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Report Highlights:

Plentiful, and generally cheap, corn supplies in Brazil's Center-West region have enticed investment in the corn ethanol sector over the last few years. The Brazilian Corn Ethanol Union (UNEM) estimates that the sector will produce about 2.5 billion liters of corn-based ethanol in market year 2020/21. There are currently 16 corn ethanol plants in Brazil, located in the Center-West states of Mato Grosso, Goias, and Mato Grosso do Sul. At least four units are corn-only plants, while the rest are flex plants that produce ethanol from both sugarcane and corn. Industry sources report at least seven other corn-based ethanol plants in the planning, development, or construction stage, which could come on line in the next two years. If all the ongoing projects are built as planned, Brazil's corn ethanol production could top 5.5 billion liters per year, consuming more than 13 million metric tons of corn annually.

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Ethanol Production in Brazil

During the 1973 oil crisis, petroleum-producing countries in the Middle East proclaimed an oil embargo, which caused global oil prices to quadruple in a matter of months. In response, Brazil began investing in biofuels production and infrastructure. Today, the country is one of the world's largest producers and consumers of ethanol, second only to the United States in terms of production, and third (behind the United States and Germany) in terms of consumption. Brazil's car fleet is dominated by flex-fuel models, capable of running on pure ethanol, pure gasoline, or any blend of the two. Gas stations throughout Brazil are equipped to sell pure hydrous ethanol, which consumers generally choose over gasoline if the price is 70 percent or less of gasoline, since the biofuel has only about 70 percent as much energy as gasoline. Even "regular" gasoline in Brazil contains a 27 percent ethanol blend. These factors make Brazil an important market for ethanol, both domestically produced as well as imported (primarily from the United States).

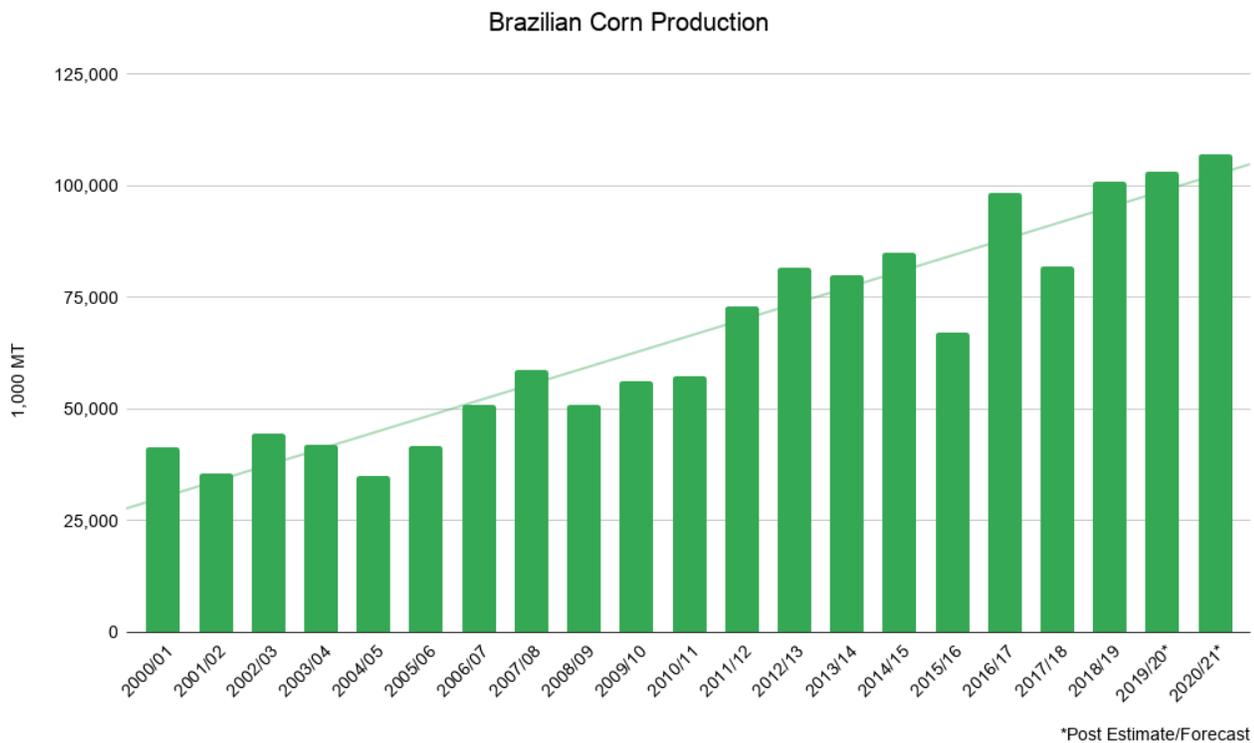
Unlike the United States, the vast majority of Brazilian ethanol is made from sugarcane. The country has roughly 350 sugarcane ethanol plants, largely concentrated along the coast. In 2019, the country produced 37.38 billion liters of ethanol, 96 percent of which came from sugarcane. However, in recent years, a small-but-growing fraction of Brazilian ethanol has been produced from corn, and the burgeoning industry is set to expand rapidly over the next decade. The sector's investors hope corn ethanol can become an important part of Brazil's biofuels equation, as the country's consumption of ethanol is expected to grow at the same time corn production is set to expand.

