Sugar: Aspects of a Complex Commodity Market

James Fry

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SUGAR: ASPECTS OF A COMPLEX COMMODITY MARKET

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PREFACE

James Fry, of Landell Mills Commodities Studies Ltd., has been a sugar market analyst for many years. In this paper he has commented on various aspects of the sugar industry that seem to be important influences affecting future investment in the industry.

It is hoped that the paper will provide points of interest and useful background material for World bank staff working in developing countries heavily dependent upon sugar production and trade.

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SUMMARY

The world sugar market is much more complex than most outsiders suspect. Sugar is unique among major world agricultural commodities in being produced from two totally different agricultural crops, namely sugar beet and sugar cane. As a result, sugar is produced in over 110 nations, ranging from nations in the north, such as Finland, to tropical countries; the only major areas of the world which do not produce sugar are the desert and semi-desert regions. The extremely wide geographical dispersion of sugar production has led to a situation in which a large majority of world sugar output is consumed within the country in which it is produced.

The traded sector, too, is far from homogeneous: a sizeable quantity of sugar entering international trade does so under bilateral agreements, in which prices are established without immediate reference to other internationally traded sugar. The remaining volume of sugar that is exported is referred to as "world sugar", although, by any standards, this is a misnomer; the fraction of global output traded on this market is very small. Nevertheless, the price on the world market is actively followed and analyzed as the closest equivalent to the opportunity costs of sugar, and, as such, its extreme volatility (it is by far the most volatile of any internationallyquoted commodity price) attracts considerable attention.

In this paper the special structural features of the sugar market are reviewed. The paper is not confined to the sugar sector, narrowly defined, but also examines topics that have a major impact upon the economics of the sugar industry. These include the likely path of development of alternative sweeteners, notably starch-based corn sweeteners, as well as the economic importance of the by-products from sugar processing.
The paper has been designed to provide information that is not readily available elsewhere. In the course of the presentation of this information, several important conclusions emerge which may have a major bearing upon the evaluation of specific elements of sugar production projects. Listed in the order in which they occur in the text, eight such conclusions are worth singling out for special mention.

(1) For cane sugar producers it is rarely economically attractive to construct sugar refineries. Therefore, they should give careful consideration to the development of blanco directo production. Already, some blanco directo sugar is suitable for the vast majority of sugar users, and the quality of blanco directo sugar should continue to improve as the technology becomes more widespread.

(2) World prices have less impact upon the revenues of most sugar exporters than is commonly supposed. In the period 1982-83 all sugar exporters (with the exception of Thailand) were able to restrict their dependence upon world prices to below 50% of their total sales by means of long-term contracts and of price protection in their home markets. However, in the longer run, as long-term contracts expire and are renegotiated, exporters cannot fail to be affected by the cycles in world sugar prices.

(3) International trade in sugar is segmented in two ways. One important segmentation is between white and raw sugar. The former sector has dominated the recent growth in world sugar trade flows, with beet exporters (notably the EEC) benefiting most. The other important segmentation is between the Atlantic and the Pacific regions. The Pacific region is typically a net importing region and thus experiences sugar prices somewhat higher than those in the Atlantic.
(4) Sugar is not the only sweetener for which investment potential should be considered. Many developing countries may prove economically well-suited to the establishment of starch-based sweetener plants. High fructose corn syrup is an almost perfect substitute for sucrose (sugar's chemical name) in many liquid sweetener applications, such as soft drinks. In many developing countries, starch is more readily available (from maize, cassava or rice, for example) than sugar, and may prove a cheaper means of utilizing local resources to produce liquid sweeteners.

(5) The net revenues to be earned from the sale of sugar by-products—molasses, beet pulp or bagasse—are typically small in relation to the revenues from sugar. Bagasse has a considerable value as an alternative to purchased fuel in sugar cane mills. Potentially the most exciting by-product (from molasses) or new end-use for sugar crops is ethanol. There are several countries where ethanol can be produced competitively from sugar cane at a lower equivalent cost than imported crude oil.

(6) Sugar cane production is potentially a major generator of employment, both in field operations and in industrial milling operations. However, the switch over to mechanized methods of cane loading and harvesting, which occur at relatively low labor capital cost ratios, reduces its employment generation ability considerably.

(7) In most countries and under a very wide range of assumptions about the appropriate basis for valuing output (ranging from the use of world market prices to the use of domestic producer prices), sugar can be shown to generate higher gross revenues per hectare than competing grain and cereal crops.

(8) There is a very substantial dispersion in the ratio of field-to-factory costs in different countries. This dispersion is more marked among cane-producing nations than among beet producers.
CHAPTER I: SUGAR – A DIFFERENTIATED PRODUCT

The chemical product sucrose may be unambiguously well-defined, but the form in which it is supplied commercially shows a surprising range of diversity. The fact that sucrose can be produced either from beets or from cane is part of the explanation, since cane sugar is capable of yielding a much wider set of products during its processing than is beet; but technical and cultural factors also have an important role to play.

In the case of sugar beets, two factors have determined that virtually all consumption occurs in the form of white sugar, which is sucrose of a very high purity. Raw beet sugar, which is produced if the final refining stages of processing are omitted relatively unattractive taste. Beet molasses (which imparts the brown color to raw sugar) is less pleasant-smelling and less palatable than cane molasses. The other factor is the development of an efficient technology for upgrading raw beet sugar syrup into a clear solution from which which granulated sugar can be crystallized.

By contrast, the brown colors associated with the various saccharides in raw cane sugar syrup are much less easy to remove directly from the syrup. Therefore, the traditional method of production of cane-based white sugar has been the crystallization of raw sugar, which allows a large proportion of the molasses in solution to be spun off during centrifuging. This process is followed by a conventional sugar-refining process, during which the raw sugar crystals are first "affined" (hot water is added to the crystals, and some of the remaining molasses is centrifuged off) and are then dissolved in a hot solution for purification and eventual recrystallization.
The process of cane raw sugar refining is a costly one. Therefore, it is understandable that cane sugar companies have tried to encourage the direct consumption of raw sugar, which can be made available to consumers at sizeable discounts to the refined price (contrary to the impression conveyed by sugar pricing in industrial country markets, where raw sugar typically sells at a large premium in the "health food" and "special sugars" markets).

Even within the category of raw sugar, there is a considerable lack of uniformity. The precise chemical composition of standard raw sugar can vary considerably, with many refiners starting to introduce premia for higher quality (e.g., High Polarisation sugar, "High Pol" for short). Then there is the simplest, most traditional, form of sugar, obtained simply by boiling cane juice without any molasses extraction: these brown cakes of sugar are found in many regions, with India (where it is known as "gur") and Colombia (where it is called "panela"), the most important of all. There is also a close substitute for sugar, known in India as khandsari, which is produced in a similar manner to raw sugar, but with the vital difference that the centrifuging of sugar occurs in an open pan, and not in a vacuum pan that typifies conventional sugar mills.

A barrier to the greater use of cane raws for direct consumption is undoubtedly the strong molasses taste and the impurities which make it unacceptable for many industrial applications. Therefore, demand has grown for an intermediate product--with some of the properties of raw sugar and some of those of refined sugar--which can be produced from cane without the costs of two crystallization stages and one re-melting. This product, known variously as "plantation white", "mill white" and "blanco directo" sugar, is produced in a method which has many similarities to that used in the production of beet
white sugar. The raw sugar syrup is treated with a variety of chemical processes in order to improve its purity, both of color and of quality. The task is much more difficult for cane than for beet; hence, until recently, it was impossible to produce a plantation white sugar that would be a complete equivalent of refined or of beet white sugar. The traditional method of production of plantation white sugar relies on a two-stage method of upgrading the raw syrup. The first stage involves the bleaching of the syrup—typically by means of sulphitation (passing sulphur dioxide through it); the second stage introduces some means of preventing the bleaching effect from wearing off too rapidly, while precipitating out impurities. Where lime is readily available, as in India, carbonization (the addition of milk of lime, and the subsequent filtering of the solution) is practiced. However, the end still falls short of the standards expected of white sugar in Europe or North America.

Within the past decade, great progress has been made in the development of a new flocculant-based technique as an alternative to carbonization; and in certain cases, the end-result passes all but the most stringent quality tests that beet sugar has to pass. Yet the savings in costs vis-a-vis the alternative of refining sugar by conventional means are substantial. A study by Landell Mills Commodities Studies put the average costs of sugar refining (ignoring the costs of the bags used to pack white sugar and the value of the sugar lost during refining—1.087 lb of raw sugar being needed to produce 1 lb of white sugar) at over $80 per ton in 1981. The comparable costs for the production of plantation white sugar were of the order of $20 per ton.
In view of the magnitude of these cost savings, which are heavily concentrated in the area of capital costs, it is worth examining whether, and under what circumstances, the construction of a sugar refinery as part of a new cane sugar project is ever justified. In the export arena, the argument in favor of the construction of a sugar refinery rather than the addition of a plantation white end to a mill is at first sight a powerful one. Projections of world import demand for refined sugar in the next ten years are of the order of about ten times greater than the demand for plantation white sugar. Thus any nation wishing to establish a sizeable white sugar export market has little choice but to sell refined white sugar.

However, the profitability of a refinery constructed specifically for export sales is mostly doubtful. Even including the period of exceptionally high premia for white sugar over raw sugar in 1974-76, the average white premium, expressed per lb of white sugar and in constant 1982 prices, was only 2.9 cents—equivalent to $63 per ton; from which the cost of jute bags, amounting to upwards of $10 per ton of sugar has to be subtracted.

Under normal circumstances, the appropriate strategy for a cane producer would appear to be clearcut. To the extent that the domestic market permits, sales of plantation white sugar should be encouraged instead of refined sugar. For the export market, the highest quality plantation whites, provide the best hope of profitable sales.

Within the domestic market, the scope for substituting plantation white sugar for refined sugar is greater than is commonly appreciated. Brazil is a large producer of both plantation white sugar (known locally as "crystal" sugar) and refined sugar; yet refined sugar has typically accounted for barely 20% of total local sugar sales in some recent years. Particularly significant
is the experience of Brazil's large soft drink sector. It is usually argued that the soft drink sector has the most demanding requirements for sugar quality; hence the highest quality of refined sugar is often called "soft drink quality". However, in Brazil, "crystal" sugar is the standard quality used in its soft drink bottling.

In the export arena, it is not so easy to substitute refined sugar with plantation white products especially if importers are unwilling to be persuaded that the latter form of sugar is more attractive to them. Consequently, exporters face something of a dilemma. If they look purely at the short- and medium-term profitability of the three alternatives—raw, plantation white or refined white sugar exports—raw sugar is always likely to be the best option, assuming that the white-raw sugar premium is maintained at average typical historical levels. However, the raw sugar market is not a growing one; thus cane producers risk being locked into a stagnant market. For marketing, rather than economic reasons, some cane producers are likely to opt for the construction of refineries, in order to share in world trade growth, even though the economic justification for this course of action is limited. Other cane producers will prefer to remain in the raw sugar exporting sector and hope that others concede their market shares to them by moving into the production of refined sugar. (If too few exporters are willing to shift to refined products, it would be expected that competition among cane producers would reach such intensity that the discount of raw sugar, in relation to refined, would make the construction of a refinery economically justifiable; however, despite the stagnation of the raws sector in the past few years, there have been few signs of this happening.)
The third option, which, a priori, has the most to commend it, is the development of plantation white production. This option may not face exciting export market prospects in the short run, but over time it is anticipated that the strong pressures for the production of cane white sugar by a similar process to that used for beet white sugar (namely, without the need for costly remelting and refining) will eventually yield major advances in plantation white technology. With a combination of clean cane harvesting, transportation practices and good sugar mill operating techniques, it is already possible to produce a blanco directo sugar that the layman cannot distinguish from white refined sugar. Further developments in methods of processing and in the chemicals used in the mills should soon bring the breakthrough in cane white technology within reach to enable cane producers to compete on an equal footing with their beet counterparts.

The choice between plantation white and refined sugar output is one that has major implications for investment in new sugar projects; but it does not exhaust the list of interesting alternatives to the standard raw or refined options. In the unrefined sector, a few exporters—such as Mauritius, Malawi and Barbados—have successfully adopted a strategy of selling their top quality raw sugar in jute bags at a premium; whilst in the refined sector, special sugars often have strong regional markets. West Africa almost monopolizes world imports of sugar cubes and sugar loaves. The Arabian Peninsula dominates the world consumption of coarse grain sugar (with a large crystal size). Entry into the exportation of these products is not necessarily easy: major European producers have the lion's share of the markets. However, the value added in these products is high, and is much more stable than the free market sugar price; hence, they could be worthy of consideration in certain
circumstances, although the total tonnages entering international trade are comparatively small (for cube sugar a typical world annual import total is 3-400,000 tons, for coarse grain sugar around 500,000 tons and for sugar loaves around 50,000 tons as against almost 1,000,000 tons for plantation white sugar, 8,000,000 tons for granulated white sugar and 17,000,000 tons for raw sugar).
CHAPTER II: ASPECTS OF THE INTERNATIONAL TRADE IN SUGAR

The single most misleading element of the world sugar market is the use of the name "world market" to describe that proportion of sugar sales that is governed by free market, "world" prices. The "world market", which receives the overwhelming share of attention when people discuss sugar prices, is truly a tip of the iceberg from the point of view of global supply and demand, accounting for as little as one-eighth of world production in some years.

In the section that follows, we shall review the main factors relevant to an understanding of international trade in sugar, starting with a discussion of the most important trading and commercial links between buyers and sellers, and proceeding to some of the technical issues to be noted in the evolution of sugar trading relationships, such as shipping methods and qualities of sugar entering trade.

A. The Structure of International Trade in Sugar

The production and consumption of sugar has been characterized since the development of beet cultivation during the Napoleonic Wars by a comparatively small proportion of total global production and consumption entering international trade. In recent years, over 70% of world output has often been consumed within the producing nations, leaving under 30 percent for world trade.

Many of the world's largest producers and consumers of sugar, including the USSR, the United States, EEC, Brazil, India, China and Japan, are also major exporters (in the case of the EEC) or importers; but the scale
of their sugar production and use is sufficiently great to ensure that, with the sole exception of Japan, they are importers or exporters of only a minority of their domestic sugar requirements. However, many exporters of sugar have to rely upon exports to absorb the overwhelming majority of their output: this is true, for example, of Australia, Cuba, the Dominican Republic and Thailand, as well as of many small Central American and Southern African producers.

It is usual for governments in sugar producing nations to insulate their growers from the full impact of fluctuations in world prices by setting fixed cost-related selling prices; but where the domestic market absorbs only 10 to 20 percent of total output, the extent of the cushion from external market developments provided by domestic sales is limited. Accordingly, the major objective of sugar marketing policy in leading sugar exporting nations has become the construction of ways and means to reduce their vulnerability to extreme swings in revenues from the export market.

