel and, in 1972, almost completely replaced the existing installation. The sugar mill as well as the Borja-owned cane lands were expropriated by the government in 1980. The mill was returned to the former owners in 1986 when its expropriation was found to be illegal, on the grounds that the plantation and the mill had formerly been operated as two separate companies.

During the 1990/91 crop, El Angel, in approximately 110 crop days, ground 533,689 T of cane and made 910,097 Q of sugar. Nominal grinding rate is 5,000 T per day, but daily volumes of 6,000 T have been recorded. Cane supply has been decreasing over the last few years, in spite of the high official cane price. This is probably a consequence of El Angel's proximity to the San Salvador metropolitan area.

El Angel makes mill white sugar only, swapping its raw sugar quota for the domestic, white quota of the Izalco mill which is located near the Acajutla export terminal. El Angel is in the process of installing a 300 T per day refinery section, in order to be able to sell refined sugar in the ten million ton refined sugar slice of the world market. Technical assistance is provided to El Angel by a Cuban residing in Guatemala.

Along the way from San Salvador to El Angel, there are the installations of the former Refineria Salvadorena de Azucar are on the way to El Angel. This facility, operating from the fifties into the early eighties, was owned by a consortium of Salvadoran sugar producers (except El Angel) and was designed for a year-round 12,000 Q per day melt. As it was dependent on oil for its energy, it is likely that the increase in oil prices contributed as much to its demise as did the political constellation. Two vacuum pans of the former Salvadoreña are presently being installed in the new white sugar end at El Angel.

9. Ingenio San Francisco

The San Francisco sugar mill is located about 40 km due North of San Salvador, past Aguilares, in the plain between the volcanic coastal range and the continent's central mountain range which rises into Honduras. It is owned by the Nottebohm group.

In 1980, the mill was expropriated by the agrarian reform, along with the Nottebohm land. This land supplied about 50 percent of all cane ground. In 1986, the mill was returned, following a decision by the supreme court.

Today, the mill receives half of its cane, about 200,000 T, from 21 co-operatives and the other half from 158 independent growers. The average agricultural yield for the former is 63.0 T per mz, and for the latter, 57.5 T per mz. Practically all cane is mechanically loaded. Hauling is done in 25 ton trucks, about 40 percent of the total cane supply originating within a radius of 10 km around the mill. A 20 km radius includes another 30 percent, and within a 30 km distance, all but 10 percent of the cane is found.

Certain informal contacts with the guerrilla fighters do occur from time to time. One way to avert their demands for contributions, and thus formal recognition, has been the execution of public infrastructure maintenance in areas under their influence. In years past, around-the-clock cane transport was not possible due to the armed conflict. The security having lately improved, 24 hour transport will be re-instituted for the coming crop.

The factory was the object of a total overhaul and expansion in the early fifties. At that time, a considerable amount of equipment was bought from Buckau Wolf. Buckau also was involved with the erection and later expansion of the Refineria Salvadorena.

Details about the installations seen on a quick walk through the plant are reported in Appendix D. There is a permanent work force of 149, which is increased during the crop to 475. Plans are underway to install a refining section, with parts of the Refineria Salvadorena, where about 20 percent of the raw sugar output would be melted. The treated liquor would then be added to the syrup, to improve the quality of mill white sugar. Eventually, the entire boiling station will be raised to the level of the present "B" pan.

The fiber board plant adjacent to the sugar factory is of the same vintage and uses the same process as the Tablopan installation at El Palmar in Venezuela. Apparently, lost time is rather high and profitability, at this time, somewhat questionable.

10. Ingenio Ahuachapan

Ahuachapan was installed by a private group (Salaverria) in 1976, using equipment discarded by El Angel after its modernization the same year. Ahuachapan did not operate during the 1979/80 crop, resuming production only in the 1984/85 crop. It thus escaped being expropriated by the agrarian reform.

Cane production conditions are much the same as for La Magdalena.

Operation normally only starts well into December, as the labor force is occupied in the coffee harvest. There are 260 people working during the crop, the permanent work force being about 70. Ahuachapan produces raw sugar and potable alcohol. For its alcohol production, Ahuachapan buys additional molasses from La Magdalena and El Carmen. Processing outside molasses necessitates the burning of wood. Present yield is 1.1 l of alcohol per gal of molasses. In the event of fuel alcohol production, cyclohexane is used as the dehydrating agent. Capacity of the slops-degrading basin limits the yearly output of alcohol to 2,000,000 l.

Cold water for the distillery condensers is a critical issue, as all fresh water in the area is warm to hot. (The country's geothermal power plant is located nearby.) Fresh water needs to go through a cooling tower before being used in condensers.

11. Acajutla Terminal

Acajutla, located about 80 km West of San Salvador, is the country's only commercial port with a pier. The other two ports are La Libertad and La Cuca.

Almacenadora del Pacifico operates a bulk solids warehouse and four bulk liquid tanks, located at about one kilometer from the pier. In terms of raw sugar, the warehouse has a capacity of 44,000 metric tons. The two largest tanks hold 600,000 gallons of molasses each and the others 500,000 and 300,000 gallons respectively. There are 211.6 local (Spanish) gallons to a metric ton of molasses at 85 Brix. The 1.3 km two-way 40" conveyor belt is capable of loading 600 metric tons of sugar per hour. There is an appropriate pumping installation for liquids which, however, was not seen.

The solids warehouse is used not only for sugar but also for grains and fertilizer. At the time of this visit, both yellow corn and urea were being stored. The incoming trucks are weighed on a computer-equipped weighbridge that allows the automatic taring of trucks and recording of incoming commodities. Bulk solids from bottom discharge trucks are emptied into the receiving hopper through a drive-on grate. There also is a rear-end tipper for ordinary trucks. From the hopper, the material is transported to an elevator and elevated to an overhead distributing conveyor. There is a central underground reclaiming belt along the entire warehouse, feeding back into the main elevator. The elevator feeds outgoing material to the 1.3 km belt via a set of Servo Balans type scales. The same scales are used for incoming material. Extensive cleaning of the materials handling equipment takes place between different commodities.

There is a permanent crew of 30 people, additional staff being hired for such tasks as bagging. There are portable bagging lines which can be set up on the main warehouse floor. No sprinkler system for fire protection exists in the warehouse. The tanks, other than for exporting molasses, are used also for receiving imported tallow.

There are other warehousing operations in Acajutla, one of them owned by the Comision Ejecutiva Portuaria Autonoma (CEPA), the government port authority. The CEPA operates the F-shaped pier, the lower or inner spike of which contains the bulk loading and unloading gantries, while the upper or outer spike of the F contains conventional freight handling installations only.

APPENDIX D

PRINCIPAL EQUIPMENT AND INSTALLATIONS

1. Ingenio Jiboa

CANE RECEIVING

3 Truck Scales, 50 t, Howe Richardson

1 Core Sampler for Cane Trucks, CCS-500, Thompson, 1987
complete with:

- 1 50 HP Electric Motor on Boom
- 1 Hydraulic Motor on Drill
- 1 Sample Shredder
- 1 Hydraulic Sample Press

1 Hydraulic Tipper for Rear End Unloading of Trucks
Whole-Stalk Cane, 40 t, Cameco

1 Hydraulic Tipper for Rear End Unloading of Trucks
Short Cane, 40 t, Cameco

4 Front End Loaders for Whole-Stalk Storage and Reclaiming

Paved Surface for Storing 4,500 t of Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

