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## International Agricultural Trade and Policy Center

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By

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# **Sweetener-Ethanol Complex in Brazil, the United States, and Mexico: Do Corn and Sugar Prices Matter?**

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## **Introduction**

Sugar is a major commodity, produced and traded around the world, but it is no longer the only sweetener. For example, in the United States, roughly 50 percent of the sweetener market is made up of high fructose corn syrup (HFCS), which is also making inroads into Mexico. This is not the case, however, for the European Union and countries such as Brazil, which dominates the world sugar market in almost all aspects (Schmitz, 2002). In the United States, 8 to 10 percent of the U.S. corn crop goes into HFCS production, with roughly the same percentage of corn being used for the production of ethanol (Schmitz and Polopolous, 1999). In Brazil, however, sugarcane, rather than corn, is used in the production of ethanol. Because of relative price differences for corn and sugar, along with government subsidies, countries like Brazil will remain heavily dependent on sugar for both its sweetener needs and ethanol production.

## **The World Sugar Market**

Brazil, the European Union, and India, respectively, are the top three world sugar producers. For example, Brazil produced 19.07 million metric tons (mmt) of sugar in 1998-99.

Brazil is one of the largest sugar-consuming countries in the world. Brazilian sugar consumption increased from 42 kilograms per capita in 1990-91 to 54 kilograms per capita in 2001-02 (Table 1). Brazil ranks among the top three countries in world sugar consumption at 9.45 mmt in 1998-99, behind India at 16.5 mmt and the European Union at 14.4 mmt.

Brazil is also the largest exporter of sugar in the world, exporting both raw and refined sugar. Brazil dominated the 1998-99 export market at roughly 8.9 mmt of sugar, followed by the European Union at 5.2 mmt and Australia at 4.0 mmt. The former Soviet Union was the largest sugar importer, importing 5.2 mmt of sugar in 1998-99. The remaining top-five sugar importers are the European Union, Indonesia, the United States, and Japan.

Brazilian sugar exports increased nearly six-fold from 1990-91 to 1997-98 while Australian sugar exports doubled over the same period. Sugar exports from the European Union and Thailand experienced moderate growth while Cuban raw-sugar exports decreased by two-thirds, down from 6.8 mmt in 1990-91 to only 2.3 mmt in 1997-98. In 1990-91, Cuba was the leading sugar exporter, while Brazil ranked fifth. However, in 1997-98, Cuba was at the bottom of the top five sugar exporters.

Table 1. Brazil: Domestic sugar consumption, 1990-2003.

| <b>Year</b> | <b>Total<br/>(1000 metric tons)</b> | <b>Per Capita<br/>(kilograms)</b> |
|-------------|-------------------------------------|-----------------------------------|
| 1990-1991   | 6,140                               | 42                                |
| 1991-1992   | 6,591                               | 45                                |
| 1992-1993   | 6,829                               | 46                                |
| 1993-1994   | 7,070                               | 47                                |
| 1994-1995   | 7,258                               | 47                                |
| 1995-1996   | 7,703                               | 49                                |
| 1996-1997   | 8,078                               | 51                                |
| 1997-1998   | 8,170                               | 51                                |
| 1998-1999   | 8,600                               | 53                                |
| 1999-2000   | 8,500                               | 52                                |
| 2000-2001   | 8,700                               | 52                                |
| 2001-2002   | 9,050                               | 54                                |
| 2002-2003*  | 9,400                               | 55                                |

\* Forecast: LMC International and Peter Buzzanell & Associates, Inc.

The European Union is by far the largest exporter of refined sugar, followed by Brazil, Thailand, and the Ukraine. In 1995, roughly half of the world's sugar was exported in refined form, dropping to 40 percent in 1996. Exports of refined sugar from Brazil increased from 0.7 mmt in 1991 to 3.6 mmt in 1998. The Brazilian sugar industry is highly flexible because of its ability to refine and export refined sugar (Peña Castellanos and Alvarez, 2002).