In 2019, Brazil produced 1.33 billion liters of corn ethanol, but that volume is projected to expand to 8 billion liters by 2028, according to the National Union of Corn Ethanol Producers (UNEM, in Portuguese), the trade group representing the nascent industry. At the same time, Brazilian consumption of ethanol is forecast to grow to 43 billion liters by 2029, according to the Minister of Mines and Energy/Energy Research Enterprise (MME/EPE), supported by the country's new carbon credits program, *RenovaBio*. This expected increase in demand is fueling investment to expand Brazilian production of ethanol from corn, a crop for which the country now harvests more than 100 mmt annually.

For more detailed information about biofuels production in Brazil, please see the [2020 Brazil Biofuels Annual Report](#).

Corn Production in Brazil

In addition to the expected increase in ethanol consumption in Brazil and abroad, another factor encouraging expansion of corn ethanol production in the country is the huge volume of the annual corn harvest. Over the last two decades, Brazil's annual corn crop has more than doubled in volume, reaching an estimated 103 mmt in market year 2019/20. Much of that expansion has come from expanded second-crop corn, which is largely grown in Brazil's Center-West region and is planted after the soybean harvest each year. Decades ago, Brazil's corn crop was largely produced in southern states, where the country's poultry and livestock operations consumed most of the harvest. Domestic demand from the poultry and livestock sectors has also grown in recent years, as exports of chicken and pork meat have surged. However, Brazil still has plenty of supply to export, with nearly 40 mmt in exports in market year 2018/19, much of it coming from logistically difficult locations in the Center-West. That volume is more than 550 percent larger than a decade ago when Brazil exported just 7.1 mmt in market year 2008/09.