1 Cane Carrier, 40 m

2 Cane Levellers
2 Sets of Rotating Knives

4 Three Roller Mills, Fletcher & Stewart
Rollers of 84" x 40"
complete with

- 1 Central Lubricating System, Farval
- 1 Hydraulic Pressure System, Edwards

4 Steam Turbines on Mills
complete with

4 Steam Turbines on Mills
complete with
4 High Speed Gear Boxes
4 Sets of Low Speed Gears

3 Intermediate Carriers 84"

1 Imbibition Water Flow Meter, Foxboro

2 Imbibition Juice Screens
2 Inclined Bagasse Carriers
Juice Circulation Pumps

2 Mixed Juice Screens, DSM
1 Mixed Juice Tank, 40 m3
2 Mixed Juice Pumps, 140 m3/h, KSB

1 Bridge Crane for Mill Maintenance, 25 t, Street Crane
1 Lathe for Machining Mill Rollers, Broadbent

JUICE CLARIFICATION AND EVAPORATION

1 Automatic Juice Scale, 3.5 t

2 Liming Tanks
Dosing Valve with Automatic pH Control, Foxboro

2 Milk of Lime Circulation Pumps, KSB

2 Limed Juice Pumps, 75 HP

4 Horizontal Juice Heaters

1 Flash Tank

1 Floculant Storage Tank

1 Continuous Clarifier, "444", Dorr Oliver

1 Bagacillo Mixing Tank
2 Mud Recirculation Pumps

2 Rotary Vacuum Filters, Dorr Oliver
complete with
1 Vacuum Pump
2 Filtrate Pumps and Tank
2 Wash Water Pumps, KSB

Filter Cake Belt and Hopper

2 Clarified Juice Screens, DSM
1 Clarified Juice Tank
2 Clarified Juice Pumps, 55 kw, KSB
2 Clarified Juice Heaters

1 Pre-Evaporator, 1,200 m2

1 Quadruple Effect Evaporator
consisting of
4 Bodies, one per Effect
Condensate Collecting Tanks
1 Barometric Condenser

4 Syrup Tanks
2 Syrup Pumps

2 First Condensate Pumps, 50 m3/h, KSB
4 General Condensate Pumps, KSB

2 Caustic Soda Tanks
1 Caustic Soda Circulation Pump

CRYSTALLIZATION AND CENTRIFUGATION

13 Pan Feed Tanks, Syrup and Molasses

5 Vacuum Pans, 45 m3, Fletcher & Stewart
complete with individual Multi-Jet Condensers

1 Horizontal Cylindrical Magma Tank, Agitator and Drive
2 Horizontal Cylindrical Seed Tanks, Agitators and Drives

2 Refinery and High Grade Raw Massecuite Receivers, 45 m3
Agitators and Drives

5 "C" Massecuite Crystallizers, 50 m3
Cooling Elements and Drives, Unice

7 Automatic Batch Centrifugals, Broadbent
complete with Controls
for Refined and High Grade Raw Massecuites

4 Continuous Centrifugals, Konti
for Low Grade Raw Massecuites

3 Centrifugals Run-Off Tanks
3 Refinery and High Grade Molasses Pumps, 35 m3/h
2 Final Molasses Pumps

2 Sugar Minglers
2 Magma Pumps, Stork

REFINERY ("WHITE END")

2 Raw Sugar Vibrating Conveyors
1 Raw Sugar Melter
1 Clarifier Feed Tank

2 Milk of Lime Tanks
2 Milk of Lime Pumps

2 Phosphoric Acid Tanks, Stainless Steel
2 Phosphoric Acid Pumps

2 Jacobs Clarifiers

3 Clarified Melt Tanks
2 Clarified Melt Pumps

3 Pressure Filters, Industrial
complete with
1 Sweet Water Tank
2 Sweet Water Pumps

4 Liquor Receiving Tanks
4 Liquor Pumps, KSB

10 Pan Feed Tanks, Liquor

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Sugar Conveyor, from Batch Centrifugals, 50 t/h
2 Bucket Elevators, 15 m
1 Screw Conveyor, 20 m
Vitamin A Addition Installation

1 Horizontal Rotary Sugar Drier, 375 t/d

Assorted Bulk Sugar Transportation Equipment

4 Steel Sugar Bins

1 Bagging Scale for 100 lb Bags, 10 bags/min

Assorted Bagged Sugar Transportation Equipment

1 Bagged Sugar Warehouse, 15,000 t

1 Bulk Sugar Warehouse
1 Sugar Slinger, Crone & Taylor

1 Automatic Molasses Scale, Fletcher
2 Final Molasses Storage Pumps

2 Final Molasses Tanks, 3,800 m3, 1,900 m3

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

2 Boilers, 32 t/h, 250 psig, Chapman & Thompson
complete with
Induced and Forced Draft Fans, Oil Burners
Air Pre-Heater, Economizer, Superheater

1 Boiler under Construction, no Data Available

1 Boiler Feed Make-up Softening Plant
2 Treated Water Tanks, 1,250 m3

1 Deaerating BFW Heater

2 Deaerating Heater Supply Pumps, 15 kw, KSB

1 Boiler Feed Pump, KSB, 164 kw Electric Motor
2 Boiler Feed Pumps, KSB, Turbine Driven
1 Bagasse Conveyor, Belt, 1.50 m x 20 m
2 Bagasse Conveyors, Drag, Inclined, 1.68 m x 30 m
1 Bagasse Conveyor, Drag, Distribution, 1.68 m x 57 m
1 Bagasse Conveyor, Drag, Return, 1.20 m x 30 m

1 Ash Recovery System, 15 Rail Carts, Hudson

1 Storage Tank for Bunker C Fuel Oil, 900 m3

2 Three-Stage Turbo-Generators, 1,700 kw, Brotherhood/Brush
1 Condensing Turbo-Generator for Co-Generation being Installed
no Data Available
1 Diesel Generator, 150 kw, Lister & Blackstone

1 Bridge Crane, 10 t

4 Substations, 1,150 kva, Brush
1 Substation for Public Grid, 1,150 kva, Yorkshire

1 Cooling Pond
2 Hot Water Pumps
3 Cold Water Pumps, 220 kw

2 Fresh Water Pumps, Well Nr. 1, 150 m3/h, SPP, 37 kw Motor
2 Fresh Water Pumps, Well Nr. 1
1 Fresh Water Pump, Well Nr. 2

1 Elevated (25 m) Fresh Water Reservoir, 55 m3

2. Ingenio La Cabaña

CANE RECEIVING

Truck Scale

1 Core Sampler for Cane Trucks, CCS-500, Thompson, 1987
complete with
- 1 50 HP Electric Motor on Boom
- 1 Hydraulic Motor on Drill
- 1 Sample Shredder
- 1 Hydraulic Sample Press

Paved Surface for Storing Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

1 Hilo Type (Chain Net) Whole-Stalk Cane Truck Unloader

1 Cane Feed Table for Whole-Stalk Cane, 1975
9 Strands of Pronged Chain, Perforated Bottom
complete with Rotating Leveler

1 Hydraulic Tipper for Rear End Unloading of Trucks
Short Cane

1 Auxiliary Carrier, Inclined, Steel Slats, Short Cane
1 Main Cane Carrier, Inclined, Steel Slats, 66", 1975

2 Sets of Rotating Knives, 1975
2 Turbines on Knives, 750 HP
complete with
- 2 High Speed Gear Boxes

5 Three Roller Mills, 78", Bancroft, 1988
complete with
- 1 Central Lubricating System, Farval
- 1 Hydraulic Pressure System, Edwards

1 Steam Turbine on Mill 1, 1,000 HP, Elliot

complete with
1 High Speed Gear Box, Lufkin
1 Set of Low Speed Gears, Lufkin

1 Steam Turbine on Mill 2, 1,000 HP, Elliot
complete with
1 High Speed Gear Box, Philadelphia
1 Set of Low Speed Gears, Philadelphia

3 Steam Turbines on Mill 3, 4, 5, 1,000 HP, Elliot
complete with
3 High Speed Gear Boxes, Falk
3 Sets of Low Speed Gears, Falk

4 Intermediate Carriers, 78", Mill Driven

1 Imbibition Juice Screen
complete with
1 Inclined Bagasse Carrier

Mixed Juice Pumps
Imbibition Juice Pumps

1 Electronic Imbibition Water Flow Meter, Foxboro

1 Bridge Crane for Mill Maintenance
1 Lathe for Machining Mill Rollers

JUICE CLARIFICATION AND EVAPORATION

1 Electronic Mixed Juice Flow Meter, Foxboro, 1988

1 Sulphur Burner, Tray Type
1 Wooden Sulphitation Tower, 1.20 m x 1.20 m x 6.20 m

1 Sulphitated Juice Liming Tank
1 Dosing Valve with Automatic pH Control, Foxboro

Limed Juice Pumps
3 Limed Juice Heaters

1 Floculant Storage Tank

1 Continuous Clarifier, 105 m3
1 Continuous Clarifier, 245 m3

1 Rotary Vacuum Filter, 24' x ?', Dorr Oliver
complete with
1 Vacuum Pump
2 Filtrate Pumps
1 Wash Water Pump
1 Mud Overflow Pump