### **The Brazilian Sugar Industry and Ethanol Production**

There are two important observations concerning the Brazilian sugar industry. First, Brazilian sugarcane is heavily used for ethanol production and, second, almost all sweeteners consumed in Brazil are derived from sugar. If either of these were to change, the sugar industry would be negatively impacted. However, there are unlikely to be any major changes in the percent of sweeteners derived from sugar or ethanol derived from sugarcane in Brazil.

#### **The Blend Ratio**

The largest portion of sugarcane production in Brazil (as high as 64 percent in 1997-98) goes into ethanol alcohol, both anhydrous and hydrous, with exports between 0.5 billion and 1.0 billion liters per year. The increase in the yield of ethanol from sugarcane has been phenomenal. In 1999, roughly 5,500 liters were produced per hectare whereas, in 1975, per-hectare yield was only approximately 2,000 liters (Schmitz, Schmitz, and Seale, 2003).

Over the past ten years, hydrous-alcohol production has declined by more than 50 percent, while anhydrous-alcohol production has increased more than five-fold over that same period (Schmitz, Schmitz, and Seale, 2003). Anhydrous alcohol is mixed with gasoline according to the blend ratio mandated by the Brazilian government. Vehicles that solely utilize alcohol are fueled by hydrous alcohol, and they mainly exist because of Brazil's government subsidies for rental cars, taxis, and some government vehicles. Ethanol prices were liberalized on February 1, 1999. Subsidies for production of hydrous-alcohol were reduced by more than 50 percent, from

0.98 reais per liter to 0.45 reais per liter, and subsidies for production of anhydrous-alcohol were eliminated (USDA, 2001). However, the alcohol-to-gasoline blend-ratio range for the percentage of ethanol used in Brazilian gasoline is set each year by Presidential decree, so the sugar industry still enjoys the benefits of hidden subsidies (Schmitz, Schmitz, and Seale, 2003). In addition, a common external tariff of 20 percent on sugar imports was put in place in 2001. Imports of ethanol are taxed at 30 percent to ensure that sugar and ethanol producers receive a higher price for their product, without facing competition from other low-cost exporters with respect to the domestic market. However, there is no tax on the intra-zone trade of ethanol for Brazil's Southern Cone Common Market (MERCOSUR) partners. There still remains a support mechanism that compensates for sugarcane-cost differentials across regions that is well under the *de minimis* clause of the World Trade Organization's (WTO) agricultural agreement.

### Sugar and Ethanol Prices

Beginning in 1998, the government no longer set the price paid to independent growers of sugarcane in Brazil. In response to this, the Sao Paulo State Sugarcane, Sugar, and Alcohol Producers' Council (CONSECANA-SP) regulated a model sugarcane-payment system established by the Sao Paulo producers, the largest sugarcane producers in Brazil. This system is based on four criteria, one of which is the quality of each grower's sugarcane expressed in terms of recoverable total sugar (Schmitz, Schmitz and Seale, 2003). Monthly prices received for refined sugar, anhydrous alcohol, and hydrous alcohol are provided in Figure 1.

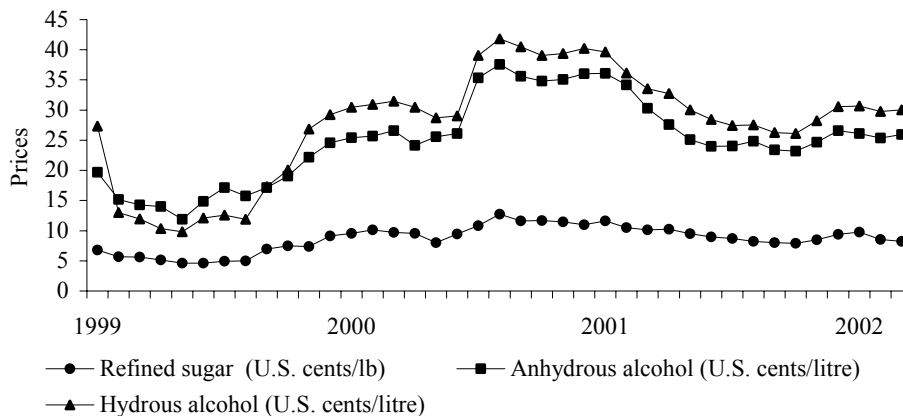


Figure 1. Prices for refined sugar (world), anhydrous alcohol, and hydrous alcohol in Brazil, January 1999–March 2002 (Schmitz, Seale and Buzzanell, 2002).