The inherent dilemma created for sugar exporting nations is that, by their very actions to insulate themselves from world price fluctuations, they exacerbate the price swings that are the causes of their anxiety. For example, sugar exporters actively develop long-term contractual commitments with buyers at pre-determined, stable prices; but by so doing, they force the remaining tonnages of sugar being traded at free market prices (such as those quoted on the New York, London or Paris sugar exchanges) to become even more of a residual tonnage, exposed to wild swings in price. When the residual, free market is of the order of 15% of total world output, it requires a mere 4% upward deviation of production from long-term trend to coincide with a 4% downward deviation in consumption to leave the residual "world" market having
to absorb within one year a surplus equal to over one-half of its annual volume. It can be no surprise that the world sugar price is the most price volatile of those for any major commodity, as the following (Table 1) indicates.
Table 1: Indices of fluctuations in commodity prices (1981 constant $)

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Deviations from moving averages /a</th>
<th>Annual average change /b</th>
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<tr>
<td></td>
<td>3-YEAR</td>
<td>5-YEAR</td>
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<tr>
<td>PETROLEUM</td>
<td>6.3</td>
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<td>12.1</td>
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<td>COCOA</td>
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<td>TEA</td>
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<td>SUGAR</td>
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<td>BEEF</td>
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<td>BANANAS</td>
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<tr>
<td>ORANGES</td>
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<td>8.5</td>
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<tr>
<td>RICE</td>
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<td>14.1</td>
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<tr>
<td>WHEAT</td>
<td>4.5</td>
<td>7.9</td>
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<tr>
<td>MAIZE</td>
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<tr>
<td>GRAIN SORGHUM</td>
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<td>PALM OIL</td>
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<tr>
<td>COCONUT OIL</td>
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<td>GROUNDNUT OIL</td>
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<td>SOYBEANS</td>
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<td>COPRA</td>
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<td>GROUNDNUTS</td>
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<td>SOYBEAN MEAL</td>
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<td>LOGS (LAUAN)</td>
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<td>MANGANESE ORE</td>
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<tr>
<td>PHOSPHATE ROCK</td>
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Notes: For the calculation of the indices of fluctuation in commodity prices, annual price data in 1981 constant dollars for 1955-81 were used. Formulas used are as follows:

/a The average percentage deviation from the moving average.
\[ \text{sum} \left[ \frac{p_t - p_t'}{p_t'} \right] /n \times 100 \]
where \(pt\) = the price in year \(t\).
\(p_t'\) = the moving average centered on the year \(t\).
\(n\) = the number of observations of the relevant moving average.

/b Average of annual percentage changes, devoid of sign.

(1) Bilateral long-term governmental trading contracts.

The longest established mechanism adopted by sugar exporters to stabilize their export earnings is the negotiation of bilateral contracts with major importers. The former Commonwealth Sugar Agreement, which has been carried over in a modified form into the Lomé Agreement between the African, Caribbean and Pacific (ACP) group of nations and the EEC, is a very good example. The ACP nations are guaranteed access to the EEC market for a fixed tonnage of sugar, which is paid the EEC internal sugar price. The quotas and actual shipments to the EEC in recent years are summarized in Table 2 below.

Cuba's bilateral trade ties with the Soviet Union and other Socialist nations in Eastern Europe and Eastern Asia are governed by long-term trade agreements, which include stable high prices for Cuban sugar exports in many cases. The recent evolution of Cuban sales to these countries is summarized in Table 3.

(2) Government import quotas.

It could be argued that the EEC-ACP accord represents an import quota, restricting suppliers' access to the EEC domestic market. However, the US sugar import controls are what most speakers have in mind when they speak of import quotas.

US import quotas were introduced as an emergency measure in 1982 when it became clear that it would have been impossible, under existing legislation, to protect US government target prices for domestic sugar by relying solely upon the other instruments of import duties and fees that were available. (The 1933 Agricultural Adjustment Act set the maximum permitted level of import fees at 50% of the ad valorem world price, while duties on raw sugar were held at 2.8125 cents per lb.)
The imposition of quotas—allocated on the basis of historical shares of US supplies—enabled supplies to the US market to be restricted, and domestic prices to be supported, without any cost for the US exchequer. Yet, in the process, the overseas holders of quotas, listed below in Table 4, benefited from receiving the domestic US price, rather than the (much lower) world price.

(3) Private long-term contracts.

The third of the three main classes of long-term contracts found in international sugar trade consists of privately-negotiated, long-term agreements for deliveries to be made at pre-determined prices, similar in form to the contracts found in many other commodity markets. However, sugar is unusual to the extent that sellers have shown themselves willing to enter into such contracts, rather than be vulnerable to the vagaries of world market prices.

Australia's sugar exporting company, Colonial Sugar Refiners Ltd. (CSR), took the lead in establishing long term contracts, initially with the two largest Japanese trading houses, Mitsui and Mitsubishi (which have close links with a number of large local refineries) and subsequently with importing sugar refineries in the Republic of Korea, Malaysia, Singapore and China. In these contracts both tonnages and price ranges (fixing upper and lower limits to price) were pre-detemined. Other exporters have followed the Australian example to a greater or lesser extent, including Fiji, Brazil and, most interestingly, the Philippines.

The unusual feature of the Philippine example was that it involved a four-year price agreement, not with sugar refineries, government agencies, nor
Table 2: EEC SUGAR IMPORTS FROM ACP PRODUCERS, 1980-1983

(in tons, raw value)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Africa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congo</td>
<td>5,352</td>
<td>0</td>
<td>5,326</td>
<td>5,821</td>
<td>8,000</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>0</td>
<td>4,932</td>
<td>3,015</td>
<td>1,855</td>
<td>2,000</td>
</tr>
<tr>
<td>Kenya</td>
<td>104</td>
<td>94</td>
<td>2</td>
<td>4,003</td>
<td>4,000</td>
</tr>
<tr>
<td>Madagascar</td>
<td>12,371</td>
<td>0</td>
<td>10,446</td>
<td>10,465</td>
<td>10,000</td>
</tr>
<tr>
<td>Malawi</td>
<td>16,784</td>
<td>21,000</td>
<td>20,725</td>
<td>21,031</td>
<td>20,000</td>
</tr>
<tr>
<td>Mauritius</td>
<td>611,058</td>
<td>486,000</td>
<td>570,309</td>
<td>560,797</td>
<td>487,200</td>
</tr>
<tr>
<td>Swaziland</td>
<td>115,131</td>
<td>123,000</td>
<td>126,927</td>
<td>136,473</td>
<td>116,400</td>
</tr>
<tr>
<td>Tanzania</td>
<td>10,565</td>
<td>0</td>
<td>9,793</td>
<td>10,167</td>
<td>10,000</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>0</td>
<td>0</td>
<td>19,530</td>
<td>29,924</td>
<td>25,000</td>
</tr>
<tr>
<td>Total Africa</td>
<td>771,365</td>
<td>635,026</td>
<td>766,073</td>
<td>780,936</td>
<td>682,600</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asia &amp; Oceania</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiji</td>
<td>143,905</td>
<td>190,000</td>
<td>197,263</td>
<td>197,709</td>
<td>163,600</td>
</tr>
<tr>
<td>India</td>
<td>26,550</td>
<td>71</td>
<td>933</td>
<td>0</td>
<td>10,000</td>
</tr>
<tr>
<td>Total Asia &amp; Oceania</td>
<td>170,455</td>
<td>190,071</td>
<td>198,196</td>
<td>197,709</td>
<td>173,600</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central &amp; South America, including the Caribbean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barbados</td>
<td>54,076</td>
<td>45,000</td>
<td>44,503</td>
<td>52,808</td>
<td>49,300</td>
</tr>
<tr>
<td>Belize</td>
<td>37,217</td>
<td>43,000</td>
<td>42,566</td>
<td>44,281</td>
<td>39,400</td>
</tr>
<tr>
<td>Guyana</td>
<td>148,707</td>
<td>184,000</td>
<td>160,158</td>
<td>167,584</td>
<td>157,700</td>
</tr>
<tr>
<td>Jamaica</td>
<td>92,144</td>
<td>124,000</td>
<td>120,305</td>
<td>130,513</td>
<td>118,300</td>
</tr>
<tr>
<td>St. Christopher-Nevis</td>
<td>14,137</td>
<td>15,000</td>
<td>21,945</td>
<td>0</td>
<td>14,800</td>
</tr>
<tr>
<td>Trinidad-Tobago</td>
<td>49,945</td>
<td>67,000</td>
<td>51,891</td>
<td>62,649</td>
<td>69,000</td>
</tr>
<tr>
<td>Total C. &amp; S. America</td>
<td>396,226</td>
<td>478,000</td>
<td>441,368</td>
<td>457,835</td>
<td>448,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Of Above</td>
<td>1,338,046</td>
<td>1,303,097</td>
<td>1,405,637</td>
<td>1,436,480</td>
<td>1,304,700</td>
</tr>
</tbody>
</table>

Note: Uganda and Suriname have lost their Lomé quotas through non-delivery, but remain in the protocol.

<table>
<thead>
<tr>
<th>Table 3: CUBAN SUGAR EXPORTS TO SOCIALIST COUNTRIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(in tons, raw value)</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td><strong>USSR</strong></td>
</tr>
<tr>
<td>2,726,339 3,204,475 4,425,519 3,314,985</td>
</tr>
<tr>
<td><strong>Other Eastern Europe</strong></td>
</tr>
<tr>
<td>Albania</td>
</tr>
<tr>
<td>17,069 12,143 15,946 15,698</td>
</tr>
<tr>
<td>Bulgaria</td>
</tr>
<tr>
<td>234,112 249,851 277,678 331,485</td>
</tr>
<tr>
<td>Czechoslovakia</td>
</tr>
<tr>
<td>98,775 99,871 134,892 144,648</td>
</tr>
<tr>
<td>German Dem. Rep.</td>
</tr>
<tr>
<td>209,900 254,770 213,461 280,922</td>
</tr>
<tr>
<td>Hungary</td>
</tr>
<tr>
<td>34,152 76,216 72,903 0</td>
</tr>
<tr>
<td>Poland</td>
</tr>
<tr>
<td>63,128 70,154 0 0</td>
</tr>
<tr>
<td>Romania</td>
</tr>
<tr>
<td>46,754 138,820 89,663 221,454</td>
</tr>
<tr>
<td>Yugoslavia</td>
</tr>
<tr>
<td>0 10,389 0 0</td>
</tr>
<tr>
<td><strong>Total Other E. Europe</strong></td>
</tr>
<tr>
<td>703,890 912,214 804,543 1,003,604</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
</tr>
<tr>
<td>China</td>
</tr>
<tr>
<td>512,095 573,246 915,311 771,717</td>
</tr>
<tr>
<td>Kampuchea</td>
</tr>
<tr>
<td>5,423 1,626 0 529</td>
</tr>
<tr>
<td>Korea, Dem. P. Rep. of</td>
</tr>
<tr>
<td>10,897 27,559 17,079 22,511</td>
</tr>
<tr>
<td>Mongolia</td>
</tr>
<tr>
<td>4,720 4,697 4,701 4,699</td>
</tr>
<tr>
<td>Viet Nam</td>
</tr>
<tr>
<td>41,841 102,613 24,155 77,134</td>
</tr>
<tr>
<td><strong>Total Asia</strong></td>
</tr>
<tr>
<td>574,976 709,741 961,246 876,590</td>
</tr>
<tr>
<td><strong>Total of Above</strong></td>
</tr>
<tr>
<td>4,005,205 4,826,430 6,191,308 5,195,179</td>
</tr>
</tbody>
</table>

**Source:** International Sugar Organization, _Sugar Yearbook, 1983._
Table 4: US SUGAR IMPORT QUOTA ALLOCATIONS, 1982/83 TO 1984/85
(in '000 short tons, raw value)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Africa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congo</td>
<td>-</td>
<td>16.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>16.5</td>
<td>16.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Madagascar</td>
<td>16.5</td>
<td>16.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Malawi</td>
<td>19.6</td>
<td>20.7</td>
<td>35.4</td>
</tr>
<tr>
<td>Mauritius</td>
<td>30.8</td>
<td>32.5</td>
<td>27.9</td>
</tr>
<tr>
<td>Mozambique</td>
<td>36.4</td>
<td>38.4</td>
<td>33.0</td>
</tr>
<tr>
<td>South Africa</td>
<td>64.4</td>
<td>67.9</td>
<td>58.4</td>
</tr>
<tr>
<td>Swaziland</td>
<td>44.8</td>
<td>47.2</td>
<td>40.6</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>33.6</td>
<td>35.4</td>
<td>30.5</td>
</tr>
<tr>
<td><strong>Total Africa</strong></td>
<td>262.6</td>
<td>291.6</td>
<td>263.3</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>22.4</td>
<td>23.6</td>
<td>20.3</td>
</tr>
<tr>
<td>The Philippines</td>
<td>378.0</td>
<td>398.3</td>
<td>342.9</td>
</tr>
<tr>
<td>Thailand</td>
<td>39.2</td>
<td>41.3</td>
<td>35.6</td>
</tr>
<tr>
<td><strong>Total Asia</strong></td>
<td>473.2</td>
<td>498.6</td>
<td>429.3</td>
</tr>
<tr>
<td><strong>Caribbean</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barbados</td>
<td>19.6</td>
<td>20.7</td>
<td>17.8</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>492.8</td>
<td>519.2</td>
<td>447.0</td>
</tr>
<tr>
<td>Haiti</td>
<td>16.5</td>
<td>16.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Jamaica</td>
<td>30.8</td>
<td>32.5</td>
<td>27.9</td>
</tr>
<tr>
<td>St. Christopher-Nevis</td>
<td>16.5</td>
<td>16.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Trinidad-Tobago</td>
<td>19.6</td>
<td>20.7</td>
<td>17.8</td>
</tr>
<tr>
<td><strong>Total Caribbean</strong></td>
<td>595.8</td>
<td>626.1</td>
<td>535.5</td>
</tr>
<tr>
<td><strong>Central America</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belize</td>
<td>30.8</td>
<td>32.5</td>
<td>27.9</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>42.0</td>
<td>61.0</td>
<td>52.3</td>
</tr>
<tr>
<td>El Salvador</td>
<td>72.8</td>
<td>86.8</td>
<td>74.6</td>
</tr>
<tr>
<td>Guatemala</td>
<td>134.4</td>
<td>141.6</td>
<td>121.9</td>
</tr>
<tr>
<td>Honduras</td>
<td>28.0</td>
<td>58.6</td>
<td>50.0</td>
</tr>
<tr>
<td>Mexico</td>
<td>16.5</td>
<td>16.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>58.8</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Panama</td>
<td>81.2</td>
<td>85.6</td>
<td>73.7</td>
</tr>
<tr>
<td><strong>Total Central America</strong></td>
<td>464.5</td>
<td>488.6</td>
<td>418.9</td>
</tr>
</tbody>
</table>