1 Clarified Juice Screen, DSM
1 Clarified Juice Tank
Clarified Juice Pumps

1 Quadruple Effect Evaporator
consisting of
5 Bodies, one per Effect plus one Swing Body
1 Barometric Condenser

Syrup Tanks
Syrup Pumps

First Condensate Pumps
General Condensate Pumps

Caustic Soda Tank
Caustic Soda Circulation Pump

CRYSTALLIZATION AND CENTRIFUGATION

Pan Feed Tanks, Syrup, "A" and "B" Molasses

5 Vacuum Pans, 35 m3
complete with Individual Barometric Condensers

Seed and Magma Crystallizers, Agitators and Drives

"A" and "B" Massecuite Crystallizers, Agitators and Drives

9 Continuous "C" Massecuite Crystallizers
Cooling Elements and Drives

5 "A" Massecuite Automatic Batch Centrifugals
48" x 40", Roberts
4 "B" Massecuite Continuous Centrifugals, Silver
4 "C" Massecuite Continuous Centrifugals, Silver

"A" and "B" Molasses Pumps
Final Molasses Pumps
Magma Pumps

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals
1 Screw Conveyor
1 Bucket Elevator

1 Horizontal Rotary Sugar Drier

1 Bagging Scale for 100 lb Bags

1 Sugar Warehouse, 50,000 t (bulk capacity)

2 Molasses Tanks, 4,000 m3, 3,000 m3 (?)

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

2 Boilers, 20 t/h, 250 psig, Heine
complete with
Induced Draft Fan
Economizer, Superheater

1 Boiler, ? t/h, 250 psig, VU-10, Combustion Engineering
complete with
Forced and Induced Draft Fans, Oil Burners
Economizer, Superheater

1 Boiler, 50 t/h, 250 psig, Babcock Wilcox
complete with
Forced and Induced Draft Fans, Oil Burners

Economizer, Superheater

1 Boiler Feed Make-up Water Softening Plant

Boiler Feed Pumps

Bagasse Conveyor, Drag, Inclined
1 Bagasse Conveyor, Drag, Distribution
1 Bagasse Conveyor, Drag, Return
1 Bagasse Conveyor, Drag, Auxiliary, to Press

1 Bagasse Bale Press
Bagasse Bales Storage Area
1 Turbo-Generator, 3,000 kw, Murray
1 Turbo-Generator, 1,500 kw, Siemens

1 Spray Pond
Hot Water Pumps
Cold Water Pumps

1 Fresh Water Pump, Well, 180 m3/h (Distillery)

<u>ANHYDROUS ETHANOL PRODUCTION</u> (Not in Use since 1990)

Equipment for the

Cooling, Dilution, and Filtration of "A" and "B" Molasses

Continuous Fermentation, Recycling, and Cooling of Beer

Centrifugal Separation, Treatment, and Recycling of Yeast

Heat Exchange between Inflows and Outflows of Columns

1 Distilling Column, 120,000 l/d, complete with Condensers

1 Rectifying Column, complete with Condensers

1 Dehydrating Column, complete with Reboiler and Condensers

1 Dehydrating Agent Recovery Column

Fusel and Secondary Alcohol Handling Systems

Primary Alcohol Handling and Measuring System

Slops Evaporation and Disposal System

Condenser Water Cooling System
Steam Reduction and Distribution System
Electrical Power Distribution System

2 Alcohol Storage Tanks, 1,000 m3

3. Ingenio La Magdalena

CANE RECEIVING

1 Truck Scale

1 Core Sampler for Cane Trucks, CCS-500, Thompson, 1987
complete with
1 50 HP Electric Motor on Boom
1 Hydraulic Motor on Drill
1 Sample Shredder
1 Hydraulic Sample Press

1 Hammerhead Type Crane
for Whole-Stalk Cane

Unpaved Surface for Storing Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

1 Cane Feed Table for Whole-Stalk Cane
12 Strands of Pronged Chain, Electric Motor
complete with
1 Rotating Cane Leveller, Electric Motor

1 Auxiliary Cane Carrier for Short Cane
Steel Slats, Electric Motor

1 Main Cane Carrier, 42" x 30 m, Steel Slats, Electric Motor
complete with
1 Rotating Cane Leveller, Electric Motor

1 Set of Rotating Knives, Electric Motor
1 Set of Rotating Knives, Turbine, Gear Box

6 Three Roller Mills, 42", Cast Iron Housings
Nr. 6 is Buckau Wolf

1 Steam Turbine on Mills 1 and 2, 400 HP
complete with
1 High Speed Gear Box

2 Sets of Low Speed Gears, Left Hand Drive

1 Steam Turbine on Mills 3 and 4, 400 HP
complete with
1 High Speed Gear Box
2 Sets of Low Speed Gears, Right Hand Drive

1 Steam Turbine on Mill 5, 250 HP
complete with
1 High Speed Gear Box
1 Set of Low Speed Gears, Right Hand Drive

1 Steam Turbine on Mill 6, 250 HP
complete with
1 High Speed Gear Box
1 Set of Low Speed Gears, Left Hand Drive

5 Intermediate Carriers, 42", Steel Slats, Mill Driven

Juice Screen, complete with Inclined Bagasse Carrier

Mixed Juice Pumps
Imbibition Juice Pumps

1 Bridge Crane for Mill Maintenance
1 Lathe for Machining Mill Rollers

JUICE CLARIFICATION AND EVAPORATION

1 Sulphur Burner, Tray Type
1 Multi-Jet Suction Sulphitation Column, Home Made

Raw Juice Liming Tanks
Dosing Valve with pH Control

Limed Juice Pumps

2 Limed Juice Heaters

1 Floculant Storage Tank

1 Flash Tank

1 Continuous Clarifier, 170 m3
1 Continuous Clarifier, 110 m3

1 Rotary Vacuum Filter, 8' x 12', Dorr Oliver

Clarified Juice Tank
Clarified Juice Pumps

1 Pre-Evaporator

2 Triple Effect Evaporators
consisting of
1 Body per Effect
1 Multi-Jet Condenser

Syrup Tanks
Syrup Pumps

First Effect Condensate Pumps
Other Condensate Pumps

CRYSTALLIZATION AND CENTRIFUGATION

Pan Feed Tanks, Syrup, "A" and "B" Molasses

6 Vacuum Pans, 25 m3, Multi-Jet Condensers

Seed and Magma Tanks, Agitators and Drives

"A" and "B" Massecuite Receivers, Agitators and Drives
"C" Massecuite Crystallizers, Cooling Elements and Drives

1 Semi Automatic Batch Centrifugal, Manual Discharge, Roberts
3 Belt-Driven Batch Centrifugals, Roberts
Electric Motor, Drive Shaft, Pulleys

2 Continuous Centrifugals, "B" Massecuites, Silver
1 Continuous Centrifugal, "B"/"C" Massecuites, Hein Lehmann
1 Continuous Centrifugal, "C" Massecuites, Silver
1 Continuous Centrifugal, "C" Massecuites, Roberts
1 Continuous Centrifugal, "C" Massecuites, Buckau Wolf (Horizontal)

"A" and "B" Molasses Pumps
Final Molasses Pumps
Magma Pumps

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals
1 Screw Conveyor
1 Bucket Elevator
1 Vibrating Dosing Hopper to Add Vitamin A Pre-Mixture

1 Rotating Horizontal Sugar Drier

1 Automatic Bagging Scale for 100 lb Bags

1 Bulk Sugar Warehouse, mostly Used for Bagged Sugar

3 Brick-Lined, Corrugated-Steel-Covered Molasses Pits

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

1 Boiler, 32 t/h, 250 psig, Babcock & Wilcox
complete with
Induced Draft Fan, Oil Burners
Economizer, Superheater

1 Boiler, 17 t/h, 250 psig, Erie
complete with
Induced Draft Fan, Oil Burners
Economizer, Superheater on Order

Boiler Make-up Water Softening Plant

Boiler Feed Pumps

Bagasse Conveyors, Drag Type

1 Turbo-Generator, 1,000 kw

1 Diesel Generator, 350 kw

1 Cooling Pond
Hot Water Pumps
Cold Water Pumps

Fresh Water Pumps

4. Ingenio Chanmico

CANE RECEIVING

1 Truck Scale, F. A. Dalton/Toledo, 1984
1 Truck Scale, Howe Richardson, 1976

1 Core Sampler for Cane Trucks, CCS-500, Thompson, 1987
complete with
- 1 50 HP Electric Motor on Boom
- 1 Hydraulic Motor on Drill
- 1 Sample Shredder
- 1 Hydraulic Sample Press