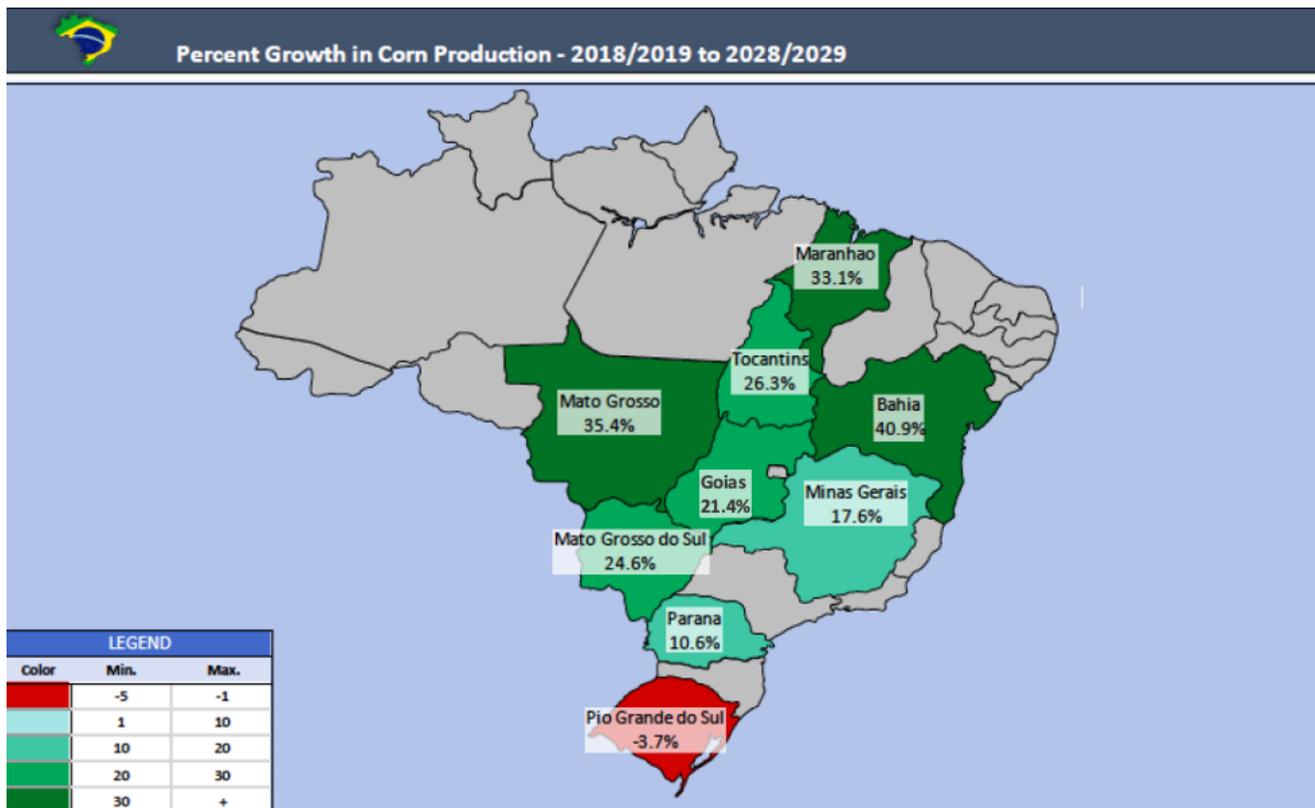


Data Source: USDA PSD

Starting in the 1970s, many farmers from southern Brazil took advantage of relatively cheap land, a warmer climate, and new seed and soil technologies to expand agricultural production in the interior of the country. In much of Brazil's Center-West region, the climate allows producers to harvest two crops each year from the same land. Most producers choose to plant soybeans first, with corn planted on the same fields as soon as the soy harvest wraps up. This practice has drastically increased Brazil's corn production, with more than half of the harvest now grown in the Center-West. Overall, second-crop corn now accounts for about three-fourths of Brazil's national corn crop, with much of the crop intended for export, since production is concentrated in an area with limited transportation options, making it

expensive and logistically difficult to move the crop to southern Brazil, where many poultry and livestock producers are still concentrated. As a result, corn in the Center-West region is consistently less expensive than supplies in the South.

As a result of these factors, Brazil has an abundance of corn supplies in the country’s Center-West region, and that volume is expected to grow rapidly in the coming years. According to Brazil’s agricultural statistics agency, CONAB, production in the largest producing state, Mato Grosso, is forecast to expand by another 35 percent over the next decade, while the neighboring Center-West states of Goiás and Mato Grosso do Sul are both expected to see corn production increase by more than 20 percent.