## The U.S. Sweetener and Ethanol Markets

### U.S. Sweeteners

The United States is a large sugar producer. U.S. sugar prices are kept significantly above world levels through U.S. government farm policies. In addition, unlike Brazil, over 40 percent of the sweeteners consumed in the United States are made up of HFCS (Table 2).

Table 2. U.S. Sugar and HFCS Use: 1992 – 2001

| <b>Year</b>       | <b>Sugar</b><br>(1,000 short tons raw value) | <b>HFCS</b><br>(1,000 short tons dry weight) <sup>a</sup> |
|-------------------|--|---|
| 1992              | 8,259  | 6,627   |
| 1993              | 8,394  | 7,060   |
| 1994              | 8,575  | 7,358   |
| 1995              | 8,804  | 7,629   |
| 1996              | 8,962  | 7,833   |
| 1997              | 9,100  | 8,241   |
| 1998              | 9,317  | 8,491   |
| 1999              | 9,434  | 8,833   |
| 2000              | 9,383  | 8,793   |
| 2001 <sup>b</sup> | n.a. <sup>c</sup>                            | 9,147   |

<sup>a</sup> Excluding exports

<sup>b</sup> 2001 value for HFCS is for first quarter of that year

<sup>c</sup> N/A = not available

Sources: USDA, 2001.

## **U.S. Sugar Program**

Like the previous programs, the U.S. sugar program passed in 2002 supports U.S. sugar producers. The two main elements of the U.S. sugar policy are the price support loan program (LP) and the tariff-rate quota (TRQ) import system. The LP supports the U.S. price of sugar. The TRQ ensures that there is an adequate supply of sugar at reasonable prices for both producers and consumers.

### ***Sugar Loan Program (LP)***

A sugar loan program (LP) allows the United States Department of Agriculture (USDA) to make loans available to processors of domestically grown sugarcane at a rate of 18 cents per pound and to processors of domestically grown sugar beets at a rate of 22.9 cents per pound for refined sugar (U.S. currency). Loans, along with interest charges, are taken out for a maximum term of nine months and must be liquidated by the end of the fiscal year in which the loan was made. Sugar loans are made to processors and not directly to producers. This is because sugarcane and sugar beets must be processed into sugar before they can be traded and stored. To qualify for loans, processors must provide payments to producers proportional to the value of the loan received by the processor for beets and cane delivered by producers. The loans are nonrecourse, which means that when the loan matures, the USDA must accept sugar, pledged as collateral, as payment-in-full in lieu of cash repayment of the loan.

The LP is intended to operate at no cost to the Federal Government. Under the 2002 U.S. Farm Act, the USDA can accept bids from sugarcane and beet processors to add to the Commodity Credit Corporation (CCC) inventory in exchange for reduced sugar production. Also, the USDA is required to establish flexible marketing allotments for sugar.

### ***Tariff-Rate Quota (TRQ)***

A tariff-rate quota (TRQ) is a two-tiered tariff in which the tariff-rate charged depends on the volume of imports. A lower (in-quota) tariff applies to imports within the quota volume and a higher (over-quota) tariff is charged on imports in excess of the quota allotments. The United States has separate TRQs for imports of raw cane sugar and for imports of certain other sugars, syrups, and molasses. Under the Uruguay Round, the United States agreed to import a minimum quantity of 1.256 million tons of raw and refined sugar each year, which includes at least 24,251 tons of refined sugar. The TRQ for raw cane sugar is allocated to at least 40 countries. Under this arrangement, these exporters of sugar to the United States receive the higher U.S. price, which at times is significantly above the world market price. Also, the United States operates two re-export programs. Under the Refined Sugar Re-Export Program, there is a license against which the company can import sugar at world prices for both refining sugar and replacing sugar that has been exported as refined sugar or sugared products. The Program allows U.S. participants to buy world-priced sugar to use in products to be exported onto the world market. HFCS often replaces sugar because sugar prices are significantly above HFCS prices (Table 3). Roughly 10 percent of the U.S. corn crop is used for HFCS production.