1 Rotating Hammerhead Type Crane, for Whole-Stalk Cane
8 t, 37 KW Electric Motor, 1963

Paved Surface for Storing 350 t of Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

1 Cane Feed Table for Whole-Stalk Cane
Pronged Chains, Perforated Bottom,
12.87 m x 6.50 m, 21.5 HP Electric Motor

1 Cane Carrier, 2 Chains, 6" Steel Slats, 48" x 19.80 m
1 Cane Carrier, 2 Chains, 6" Steel Slats, 48" x 12.90 m

1 Set of Rotating Knives, 24 Blades, 118 HP Electric Motor

1 Cane Shredder "Unigrator", 20 Hammers, Unice Machine Co.

1 Stearn Turbine on Shredder, Single Stage, 600 HP, Elliot
complete with
- 1 High Speed Gear Box, Foote, Jones & Dresser

4 Three Roller Mills, Service Foundry
Rollers of 48" x 28", Pitch 2", Journals 17"
complete with
- 1 Central Lubricating System, Farval
- 1 Hydraulic Pressure System Edwards/Farrel

1 Three Roller Mill, BMA
Rollers of 56" x 30", Pitch 1.5", Journals 19"
complete with
1 Individual Lubricating System
1 Hydraulic Pressure System

1 Steam Turbine on Mills 1 and 2, Terry
1,500 HP original, 750 HP after closing some ports
complete with
1 High Speed Gear Box, Lufkin
2 Sets of Low Speed Gears, Service Foundry

1 Steam Turbine on Mills 3 and 4, Murray
1,500 HP original, 750 HP after closing several ports
complete with
1 High Speed Gear Box, Philadelphia
2 Sets of Low Speed Gears, Service Foundry

1 Steam Turbine on Mill 5, 375 HP, KKK, 1970
complete with
1 Gear Box, Flender

3 Mill Feed Carriers, 48", Mill Driven
1 Mill Feed Carrier, 56", Mill Driven

2 Mixed Juice Screens, Home Built

1 Imbibition Juice Screen, Stainless Steel
complete with
1 Inclined Bagasse Carrier, 30" x 13 m

2 Mixed Juice Pumps, 45 m3/h, KSB, Stork
4 Imbibition Juice Pumps, 50 m3/h, Turo

1 Electronic Imbibition Water Flow Meter, Foxboro, 1988

1 Bridge Crane for Mill Maintenance, 8 t, Tragraf
1 Lathe for Machining Mill Rollers, 32" - 96", New Haven

JUICE CLARIFICATION AND EVAPORATION

1 Juice Scale, 1 t, Maxwell-Boulogne (not in use)

1 Electronic Mixed Juice Flow Meter, Foxboro, 1988

1 Sulphur Burner, Tray Type
1 Wooden Sulphitation Tower, 1.20 m x 1.20 m x 6.20 m

1 Sulphitated Juice Liming Tank, 5,000 l
1 Dosing Valve with Automatic pH Control, Foxboro

Limed Juice Pumps
3 Limed Juice Heaters, 90 m2, BMA

1 Floculant Storage Tank, 800 l

1 Continuous Clarifier, 20' Diameter, 6 Trays, 173 m3, BMA

1 Beltless Rotary Vacuum Filter, 12' x 8', Eimco
complete with
- 1 Vacuum Pump H6, Nash Hytor
- 2 Filtrate Pumps
- 1 Wash Water Pump, 9 m3/h, KSB
- 1 Mud Overflow Pump, 36 m3/h, Helmut Kahe

2 Vibrating Clarified Juice Screens, 2.45 x 0.56 m, Link Belt
1 Clarified Juice Tank, 10 m3

3 Clarified Juice Pumps, 39 m3/h (BMA), ?, 60 m3/h (KSB)
2 Clarified Juice Heaters, 90 m2, BMA

1 Quadruple Effect Evaporator, 2,560 m2
consisting of
- 1 First Effect Body, 800 m2
- 1 Second Effect Body, 600 m2
- 3 Third Effect Bodies, 280 m2 + 160 m2 + 160 m2
- 3 Fourth Effect Bodies, 284 m2 + 160 m2 + 116 m2

3 Syrup Tanks, 6 m3
2 Syrup Pumps, 9 m3/h, KSB

3 Condensate Pumps, 1., 2., 3. Effects
2 Condensate Pumps, 4. Effect, 22.5 m3/h, KSB

1 Caustic Soda Tank, 50 m3
1 Caustic Soda Circulation Pump

CRYSTALLIZATION AND CENTRIFUGATION

5 Pan Feed Tanks, Syrup, 10 m3
5 Pan Feed Tanks, "A" Molasses, 10 m3
5 Pan Feed Tanks, "B" Molasses, 10 m3

5 Vacuum Pans, 20 m3, 90 m2
complete with individual Multi-Jet Condensers

4 Seed Tanks, 10 m3, Agitators and Drives
2 "B" Magma Tanks, 10 m3, Agitators and Drives
2 "C" Magma Tanks, 10 m3, Agitators and Drives

3 "A" Massecuite Crystallizers, 20 m3, Agitators and Drives
1 "B" Massecuite Crystallizer, 20 m3, Agitators and Drives

5 Continuous "C" Massecuite Crystallizers
20 m3, Cooling Elements and Drives

1 "A" Massecuite Batch Centrifugal, 800 kg, BMA, 1973
2 "A" Massecuite Batch Centrifugals, 500 kg, BMA, 1967/8
1 "A" Massecuite Batch Centrifugal, 350 kg, BMA, 1956

2 "B" Massecuite Continuous Centrifugals, Silver

1 "C" Massecuite Continuous Centrifugal, K1000, BMA, 1964
1 "C" Massecuite Continuous Centrifugal, K 850, BMA, 1975

3 "A" and "B" Molasses Pumps, RTB-3N-80, Stork
2 Final Molasses Pumps, 12 m3/h (KSB), 4.8 m3/h (A. Ahrendts)
1 Magma Pump, 15 m3/h, BMA

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals, 7.21 m x 0.77 m
1 Screw Conveyor, 2.41 m x 0.34 m
1 Bucket Elevator, 7.38 m

1 Horizontal Rotary Sugar Drier, 5 t/h, BMA
complete with 10 HP Electric Motor, Gear Box by Flender

1 Bagging Scale for 100 lb Bags

1 Belt Conveyor for Sugar Bags, 80 m x 0.65 m
2 Auxiliary Bag Conveyors

1 Bagged Sugar Warehouse, 76,000 cwt
1 Bagged Sugar Warehouse, 34,000 cwt

2 Bulk Sugar Warehouses, 5,000 t

5 Molasses Tanks, 600 m3

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

1 Boiler, 20 t/h, 250 psig, Babcock & Wilcox Mexicana, 1964
complete with
Induced Draft Fan, 80 HP Electric Motor
Economizer, Superheater

1 Boiler, 13 t/h, 250 psig, Babcock & Wilcox Mexicana, 1956
complete with
Induced Draft Fan
Oil Burners
Economizer, Superheater

1 Boiler, 40 t/h, 300 psig, Fives Lille Babcock, France
complete with
Induced Draft Fan, 143 kw
Forced Draft Fan, Oil Burners
5 Spreader Stokers, Dump Grate
Economizer, Superheater

1 Boiler Feed Make-up Softening Plant

1 Boiler Feed Pump, 36 m3/h, 230 m, 55 HP Electric Motor
1 Boiler Feed Pump, 52 m3/h, 280 m, 70 kw Electric Motor

2 Boiler Feed Pumps, Turbine Driven

1 Bagasse Drag Conveyor, Inclined, 37.50 m
1 Bagasse Drag Conveyor, Distribution, 35 m
1 Bagasse Drag Conveyor, Return, 62.5 m
1 Bagasse Drag Conveyor, Auxiliary, 17 m

