Brazil is the world’s largest producer of ethanol, a biofuel used mainly in automobiles as an additive or alternative to gasoline. In the mid-1970s the country undertook a major program to produce ethanol, and since then the industry has had both successes and failures. Although Brazil’s program was criticized as being uneconomic during periods of low oil prices, the ethanol industry today is recognized as an efficient sector that brings substantial benefits to the Brazilian economy.

All Brazilian ethanol is produced from sugarcane through the fermentation of sugars contained in sugarcane juice. In the 2005/06 growing season, Brazil harvested about 400 million metric tons of sugarcane on 5.5 million hectares (all tons in this brief are metric tons). Three hundred and thirty privately owned sugar mills each process an average of 1.2 million tons per year. The by-products, bagasse (residues from the sugar manufacturing process) and barbojo (tops and leaves remaining from harvesting), are generally burned. Bagasse in particular is traditionally burned in boilers and used as a source of heat and electricity for sugar/ethanol processing, as well as in other agroindustries, whereas barbojo is burned in the field, yielding no energy value.

PERCEIVED BENEFITS AND REASONS FOR GOVERNMENT SUPPORT
The government’s reasons for supporting biofuels, at first purely economic, have expanded to include concerns about the energy security of the country, greenhouse gas emissions and global climate change, rural employment and equity issues, and local air pollution.

Oil import dependence and energy security. The oil shocks of 1973 and 1979 caused oil prices to soar to US$40 a barrel, pushing Brazil’s annual expenditures for oil imports to more than US$10 billion and causing a global recession. To pay these high import bills and develop domestic energy alternatives, Brazil borrowed heavily from abroad. In the early 1980s, however, a substantial increase in interest rates worldwide forced Brazil, along with other Latin American countries, to implement strict economic adjustments that led to negative economic growth and rapid inflation.

Ethanol production has thus played an important role in guaranteeing fuel security, with the advantage of not requiring hard currency disposal. Since 1975 ethanol has displaced more than 280 billion liters (1.7 billion barrels) of gasoline and saved more than US$65 billion in the cost of oil imports. When the cost of servicing the debt that such imports would have required is included, the cost savings rise to more than US$100 billion.

Employment. The sugar/ethanol sector has become a major employer: in 2001 it was estimated that ethanol production accounted for roughly 1 million jobs in Brazil, of which about 65 percent were permanent and the remainder seasonal (for harvesting). The indirect creation of employment in manufacturing and other sectors was estimated at about another 300,000 jobs.

Sugarcane plantations create jobs in rural areas, most of them for unskilled workers. Moreover, around 30 percent of sugarcane production is in the hands of 60,000 independent producers, representing a major activity for small farmers.

Local air quality. The introduction of gasohol, a combination of gasoline and ethanol, had an immediate impact on the air quality of Brazil’s large cities, particularly São Paulo. Evaluations of ethanol’s impact on air quality found that E-10 (gasohol made up of 10 percent ethanol) reduces carbon monoxide, a precursor for ozone formation, by more than 25 percent. When used as an additive, ethanol also displaces highly toxic and volatile components of gasoline (such as lead, benzene, toluene, and xylene).

REASONS FOR THE SUCCESS OF BIOFUELS IN BRAZIL
Synergies with the sugar market. The coupled production of ethanol and sugar, which occurs in almost all sugar mills, is a significant driver of Brazil’s successful ethanol program. International sugar prices have been both highly volatile and on a general downward trend. If sugar prices fall, mills may find it more profitable to shift to ethanol production. Experience has shown, however, that it is important to protect the domestic market for ethanol—that is, in order to prevent domestic ethanol shortages, sugarcane producers often have to produce ethanol even when they could make greater profits by selling sugar.

Significant improvements in the productivity of the sugar industry have benefited ethanol production. Between 1975 and 2000, sugarcane yields in the São Paulo region rose by 33 percent, ethanol production per unit of sucrose rose by 14 percent, and the productivity of the fermentation process rose by 130 percent. Thanks to these productivity improvements, the cost of producing ethanol declined by an annual average of 3.8 percent from 1980 to 1985 and 5.7 percent from 1985 to 2005 (see figure next page).