(Cont'd)
Table 4: US SUGAR IMPORT QUOTA ALLOCATIONS, 1982/83 TO 1984/85 (Continued)
(in '000 short tons, raw value)

<table>
<thead>
<tr>
<th>Initial Quotas for the October/September Sugar Years</th>
<th>1982/83</th>
<th>1983/84</th>
<th>1984/85</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>30.8</td>
<td>12.45</td>
<td>27.9</td>
</tr>
<tr>
<td>Total North America</td>
<td>30.8</td>
<td>32.45</td>
<td>27.9</td>
</tr>
<tr>
<td>Oceania</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>232.4</td>
<td>244.85</td>
<td>210.8</td>
</tr>
<tr>
<td>Fiji</td>
<td>19.6</td>
<td>20.65</td>
<td>17.8</td>
</tr>
<tr>
<td>Total Oceania</td>
<td>252.0</td>
<td>265.50</td>
<td>228.6</td>
</tr>
<tr>
<td>South America</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>120.4</td>
<td>126.85</td>
<td>109.2</td>
</tr>
<tr>
<td>Bolivia</td>
<td>22.4</td>
<td>23.60</td>
<td>20.3</td>
</tr>
<tr>
<td>Brazil</td>
<td>406.0</td>
<td>427.75</td>
<td>368.3</td>
</tr>
<tr>
<td>Colombia</td>
<td>67.2</td>
<td>70.80</td>
<td>61.0</td>
</tr>
<tr>
<td>Ecuador</td>
<td>30.8</td>
<td>32.45</td>
<td>27.9</td>
</tr>
<tr>
<td>Guyana</td>
<td>33.6</td>
<td>35.40</td>
<td>30.5</td>
</tr>
<tr>
<td>Paraguay</td>
<td>16.5</td>
<td>16.50</td>
<td>12.5</td>
</tr>
<tr>
<td>Peru</td>
<td>114.8</td>
<td>120.95</td>
<td>104.1</td>
</tr>
<tr>
<td>Uruguay</td>
<td>0.0</td>
<td>16.50</td>
<td>12.5</td>
</tr>
<tr>
<td>Total South America</td>
<td>811.7</td>
<td>870.80</td>
<td>746.3</td>
</tr>
<tr>
<td>Total US Import Quotas, By Country</td>
<td>2,890.6</td>
<td>3073.15</td>
<td>2,650.0</td>
</tr>
</tbody>
</table>

Note:

/a The 1983/84 quota total was subsequent raised by 100,000 short tons, pro-rated for each country.

/b In 1983/84 the US Department of Agriculture agreed to treat the CARICOM nations as a block for purposes of quota allocations, thereby allowing any nation's unused quota to be reallocated within the CARICOM group.

/c The major share of the Nicaraguan quota for 1983/84 (as computed on the basis of the 1982/83 share by country) was redistributed to Costa Rica, El Salvador and Honduras.

Source: Foreign Agricultural Service Sugar Imports, Status Report, Various weekly issues.
traders (like Mitsui and Mitsubishi) with specially close ties with particular refineries, but with merchants (known in the sugar market as "operators") who take physical delivery of sugar for onward sale, without any long-term plan for disposing of the sugar, other than to sell it on the best terms available at the time of delivery. The operators avoided their price risk (implied by the difference between their initial buying price and eventual sales revenue) by hedging their purchases on the futures market.

(4) The share of sugar trade that occurs at world prices.

The proportions of world sugar trade that occur under the various fixed-price formula vary from year to year, as some contracts (notably those discussed under section (3)) mature and new ones are entered into. In addition, there are a number of small-scale, ad-hoc sales of sugar which effectively have the selling price determined as far forward as one year, but which are seen as "one-off" arrangements, rather than longer term contractual arrangements between the buyer and seller.

In order to convey an accurate impression of the importance of long-term contractual links that protect the seller from day-to-day volatility in the world price, and its corollary—the limited scale of sales made at the free market, world price—the following table (Table 5) has been prepared. The table represents an average of the 1982 and 1983 situations for the majority of the world's net exporters of sugar. It will be evident that only one country (Thailand) had to sell over 50% of its total production at world market-related prices (since, in that country, as for all the others listed, domestic sugar prices have no link to the world market).

Overall, only 15.6 million tons raw value of exports, out of total exports of 27.8 million tons by these same countries, took place at world
Table 5: IMPORTANCE OF THE WORLD MARKET IN TOTAL SUGAR SALES

<table>
<thead>
<tr>
<th>Geographical Region</th>
<th>Proportion of Total 1982-83 Sales Sold on the Basis of World Market Quotations /a /c</th>
<th>Proportion of Total 1982-83 Sales Accounted for by the Domestic Market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Z) (Ranking)</td>
<td>(Z)</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>30 (12)</td>
<td>59</td>
</tr>
<tr>
<td>Madagascar</td>
<td>0 (29=)</td>
<td>85</td>
</tr>
<tr>
<td>Malawi</td>
<td>35 (5)</td>
<td>37</td>
</tr>
<tr>
<td>Mauritius</td>
<td>5 (25=)</td>
<td>6</td>
</tr>
<tr>
<td>Mozambique</td>
<td>0 (29=)</td>
<td>73</td>
</tr>
<tr>
<td>South Africa</td>
<td>32 (10=)</td>
<td>65</td>
</tr>
<tr>
<td>Swaziland</td>
<td>48 (2)</td>
<td>6</td>
</tr>
<tr>
<td>Tanzania</td>
<td>0 (29=)</td>
<td>92</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>38 (3)</td>
<td>47</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>8 (24)</td>
<td>92</td>
</tr>
<tr>
<td>The Philippines</td>
<td>13 (20=)</td>
<td>50</td>
</tr>
<tr>
<td>Thailand</td>
<td>72 (1)</td>
<td>27</td>
</tr>
<tr>
<td><strong>Central America and the Caribbean</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barbados</td>
<td>13 (20=)</td>
<td>16</td>
</tr>
<tr>
<td>Belize</td>
<td>32 (10=)</td>
<td>5</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>5 (25=)</td>
<td>71</td>
</tr>
<tr>
<td>Cuba</td>
<td>14 (18=)</td>
<td>9</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>37 (4)</td>
<td>20</td>
</tr>
<tr>
<td>El Salvador</td>
<td>0 (29=)</td>
<td>69</td>
</tr>
<tr>
<td>Guatemala</td>
<td>33 (9)</td>
<td>45</td>
</tr>
<tr>
<td>Honduras</td>
<td>3 (28)</td>
<td>54</td>
</tr>
<tr>
<td>Jamaica</td>
<td>0 (29=)</td>
<td>47</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>19 (17)</td>
<td>57</td>
</tr>
<tr>
<td>Panama</td>
<td>23 (15)</td>
<td>39</td>
</tr>
<tr>
<td>St. Christopher-Nevis</td>
<td>0 (29=)</td>
<td>6</td>
</tr>
<tr>
<td>Trinidad</td>
<td>0 (29=)</td>
<td>67</td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>24 (14)</td>
<td>76</td>
</tr>
<tr>
<td>EEC</td>
<td>34 (6=)</td>
<td>66</td>
</tr>
<tr>
<td>Turkey</td>
<td>16 (18)</td>
<td>84</td>
</tr>
</tbody>
</table>

(Cont'd)
Table 5: IMPORTANCE OF THE WORLD MARKET IN TOTAL SUGAR SALES (Continued)

<table>
<thead>
<tr>
<th></th>
<th>Proportion of Total 1982-83 Sales Sold on the Basis of World Market Quotations /a (%)</th>
<th>(Ranking)</th>
<th>Proportion of Total 1982-83 Sales Accounted for by the Domestic Market (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oceania</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>34</td>
<td>(6=)</td>
<td>24</td>
</tr>
<tr>
<td>Fiji</td>
<td>5</td>
<td>(25=)</td>
<td>9</td>
</tr>
<tr>
<td><strong>South America</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>29</td>
<td>(13)</td>
<td>64</td>
</tr>
<tr>
<td>Bolivia</td>
<td>10</td>
<td>(23)</td>
<td>80</td>
</tr>
<tr>
<td>Brazil</td>
<td>22</td>
<td>(16)</td>
<td>68</td>
</tr>
<tr>
<td>Colombia</td>
<td>14</td>
<td>(18=)</td>
<td>81</td>
</tr>
<tr>
<td>Guyana</td>
<td>13</td>
<td>(20=)</td>
<td>14</td>
</tr>
<tr>
<td>Peru</td>
<td>0</td>
<td>(29=)</td>
<td>100</td>
</tr>
<tr>
<td><strong>Weighted Average /b</strong></td>
<td></td>
<td>25</td>
<td>56</td>
</tr>
<tr>
<td><strong>For the Entire Sample</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:

/a These figures assume that US import quotas for the 1982/83 and 1983/84 applied to calendar years 1982 and 1983, respectively.

/b The weights in the average are total sugar sales by each producer listed.

/c This represents 15.6 million tons, raw value, of sugar exports, out of total exports of almost 27.8 million tons by the countries listed (after netting out imports for the EEC and South Africa).
market-related prices. For the world as a whole, it is estimated that a net annual volume of approximately 16 million tons of sugar out of 99 million tons annual production is was traded at world prices.

One aspect of Table 5 may be potentially misleading. The volumes of sugar considered to be sold on the basis of world market quotations exclude all sugar sold under long-term bilateral contracts. However, it should not be forgotten that most bilateral long-term contracts eventually expire, and that they need to be renegotiated if they are to survive. In some cases (as when the Australian contract with Japan expired), it proves impossible to reach agreement on renegotiation terms; in others, it is virtually inevitable that the prices established in the new long-term contracts reflect prevailing market conditions at the time the contracts are signed. Thus, in the very long run, the average revenues from long-term contacts should approximate to those obtained on the free market.

B. The Participants in the World Sugar Market

On the production and consumption sides of the world market, the sugar industry is not unlike other commodity markets. Producers and exporters deal with overseas trade issues under a wide variety of institutional forms. In some countries, a government agency handles all sugar export transactions (e.g. in the cases of Cuba, Brazil or the Ivory Coast); in others, a private company acts on behalf of a government agency (the example of CSR, in its role as representative of the Queensland government, is the best-known one); in yet others, the industry forms itself into one, or even two or three, selling organizations, each representing a number of growers and processors (as in Thailand, South Africa or Swaziland); in the remainder, exports are handled separately by each processor (e.g. in the EEC or Dominican Republic).
Consumers, refiners and importers have nearly as large a range of institutional forms as do the exporters/producers. Government agencies are to the fore in many developing and non-market economies; in a few countries (mainly in Asia, such as Malaysia and the Republic of Korea), privately-owned importing refineries cooperate in some major long-term purchases; in other (such as Japan), the leading trading houses have special links with refinery groups, and act on their behalf in negotiating for supplies; in the remainder (e.g. the United States or Canada), imports are handled by the individual refineries.

In the middle of the market, acting as intermediaries, the sugar industry has essentially two different types of institution (although the same trading company can act in both capacities). One is the broking sector. Sugar brokers represent major sellers or buyers, but do not acquire ownership of the sugar being traded at any stage of the transaction. Even very large, sophisticated exporters, such as the Australians and South Africans, use brokers. In return for their commission, which typically ranges up to 1% of the total value of the transaction, brokers handle the paper work and the foreign exchange transactions involved in a contract; and they perform the valuable service of attending to the futures market hedging and price-fixing operations that are integral to many sales contracts.

The other institution that has an important role to play within the sugar market is the "operator", who would be called a merchant in most other commodity markets. The operator buys and sells physical sugar, and is valuable in maintaining the liquidity of the futures market and maintaining the connection between physical and futures prices. Operators are also important in achieving some sort of equilibrium between the markets in
different regions and between supply and demand (via stocks) in different seasons of the year. Some major exporters, notably the Australians and South Africans, do not sell their sugar to operators, in order to retain control over the final destination of their sales. Many others, including the Philippines, Brazil and Cuba, use operators very frequently; and a few, including the EEC, the Dominican Republic and Thailand, rely upon operators to handle virtually all of their exports.

C. Market Segmentation

Mention has already been made of the regional nature of the world sugar market in discussing the role of operators. In fact, the world trade in sugar is generally considered to be segmented in two main ways—one is by region, which is primarily seen in terms of a division between the Atlantic and Pacific Ocean Zones; the other is by type of sugar, with the main distinction being between raw and white sugar.

In the next few paragraphs we shall outline the way in which the overall segmentation of the market has evolved over the past decade.