1 Turbo-Generator, 670 kw, 400 V, Schorch
2 Turbo-Generators, 1,000 kw, 400 V, Schorch
1 Diesel Generator, 150 kw

1 Cooling Pond
2 Hot Water Pumps, 400 m3/h - 75 kw, ? - 50 kw
2 Cold Water Pumps, 260 m3/h, ?

3 Fresh Water Pumps, Laguna Chanmico, 36 m3/h, Helmut Kahe

ANHYDROUS ETHANOL PRODUCTION (Not in Use since 1988)

Equipment for the

Cooling, Dilution, and Filtration of "A" and "B" Molasses

Continuous Fermentation, Recycling, and Cooling of Beer

Centrifugal Separation, Treatment, and Recycling of Yeast

Heat Exchange between Inflows and Outflows of Columns

1 Distilling Column, 60,000 l/d, complete with condensers

1 Rectifying Column, complete with condensers

1 Dehydrating Column, complete with reboiler and condensers

1 Dehydrating Agent Recovery Column

Fusel and Secondary Alcohol Handling Systems

Primary Alcohol Handling and Measuring System

Condenser Water Cooling System

Steam Reduction and Distribution System

Electrical Power Distribution System

Alcohol Storage Tanks

5. Ingenio El Carmen

CANE RECEIVING

2 Truck Scales, 60 t, Toledo Model 400

1 Core Sampler for Cane Trucks, CCS-500, Thompson, 1987
complete with
- 1 50 HP Electric Motor on Boom
- 1 Hydraulic Motor on Drill
- 1 Sample Shredder
- 1 Hydraulic Sample Press

1 Dragline Type Crane, 12 m Radius, 8 t, Fixed
for Whole-Stalk Cane, Lima

1 Dragline Type Crane, 10 m Radius, 6 t, on Lugs
for Whole-Stalk Cane, Bucyrus

Unpaved Surface for Storing Whole-Stalk Cane, 1,600 m2

CANE PREPARATION AND JUICE EXTRACTION

1 Cane Feed Table for Whole-Stalk Cane, 9.25 degrees incl.
240" x 205", 16 t Capacity, 40 HP Electric Motor
complete with
- 1 Rotating Cane Leveller, Electric Motor
- 1 Set of Rotating Knives, Electric Motor

1 Cane Carrier, 48" x 30 m, Steel Slats, 50 HP Electric Motor
complete with
- 1 Rotating Cane Leveller, Electric Motor

1 Set of Rotating Knives, 22 Blades, 300 HP Electric Motor

1 Set of Rotating Knives, 30 Blades, 250 HP Electric Motor

2 Three Roller Mills, Cast Iron Housings, Sangerhausen
Rollers of 60" x 34", Pitch 2.5", 1.5", Pistons 12"
complete with Hydraulic Pressure System Edwards

2 Three Roller Mills, Cast Iron Housings, Bancroft

Rollers of 60" x 34", Pitch 1.5", Hydraulic Pistons 12"
complete with Hydraulic Pressure System Edwards

1 Steam Turbine on Mill 1, 350 HP
complete with
1 High Speed Gear Box, Lufkin
1 Set of Low Speed Gears

1 Steam Turbine on Mill 2, 500 HP
complete with
1 High Speed Gear Box, Philadelphia
1 Set of Low Speed Gears

1 Steam Turbine on Mills 3 and 4, 750 HP
complete with
1 High Speed Gear Box
2 Sets of Low Speed Gears, Bancroft

3 Intermediate Carriers, 60", Steel Slats, Mill Driven

Mixed Juice Screens

1 Imbibition Juice Screen
complete with
1 Inclined Bagasse Carrier

Mixed Juice Pumps
Imbibition Juice Pumps

1 Electronic Imbibition Water Flow Meter, Fischer & Porter
(Not in Use)

1 Bridge Crane for Mill Maintenance, 15 t
1 Lathe for Machining Mill Rollers

JUICE CLARIFICATION AND EVAPORATION

1 Electronic Mixed Juice Flow Meter, Fischer & Porter

3 Raw Juice Liming Tanks
1 Dosing Valve with Automatic pH Control

Limed Juice Pumps

2 Limed Juice Heaters, Horizontal, 74 m2
1 Limed Juice Heater, Horizontal, 145 m2

1 Floculant Storage Tank

1 Flash Tank

1 Continuous Clarifier, 20' Diameter, 150 m3
1 Continuous Clarifier, 16' Diameter, 110 m3

1 Rotary Vacuum Filter, 8' x 12', Oliver

1 Clarified Juice Tank, 10 m3
Clarified Juice Pumps

1 Quadruple Effect Evaporator (A), 1,550 m2
consisting of
- 1 First Effect Body, 740 m2
- 1 Second Effect Body, 290 m2
- 2 Third Effect Bodies, 130 m2 + 130 m2
- 2 Fourth Effect Bodies, 130 m2 + 130 m2
- 1 Multi-Jet Spray Condenser

1 Quadruple Effect Evaporator (B), 1,480 m2
consisting of
- 1 First Effect Body, 590 m2
- 1 Second Effect Body, 280 m2
- 1 Third Effect Body, 280 m2
- 1 Fourth Effect Body, 280 m2
- 1 Multi-Jet Spray Condenser

Syrup Tanks
Syrup Pumps

First Effect Condensate Pumps
Other Condensate Pumps

CRYSTALLIZATION AND CENTRIFUGATION

Pan Feed Tanks, Syrup

Pan Feed Tanks, "A" Molasses
Pan Feed Tanks, "B" Molasses

1 Vacuum Pan, 21 m3, 134 m2, M-J Spray Cond., "A", "B"
1 Vacuum Pan, 41 m3, 261 m2, M-J Spray Cond., "A", "B"
1 Vacuum Pan, 41 m3, 261 m2, M-J Spray Cond., "A", "B", "C"
1 Vacuum Pan, 16 m3, 98 m2, M-J Cond., "A", "B", "C"
1 Vacuum Pan, 14 m3, 80 m2, M-J Spray Cond., "C"

3 Seed and Magma Tanks, Agitators and Drives

2 "A" and "B" Massecuite Crystallizers, Agitators and Drives
5 Continuous "C" Massecuite Crystallizers
Cooling Elements and Drives

4 Batch Centrifugal, 100 HP Motors, Manual Discharge, Roberts
2 Continuous Centrifugals, 60 HP Motors

1 "C" Massecuite Continuous Centrifugal, K1000, BMA, 1964
1 "C" Massecuite Continuous Centrifugal, K 850, BMA, 1975

"A" and "B" Molasses Pumps
Final Molasses Pumps
Magma Pumps

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals
1 Screw Conveyor
1 Bucket Elevator
1 Dump Truck Loading Hopper

1 Bulk Sugar Warehouse, 10,000 t

3 Molasses Tanks, 250 m3, 500 m3, 750 m3

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

1 Boiler, 25 t/h, 225 psig, 200 C
complete with
Induced Draft Fan, Economizer

1 Boiler, 30 t/h, 225 psig, 200 C, Erie
complete with
Induced Draft Fan, Economizer

1 Boiler, 17.5 t/h, 225 psig, 200 C, Erie
complete with
Induced Draft Fan, Economizer

1 Boiler, 9 t/h, 225 psig, 200 C
(Not in Use)

1 Boiler Make-up Water Softening Plant

3 Boiler Feed Pumps, Motor Driven

1 Bagasse Drag Conveyor, Inclined
1 Bagasse Drag Conveyor, Auxiliary
1 Bagasse Drag Conveyor, Distribution
1 Bagasse Drag Conveyor, Return

1 Turbo-Generator, 390 kw, 440 V
1 Turbo-Generator, 792 kw, 440 V, Turbodyne
1 Turbo-Generator, 500 kw, 440 V, Murray

1 Cooling Pond
4 Hot Water Pumps, 100 HP, 75 HP, 75 HP, 50 HP
5 Cold Water Pumps, 180 HP, 100 HP, 75 HP, 75 HP, 60 PH

2 Fresh Water Pumps, Quebrada Pena Trabada, 36 m3/h

<u>ANHYDROUS ETHANOL PRODUCTION</u> (Not in Use since 1990)

Equipment for:

Storage of Molasses

Cooling, Dilution, and Filtration of "A" and "B" Molasses

Continuous Fermentation, Recycling, and Cooling of Beer
complete with 6 Vats of 1,420 m3

Centrifugal Separation, Treatment, and Recycling of Yeast

Heat Exchange between Inflows and Outflows of Columns

1 Distilling Column, 120,000 l/d, Diam. 2.32 m, 9 Trays
complete with condensers

1 Rectifying Column, Diam. 2.00 m, 50 Trays
complete with condensers

1 Dehydrating Column, Diam. 1.90 m, 42 Trays
complete with reboiler and condensers

1 Dehydrating Agent Recovery Column

Fusel and Secondary Alcohol Handling Systems

Primary Alcohol Handling and Measuring System

Condenser Water Cooling System

Steam Generation and Distribution System

Electrical Power Distribution System

Alcohol Storage Tanks

6. Ingenio Chaparrastique

CANE RECEIVING

2 Truck Scales, 51 t

1 Core Sampler for Cane Trucks, CCS-500, Thompson, 1987
complete with
- 1 50 HP Electric Motor on Boom
- 1 Hydraulic Motor on Drill
- 1 Sample Shredder
- 1 Hydraulic Sample Press

1 Rotating Hammerhead Type Crane, for Whole-Stalk Cane
8 t, 120 HP Electric Motor, Henderson/Sarti

3 Hydraulic Rear End Unloading Tippers for Trucks, 15 t
Edwards, used for Whole-Stalk Cane

Paved Surface for Storing 2,000 t of Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

1 Cane Feed Table for Whole-Stalk Cane, 24' x 28'
Pronged Chains, Perforated Bottom
25 HP Electric Motor, Gear Link Belt
complete with
- 1 Rotating Cane Leveller, 46 Blades of 13"

1 Auxiliary Cane Carrier, 48" x 24 m, 2 Chains, 6" Slats
15 HP Motor, 35 fpm, for Short Cane

1 Cane Carrier, 84" x 23 m, 2 Chains, 6" Slats, 35 fpm
complete with
- 1 Rotating Leveller, 20 Blades of 2'

1 Cane Carrier, 66" x 22 m, 2 Chains, 6" Slats, 35 fpm
complete with
- 1 Rotating Leveller, 32 Blades of 2'

1 Set of Rotating Knives, 34 Blades, 300 HP Motor

1 Set of Rotating Knives, 42 Blades, Sarti, 300 HP Motor

2 Three Roller Mills, Service Foundry, 1964
Rollers of 66" x 33", Pitch 2.5"

2 Three Roller Mills, Service Foundry, 1976
Rollers of 66" x 36", Pitch 1.5"

2 Steam Turbines on Mills 1 and 2, 750 HP, Worthington
complete with
2 High Speed Gear Boxes, Western Gear
2 Sets of Low Speed Gears, Service Foundry, Left Hand

2 Steam Turbines on Mills 3 and 4, 700 HP, Elliot
complete with
2 High Speed Gear Boxes, Philadelphia
2 Intermediate Speed Gear Boxes, Philadelphia
2 Sets of Low Speed Gears, Service Foundry, Left Hand

3 Intermediate Carriers, 66", 3" Slats, Mill Driven

Juice Screen complete with inclined Bagasse Carrier

Imbibition Water Flow Meter

Imbibition Juice Pumps
Mixed Juice Pumps

1 Bridge Crane for Mill Maintenance
1 Lathe for Machining Mill Rollers

JUICE CLARIFICATION AND EVAPORATION

Mixed Juice Flow Meter

1 Sulphur Burner, Tray Type
1 Wooden Sulphitation Tower, 1.20 m x 1.20 m x 6.20 m

1 Sulphitated Juice Liming Tank, 24 m3
Dosing Valve with pH Control

3 Limed Juice Pumps, 75 HP, Goulds

2 Limed Juice Heaters, 135 m2, St. Mary
1 Limed Juice Heater, 110 m2, St. Mary
1 Limed Juice Heater, 100 m2, three-shell
1 Flash Tank

1 Floculant Storage Tank

1 Continuous Clarifier, 5 Trays, 193 m3, Dorr Oliver
1 Continuous Clarifier, 5 Trays, 177 m3, Dorr Oliver

1 Mud Mixing Scroll

1 Rotary Vacuum Filter, 10' x 20', Dorr Oliver
complete with
1 Vacuum Pump, Nash
2 Filtrate Pumps
1 Wash Water Pump, 9 m3/h, KSB
1 Mud Overflow Pump, 36 m3/h, Helmut Kahe

1 Clarified Juice Tank
2 Clarified Juice Pumps

1 Clarified Juice Heater, 90 m2

1 Quadruple Effect Evaporator, 2,930 m2
consisting of
6 Bodies, 1,100, 525, 360, 315, 315, and 315 m3
2 Barometric Condensers

Syrup Tanks
Syrup Pumps

First Condensate Pumps
General Condensate Pumps

Caustic Soda Tank
Caustic Soda Circulation Pump

CRYSTALLIZATION AND CENTRIFUGATION

7 Pan Feed Tanks, Syrup, "A" and "B" Molasses

1 Seed Tank, 27 m3, Agitator and Drive
1 "B" Magma Tanks, 10 m3, Agitator and Drive
1 "C" Magma Tanks, 20 m3, Agitator and Drive

3 Strike Cutting Tanks
3 Vacuum Pans, 38 m3, 250 m2
complete with Individual Barometric Condensers

1 Vacuum Pump for Pans 1, 2, and 3, 30 HP, Nash

1 Vacuum Pan, 25 m3, 130 m2
complete with Barometric Condenser

1 Vacuum Pan, 25 m3, 160 m2
complete with Barometric Condenser

1 Vacuum Pump for Pans 4 and 5, 30 HP, Nash

1 "A"/"B" Massecuite Receiver, 28 m3, Agitator and Drive

1 "A" Massecuite Crystallizer, 60 m3, Agitator and Drive
1 "B" Massecuite Crystallizer, 60 m3, Agitator and Drive

5 Continuous "C" Massecuite Crystallizers
45 m3, Cooling Elements and Drives

3 Automatic Batch Centrifugals, "A", 48' x 36", 25 HP, Roberts

2 Continuous Centrifugals, "B", 30" x 34 deg., 30 HP, Silver
1 Continuous Centrifugal, "B", Konti 10, Hein Lehmann

2 Continuous Centrifugals, "C", 30" x 37 deg., 50 HP, Roberts
2 Continuous Centrifugals, "C", Horiz., 30 HP, Allis Chalmers

"A" and "B" Molasses Pumps
Final Molasses Pumps
Magma Pumps

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals

1 Screw Conveyor
1 Bucket Elevator, 16 m

1 Horizontal Rotary Sugar Drier, 1.88 m x 9.00 m, 10 t/h
complete with 10 HP Motor, Gear Box, Buckau Wolf

1 Bagging Scale for 100 lb Bags, Howe Richardson

1 Bagged Sugar Warehouse, 370,000 cwt

Molasses Tanks

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

1 Boiler, 50 t/h, 230 psig, Stirling
complete with
Induced Draft Fan
Economizer, Superheater

1 Boiler, 22 t/h, 230 psig, Stirling
complete with
Forced Draft Fan, 75 HP
Induced Draft Fan, 300 HP
Economizer, Superheater

1 Boiler, 50 t/h, 230 psig, Distral (Babcock, Colombia)
complete with
Forced Draft Fan, 30 HP
Induced Draft Fan, 100 HP
Economizer, Superheater

1 Boiler Make-up Water Demineralizing Plant, 11 m3/h, Autotrol

3 Boiler Feed Pumps, Motor Driven

4 Bagasse Conveyors, Drag Type, 15, 33, 40, and 22 m

1 Turbo-Generator, 2000 kw, 480 V, Worthington/Turbodyne/Ideal
1 Turbo-Generator, 600 kw, 480 V, Murray/Ideal

1 Diesel Generator, 245 kw, Marathon

1 Cooling Pond
Hot Water Pumps
Cold Water Pumps

Fresh Water Pumps

7. Ingenio Izalco

CANE RECEIVING

2 Truck Scales

1 Core Sampler for Cane Trucks, Cameco

2 Rotating Hammerhead Type Cranes, for Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

2 Cane Feed Tables for Whole-Stalk Cane
12 Pronged Chains, Perforated Bottom,
each complete with
1 Rotating Cane Leveller