Table 3. U.S. Spot Price for HFCS-42 & U.S. Wholesale Refined Beet Sugar Price.

| <b>Year</b>       | <b>HFCS Price, Dry Weight<br/>(cents per pound)</b> | <b>Wholesale Refined Beet Sugar<br/>Price<br/>(cents per pound)</b> |
|-------------------|---|---|
| 1994              | 18.77   | 25.15   |
| 1995              | 15.63   | 25.83   |
| 1996              | 14.46   | 29.20   |
| 1997              | 10.70   | 27.09   |
| 1998              | 10.58   | 26.12   |
| 1999              | 11.71   | 26.71   |
| 2000              | 11.32   | 20.80   |
| 2001 <sup>a</sup> | 11.97   | 22.63   |

<sup>a</sup> 2001 value is for the first quarter of that year

Source: *Milling & Baking News*.

### **U.S. Ethanol**

In the United States, corn is not only used in the production of HFCS, but is also used in the production of ethanol (roughly 10 percent of U.S. corn production goes into ethanol production, which is highly subsidized). However, unlike Brazil, the United States uses essentially no sugar to produce ethanol (Schmitz and Polopolus, 1999). Even with the ethyl tertiary butyl ether (ETBE) tax credit, sugarcane and sugar beets cannot compete with corn in the production of ethanol. According to Schmitz and Polopolus (1999),

- (1) ETBE tax credit is a minor extension of a long list of other tax incentives and subsidies; (2) ETBE tax credit, as well as all other related tax incentives and subsidies, has not had direct stimulus upon the production of ethanol from domestically produced sugarcane or sugar beets; (3) current U.S. sugar program inhibits production of ethanol from sugarcane and sugar beets because it provides both a price support and a price lid at levels too attractive to divert sugar crops from the production of high value sugar to the production of relatively low value ethanol; and (4) the ETBE tax credit is not expected to increase the prices of corn, corn sweeteners and/or sugar (p. 157).

In addition to the ETBE tax credit, the 2002 U.S. Farm Program reinstated target prices for corn (Table 4), providing relatively cheap corn for both ethanol and HFCS production.

Table 4. U.S. Agricultural Commodity Loan Rates & Target Prices.

| <b>Crop</b>               | <b>1996<br/>Loan Rate</b> | <b>2002<br/>Loan Rate</b> | <b>2002<br/>Target Price</b> |
|---------------------------|---------------------------|---------------------------|------------------------------|
| Corn (\$/bushel)          | 1.89                      | 1.98                      | 2.60                         |
| Sorghum (\$/bushel)       | 1.69                      | 1.98                      | 2.54                         |
| Wheat (\$/bushel)         | 2.58                      | 2.80                      | 3.86                         |
| Upland Cotton (\$/pound)  | 0.519                     | 0.52                      | 0.72                         |
| Rice (\$/hundredweight)   | 6.50                      | 6.50                      | 10.50                        |
| Barley (\$/bushel)        | 1.71                      | 1.88                      | 2.21                         |
| Oats (\$/bushel)          | 1.14                      | 1.35                      | 1.40                         |
| Soybeans (\$/bushel)      | 5.26                      | 5.00                      | 5.80                         |
| Minor Oilseeds (\$/pound) | 0.10                      | 0.096                     | 0.10                         |

Source: Bruce A. Babcock, *Iowa Ag Review* 8 (3, 2002) and Parr Rosson, Texas A&M University.

### **The Mexican HFCS Market**

Mexico, like the United States, maintains high prices for sugar producers, many whom are very small relative to their U.S. counterparts (Figure 2). This, along with excess capacity in the U.S. HFCS manufacturing sector, has brought about an increasing use of HFCS in Mexico through increased exports from the United States. Roughly 20 percent of the total sweetener consumption in Mexico was made up of HFCS in 2002 (Garcia-Chavez, Spreen, and Greene, 2002; Buzzanell, 2002).