The evolution of the regional balances of trade in white and raw sugar is summarized in the following two tables (Tables 6 and 7). Turning to the raw sugar picture first, (Table 6) it is readily apparent that the underlying growth in world trade flows has been very slow: indeed, were it not for the rapid expansion in East European imports (and in the USSR in particular), world trade in raw sugar would have declined over the past decade. With US imports contracting, North and Central America have emerged as larger net exporters of raws. South American net exports have shrunk slowly, while the African net export total has displayed considerable stability. The decline in
Table 6: REGIONAL TRADE BALANCE IN RAW SUGAR

(millions of tons, raw value)

<table>
<thead>
<tr>
<th></th>
<th>North &amp; Central America</th>
<th>South America</th>
<th>West Europe</th>
<th>East Europe</th>
<th>Asia &amp; Oceania</th>
<th>Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>5.9</td>
<td>0.3</td>
<td>2.8</td>
<td>2.3</td>
<td>4.7</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exports</td>
<td>6.6</td>
<td>3.5</td>
<td>0.0</td>
<td>0.0</td>
<td>4.6</td>
<td>2.1</td>
</tr>
</tbody>
</table>

|        |                         |                |             |             |                |        |
| Imports |                         |                |             |             |                |        |
| 1974   | 6.1                     | 0.2            | 2.9         | 2.6         | 4.9            | 0.4    |
|        |                         |                |             |             |                |        |
| Exports| 7.9                     | 3.0            | 0.0         | 0.0         | 5.0            | 2.0    |

|        |                         |                |             |             |                |        |
| Imports |                         |                |             |             |                |        |
| 1976   | 5.1                     | 0.1            | 2.6         | 3.9         | 4.5            | 0.6    |
|        |                         |                |             |             |                |        |
| Exports| 7.5                     | 1.7            | 0.1         | 0.0         | 6.2            | 2.0    |

|        |                         |                |             |             |                |        |
| Imports |                         |                |             |             |                |        |
| 1978   | 5.2                     | 0.3            | 2.1         | 4.5         | 5.3            | 0.5    |
|        |                         |                |             |             |                |        |
| Exports| 8.8                     | 2.1            | 0.4         | 0.0         | 4.8            | 1.8    |

|        |                         |                |             |             |                |        |
| Imports |                         |                |             |             |                |        |
| 1980   | 4.9                     | 0.5            | 1.9         | 4.5         | 5.3            | 0.5    |
|        |                         |                |             |             |                |        |
| Exports| 7.4                     | 2.5            | 0.4         | 0.0         | 5.3            | 2.2    |

|        |                         |                |             |             |                |        |
| Imports |                         |                |             |             |                |        |
| 1981   | 5.6                     | 0.4            | 1.7         | 5.1         | 4.5            | 0.6    |
|        |                         |                |             |             |                |        |
| Exports| 8.0                     | 2.6            | 0.3         | 0.0         | 5.8            | 2.0    |

Source: Derived from Landell Mills Commodities Studies, "Patterns of Sweetener Demand and Trade", August 1983.
Table 7: REGIONAL TRADE BALANCE IN WHITE SUGAR
(millions of tons, raw value)

<table>
<thead>
<tr>
<th></th>
<th>North &amp; Central America</th>
<th>South America</th>
<th>West Europe</th>
<th>East Europe</th>
<th>Asia &amp; Oceania</th>
<th>Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>Imports</td>
<td>0.1</td>
<td>0.1</td>
<td>0.9</td>
<td>0.8</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Exports</td>
<td>0.5</td>
<td>0.5</td>
<td>2.1</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>1974</td>
<td>Imports</td>
<td>0.1</td>
<td>0.1</td>
<td>1.0</td>
<td>0.4</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Exports</td>
<td>0.4</td>
<td>1.0</td>
<td>1.2</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>1976</td>
<td>Imports</td>
<td>0.1</td>
<td>0.1</td>
<td>0.6</td>
<td>1.1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Exports</td>
<td>0.8</td>
<td>0.8</td>
<td>2.0</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>1978</td>
<td>Imports</td>
<td>0.2</td>
<td>0.3</td>
<td>0.5</td>
<td>0.2</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Exports</td>
<td>0.8</td>
<td>1.0</td>
<td>3.3</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>1980</td>
<td>Imports</td>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
<td>1.3</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>Exports</td>
<td>1.2</td>
<td>1.5</td>
<td>4.2</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>1981</td>
<td>Imports</td>
<td>1.0</td>
<td>0.4</td>
<td>0.6</td>
<td>1.4</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>Exports</td>
<td>2.0</td>
<td>1.2</td>
<td>5.3</td>
<td>0.6</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Source: Derived from Landell Mills Commodities Studies, "Patterns of Sweetener Demand and Trade", August 1983.
West European net imports of raws, in the wake of the emergence of the EEC as a major sugar producer, has been offset by the growth in East Europe's net imports. The final large trade region, Asia and Oceania, has been fluctuating very close to net trade equilibrium.

The white sugar trade position (see Table 7) displays several marked contrasts with the raw sugar picture. The first, and most striking, is the upsurge in West European net exports, under the lead of the EEC. North and Central America, like South America, have remained modest net exporters over the past ten years, but East Europe has been transformed from a minor net exporter into a net importer in most years. Both of the remaining two regions, Africa and Asia and Oceania, have provided a substantial boost to world imports of white sugar. Thanks to the rapid growth in sugar demand in African and Asian oil-exporting nations, without the facilities to refine sugar, world trade in white sugar more than doubled between the early 1970's and the early 1980's. (The upsurge in EEC exportable surpluses of beet white sugar proved to be sufficiently strong to prevent the premium for white sugar over raw sugar from rising to levels high enough to make the construction of new refineries economically attractive.)

Within the global sugar market, one particular regional form of segmentation that is clearly distinguishable is that between the Pacific and Atlantic regions. At one time, the Pacific was virtually as important as the Atlantic as a sugar-exporting area, with Indonesia, the Philippines, India and Australia to the fore. However, a disproportionate share of the growth in total trade has occurred in the Atlantic, most notably from Brazil and the EEC. The table describing net trade within and between the Pacific and Atlantic regions demonstrates the much greater importance of the Atlantic
region in world trade, and specifically the importance of intra-Atlantic trade flows (Table 8). It also shows how dependent the Pacific region has become upon imports from Atlantic region producers, including the EEC, Cuba and Brazil.

This high dependence upon imports from outside the Pacific region explains why the Far Eastern market for sugar is typically viewed as being at a small price premium (reflecting transport costs) vis-a-vis quotations in the Atlantic. The situation is far from fixed, and can change substantially from month to month, but transport cost differentials probably entitle Asian exporters to expect to receive up to $5 per ton higher revenue than comparable Latin American exports.

Table 8: NET TRADES WITHIN AND BETWEEN THE PACIFIC AND ATLANTIC REGIONS
(million of tons, raw value)

<table>
<thead>
<tr>
<th></th>
<th>Exports From</th>
<th></th>
<th>Total Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pacific</td>
<td>Atlantic</td>
<td></td>
</tr>
<tr>
<td>Imports</td>
<td>4.93</td>
<td>3.99</td>
<td>8.92</td>
</tr>
<tr>
<td>into</td>
<td>3.15</td>
<td>16.14</td>
<td>19.29</td>
</tr>
<tr>
<td>Total Exports</td>
<td>8.08</td>
<td>20.13</td>
<td>28.21</td>
</tr>
</tbody>
</table>

Note: The Pacific Area includes Asia, Oceania and Eastern Africa. The Atlantic region comprises the rest of the world.

Source: International Sugar Organization statistics.
D. Sugar Freight Costs

Mention of the impact of transport costs upon the f.o.b. valuation of sugar in the Pacific and Atlantic Regions is an indication of the importance of freight in the determination of the net receipts to the sugar exporter.

The sea freight of sugar constitutes a small segment of the dry bulk freight sector, which is dominated by grain, coal and iron ore shipments. However, sugar cargoes are important to smaller dry bulk carriers. Prior to the 1960's, sugar was primarily a bagged cargo, being shipped in 50 and 100 kilogram bags at the high rates charged for bagged cargoes. In the 1960's, the Australian sugar industry, facing very high dock labor costs, introduced bulk raw sugar terminals for the bulk exportation of its sugar, and persuaded its main customers to install bulk import facilities.

The overwhelming majority of raw sugar exporters have since switched over to bulk handling methods for raw sugar, although white sugar still has to be shipped in bags (for reasons of hygiene). Bulk raw sugar is most commonly shipped in lots of 10-15,000 tons, in small bulk carriers or in tweendeckers (carrying cargoes between their decks, but able to carry move than one kind of cargo), but the largest shipments (from Australia and Hawaii) range up to over 25,000 tons. Bagged white sugar is also transported in tweendeckers, but attracts a higher freight rate because of the more costly handling that the bags necessitate.

Freight rates for cargoes follow the dry bulk freight market very closely, and thus share its volatility and wide dispersion between cyclical highs and lows. Diagram A reveals the extent of the volatility in recent years, and illustrates the similarity between the volatility in the single voyage charter market (represented by the lower, dotted, line tracing the rate
paid in dollars per ton to take a cargo of Caribbean raw sugar to Europe) and the trip charter market (represented by the two solid lines, tracing the rates paid per day for the hire of an entire vessel for a specific route).

It should be noted that sugar freight can amount to a sizable proportion of the final landed cost of sugar. Even at a historically depressed $20 or so per ton, the freight from the Caribbean to Europe amounts to 1¢ per lb of sugar, and the rate touched $40 per ton at the start of 1981. Moreover, the rates on some routes are much higher than those on the Caribbean-Europe run: those for bagged cargoes from the Caribbean to the Far East are often twice those for bulk sugar to Europe.
Diagram A
Trip Charter Freight Rates for Tweendeckers and Bulk Carriers contrasted with London Committee's Caribbean: London Rate.

Source: Landell Mills Commodities Studies.
CHAPTER III: ALTERNATIVE SWEETENERS

The world market for sweeteners is still dominated by sugar and sugar-derived products (such as gur and khandsari in South Asia, or panela in Colombia), but the development of alternative sweeteners has now progressed to a stage at which it is arguable that evaluations of sugar production schemes would be seriously deficient if they did not give some attention to the possibility of developing the production of sweeteners that are not derived from sugar beet or cane. There are essentially two major classes of competitors for sucrose: starch-based caloric sweeteners, generally known as corn sweetener, since maize starch is the most popular raw material for these products; and chemically derived high-intensity, low-calorie sweeteners, whose sweetness per unit weight is many times that of sucrose. The latter group of products is the simpler to analyse; therefore, we shall discuss it first.

A. High-Intensity Sweeteners

High-intensity sweeteners comprise a large group of products which have been discovered (usually by accident, as when a researcher at CD Searle studying two amino-acids happened to lick his fingers and set in chain the events that led to the marketing of aspartame) to have a remarkably high degree of sweetness. The two oldest established such sweeteners are saccharin, which is roughly 300 times sweeter than sucrose, and cyclamates, which is 30 times as sweet; but both have fallen under a cloud after the presentation of medical evidence—subsequently disputed—that they can induce cancer under certain circumstances. The official response to this evidence has varied from country to country, as the following (Table 9) makes clear;
but in all countries, there has been an effort to move towards other, as yet less criticized, sweeteners, notably stevioside, aspartame and acesulfame-k, with many other newer products undergoing medical tests and waiting in the wings.

**Table 9: REGULATORY POSITION OF HIGH-INTENSITY SWEETENERS, 1984**

<table>
<thead>
<tr>
<th>Sugar</th>
<th>United States</th>
<th>Canada</th>
<th>EEC</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharin</td>
<td>FDA proposed a</td>
<td>Banned in</td>
<td>Approved in</td>
<td>Approved</td>
</tr>
<tr>
<td></td>
<td>ban in 1977, 1977</td>
<td></td>
<td>several nations; under some restrictions elsewhere</td>
<td></td>
</tr>
<tr>
<td></td>
<td>this has been suspended by Congress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclamates</td>
<td>Banned in 1970</td>
<td>Restricted Use</td>
<td>Restricted Use</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Aspartame</td>
<td>Approved</td>
<td>Approved</td>
<td>Approved in several nations; under restrictions elsewhere</td>
<td>Approved</td>
</tr>
<tr>
<td>Stevioside</td>
<td>Not Approved</td>
<td>Not Approved</td>
<td>Not approved</td>
<td>Approved</td>
</tr>
<tr>
<td>Acesulfame-k</td>
<td>Not Approved</td>
<td>Not Approved</td>
<td>Restricted Use</td>
<td>Not Approved</td>
</tr>
</tbody>
</table>

In industrial countries, and most notably the United States, the growth of high-intensity sweetener use has been rapid (Table 10). The United States Department of Agriculture figures on per capita consumption of high intensity sweeteners in relation to caloric products show the extent of the advance after the banning of cyclamates.
Table 10: PER CAPITA SWEETENER CONSUMPTION IN THE UNITED STATES, 1970-1983
(in lb of sugar equivalent per capita)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sugar</th>
<th>HFCS</th>
<th>Total Corn Sweeteners</th>
<th>Total Caloric Sweeteners</th>
<th>Saccharin</th>
<th>Aspartame</th>
<th>Total Non-Caloric Sweeteners</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>101.7</td>
<td>0.7</td>
<td>19.3</td>
<td>122.5</td>
<td>5.8</td>
<td>-</td>
<td>5.8</td>
</tr>
<tr>
<td>1971</td>
<td>102.1</td>
<td>0.9</td>
<td>20.8</td>
<td>124.3</td>
<td>5.1</td>
<td>-</td>
<td>5.1</td>
</tr>
<tr>
<td>1972</td>
<td>102.3</td>
<td>1.3</td>
<td>21.1</td>
<td>124.9</td>
<td>5.1</td>
<td>-</td>
<td>5.1</td>
</tr>
<tr>
<td>1973</td>
<td>100.8</td>
<td>2.1</td>
<td>23.4</td>
<td>125.6</td>
<td>5.1</td>
<td>-</td>
<td>5.1</td>
</tr>
<tr>
<td>1974</td>
<td>95.6</td>
<td>3.0</td>
<td>25.1</td>
<td>121.8</td>
<td>5.9</td>
<td>-</td>
<td>5.9</td>
</tr>
<tr>
<td>1975</td>
<td>89.1</td>
<td>5.0</td>
<td>27.5</td>
<td>118.0</td>
<td>6.2</td>
<td>-</td>
<td>6.2</td>
</tr>
<tr>
<td>1976</td>
<td>93.4</td>
<td>7.2</td>
<td>29.7</td>
<td>124.4</td>
<td>6.1</td>
<td>-</td>
<td>6.1</td>
</tr>
<tr>
<td>1977</td>
<td>94.2</td>
<td>9.5</td>
<td>31.2</td>
<td>126.8</td>
<td>6.6</td>
<td>-</td>
<td>6.6</td>
</tr>
<tr>
<td>1978</td>
<td>91.5</td>
<td>12.1</td>
<td>33.7</td>
<td>126.7</td>
<td>6.9</td>
<td>-</td>
<td>6.9</td>
</tr>
<tr>
<td>1979</td>
<td>89.3</td>
<td>14.9</td>
<td>36.4</td>
<td>127.1</td>
<td>7.0</td>
<td>-</td>
<td>7.0</td>
</tr>
<tr>
<td>1980</td>
<td>83.7</td>
<td>19.2</td>
<td>40.3</td>
<td>125.2</td>
<td>7.1</td>
<td>-</td>
<td>7.1</td>
</tr>
<tr>
<td>1981</td>
<td>79.5</td>
<td>23.3</td>
<td>44.6</td>
<td>125.3</td>
<td>7.2</td>
<td>-</td>
<td>7.2</td>
</tr>
<tr>
<td>1982</td>
<td>73.8</td>
<td>26.7</td>
<td>48.2</td>
<td>123.3</td>
<td>7.3</td>
<td>1.0</td>
<td>8.3</td>
</tr>
<tr>
<td>1983</td>
<td>71.0</td>
<td>29.8</td>
<td>51.1</td>
<td>123.7</td>
<td>7.2</td>
<td>2.0</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Source: United States Department of Agriculture.