1 Auxiliary Cane Carrier below Grade, for Short Cane

1 Cane Carrier, Receiving Auxiliary Carrier and both Tables
complete with
1 Rotating Cane Leveller

1 Mill Feed Cane Carrier

2 Sets of Rotating Knives, 150 HP Electric Motors

1 Cane Shredder, Walker

1 Steam Turbine on Shredder, 1,600 HP
complete with
1 High Speed Gear Box

4 Three Roller Mills, 54" x 30", Farrel
complete with
1 Central Lubricating System, Farval
1 Hydraulic Pressure System, Edwards/Farrel

1 Five Roller Mill, 84" x 42", Walker
complete with
1 Individual Lubricating System

1 Hydraulic Pressure System

4 Steam Turbines, 550 HP, on Mills 1, 2, 3, and 4
each complete with
1 High Speed Gear Box
1 Set of Low Speed Gears, Farrel

1 Steam Turbine on Mill 5, 1,600 HP
complete with
1 High Speed Gear Box
1 Set of Low Speed Gears, Walker

3 Mill Feed Carriers, 48", Stainless Steel, Mill Driven
1 Mill Feed Carrier, 84", Motor Driven

1 Juice Screen complete with Inclined Bagasse Carrier

1 Imbibition Water Flow Meter

Imbibition Juice Pumps
Mixed Juice Pumps

1 Bridge Crane for Mill Maintenance
1 Lathe for Machining Mill Rollers

JUICE CLARIFICATION AND EVAPORATION

1 Juice Scale, Toledo - Brasil (being installed)

Sulphur Burners, Tray Type
Wooden Sulphitation Columns

Liming Tanks
Liming Valve with pH Control

Limed Juice Pumps

4 Limed Juice Heaters

1 Floculant Storage Tank

2 Continuous Clarifiers, Dorr Oliver

1 Continuous Clarifier, Graver
1 Rotary Vacuum Filter, 8' x 12', Dorr Oliver
1 Rotary Vacuum Filter, 10' x 20', Dorr Oliver
complete with Accessories for
Mud Mixing
Cake Disposal
Filtrate Collection
Vacuum

Clarified Juice Tanks
Clarified Juice Pumps

Clarified Juice Heaters

2 Quintuple Effect Evaporators

Syrup Tanks
Syrup Pumps

First Condensate Pumps
General Condensate Pumps

Caustic Soda Tanks
Caustic Soda Circulation Pumps

CRYSTALLIZATION AND CENTRIFUGATION

Pan Feed Tanks, Syrup, "A" and "B" Molasses
Seed and Magma Tanks, Agitators and Drives

2 Vacuum Pans, 55 m3, individual Multi-Jet Condensers
4 Vacuum Pans, 41 m3, individual Multi-Jet Condensers

"A" and "B" Massecuite Crystallizers, Agitators and Drives

7 Continuous "C" Massecuite Crystallizers
Cooling Elements and Drives

5 "A" Massecuite Batch Centrifugals, Broadbent
1 "A" Massecuite Batch Centrifugal, Western States

3 "B" Massecuite Continuous Centrifugals, Silver

1 "B" Massecuite Continuous Centrifugal, BMA

5 "C" Massecuite Continuous Centrifugals, K-1000, BMA
Centrifugal Run-Off Tanks and Pumps
Sugar Minglers and Magma Pumps

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals
1 Screw Conveyor
1 Bucket Elevator

1 Horizontal Rotary Sugar Drier

1 Bagging Scale for 100 lb Bags

1 Sugar Warehouse, 27,000 t Raw / 17,500t Bagged

5 Molasses Tanks, 600 m3

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

2 Boilers, 35 t/h, 250 psig
complete with
Forced and Induced Draft Fans
Economizer, Superheater

1 Boiler, 45 t/h, 250 psig
complete with
Forced and Induced Draft Fans, Oil Burners
Economizer, Superheater

1 Boiler, 70 t/h, 400 psig (under Erection for Co-Generation)

Boiler Make-up Water Softening Plant

Boiler Feed Pumps

Bagasse Distribution, Storage, and Return Conveyors

1 Turbo-Generator, 3,500 kw, 440 V, Worthington
1 Turbo-Generator, 2,500 kw, 440 V, Worthington

Diesel Generator

Cooling Pond
Hot Water Pumps
Cold Water Pumps
Fresh Water Pumps

8. Ingenio El Angel

CANE RECEIVING

2 Truck Scales

1 Core Sampler for Cane Trucks, CCS-500, Thompson, 1987
complete with
- 1 50 HP Electric Motor on Boom
- 1 Hydraulic Motor on Drill
- 1 Sample Shredder
- 1 Hydraulic Sample Press

1 Bridge Crane, 15 t, Track Straddling Tail of
Whole-Stalk Tables, Used with Cane Slings

1 Bridge Crane, 15 t, on Extension of Mill Building Track
Covering Head of Whole-Stalk Tables and Storage Area
Used with Cane Slings

1 Rotating Gantry, Operating Rear End Truck Tipper at
Table for Short Cane

Unpaved Surface for Storing Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

2 Parallel Cane Feed Tables for Whole-Stalk Cane
Pronged Chains, Perforated Bottom
each one complete with
- 1 Rotating Cane Leveller

Belt Conveyors and Hopper for Dirt
from beneath Whole-Stalk Tables

1 Cane Feed Table for Short Cane, below Grade, Steel Slats

1 Carrier for Short Cane, 6" Steel Slats, appr. 30 m
1 Mill Feed Cane Carrier, 6" Steel Slats, 66" x appr. 40 m

1 Set of Rotating Knives, ? HP Electric Motor

2 Sets of Rotating Knives, 650 HP Turbine, Twin Gear, Dedini

5 Three Roller Mills, 66", Dedini, 1972
complete with
1 Central Lubricating System
1 Hydraulic Pressure System

1 Steam Turbine on Mill 1, 1,000 HP, Dedini
complete with
1 High Speed Gear Box, Dedini
1 Set of Low Speed Gears, Left Hand Drive, Dedini

1 Steam Turbine on Mills 2 and 3, 1,000 HP, Dedini
complete with
1 High Speed Gear Box, Dedini
2 Sets of Low Speed Gears, Left Hand Drive, Dedini

1 Steam Turbine on Mills 4 and 5, 1,000 HP, Dedini
complete with
1 High Speed Gear Box, Dedini
2 Sets of Low Speed Gears, Left Hand Drive, Dedini

4 Intermediate Carriers, 66", Mill Driven

Imbibition Juice Screen, with Inclined Bagasse Carrier
Imbibition Juice Pumps

Imbibition Water Flow Meter

Vibrating Mixed Juice Screens
Mixed Juice Pumps

1 Bridge Crane for Mill Maintenance, 15 t, Mausa

For Machining Mill Rollers, one of the Housings is
Fitted as a Lathe

JUICE CLARIFICATION AND EVAPORATION

Juice Scales (?)

Sulphur Burners

Wooden Sulphitation Columns
Sulphitated Juice Liming Tanks
Liming Valve with pH Control

Limed Juice Pumps

6 Vertical Juice Heaters

1 Floculant Storage Tank

2 Continuous Clarifiers

2 Rotary Vacuum Filters

Clarified Juice Tank
Clarified Juice Pumps

Clarified Juice Heaters

1 Quadruple Effect Evaporator, 4,450 m2
consisting of
10 Bodies
2 Condensers

1 Pre-Evaporator, 1,080 m2, (Being Erected)

1 Sulphitated Syrup Clarifier (Being Erected)

Syrup Tanks
Syrup Pumps

First Condensate Pumps
1 First Condensate Tank
General Condensate Pumps

Caustic Soda Tanks
Caustic Soda Circulation Pumps

CRYSTALLIZATION AND CENTRIFUGATION

Pan Feed Tanks, Syrup, "A" and "B" Molasses
Seed and Magma Tanks, Agitators and Drives

4 Vacuum Pans, 55 m3, Individual Condensers

2 "A" and "B" Massecuite Crystallizers, 55 m3
Agitators and Drives

6 "C" Massecuite Crystallizers, 55 m3
Cooling Elements and Drives

6 "A" Massecuite Automatic Batch Centrifugals, 650 kg, BMA

8 "B" and "C" Massecuite Continuous Centrifugals, BMA
1 "B" and "C" Massecuite Continuous Centrifugal, W-S