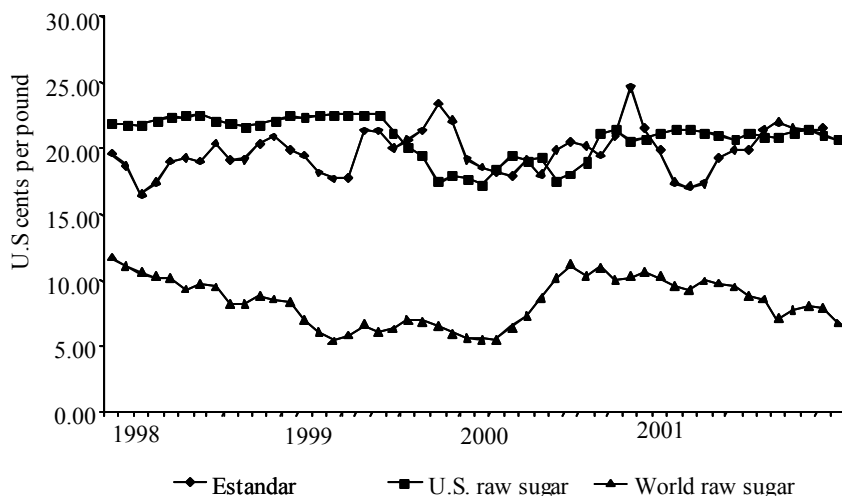


Figure 2. Domestic support prices for Estandar (Mexico) and raw (U.S.) sugar, relative to world sugar prices (1998–2002)

Increased HFCS exports by the United States to Mexico triggered antidumping and countervail duty action lawsuits by Mexico against U.S. HFCS exporters (several panels, including the NAFTA panel, ruled there were no legal bases for these suits). Like the United States, Mexico’s HFCS price is less than the price of sugar, which has placed increasing pressure for the adoption of HFCS in Mexico.

### Why Prices Matter

Sugar in Brazil is used for ethanol and makes up most of the sweetener market, unlike in the United States and Mexico, largely because of relative price differences between sugar and corn. Because of relative prices (that are influenced by government policy), the United States is a net exporter of corn and an importer of sugar, while Brazil is a net exporter of sugar and an importer of corn. Relative prices explain why corn is used in the United States to produce ethanol and sugarcane is used in Brazil.

The sugar-to-corn price ratios in Brazil and the United States are shown in Table 5. The sugar-to-corn price ratios in the United States are significantly above those in Brazil. In fact, most of the annual sugar-to-corn price ratios in Brazil are less than 1 while those in the United States are over 5. At times, the sugar-to-corn price ratio is over 10 times higher in the United States than in Brazil. From a profit-maximizing perspective, it is clear why Brazil would use sugar instead of corn to produce ethanol and why almost all of the sweeteners in Brazil are derived from sugar. Prices do matter since relative prices clearly influence the composition of the sweetener and ethanol markets in the United States and Brazil. For example, as calculated by Schmitz, Seale, and Buzzanell (2002), an increase in the anhydrous/gasoline-blend ratio from 20 to 26 percent would cause the price received by farmers for sugarcane to rise between 4 and 11 percent. This would cause the world price for refined sugar to increase by between \$3.04 and \$7.58 (U.S. dollars) per metric ton. Aggregate sugarcane consumption for all uses combined would increase by between 9 and 20 percent. The increase in the world sugar price would cause Brazilian sugar imports to drop by between 8 and 34 percent. Brazilian producers would receive higher prices due to the expanded demand for sugar, and production would rise by between 5 and 8 percent.