Synergies with electricity and heat production. Another important contributor to the success of biofuels lies in the energy content of sugarcane residues. At present, cogeneration of heat and electricity from bagasse supplies most of the energy needs of the biofuel production process itself, as well as allowing an increasing amount of electricity to be exported to the grid. From 1997 to 2004, the amount of electricity from biomass sold to the grid increased from 80 to 1550 gigawatt-hours (GWh). This surplus electricity came mainly from retrofitting existing energy supply facilities in some 30 sugar mills.

Institutional support. Replacing gasoline with another fuel faces a “chicken-and-egg” problem in the supply chain. Consumers are afraid to buy cars that use a new fuel that may be difficult to find. Service station owners are not interested in investing in a parallel fuel distribution system since the number of potential users is usually very small. Therefore the Brazilian government, at both the federal and state level, had an essential role to play in providing incentives and setting up a clear institutional framework. This role included setting technical standards, supporting the technologies involved in ethanol production and use, providing financial advantages, and ensuring appropriate market conditions.

Geographical aspects. Brazil has abundant agricultural land and an appropriate climate for sugarcane. Its sugarcane industry was already developed, and the dominant state in this industry—São Paulo—
accounted for more than half of the country’s car fleet. In other areas of the country, the government subsidized the transport costs of ethanol to ensure wide geographical coverage.

THE OUTLOOK FOR BIOFUELS IN BRAZIL

Ethanol supply and demand have not always been properly balanced in Brazil. In 1989 ethanol supply was not able to fulfill demand because of poor management of supply and demand, and as a result, sales of cars powered by neat ethanol fell from more than 90 percent of new cars in the late 1980s to almost 1 percent in 1996. Thus there was no significant increase in ethanol production during the 1990s and early 2000s. Since flex-fuel cars—capable of running on gasoline, ethanol, or any combination of the two fuels—were launched in early 2003, internal ethanol consumption has increased significantly. At the beginning of 2006, 75 percent of new cars manufactured in Brazil were flex-fuel models. Exportation of ethanol has also increased since 2001, and in 2004 exports reached 2.5 billion liters. In 2005 exports fell to just less than 2 billion liters, owing to intense internal demand for the product.

Recent expansion of internal and external markets has triggered the interest of investors, and many new sugar mills are being built. Sugarcane cultivation is being extended to new areas, and it is expected that 570 million tons of sugarcane will be harvested by 2010, compared with 400 million tons in 2005. About 90 new sugar mills will become operational between 2006 and 2010, most of them designed to handle an average of 3 million tons of sugarcane per year when in full operation. Old refineries are also being retrofitted to become more productive.

Sugar mills are also diversifying their energy outputs. Since 1997, when legislation allowed independent power producers to sell electricity to the grid, the supply of electricity to the grid from sugar mills has grown strongly. Around 600 MW of installed power from sugar mills were delivered to the grid in 2005. Sugar mills are starting to economically compete with conventional sources of electricity to meet the needs of the national power grid, and this activity is expected to increase. In addition, sugar mills are installing biodiesel plants that offer a number of synergies with sugar/ethanol production.

Sugar/ethanol production does raise concerns about land use. Sugarcane production for ethanol competes with production of food and other export crops. Yet the 5.5 million hectares cultivated with sugarcane represent only 8.6 percent of the total area harvested with essential crops. In addition, farmers are increasingly rotating between sugarcane and food crops like tomatoes, soy, peanuts, beans, rice, and maize. This approach has helped maintain the balance between energy and food and has improved land profitability. The expansion of sugarcane plantations could, however, indirectly lead to increased deforestation, as cattle ranching displaced from pastureland by sugarcane production could encroach on forest areas. Until now, most of the cattle ranching activities in the region have continued on a more confined, less land-intensive scale.

POLICY LESSONS

For countries that wish to improve their energy security while promoting rural development, Brazil’s experience offers some relevant policy lessons. Among the policies most important to Brazil’s success were the following:

- requiring the auto industry to produce cars using neat or blended biofuels;
- subsidizing biofuels during market development until economy of scale allowed fair competition with oil products;
- allowing renewable energy-based independent power producers to compete with traditional utilities in the large electricity market;
- supporting private ownership of sugar mills, which helps guarantee efficient operations; and
- stimulating rural activities based on biomass energy to increase employment in rural areas.

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