The demand for low calorie products in developing economies is, for obvious reasons, much less strong than that in the United States. In nutritionally-deficient nations, it is argued by the sugar industry that sugar provides one of the simplest and cheapest means of providing calories, and therefore that attempts to provide sweetness without calories are undesirable. Nevertheless, an examination of the world demand for saccharin, which is still by far the most important low-calorie sweetener, reveals that there is a substantial use of it in several developing countries, especially in Eastern Asia. In Thailand, for example, apparent consumption of saccharin has, in some years, approached 10% of the total sweetener market (expressed on a sugar-equivalent basis).
The major part of the saccharin consumed in countries like Thailand is used in the beverage industry, even though such uses are not officially authorized. Whatever the legal status of this consumption, it is important to appreciate the full extent of the competitive advantage enjoyed by sweeteners like saccharin over sugar. The following table indicates the relative prices of different sweeteners in recent years: saccharin, which is comparatively simple to produce, and which is exported on a large scale from Japan, the Republic of Korea and China, is now an extremely cheap sweetener (Table 11). By contrast, the most successful new sweetener--aspartame--is produced from two amino-acids, whose production costs will remain high until genetic engineering methods for their manufacture are perfected. Thus, where sweeteners are required purely as a flavoring (which means, in practice, primarily in the soft drink industry and in table-top applications, such as sweetening coffee or tea) it may be useful to take into account the possible use of saccharin as a cheap alternative to sucrose.

Table 11: TYPICAL SWEETENER COSTS
(in cents per lb of sugar equivalent)

<table>
<thead>
<tr>
<th>Sweetener</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>10 - 40 ¢/lb</td>
</tr>
<tr>
<td>Saccharin</td>
<td>0.8 - 2.0 ¢/lb</td>
</tr>
<tr>
<td>Cyclamates</td>
<td>4 - 8 ¢/lb</td>
</tr>
<tr>
<td>Acesulfame-k</td>
<td>5 - 10 ¢/lb</td>
</tr>
<tr>
<td>Aspartame</td>
<td>10 - 45 ¢/lb</td>
</tr>
</tbody>
</table>
B. Starch-Based Sweeteners

One of the major changes in the world market for sweeteners within the past 20 years has been the advent of high fructose corn syrup (HFCS). During the late-1960's and early -1970's, US and Japanese companies developed economically viable techniques for applying enzymes to a starch slurry to liquify it, convert it into glucose (a comparatively low grade sweetener) and finally upgrade the glucose into fructose (which is sweeter than sugar). The resultant product was liquid sweetener, which by judicious blending of the glucose/fructose mixtures emerging from different stages of the processing chain, was identical from a chemical point of view (barring some very minor impurities) to liquid invert sugar. As such, HFCS was an ideal substitute for sugar in a number of applications in which liquid sugar is used.

HFCS does not present a threat to sugar in household uses or in those industrial applications requiring dry crystal sugar (as in confectionery and some baking), but its impact upon the liquid sugar market, and upon sugar's sales to the soft drink, canning, baking and dairy product sectors in particular, has been very substantial indeed. The following figures, covering the past five years, illustrate the extent of this penetration by HFCS into sugar's traditional industrial markets in the United States (Table 12).
Table 12: US SUGAR AND HFCS DELIVERIES, 1979-1983

(in '000 short tons, refined value, for sugar, and dry basis, for HFCS)

<table>
<thead>
<tr>
<th></th>
<th>1979</th>
<th>1981</th>
<th>1983</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Sugar Consumption</td>
<td>6,255</td>
<td>5,665</td>
<td>4,992</td>
</tr>
<tr>
<td>of which: for Beverages</td>
<td>2,411</td>
<td>1,852</td>
<td>1,248</td>
</tr>
<tr>
<td>Household Sugar Consumption</td>
<td>3,679</td>
<td>3,547</td>
<td>3,207</td>
</tr>
<tr>
<td>Total Sugar Consumption</td>
<td>9,934</td>
<td>9,212</td>
<td>8,199</td>
</tr>
<tr>
<td>HFCS Consumption</td>
<td>1,725</td>
<td>2,800</td>
<td>3,730</td>
</tr>
<tr>
<td>Total Industrial Use of Sugar and HFCS</td>
<td>7,980</td>
<td>8,465</td>
<td>8,722</td>
</tr>
</tbody>
</table>

Source: USDA, Landell Mills Commodities Studies.

The economics of the production of starch-based sweeteners vis-a-vis the alternative of sugar depends upon four main factors: (i) the size of the potential market for HFCS; 
1/ (ii) the comparative local costs of the raw materials from which starch and sucrose can be manufactured; (iii) the costs of processing starch and beet or cane into HFCS or sugar; and (iv) the value to be attached to the by-products from starch processing.

The potential market for HFCS depends crucially upon not only the share of industrial consumption within total sugar demand, but more specifically, that proportion of industrial consumption which uses sugar in a liquid form. Cross-sectional analysis of patterns of demand for sugar and

---

1/ Other corn sweeteners compete little with sugar, since they possess specific properties that make them ideal for certain applications; hence the major choice, in practice, is between sugar and HFCS production.
HFCS combined 1/ reveal that the income-elasticities of demand for these two sweeteners (taking per capita GNP as the income measure) was 0.59 in industrial uses and only 0.15 in household uses. However, until comparatively high per capita income levels are reached, the majority of sugar demand in most countries is for household rather than industrial purposes. Thus, even in Eastern Europe, for example, the majority of consumption is for direct household use, rather than for industrial processing. Yet, there are a number of developing nations--Nigeria is one--for which industrial offtake accounts for the major share of demand.

The comparative costs of local starch sources in relation to those of sugar beet and cane can most easily be assessed from an examination of local producer prices of starch raw materials as a proportion of those of sugar beet or cane. In the following table (Table 13) we have listed such ratios, for the most recent years for which such data are available. These ratios were estimated on the assumption that sugar cane contains 10% recoverable sucrose and sugar beet 14% recoverable sucrose.

Another important factor to consider in a good number of actual, or potential, sugar producing countries is the availability of local starch sources as an alternative raw material in the production of liquid sweeteners. Table 14 lists a number of countries for which it is arguable that an increase in the area under starch/cereal crops might be easier to achieve than an increase in the area under sugar-bearing crops with a similar impact upon sweetener output.

### Table 13: Relative Producer Prices for Starch Raw Materials Vis-à-Vis Those for Sucrose in Beet or Cane

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>HFCS Production</th>
<th>Ratio of the Maize Price to the Price of Sucrose in Beet or Cane</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maize</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>1980</td>
<td>Yes</td>
<td>0.33</td>
</tr>
<tr>
<td>Canada</td>
<td>1979</td>
<td>Yes</td>
<td>0.24</td>
</tr>
<tr>
<td>Spain</td>
<td>1980</td>
<td>Yes</td>
<td>0.56</td>
</tr>
<tr>
<td>Hungary</td>
<td>1980</td>
<td>Yes</td>
<td>0.65</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>1979</td>
<td>Yes</td>
<td>0.82</td>
</tr>
<tr>
<td>Japan</td>
<td>1980</td>
<td>Yes</td>
<td>1.10</td>
</tr>
<tr>
<td>Argentina</td>
<td>1980</td>
<td>Yes</td>
<td>0.32</td>
</tr>
<tr>
<td>Uruguay</td>
<td>1980</td>
<td>Yes</td>
<td>0.65</td>
</tr>
<tr>
<td>Iran, Islamic Rep. of</td>
<td>1979</td>
<td>No</td>
<td>0.53</td>
</tr>
<tr>
<td>Kenya</td>
<td>1979</td>
<td>No</td>
<td>0.58</td>
</tr>
<tr>
<td>Sudan</td>
<td>1978</td>
<td>No</td>
<td>0.61</td>
</tr>
<tr>
<td>Tunisia</td>
<td>1978</td>
<td>No</td>
<td>0.47</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1980</td>
<td>No</td>
<td>0.80</td>
</tr>
<tr>
<td>Algeria</td>
<td>1978</td>
<td>No</td>
<td>0.49</td>
</tr>
<tr>
<td>Cameroon</td>
<td>1980</td>
<td>No</td>
<td>0.46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>HFCS Production</th>
<th>Ratio of Cassava Price to the Price of Sucrose in Cane</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Cassava</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>1980</td>
<td>Yes</td>
<td>0.11</td>
</tr>
<tr>
<td>The Philippines</td>
<td>1979</td>
<td>No</td>
<td>0.32</td>
</tr>
<tr>
<td>Thailand</td>
<td>1979</td>
<td>No</td>
<td>0.26</td>
</tr>
<tr>
<td>Cameroon</td>
<td>1980</td>
<td>No</td>
<td>0.15</td>
</tr>
<tr>
<td>Kenya</td>
<td>1979</td>
<td>No</td>
<td>0.35</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1980</td>
<td>No</td>
<td>0.52</td>
</tr>
<tr>
<td>Brazil</td>
<td>1979</td>
<td>No</td>
<td>0.35</td>
</tr>
<tr>
<td>Mexico</td>
<td>1980</td>
<td>No</td>
<td>0.56</td>
</tr>
<tr>
<td>India</td>
<td>1980</td>
<td>No</td>
<td>0.34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>HFCS Production</th>
<th>Ratio of Rice Price to the Price of Sucrose in Cane</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Rice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pakistan</td>
<td>1978</td>
<td>Yes</td>
<td>0.97</td>
</tr>
<tr>
<td>Thailand</td>
<td>1979</td>
<td>No</td>
<td>0.79</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1978</td>
<td>No</td>
<td>0.76</td>
</tr>
<tr>
<td>India</td>
<td>1980</td>
<td>No</td>
<td>0.80</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>1980</td>
<td>No</td>
<td>0.86</td>
</tr>
<tr>
<td>Egypt</td>
<td>1978</td>
<td>No</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Sources: FAO; Landell Mills Commodities Studies.
Table 14: THE POTENTIAL FOR THE SUBSTITUTION OF SUGAR DEMAND BY STARCH-DERIVED SWEETENERS

<table>
<thead>
<tr>
<th>Country</th>
<th>Starch Crop Source</th>
<th>Harvested Area '82 ('000 hectares)</th>
<th>Average Yield '80-82 (Tons/ha)</th>
<th>Sugar Crop Area '82 ('000 hectares)</th>
<th>Average Yield '80-82 (Tons/ha)</th>
<th>% Increase Needed in Starch Area to Displace 10% of Local Sugar Demand</th>
<th>% Increase Need in Sugar Area to Provide 10% of Local Sugar Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Maize</td>
<td>3,170</td>
<td>3.13</td>
<td>319</td>
<td>50.32</td>
<td>1.6%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Chile</td>
<td>Maize</td>
<td>107</td>
<td>4.04</td>
<td>22</td>
<td>41.41</td>
<td>15.4%</td>
<td>30.9%</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Cassava</td>
<td>1,300</td>
<td>9.79</td>
<td>210</td>
<td>103.53</td>
<td>6.5%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Kenya</td>
<td>Maize</td>
<td>1,300</td>
<td>1.78</td>
<td>42</td>
<td>110.93</td>
<td>2.5%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Mexico</td>
<td>Maize</td>
<td>6,272</td>
<td>1.85</td>
<td>450</td>
<td>71.22</td>
<td>5.0%</td>
<td>14.1%</td>
</tr>
<tr>
<td>Morocco</td>
<td>Maize</td>
<td>392</td>
<td>2.48</td>
<td>62</td>
<td>35.55</td>
<td>10.6%</td>
<td>16.4%</td>
</tr>
<tr>
<td>Nigeria</td>
<td>Cassava</td>
<td>1,250</td>
<td>9.19</td>
<td>20</td>
<td>56.30</td>
<td>3.7%</td>
<td>119.1%</td>
</tr>
<tr>
<td>Spain</td>
<td>Maize</td>
<td>412</td>
<td>5.22</td>
<td>260</td>
<td>36.20</td>
<td>8.6%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Cassava</td>
<td>51</td>
<td>9.80</td>
<td>7</td>
<td>50.30</td>
<td>19.8%</td>
<td>75.0%</td>
</tr>
<tr>
<td>United States</td>
<td>Maize</td>
<td>29,604</td>
<td>6.60</td>
<td>7.4</td>
<td>62.35</td>
<td>0.7%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>Maize</td>
<td>2,220</td>
<td>4.51</td>
<td>142</td>
<td>41.76</td>
<td>1.4%</td>
<td>10.6%</td>
</tr>
</tbody>
</table>

Note: Maize is assumed to have a 60% starch content. Cassava is assumed to yield 1 ton of starch per 4.5 tons of roots.

Sources: FAO; International Sugar Organization.
CHAPTER IV: SUGAR BY-PRODUCTS

Among the aspects of the sugar industry that receive less attention than they are entitled to is the revenue that can be obtained from the sale of by-products. There are essentially three main by-products, molasses, beet pulp and bagasse, although there are small net credits available from beet tops and cane tops as cattle feed and from the use of filter press muds as fertilizer. In addition, there is a large, and growing, market for ethyl alcohol, produced indirectly from sugar crops by the fermentation of molasses or directly by the fermentation of sugar cane or beet juice. Ethyl alcohol can be considered either as a by-product or an end-product of sugar cultivation.

A. Molasses

The production of molasses is an integral part of centrifugal sugar manufacture. Molasses is spun off during the crystallization stage of sugar production. The rate at which molasses is produced in conjunction with sugar varies from country to country and from mill to mill depending on technological/economic grounds. Newer cane mills and beet factories have higher recovery rates of sugar from molasses and correspondingly lower levels of molasses output than older plants. Also, many producers have introduced measures to reduce the sucrose content of the molasses produced. Typically, molasses output is between one-third and one-half of sugar output, where cane is the raw material, and between one-quarter and one-third of sugar output, where beet is the raw material. (See Table 16 for recent levels of molasses output worldwide.)
Even more so than sugar, molasses cannot be considered a homogeneous product. As a result of the different trade-offs made by producers between sugar output and the quantity and quality of molasses, molasses is available with a great range of qualities. The standard method of assessing molasses is in terms of its solid matter content (measured in terms of degrees of Brix), but the type of solid matter is also a matter of variation, since the saccharides within molasses have special appeal, according to whether the molasses is destined for cattle feeding, where palatability and nutrient composition is vital (cane molasses being preferred to beet molasses on the former ground), or whether it is destined for fermentation, where the composition of fermentables is crucial.

The reference world price for molasses has long been the New Orleans ex-tank quotation for 79.5° Brix cane molasses, as published weekly by the USDA. To some extent, the price of molasses is determined by its availability, which moves in step with world sugar production worldwide. However, molasses is just one of a number of fairly closely-competing liquid feeds, which compounders use to bind other feeds together while imparting palatability. This property, usually gives rise to a price premium over and above the valuation that might be attributed purely to the nutrient content of molasses; but when animal feed offtake is depressed, the price of molasses falls to a floor, at which its value as a source of carbohydrate feed, or as a fermentable, is equivalent to that of maize. Purely on the basis of the total digestive nutrient percentages of beet and cane molasses available to ruminants, the equilibrium price ratios of molasses to maize would be 6.28 gallons (171 gallons to a short ton) of beet molasses and 7.09 gallons of cane molasses equivalent to 1 bushel of maize; which explains the feed rule of thumb that 6.5 gallons of molasses are the nutritional equivalent of one bushel of maize.
Once inland transport costs of upwards of $20 per ton to the main US cattle feeding areas are taken into account, the basic feed equivalences are reflected in the floors to the molasses:maize price ratio in the following Table (Table 15). However, it is striking to observe how a period of tighter molasses supplies, as indicated by slower-than-normal growth in world sugar output (e.g., 1978-80), tends to be correlated with above-normal molasses:maize price ratios.