Table 5. Sugar-Corn Price Ratios, Brazil and the U.S., 1985-2001.

| Year  | Brazil                                      |  |  | United States                            |                                |                           |
|-------|---|--|--|--|--------------------------------|---------------------------|
|       | Sugar Farm Price (cents/pound) <sup>a</sup> | Corn Import Price (cents/pound) <sup>b</sup> | Sugar-to-Corn Price Ratio <sup>c</sup> | Wholesale Beet Sugar Price (cents/pound) | Farm Corn Price, (cents/pound) | Sugar-to-Corn Price Ratio |
| 85/86 | 2.68  | 4.17   | 0.77                                   | 23.38                                    | 2.50                           | 9.35                      |
| 86/87 | 2.58  | 4.90   | 0.63                                   | 23.60                                    | 3.23                           | 7.30                      |
| 87/88 | 2.78  | 5.90   | 0.57                                   | 25.44                                    | 4.23                           | 6.01                      |
| 88/89 | 2.75  | 5.60   | 0.59                                   | 29.06                                    | 3.93                           | 7.39                      |
| 89/90 | 3.26  | 5.47   | 0.72                                   | 29.97                                    | 3.80                           | 7.89                      |
| 90/91 | 3.47  | 5.62   | 0.74                                   | 25.65                                    | 3.95                           | 6.49                      |
| 91/92 | 3.09  | 5.12   | 0.72                                   | 25.44                                    | 3.45                           | 7.37                      |
| 92/93 | 3.19  | 5.83   | 0.66                                   | 25.15                                    | 4.17                           | 6.04                      |
| 93/94 | 3.57  | 5.43   | 0.79                                   | 25.15                                    | 3.77                           | 6.68                      |
| 94/95 | 4.19  | 5.40   | 0.93                                   | 25.83                                    | 3.73                           | 6.92                      |
| 95/96 | 4.46  | 6.18   | 0.87                                   | 29.20                                    | 4.52                           | 6.46                      |
| 96/97 | 4.95  | 5.72   | 1.04                                   | 27.09                                    | 4.05                           | 6.69                      |
| 97/98 | 4.95  | 4.90   | 1.21                                   | 26.12                                    | 3.23                           | 8.08                      |
| 98/99 | 3.61  | 4.70   | 0.92                                   | 26.71                                    | 3.03                           | 8.81                      |
| 99/00 | 2.20  | 4.75   | 0.56                                   | 20.80                                    | 3.08                           | 6.75                      |
| 00/01 | 3.61  | 4.92   | 0.88                                   | 22.63                                    | 3.25                           | 6.85                      |

<sup>a</sup> A conversion factor of .134 is used to convert sugarcane to raw sugar

<sup>b</sup> Brazilian corn import price includes dollar/bushel transaction costs added to U.S. prices received by farmers

<sup>c</sup> To calculate corn/sugar price ratio, assume end users pay 20 percent above sugar prices received by farmers

*Source: Calculated by Authors*

## Conclusions

Brazil is a major player in the world sugar market and one of the lowest-cost sugar-producing countries in the world. More than half of Brazil's sugarcane is used to produce fuel alcohol and almost all sweeteners in Brazil are derived from sugarcane. This is in sharp contrast to the highly subsidized U.S. ethanol program, which uses corn instead of sugar beets or sugarcane. Also, the U.S. sweetener market is made up of almost half HFCS. These differences can be explained largely by relative price differences in the two countries for sugar and corn. Government policies in both countries clearly impact sugar and corn prices. Mexico is increasing both its HFCS production and HFCS imports due to high sugar support prices in Mexico and excess HFCS production capacity in the United States.

The Brazilian government is committed to its ethanol program and has repeatedly stated that it will continue to promote alcohol as a strategic source of energy and as a means to help fight pollution. It is unlikely that this policy will change radically with subsequent governments in Brazil. Looking forward, some promoters of fuel alcohol in Brazil foresee the development of a substantial fuel-alcohol-export market (in 2002, only about 0.5 to 1.0 billion liters were exported). To help promote the trade globalization of ethanol, Brazil is providing information on the economics and technological aspects of ethanol production and trade worldwide. The United States is also promoting ethanol fuel but, unlike Brazil, its fuel is made from corn rather than from sugarcane. Three factors account for this difference. First, the U.S. sugar policy keeps domestic sugar prices high. Second, subsidies are available in the United States for converting corn into

ethanol. Third, the 2002 U.S. Farm Program uses both loan rates and target prices, coupled with deficiency payments. As a result, U.S. corn production is higher and prices are lower than under a free-market regime.

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