Centrifugal Run-Off Tanks and Pumps
Magma Pumps

REFINERY ("WHITE END")

An Installation for 300 t/d is presently under Construction

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals
1 Screw Conveyor
1 Bucket Elevator

1 Horizontal Rotary Sugar Drier

1 Bagging Scale for 100 lb Bags

2 Sugar Warehouses, 50,000 t Raw

2 Molasses Tanks, 4,500 m3 (?)

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

1 Boiler, 60 t/h, 300 psig, Mirrlees, OK (?) (Stand-By)
complete with
4 Detrick Cells, Diesel Oil Burners

Induced Draft Fan
Air Heater, Economizer, Superheater

1 Boiler, 60 t/h, 300 psig, Dedini- Stirling
complete with
Forced and Induced Draft Fans, Oil Burners
Air Heater, Economizer, Superheater

1 Boiler, 100 t/h, 300 psig, Dedini, Modif. El Angel
complete with
Forced and Induced Draft Fans, Oil Burners
6 Spreader Stokers, Air-Cleaned Inclined Grate
Air Heater, Economizer, Superheater

Boiler Make-up Water Softening Plant

Boiler Feed Pumps

1 Bagasse Distribution Conveyor
1 Bagasse Return Conveyor

2 Payloaders for Bagasse Transport to and from Storage

1 Diesel Oil Tank

2 Turbo-Generators, 1,500 kw, Worthington
1 Turbo-Generator, 1,500 kw, Brown Boveri

Diesel Generator (?)

1 Cooling Pond
Hot Water Pumps
Cold Water Pumps

Fresh Water Pumps

9. Ingenio San Francisco

CANE RECEIVING

2 Truck Scales

1 Core Sampler for Cane Trucks, Thompson

2 Rotating Hammerhead Type Cranes, for Whole-Stalk Cane

CANE PREPARATION AND JUICE EXTRACTION

2 Cane Feed Tables for Whole-Stalk Cane
Pronged Chains, Perforated Bottom,
each one complete with
1 Rotating Cane Leveller

1 Auxiliary Cane Carrier below Grade, for Short Cane
1 Cane Carrier, Receiving Auxiliary Carrier and both Tables

1 Set of Rotating Knives, 170 HP Electric Motor

1 Cane Shredder, "Unigrator", Unice Machine Co.

1 Steam Turbine on Shredder, 800 HP, KKK
complete with
1 High Speed Gear Box

2 Three Roller Mills, 60", Buckau Wolf, 1953
3 Three Roller Mills, 52", Buckau Wolf (Locally Modif. Width)

1 Centralized Mill Lubricating System, Farval
1 Centralized Hydraulic Mill Pressure System, Edwards

1 Steam Turbine on Mill 1, 550 HP, KKK
complete with
1 High Speed Gear Box, Flender
1 Set of Low Speed Gears, Flender

1 Steam Turbine on Mill 2, 350 HP, KKK
complete with

1 High Speed Gear Box, Flender
1 Set of Low Speed Gears, Buckau Wolf

3 Steam Turbines on Mills 3, 4, 5, 330 HP, KKK
each one complete with
1 High Speed Gear Box, Buckau Wolf
1 Set of Low Speed Gears, Buckau Wolf

4 Intermediate Carriers, Mill Driven

1 Juice Screen, complete with Inclined Bagasse Carrier

1 Imbibition Water Flow Meter

Imbibition Juice Pumps
Mixed Juice Pumps

1 Bridge Crane for Mill Maintenance
1 Lathe for Machining Mill Rollers

JUICE CLARIFICATION AND EVAPORATION

1 Juice Flow Meter

Liming Tanks
Liming Valve with pH Control
Limed Juice Pumps

1 Sulphur Burner, Tray Type
Wooden Sulphitation Column
Sulphitated Juice Pumps

4 Vertical Raw Juice Heaters, 125 m2
1 Vertical Raw Juice Heater, 100 m2

1 Floculant Storage Tank

2 Continuous Clarifiers, "444", Dorr Oliver

1 Rotary Vacuum Filter, Eimco
1 Rotary Vacuum Filter, Beltless, Eimco
complete with Accessories for
Mud Mixing, Cake Disposal

Filtrate Collection
Maintenance of Vacuum

Clarified Juice Tanks
Clarified Juice Pumps

1 Quintuple Effect Evaporators, 4,200 m2
consisting of
1 First Effect Body, 1,800 m2 (Being Erected)
1 Second Effect Body, 1,400 m2
1 Third Effect Body, 1,000 m2
1 Fourth Effect Body, 600 m2
2 Fifth Effect Bodies, 200 m2
1 Multi-Jet Condenser

Syrup Tanks
Syrup Pumps

First Condensate Pumps
General Condensate Pumps

Caustic Soda Tanks
Caustic Soda Circulation Pumps

CRYSTALLIZATION AND CENTRIFUGATION

Pan Feed Tanks, Syrup, "A" and "B" Molasses
Seed and Magma Tanks, Agitators and Drives

1 Vacuum Pan, 41 m3, "B" Massecuite, on New (High) Pan Floor
complete with Multi-Jet Condenser, 1975

2 Vacuum Pans, 36 m3, "A" Massecuite, on Old (Low) Pan Floor
complete with Multi-Jet Condensers, 1945

2 Vacuum Pans, 8 m3, "C" Graining, on Old (Low) Pan Floor
complete with Multi-Jet Condensers,

2 Vacuum Pans, 19 m3, "C" Massecuite, on Old (Low) Pan Floor
complete with Multi-Jet Condensers, 1945

"A" and "B" Massecuite Crystallizers, Agitators and Drives

"C" Massecuite Crystallizers, Cooling Elements and Drives

4 Semi-Automatic Batch Centrifugals, "A", Buckau Wolf,

1 Continuous Centrifugal, "B", Hein Lehmann
1 Continuous Centrifugal, "B", BMA
1 Continuous Centrifugal, "B", Buckau Wolf (Horizontal)

3 Continuous Centrifugals, "C", Konti-10, Hein Lehmann

Centrifugal Run-Off Tanks and Pumps
Sugar Minglers and Magma Pumps

SUGAR AND MOLASSES HANDLING AND STORAGE

1 Vibrating Conveyor below Batch Centrifugals
1 Screw Conveyor
1 Bucket Elevator

1 Horizontal Rotary Sugar Drier

1 Bagging Scale for 100 lb Bags

1 Sugar Warehouse, 17,500 t, Bagged

5 Molasses Tanks, 3,800 m3, 3,000 m3, 850 m3, 850 m3, 750 m3

STEAM AND POWER GENERATION AND DISTRIBUTION, GENERAL SERVICES

2 Boilers, 20 t/h, 300 psig, Buckau Wolf, 1953
complete with
Forced and Induced Draft Fans
Economizer, Superheater

1 Boiler, 40 t/h, 300 psig, Energie + Verfahrenstechnik (EVT)
complete with
Forced and Induced Draft Fans
Economizer, Superheater

Boiler Make-up Water Softening Plant

Boiler Feed Pumps

Bagasse Distribution, Storage, and Return Conveyors

Bagasse Conveyor to Fiber Board Plant

1 Turbo-Generator, 1,500 kw, 440 V, Worthington
1 Turbo-Generator, 1,000 kw, 440 V, Siemens
1 Turbo-Generator, 800 kw, 220 V, Worthington

1 Diesel Generator, Emergency, 250 kw, Detroit
1 Diesel Generator, Emergency Lighting, 50 kw

1 Cooling Tower
Hot Water Pumps
Cold Water Pumps

Fresh Water Pumps

1 Rain Water Cistern

10. Ingenio Ahuachapan

1	Shredder
3	Three Roller Mills, 36"
1	Turbine and Gears on Mill Tandem
1	Continuous Clarifer
1	Rotary Vaccum Filter
5	Evaporator Bodies (incl. 1 pre-evaporator)
3	Vacuum Pans
1	Boiler, 33 t/h, 215 psig
1	Distillery for Anyhdrous Ethanol, 75,000 l/d similar to those described for El Carmen, La Cabaña, Chanmico