Table 15: HISTORICAL MOLASSES AND MAIZE PRICES IN RELATION TO SUGAR OUTPUT

<table>
<thead>
<tr>
<th>Year</th>
<th>New Orleans ex-tank molasses quotation (in $ per short ton)</th>
<th>Chicago No. 2 maize price (in $ per bushel)</th>
<th>Ratio of the molasses prices to maize prices</th>
<th>Rate of growth in world centrifugal sugar output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>19.90</td>
<td>1.27</td>
<td>15.7</td>
<td>+7.75%</td>
</tr>
<tr>
<td>1966</td>
<td>29.29</td>
<td>1.36</td>
<td>21.5</td>
<td>-1.27%</td>
</tr>
<tr>
<td>1967</td>
<td>25.60</td>
<td>1.12</td>
<td>22.9</td>
<td>+3.64%</td>
</tr>
<tr>
<td>1968</td>
<td>20.20</td>
<td>1.17</td>
<td>17.3</td>
<td>+0.67%</td>
</tr>
<tr>
<td>1969</td>
<td>24.80</td>
<td>1.25</td>
<td>19.8</td>
<td>+4.14%</td>
</tr>
<tr>
<td>1970</td>
<td>25.10</td>
<td>1.44</td>
<td>17.4</td>
<td>+4.74%</td>
</tr>
<tr>
<td>1971</td>
<td>26.10</td>
<td>1.18</td>
<td>22.1</td>
<td>+1.46%</td>
</tr>
<tr>
<td>1972</td>
<td>48.30</td>
<td>1.82</td>
<td>26.5</td>
<td>+2.29%</td>
</tr>
<tr>
<td>1973</td>
<td>68.70</td>
<td>2.86</td>
<td>24.0</td>
<td>+0.18%</td>
</tr>
<tr>
<td>1974</td>
<td>51.50</td>
<td>3.23</td>
<td>15.9</td>
<td>+0.80%</td>
</tr>
<tr>
<td>1975</td>
<td>48.60</td>
<td>2.69</td>
<td>18.1</td>
<td>+3.20%</td>
</tr>
<tr>
<td>1976</td>
<td>44.80</td>
<td>2.45</td>
<td>18.3</td>
<td>+4.52%</td>
</tr>
<tr>
<td>1977</td>
<td>42.70</td>
<td>2.62</td>
<td>18.9</td>
<td>+9.65%</td>
</tr>
<tr>
<td>1978</td>
<td>79.10</td>
<td>2.54</td>
<td>31.1</td>
<td>+0.28%</td>
</tr>
<tr>
<td>1979</td>
<td>81.70</td>
<td>2.64</td>
<td>30.9</td>
<td>-1.92%</td>
</tr>
<tr>
<td>1980</td>
<td>97.20</td>
<td>3.01</td>
<td>32.3</td>
<td>-4.80%</td>
</tr>
<tr>
<td>1981</td>
<td>84.60</td>
<td>3.16</td>
<td>26.8</td>
<td>+9.49%</td>
</tr>
<tr>
<td>1982</td>
<td>47.50</td>
<td>2.57</td>
<td>18.5</td>
<td>+8.57%</td>
</tr>
<tr>
<td>1983</td>
<td>55.38</td>
<td>3.24</td>
<td>16.6</td>
<td>-4.37%</td>
</tr>
</tbody>
</table>

Source: Landell Mills Commodities Studies.
Table 16: WORLD MOLASSES AND CENTRIFUGAL PRODUCTION BY CROP YEAR

('000 tons)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Molasses Output</td>
<td>30,941</td>
<td>34,343</td>
<td>34,864</td>
<td>33,305</td>
</tr>
<tr>
<td>Sugar Output</td>
<td>88,466</td>
<td>100,632</td>
<td>100,986</td>
<td>94,664</td>
</tr>
<tr>
<td>Molasses as a % of Sugar Output</td>
<td>35.0%</td>
<td>34.1%</td>
<td>34.5%</td>
<td>35.2%</td>
</tr>
</tbody>
</table>

Source: USDA.

Over time, the structure of the world molasses market has changed substantially. A higher proportion of molasses production is now consumed in developing countries where it is produced, whether as a feedstuff or for alcohol distillation. Also, among importing regions, the United States has declined in importance, to be overtaken by Western Europe and the Far East. In effect, the world market in molasses has three fairly distinct regional markets, linked by transport cost differentials; although, since Japan and the Republic of Korea use molasses primarily for fermentation, and Europe and the United States have a much larger animal feed use, different qualities of molasses go to the various regions. Table 17 indicates how the values of molasses within the US and in the EEC have moved over the past 5 years, both in relation to one another and in relation to dried beet pulp, which is discussed below. The EEC and United States' quotations are not directly comparable with one another, since the molasses imported into the EEC is typically higher in Brix than the norm used for the USDA quotation.
However, the extreme divergence between prices in the EEC and the United States fairly reflects the costs of transporting molasses (typically in small, old, oil tankers) between Europe and the US Gulf.

Table 17: BEET PULP, MOLASSES AND MAIZE WHOLESALE PRICES, 1979-1984

<table>
<thead>
<tr>
<th></th>
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<td>1982.Q2</td>
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<tr>
<td>1982.Q3</td>
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<td>60.9</td>
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<td>83.3</td>
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<td>2.79</td>
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<td>1983.Q2</td>
<td>135</td>
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<td>80.0</td>
<td>62.9</td>
<td>3.24</td>
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<tr>
<td>1983.Q3</td>
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<td>80.0</td>
<td>80.8</td>
<td>3.49</td>
</tr>
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<td>1983.Q4</td>
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<td>3.43</td>
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<td>1984.Q1</td>
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<td>3.36</td>
</tr>
<tr>
<td>1984.April</td>
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<td>76.7</td>
<td>90.0</td>
<td>64.8</td>
<td>3.58</td>
</tr>
<tr>
<td>1984.May</td>
<td>136</td>
<td>75.2</td>
<td>90.0</td>
<td>59.8</td>
<td>3.60</td>
</tr>
</tbody>
</table>

Source: Landell Mills Commodities Studies.
B. Beet Pulp

At first sight, beet pulp is much more valuable as a by-product than molasses. When molasses is added to the beet pulp before it is dried, the end-product is valued as a high-fibre cattle feed. The Los Angeles quotations listed in Table 17 are a fair indication of the value of beet pulp in world trade, since the US West Coast exports regular tonnages to the Far East. For much of 1984, the unit value of beet pulp on the world market was actually greater than that of sugar. In normal circumstances, gross beet pulp credits amount to 10% or so of the revenues from sugar. For example, dried pulp credits in the United States in the 1982/83 crop year averaged 2.30 cents per lb of refined sugar, compared with the USDA estimate of net production costs for beet white sugar of 25.5 cents. By contrast, the credits from beet molasses averaged only 0.74 cents per lb of white sugar (as against 0.55 cents per lb of raw sugar for US cane molasses in the same year), and the credits from filter muds and other by-products totalled only 0.17 cents per lb.

Unfortunately, the market for wet beet pulp—which is the form in which the pulp first emerges from the factory—is, as yet, relatively small. If farmers in the vicinity of the factory have good facilities for making silage, the pulp can be disposed of in a wet form; but the market for such pulp is typically very small. There is a larger demand for pressed pulp, grading around 25% dry matter, which can be used in compound feeds, but which, because of the risk of deterioration and high transport costs (in relation to its dry content), still has to be sold comparatively near the factory. The sales of pressed pulp rarely exceed 5% of total pulp production.

The major demand for beet pulp is in the form of molassed beet pulp pellets, which are dried mechanically, and which can be stored for long
periods. However, the energy costs of pulp drying are very considerable, leaving only a small net profit to the factory. In the United States in 1982/83, the costs of drying beet pulp and turning it into pellets totalled 1.84 cents per lb of white sugar, which left a net return of only 0.46 cents from the sale of such pellets.

C. Bagasse

The major value of bagasse as a by-product is almost hidden from sight, in that it substitutes for fossil fuels in supplying energy to the cane mill. Some indication of the value of bagasse, purely on this front, may be gleaned from a comparison between US beet and cane processing costs in 1982/83. Beet factories spent an average of 2.18 cents per lb of white sugar on purchased fuel; cane mills spent only 0.43 cents per lb—a cost saving of 1.75 cents per lb, entirely attributable to the use of bagasse in mill boilers and generators.

The benefits from bagasse extend also to field operations. Where electric power is required for irrigation during the crushing season (when bagasse is being produced as a by-product), this can be provided from bagasse-powered generators. In addition, an efficient mill will almost certainly be able to produce bagasse over and above its immediate energy requirements for sugar processing. Several nations have developed industrial units to use bagasse as a substitute for wood products in pulp and board manufacture. Some have also encouraged the production of special chemicals, such as furfural, from bagasse. The value of bagasse in such applications is purely as a substitute for other sources of cellulose.
The most important new application of bagasse, as greater efficiency occurs in the use of energy within the mill, is in its more traditional role as a combustible material in energy generation. However, its commercial significance arises because the energy is produced for outside consumption. On small islands that are heavily dependent upon sugar production, as in Mauritius or Hawaii, electric power generation from bagasse can be a major source of local power supplies. Such problems as arise do so primarily because the value to be attached to electric power is very much greater if bagasse-based power can be supplied throughout the year; but the vast majority of sugar cane producers are crushing cane only for part of the year. Where electricity from bagasse is available only intermittently, electric power companies still need to maintain a full generating capacity using alternative fuels; thus the savings represented by bagasse are little more than those associated with displacing other fuels. Only where bagasse-derived power is onstream 12 months a year can such power become part of the base power supply and save the large capital costs of alternative generating equipment.

Hawaii is possibly the best example of a situation where there are substantial advantages from electric power by-product revenues. Being composed of comparatively small islands, remote from sources of oil or other fossil fuels, alternatives to bagasse-derived energy are costly. Moreover, Hawaii is unusual in having virtually year-round cane crushing. Thus electric power can be generated from bagasse most of the year, without undue difficulty. When mills are closed, for maintenance or because of disruptions to cane supplies, the opportunity cost (in terms of the foregone possibility of obtaining a higher power selling price over the year as a whole) is very high. Consequently, it has become worthwhile for some Hawaiian estates to
install bagasse pelletizing plants, specifically to ensure the continuity of electric power generation throughout the year. As a result, some Hawaiian islands now rely upon bagasse for a very large share of their electric power supplies, and mills that have installed pelletizing facilities to maintain their electric output both in and out of season earn electric power credits of up to 3 cents per lb, raw value, of sugar. For Hawaii as a whole, the average credits earned from electric power generation in 1982/83 totalled 1.10 cents per lb of sugar.

D. Ethanol

Developments over the past decade in the production of fermentation ethyl alcohol have transformed this sector into one that enjoys a potentially crucial role in the balance of the markets for sugar and molasses. In the latter sector, the fermentation and subsequent distillation of cane and beet molasses have long constituted one of the main uses of molasses. Out of total world output of molasses, which has recently been in the region of 30-35 million tons, roughly one-quarter is estimated to be used in the fermentation of ethanol—producing 2.0 billion litres of ethanol, and weighing 1.6 million tons.

More recently, interest has grown considerably in the direct conversion of sugar juice (whether from cane or beet) into ethanol. Immediately after the World War II, the greatest investment in sugar-based ethanol occurred in Western Europe, and there is still a sizeable number of beet distilleries operating in France. The promotion of sugar cane distilleries originated initially in Brazil, where the Proalcool program was designed to permit the country to reduce its imports of crude oil by over 100,000 barrels
per day by 1983 and 150,000 barrels per day by 1985. This was a remarkable
target, implying the direct processing of well over 100 million tons of cane
to produce almost 8 billion litres (6.4 million tons) of ethanol in 1983 and
160 million tons of cane to produce approximately 11 billion (8.7 million
tons) in 1985.

In the event, the Brazilian targets have been met: thus, within the
space of ten years, Brazil has succeeded, not only in becoming the world's
largest sugar producing nation (with roughly 10% of the world total), but also
in planting so much additional cane for ethanol that, if this had been
processed for sugar production, it would have added 15-16% to world sugar
output. Brazil has both the land and the incentive to grow sugar cane as a
means of substituting for imported oil. Other cane producers have been
reticent about following Brazil's lead. Zimbabwe is one that has done so;
Costa Rica and Paraguay are others. However, none of these has yet tried to
emulate the Brazilian example of converting the domestic automobile market
into one dominated by vehicles powered 100% with ethanol fuel (i.e., without
any blending with gasoline).

From a purely technical point of view, maize is the crop which
generates the highest ethanol yield per ton of raw material, followed by
molasses and cassava (as Table 18 reveals). Once yields of crops per hectare
are taken into account, sugar becomes the star performer—with the added
advantage that bagasse can be burnt to provide the fuel that is needed, a
property which it shares only with sweet sorghum.
Table 18: ETHANOL YIELDS OF ALTERNATIVE CROP MATERIALS

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Ethanol Yield (per ton raw material)</th>
<th>Raw Material Yield (tons/hectare)</th>
<th>Ethanol Yield (litres/hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar Cane</td>
<td>70</td>
<td>50</td>
<td>3,500</td>
</tr>
<tr>
<td>Sugar Beet</td>
<td>85</td>
<td>35</td>
<td>2,975</td>
</tr>
<tr>
<td>Molasses</td>
<td>280</td>
<td>2 /a</td>
<td>560</td>
</tr>
<tr>
<td>Cassava</td>
<td>180</td>
<td>12</td>
<td>2,160</td>
</tr>
<tr>
<td>Sweet Sorghum</td>
<td>86</td>
<td>35</td>
<td>3,010</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>125</td>
<td>15</td>
<td>1,875</td>
</tr>
<tr>
<td>Maize</td>
<td>370</td>
<td>4</td>
<td>1,480</td>
</tr>
<tr>
<td>Babassu Nut</td>
<td>80</td>
<td>2.5</td>
<td>200</td>
</tr>
</tbody>
</table>

/a As a by-product.

Note: Yields are based upon Brazilian data, except for sugar beet and maize, where world averages are used.


The economics of ethanol production ultimately depend upon the opportunity costs of the raw material to be fermented and the costs of the fermentation and distillation itself. In the former respect, molasses is often the prime candidate. Many landlocked countries face a negative export parity value of molasses, by virtue of the product's low unit value and high freight costs; therefore molasses can be considered to have a near-zero opportunity cost. Moreover, energy can also be treated as a free good during the cane crushing season if the distillery is linked to the cane mill and takes advantage of surplus bagasse-derived heat and electric power. Thus, one is left only with the fermentation and distillation costs.

Sugar cane does have an opportunity cost—its potential value if converted into world market sugar. Taking 1979 constant prices as a measuring
rod, Table 19 indicates that a world sugar price of under 11-12 cents/lb (equivalent to $14 per ton cane prices at a mill near a port) would justify the diversion of cane to ethanol, if the Arabian crude oil price averaged $31 per barrel.

Table 19: ETHANOL PRODUCTION COST IMPLICATIONS FOR PRODUCT PRICES

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Molasses /a</th>
<th>Sugar Cane</th>
<th>Cassava</th>
<th>Maize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost of a 120,000 litre/day Ethanol Plant in a &quot;Medium Cost&quot; Country (in $ million)</td>
<td>7.6</td>
<td>9.5</td>
<td>11.4</td>
<td>11.4</td>
</tr>
<tr>
<td>Number of Operating Days/Year</td>
<td>180</td>
<td>180</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>Ex-Plant Raw Material Cost at an Arabian Crude Oil Price of $31 per bbl (i) With 10% Expected Rate of Return</td>
<td>$62</td>
<td>$14</td>
<td>$13</td>
<td>Negl. /b</td>
</tr>
<tr>
<td>(ii) With 8% Expected Rate of Return</td>
<td>$65</td>
<td>$14</td>
<td>$16</td>
<td>Negl.</td>
</tr>
</tbody>
</table>

Typical Producer Prices

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<tr>
<td></td>
<td>$12.8</td>
<td>$11.0</td>
<td>$19.6</td>
<td>$26.7</td>
<td>$48.6</td>
<td>$40.3</td>
<td>$12.5</td>
<td>$14.4</td>
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<td>$45.2</td>
<td>$93.8</td>
<td>$91.6</td>
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<td>$37.7</td>
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<td>$130.2</td>
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<td></td>
<td></td>
<td></td>
<td>$102.4</td>
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</tr>
</tbody>
</table>

/a The New Orleans molasses price in 1979 was $90.1 per ton.

/b The maize prices are expressed per ton.

Source: World Bank, FAO.
CHAPTER V: ECONOMIC AND SOCIAL ASPECTS OF SUGAR PRODUCTION

Attitudes toward sugar as a crop are typically quite different from those displayed towards the cultivation of other leading crops. In part, this is a natural consequence of the conventional view of sugar as a cash crop, rather than a staple food, even though sugar has become a major source of carbohydrates in many countries. Another reason for seeing sugar as different from, say, grains is that sugar is often produced on a very large scale as a plantation crop, and hence is implicitly contrasted with other crops produced by smallholders and peasant farmers.

The large scale of many sugar estates reinforces the impression conveyed by the sugar milling and refining sectors that sugar is, in some way, different from almost all major developing countries's export of agricultural products in the degree to which it can be classified as an "industrial" rather than an "agricultural" product. Unlike coffee, grains, cocoa, oilseeds, cotton, hard fibres etc., the high perishability of sugar cane and beet obliges producing countries to process the crop as near as possible to the grower. Thus, the international trade in sugar cane or beet is confined to a few examples of cross-border sales to nearby processors. As a result, the cultivation of sugar crops obliges a nation to establish a correspondingly large sugar cane milling or beet slicing factory, with the creation of a considerable number of industrial jobs, some of which require specialized skills: in effect, the establishment of a sugar plant inevitably brings a certain amount of rural industrialization in its train.
A. Employment Generation

There are many technologies of sugar cultivation and processing, differing widely in their degree of labor and capital-intensities; however, in general, sugar creates a much greater direct and indirect level of employment per hectare than most alternative crops. In some of the most labor-intensive cultivation regions in the world, such as Java, the labor input per hectare of cane exceeds 100 days per annum, merely at the field stage, with total input of labor through to the milling stage approaching 140-150 days per hectare. The system of cultivation and milling in Fiji is somewhat less labor-intensive than in Java, but the demanding tasks of cutting and loading cane are still performed by hand. In 1982, 69,000 hectares of cane were harvested, occupying much of the time of the nation's 21,560 cane farmers, 15,950 seasonally employed cane cutters and 3,710 mill employees--equivalent to over 7 part-time jobs per 10 hectares of cane. A similar picture emerges from Mauritius where 50,000 workers are employed in a sugar sector occupying 76,000 hectares in all. At the other extreme lie the high labor-cost producers of beet and cane, whose intensive mechanization enables them to restrict their employment requirements to under two workers per 10 hectares in certain instances.

The use of labor time is most heavily concentrated in the final stages of field operations: cutting and loading cane, or lifting beets. Thus, there exists a considerable amount of seasonality in employment. By virtue of the mechanization of beet harvesting and the desirability of rotating beet cultivation with grain farming so that beets are planted only one year in four, the seasonal demands for labor for beet are not excessive for a farmer to incorporate within a normal workload. Cane, however, is typically a monoculture, with each cane plant being harvested for several years after...
planting (as so-called ratoon or stubble crops) before replanting occurs. This reinforces the seasonality of sugar cane-related employment in field operations.

Most cane producers harvest their cane over a period of six months or so of the year, but yields and output are at their peaks for only three to four months. Irrigation helps on both counts—improving yields and extending the harvesting season—yet climatic considerations are the ultimate determinants of performance. In a few areas with stable climates all year round, such as Hawaii, Peru, Colombia and Kenya, harvesting can proceed at a steady rate for almost 12 months a year.

B. Revenue Generation Per Hectare

The reason that sugar cultivators can afford to create more employment per hectare than the growers of many other products is that the revenues that are generated by an area of sugar crops are much higher than those for most alternatives. Sugar cultivation entails high production costs per hectare, but also yields a correspondingly high revenue per hectare.

A very striking indication of the extent of the appeal of sugar crops as a revenue generator is given by the following table summarizing the cash flows per planted acre in the United States of various crops in 1983 (Table 20). Cash flows were defined as total receipts less cash expenses and replacement, and thus correspond closely to farmers' revenues from their own resources.
Table 20: US AVERAGE CASH FLOWS PER PLANTED ACRE, 1983

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average Cash Flow Per Planted Acre (in US Dollars Per Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>16</td>
</tr>
<tr>
<td>Sorghum</td>
<td>8</td>
</tr>
<tr>
<td>Barley</td>
<td>0.5</td>
</tr>
<tr>
<td>Oats</td>
<td>6</td>
</tr>
<tr>
<td>Wheat</td>
<td>23</td>
</tr>
<tr>
<td>Rice</td>
<td>19</td>
</tr>
<tr>
<td>Soya Beans</td>
<td>70</td>
</tr>
<tr>
<td>Sunflowers</td>
<td>25</td>
</tr>
<tr>
<td>Cotton</td>
<td>42</td>
</tr>
<tr>
<td>Peanuts /a</td>
<td>148</td>
</tr>
<tr>
<td>Fall Potatoes /b</td>
<td>68</td>
</tr>
<tr>
<td>Sugar Beet</td>
<td>218</td>
</tr>
<tr>
<td>Sugar Cane</td>
<td>191</td>
</tr>
</tbody>
</table>

/ a This is the average of $96 in 1983 and $201 in 1982.
/b This is the 1982 figure. None is available for 1983.

Source: USDA/ERS, ECIFS 3-1, July 1984.

For a variety of other countries, the next table presents data describing the relative attractions of sugar and other crops to farmers concerned solely with their total cash receipts per hectare, without deducting their own cash expenses (which are deducted before arriving at the USDA figures quoted above). Despite the considerable diversity of the countries selected below (Table 21), the revenues obtained from wheat or maize were consistently well below those attainable from sugar crops. For both rice and cassava, the position is less clearcut: just over 20% of the sample for rice and nearly 30% of the sample for cassava recorded higher revenues from competing crops than from sugar. However, this minority of cases does not really contradict the view commonly expressed by farmers that sugar is among
Table 21: AVERAGE PRODUCER REVENUES PER HECTARE FROM DIFFERENT CROPS, EXPRESSED AS A PERCENTAGE OF THE REVENUES FROM SUGAR CROPS

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Wheat</th>
<th>Maize</th>
<th>Rice</th>
<th>Cassava</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1980</td>
<td>15.1</td>
<td>8.6</td>
<td>40.6</td>
<td>34.8</td>
</tr>
<tr>
<td>Australia</td>
<td>1981</td>
<td>8.5</td>
<td>24.4</td>
<td>63.4</td>
<td>-</td>
</tr>
<tr>
<td>Barbados</td>
<td>1979</td>
<td>-</td>
<td>17.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bolivia</td>
<td>1980</td>
<td>16.1</td>
<td>36.3</td>
<td>36.1</td>
<td>176.9</td>
</tr>
<tr>
<td>Brazil</td>
<td>1979</td>
<td>23.4</td>
<td>27.0</td>
<td>41.0</td>
<td>72.7</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>1977</td>
<td>61.8</td>
<td>62.0</td>
<td>183.4</td>
<td>-</td>
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<tr>
<td>Chile</td>
<td>1979</td>
<td>25.7</td>
<td>52.4</td>
<td>41.8</td>
<td>-</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>1980</td>
<td>-</td>
<td>34.9</td>
<td>81.2</td>
<td>29.7</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1979</td>
<td>-</td>
<td>53.1</td>
<td>175.5</td>
<td>195.4</td>
</tr>
<tr>
<td>Egypt (Cane)</td>
<td>1978</td>
<td>25.2</td>
<td>34.1</td>
<td>46.6</td>
<td>-</td>
</tr>
<tr>
<td>Fiji</td>
<td>1979</td>
<td>-</td>
<td>-</td>
<td>22.1</td>
<td>102.3</td>
</tr>
<tr>
<td>France</td>
<td>1980</td>
<td>61.7</td>
<td>67.6</td>
<td>103.1</td>
<td>-</td>
</tr>
<tr>
<td>Guatemala</td>
<td>1978</td>
<td>11.1</td>
<td>14.0</td>
<td>53.0</td>
<td>4.1</td>
</tr>
<tr>
<td>India</td>
<td>1980</td>
<td>19.3</td>
<td>12.4</td>
<td>28.2</td>
<td>107.5</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1978</td>
<td>-</td>
<td>3.3</td>
<td>11.8</td>
<td>10.8</td>
</tr>
<tr>
<td>Iran, Islamic Rep. of (Beet)</td>
<td>1979</td>
<td>16.1</td>
<td>19.3</td>
<td>284.9</td>
<td>-</td>
</tr>
<tr>
<td>Kenya</td>
<td>1979</td>
<td>20.6</td>
<td>9.4</td>
<td>50.3</td>
<td>25.2</td>
</tr>
<tr>
<td>Malawi</td>
<td>1979</td>
<td>-</td>
<td>3.5</td>
<td>5.4</td>
<td>9.9</td>
</tr>
<tr>
<td>Mauritius</td>
<td>1980</td>
<td>-</td>
<td>17.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mexico</td>
<td>1981</td>
<td>48.0</td>
<td>29.6</td>
<td>69.4</td>
<td>51.3</td>
</tr>
<tr>
<td>Morocco (Beet)</td>
<td>1980</td>
<td>28.0</td>
<td>70.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pakistan (Cane)</td>
<td>1978</td>
<td>42.1</td>
<td>43.2</td>
<td>77.7</td>
<td>-</td>
</tr>
<tr>
<td>The Philippines</td>
<td>1979</td>
<td>-</td>
<td>21.5</td>
<td>56.4</td>
<td>93.0</td>
</tr>
<tr>
<td>Poland</td>
<td>1980</td>
<td>35.9</td>
<td>45.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>1981</td>
<td>-</td>
<td>-</td>
<td>28.5</td>
<td>-</td>
</tr>
<tr>
<td>Reunion</td>
<td>1979</td>
<td>-</td>
<td>71.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Africa</td>
<td>1979</td>
<td>18.3</td>
<td>17.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Spain (Beet)</td>
<td>1980</td>
<td>20.9</td>
<td>57.9</td>
<td>93.5</td>
<td>-</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>1980</td>
<td>-</td>
<td>13.6</td>
<td>45.0</td>
<td>85.6</td>
</tr>
<tr>
<td>Swaziland</td>
<td>1979</td>
<td>-</td>
<td>7.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1981</td>
<td>54.1</td>
<td>57.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>1979</td>
<td>-</td>
<td>37.1</td>
<td>35.6</td>
<td>92.1</td>
</tr>
<tr>
<td>Turkey</td>
<td>1979</td>
<td>29.6</td>
<td>39.5</td>
<td>258.8</td>
<td>-</td>
</tr>
<tr>
<td>USA (Beet)</td>
<td>1980</td>
<td>13.2</td>
<td>33.3</td>
<td>54.2</td>
<td>-</td>
</tr>
<tr>
<td>USA (Cane)</td>
<td>1980</td>
<td>9.0</td>
<td>22.6</td>
<td>36.8</td>
<td>-</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>1979</td>
<td>49.1</td>
<td>63.6</td>
<td>184.8</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: FAO Production Yearbooks; FAO Producer Price Data.
their most attractive crops in the short run, since it can be relied upon as a major source of cash revenues. Furthermore, the yields obtained from sugar are not exceptionally volatile by the standards of other crops.

One problem posed by the data used to derive farmers' revenues per hectare is that the producer prices which are paid in each country are typically out of line with world market quotations. This is truer of sugar than of other commodities, but applies to grains as well. In World Bank project evaluation, such divergences between internal and external prices are very disconcerting, since projects are appraised on the basis of shadow prices (which correspond to world prices, in the case of internationally traded products). Accordingly, the following tables have been drafted to show how much of a competitive advantage sugar retains over other crops as a revenue generator, where world prices are adopted as the pricing basis (Tables 22, 23, and 24).

In the tables, we have assumed that average 1980-1982 yields apply. We have examined the effect of three alternative price assumptions: (i) where prices (in 1983 constant dollars) are set at their 1976-1983 averages (Table 22); (ii) where prices are set at the actual averages for 1983 (Table 23); and (iii) where prices (in 1983 constant dollars) are set at the average of World Bank projections for 1990 and 1995 (Table 24). A further assumption made is that sugar growers receive 70% of the world market price, with the remaining 30% going to the cane mills or beet factories.

The sample of countries chosen for the three tables is intended to be representative, rather than comprehensive, and consists of countries for which ready alternatives to sugar cultivation can be identified. It is remarkable to observe just how well sugar performs as a revenue earner in comparison with
Table 22: FARMERS' REVENUES PER HECTARE HARVESTED FROM VARIOUS CROPS, PRICED AT THE AVERAGE OF WORLD PRICES FROM 1976 TO 1983 EXPRESSED IN CONSTANT 1983 US DOLLARS

<table>
<thead>
<tr>
<th>Country</th>
<th>Sugar /a</th>
<th>Wheat</th>
<th>Maize</th>
<th>Rice /b</th>
<th>Cassava c/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1041.0</td>
<td>280.4</td>
<td>385.0</td>
<td>562.2</td>
<td>367.6</td>
</tr>
<tr>
<td>Australia</td>
<td>2238.2</td>
<td>176.1</td>
<td>389.9</td>
<td>1297.9</td>
<td>-</td>
</tr>
<tr>
<td>Brazil</td>
<td>1141.1</td>
<td>152.2</td>
<td>218.9</td>
<td>296.5</td>
<td>455.0</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1203.2</td>
<td>-</td>
<td>244.8</td>
<td>724.5</td>
<td>399.8</td>
</tr>
<tr>
<td>Fiji</td>
<td>1341.3</td>
<td>-</td>
<td>-</td>
<td>379.0</td>
<td>466.2</td>
</tr>
<tr>
<td>France</td>
<td>1681.7</td>
<td>867.0</td>
<td>701.1</td>
<td>812.9</td>
<td>-</td>
</tr>
<tr>
<td>India</td>
<td>1007.0</td>
<td>271.9</td>
<td>140.2</td>
<td>375.0</td>
<td>665.2</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1695.7</td>
<td>-</td>
<td>179.6</td>
<td>691.1</td>
<td>380.4</td>
</tr>
<tr>
<td>Kenya</td>
<td>2076.1</td>
<td>391.6</td>
<td>218.9</td>
<td>964.1</td>
<td>307.0</td>
</tr>
<tr>
<td>Mauritius</td>
<td>1555.6</td>
<td>-</td>
<td>303.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mexico</td>
<td>1089.1</td>
<td>677.2</td>
<td>227.6</td>
<td>685.2</td>
<td>388.2</td>
</tr>
<tr>
<td>The Philippines</td>
<td>1159.2</td>
<td>-</td>
<td>121.8</td>
<td>451.6</td>
<td>437.1</td>
</tr>
<tr>
<td>Poland</td>
<td>710.7</td>
<td>492.5</td>
<td>489.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Africa</td>
<td>1627.6</td>
<td>198.4</td>
<td>216.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Spain</td>
<td>936.9</td>
<td>297.5</td>
<td>642.1</td>
<td>1229.1</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>1111.1</td>
<td>-</td>
<td>270.6</td>
<td>375.0</td>
<td>576.2</td>
</tr>
<tr>
<td>Turkey</td>
<td>850.9</td>
<td>319.8</td>
<td>269.4</td>
<td>895.3</td>
<td>-</td>
</tr>
<tr>
<td>United States</td>
<td>1401.4</td>
<td>396.7</td>
<td>811.8</td>
<td>1024.9</td>
<td>-</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>1141.1</td>
<td>557.5</td>
<td>554.7</td>
<td>934.6</td>
<td>-</td>
</tr>
<tr>
<td><strong>Average World Price</strong></td>
<td>286</td>
<td>171</td>
<td>123</td>
<td>357</td>
<td>97</td>
</tr>
</tbody>
</table>

/a The farmer is assumed to receive 70% of the raw sugar price.

/b The farmer is assumed to receive 55% of the milled rice price.

/c The cassava price is set at the average for 1977-1982 for Bangkok pellets, converted to constant 1983 values. Pellets are assumed to weigh 40% of the fresh root weight.
Table 23: Farmers' Revenues Per Hectare Harvested from Various Crops, Priced at the Average 1983

<table>
<thead>
<tr>
<th>Country</th>
<th>Sugar /a</th>
<th>Wheat</th>
<th>Maize</th>
<th>Rice /b</th>
<th>Cassava /c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>680.7</td>
<td>306.6</td>
<td>425.7</td>
<td>408.3</td>
<td>367.6</td>
</tr>
<tr>
<td>Australia</td>
<td>1463.4</td>
<td>192.6</td>
<td>431.1</td>
<td>1007.1</td>
<td>-</td>
</tr>
<tr>
<td>Brazil</td>
<td>746.1</td>
<td>166.4</td>
<td>242.0</td>
<td>230.1</td>
<td>455.0</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>786.7</td>
<td>-</td>
<td>270.7</td>
<td>562.1</td>
<td>399.8</td>
</tr>
<tr>
<td>Fiji</td>
<td>877.0</td>
<td>-</td>
<td>-</td>
<td>294.1</td>
<td>466.2</td>
</tr>
<tr>
<td>France</td>
<td>1099.6</td>
<td>948.1</td>
<td>775.2</td>
<td>630.7</td>
<td>-</td>
</tr>
<tr>
<td>India</td>
<td>658.4</td>
<td>297.3</td>
<td>155.0</td>
<td>291.0</td>
<td>665.2</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1108.7</td>
<td>-</td>
<td>198.6</td>
<td>536.2</td>
<td>380.4</td>
</tr>
<tr>
<td>Kenya</td>
<td>1357.5</td>
<td>428.2</td>
<td>242.0</td>
<td>748.1</td>
<td>307.0</td>
</tr>
<tr>
<td>Mauritius</td>
<td>1017.1</td>
<td>-</td>
<td>335.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mexico</td>
<td>712.1</td>
<td>740.6</td>
<td>251.7</td>
<td>531.7</td>
<td>388.2</td>
</tr>
<tr>
<td>The Philippines</td>
<td>757.9</td>
<td>-</td>
<td>134.7</td>
<td>350.4</td>
<td>437.1</td>
</tr>
<tr>
<td>Poland</td>
<td>464.7</td>
<td>538.6</td>
<td>541.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Africa</td>
<td>1064.2</td>
<td>217.0</td>
<td>239.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Spain</td>
<td>612.6</td>
<td>325.3</td>
<td>710.0</td>
<td>953.7</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>726.5</td>
<td>-</td>
<td>299.2</td>
<td>291.0</td>
<td>576.2</td>
</tr>
<tr>
<td>Turkey</td>
<td>556.4</td>
<td>349.7</td>
<td>297.9</td>
<td>694.7</td>
<td>-</td>
</tr>
<tr>
<td>United States</td>
<td>916.3</td>
<td>433.8</td>
<td>897.6</td>
<td>795.2</td>
<td>-</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>746.1</td>
<td>609.7</td>
<td>613.3</td>
<td>725.2</td>
<td>-</td>
</tr>
<tr>
<td>Average 1983 Price</td>
<td>187</td>
<td>170</td>
<td>136</td>
<td>277</td>
<td>97</td>
</tr>
</tbody>
</table>

/a The farmer is assumed to receive 70% of the raw sugar price.

/b The farmer is assumed to receive 55% of the milled rice price.

/c The cassava price is set at the average for 1977-1982 for Bangkok pellets, coverted to constant 1983 values. Pellets are assumed to weigh 40% of the fresh root weight.
Table 24: FARMERS' REVENUES PER HECTARE HARVESTED, FROM VARIOUS CROPS, PRICED AT THE AVERAGE OF THE IBRD PROJECTIONS FOR 1990 AND 1995

<table>
<thead>
<tr>
<th>Country</th>
<th>Sugar /a</th>
<th>Wheat</th>
<th>Maize</th>
<th>Rice /b</th>
<th>Cassava /c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1146.6</td>
<td>247.6</td>
<td>353.7</td>
<td>490.8</td>
<td>367.6</td>
</tr>
<tr>
<td>Australia</td>
<td>2465.2</td>
<td>155.5</td>
<td>358.2</td>
<td>1210.6</td>
<td>-</td>
</tr>
<tr>
<td>Brazil</td>
<td>1256.8</td>
<td>134.4</td>
<td>201.1</td>
<td>276.6</td>
<td>455.0</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1325.2</td>
<td>-</td>
<td>224.9</td>
<td>675.8</td>
<td>399.8</td>
</tr>
<tr>
<td>Fiji</td>
<td>1477.3</td>
<td>-</td>
<td>-</td>
<td>353.5</td>
<td>466.2</td>
</tr>
<tr>
<td>France</td>
<td>1852.2</td>
<td>765.6</td>
<td>644.1</td>
<td>758.3</td>
<td>-</td>
</tr>
<tr>
<td>India</td>
<td>1109.1</td>
<td>240.1</td>
<td>128.8</td>
<td>349.8</td>
<td>665.2</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1867.6</td>
<td>-</td>
<td>165.0</td>
<td>644.6</td>
<td>380.4</td>
</tr>
<tr>
<td>Kenya</td>
<td>2286.6</td>
<td>345.8</td>
<td>201.1</td>
<td>899.3</td>
<td>307.0</td>
</tr>
<tr>
<td>Mauritius</td>
<td>1713.3</td>
<td>-</td>
<td>279.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mexico</td>
<td>1199.5</td>
<td>598.0</td>
<td>209.1</td>
<td>639.1</td>
<td>388.2</td>
</tr>
<tr>
<td>The Philippines</td>
<td>1276.7</td>
<td>-</td>
<td>111.9</td>
<td>421.2</td>
<td>437.1</td>
</tr>
<tr>
<td>Poland</td>
<td>782.8</td>
<td>434.9</td>
<td>449.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Africa</td>
<td>1792.6</td>
<td>175.2</td>
<td>198.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Spain</td>
<td>1031.9</td>
<td>262.7</td>
<td>589.9</td>
<td>1146.5</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>1223.8</td>
<td>-</td>
<td>248.6</td>
<td>349.8</td>
<td>576.2</td>
</tr>
<tr>
<td>Turkey</td>
<td>937.2</td>
<td>282.4</td>
<td>247.5</td>
<td>835.1</td>
<td>-</td>
</tr>
<tr>
<td>United States</td>
<td>1543.5</td>
<td>350.3</td>
<td>745.8</td>
<td>956.0</td>
<td>-</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>1256.8</td>
<td>492.3</td>
<td>509.6</td>
<td>871.8</td>
<td>-</td>
</tr>
</tbody>
</table>

Price Projection for 1990 and 1995 (at constant 1983 prices)

/a The farmer is assumed to receive 70% of the raw sugar price.

/b The farmer is assumed to receive 55% of the milled rice price.

/c The cassava price is set at the average for 1977-1982 for Bangkok pellets, converted to constant 1983 values. Pellets are assumed to weigh 40% of the fresh root weight.
other crops, once the possible distortions introduced by domestic price protection are eliminated.

In the case of the calculations based upon the average long term World Bank price forecasts for 1990 and 1995, only one country/commodity combination—namely Spain/rice—generates higher revenues to farmers than sugar crops in the same country.

Where the prices used in the valuation of output are the average of the actual observed world prices during the eight-year period running from 1976 to 1983, only two country/commodity combinations—Spain/rice, again, and Turkey/rice—achieve higher gross revenues per unit area harvested than the cultivation of sugar.

The third and last of the tables, prepared on the assumption that farmer's revenues were based solely upon the average world prices prevailing in 1983, yields the most striking results of all. Notwithstanding the marked weakness of world sugar prices that year (when they averaged under 60% of the long-term projections of the World Bank), only seven of the 57 country/commodity combinations—India/cassava, Mexico/wheat, Poland/wheat, Poland/maize, Spain/maize, Spain/rice and Turkey/rice—were estimated to have been greater generators of revenues per hectare than sugar.

C. Distribution of Costs Between Field and Factory Operations.

The preceding section has presented an explanation of farmers' apparent reluctance to reduce their production of sugar crops, even in the face of prices as low as those prevailing on the world market in 1983. Low as these levels were in relation to full production costs, they were still high enough to sustain sugar in its enviable position as the highest revenue
generator per hectare in competition with grain crops, when world prices are the basis for valuing earnings. To the extent that purchased inputs need to be deducted from total revenues, the figures quoted above are misleading as a guide to the short-run profitability of alternative crops. However, against this, it must be remembered that farmers are not very dependent upon the world sugar market for their income from sugar; thus, the attraction of sugar crops to growers in 1983 would have been significantly stronger than might be deduced from the last table.

Sugar cane mills and sugar beet factories have much less interest in measures such as cash income per hectare. When sugar prices are low, they often find themselves the unwilling partners of the farmers, being supplied with beet or cane, which they are obliged to process under long-standing contractual commitments, and with the revenues being shared between the two parties under formulae that have often survived with minimal changes for over half a century.

Pressures for a reduction in the area under sugar crops in times of low prices often emerge more from the processing side of the industry than from the growers themselves; but the pattern is far from uniform. Sugar cane mills (whose share of total cane sugar production costs is typically lower than that of beet factories in total beet sugar costs) are in the fortunate position in the short run that their net variable costs are small. Bagasse by-products from cane crushing eliminate fuel as a variable cost; and molasses by-product credits help to offset any other short-run costs.

Sugar beet factories, by contrast, find fuel costs a major burden in the short term, as well as the long term. Furthermore, the energy required to dry beet pulp for final sale almost eliminates the benefits obtained from by-product-revenues in the short run.
Within the cane and beet sectors, too, there is a wide diversity of attitudes by mills and factories towards the profitability of sugar processing. The traditional revenue-sharing formulae that apply to sugar crops go some way towards reflecting different cost breakdowns in different areas. Yet, once all revenue-sharing formulae have been translated into standard components, the vast majority of cane contracts pay the mill in a range between the "upper 20's" to 40% of the total revenues; while the typical range for beet factories is from the "lower 30's" to just over 40% of total earnings from beet sugar.

The following two diagrams (Diagrams B and C), derived from sugar production cost estimates produced by Landell Mills Commodities Studies, give a visual indication of the range within which the actual, ex-post, share of factory costs (in combined field and processing costs) varied during the 1982/83 crop year. In all, 26 countries formed the sample for beet costs, and 56 countries (or regions of countries) formed the sample for cane costs. In both diagrams, the dashed vertical line indicates where the weighted mean of the sample lies (weighted by sugar production in each country).

The distribution of the factories' share within beet costs would appear, from these histograms, to be much more uniform than that for cane; but both include a very considerable dispersion within their total pictures.
Diagram B:
Distribution of Mill Costs as a Percentage of Combined Cane Field and Mill Costs, 1982-83

Number of Countries

Cane Mill Costs as % of Combined Cane Field and Mill Costs

Source: Landell Mills Commodities Studies

World Bank—27044
Diagram C:
Distribution of Factory Costs as a Percentage of Combined Beet Field and Factory Costs, 1982-83

Number of Countries

Mean

Beet Factory Costs as % of Combined Beet Field and Factory Costs.

Source: Landell Mills Commodities Studies

World Bank—27045