Source: FAS Brazil graphic based on data from CONAB forecast

For more detailed information about corn production in Brazil, please see the [2020 Brazil Grain and Feed Annual](#), or the most recent [Grain and Feed Update Report](#), published in September 2020.

For additional analysis of CONAB’s long-term forecast for corn production and area, please see the voluntary report [Brazilian Agricultural Production and Trade Long-Term Projections](#).

Corn Ethanol Takes Off in Brazil

Plentiful, and generally cheap, corn supplies in Brazil’s Center-West region enticed investment in several large corn ethanol plants over the last few years. A number of “flex” plants (capable of

processing corn or sugarcane) and full plants (corn-only ethanol plants) have sprung up over the last six years in the Center-West states of Mato Grosso, Goias, and Mato Grosso do Sul. With expectations of expanding biofuel demand in Brazil, the industry is growing rapidly and some pioneers in the industry have already doubled corn ethanol production capacity with additional investments on the horizon.

Corn-based ethanol has been produced in Brazil since 2014. The first production came from sugar mills that had been retrofitted to utilize corn during the summer rainy season when sugarcane is not available. The results of retrofitting sugar mills have been so successful that more mills made the investment in order to process ethanol feedstocks year-round. Additionally, a number of new ethanol mills have been planned and built as flex facilities from the start, with more plants expected to come online in the near future.

In 2017, UNEM was founded in Mato Grosso to represent the interests of the expanding industry. Aggregating Brazilian corn ethanol producers, UNEM has played a leading role promoting the industry's expansion, as well as lobbying for favorable government policies at the state and national level. Over the last three years, several large corn-only ethanol plants have popped up in Mato Grosso. In August 2017, a joint venture named FS Bioenergia, uniting Iowa-based Summit Agricultural Group and Brazilian company Fiagril Participacoes (later renamed Tapajos Participacoes), opened the country's first corn-only ethanol plant in the town of Lucas do Rio Verde in central Mato Grosso, approximately 200 miles north of the state capital of Cuiaba. With the initial capacity to produce about 240 million liters of ethanol each year from stocks of about 585,000 metric tons (mt), the massive investment was encouraged by cheap and abundant corn supplies, as well as expectations of growing ethanol demand in Brazil. A second FS Bioenergia plant was inaugurated in August in the town of Sorriso, about 40 miles north of the first location. Including an expansion to the original plant, FS Bioenergia now has the capacity to produce more than 1 billion liters of corn-based ethanol per year, as well as 680,000 mt of distiller's dried grains with solubles (DDGS), which are used as a livestock and poultry feed, and 34,000 mt of corn oil, which can be processed for food consumption or made into biodiesel. The company has four additional plants in various stages of development in the Mato Grosso towns of Nova Mutum, Campo Novo do Parecis, Primavera do Leste, and Querencia.

Paraguayan ethanol producer Inpasa opened its first corn-only ethanol plant in August 2019, in the town of Sinop, Mato Grosso, about 50 miles north of Sorriso, and a second plant came online in August 2020 in the town of Novo Mutum, which is about 60 miles south of Lucas do Rio Verde. Inpasa's two plants have a daily capacity to produce up to 1.5 million liters of corn ethanol, consuming up to 3,600 mt of corn in the process and producing up to 1,000 mt of DDGS.

Lucas E3, an American manufacturer of corn ethanol equipment announced in May 2020 that it has signed an agreement with Brazilian company Maracaja Bioenergia to build a corn ethanol plant in Mato Grosso. The U.S.-Brazil joint venture will invest R\$500 million (US\$90 million) to build the new plant in the northern Mato Grosso town of Matupa, which sits about 130 miles north of Sinop. The town is located on BR-163, the major transport thoroughfare that connects Mato Grosso to port facilities on tributaries of the Amazon River. The investors noted this would be an important factor to facilitate ethanol sales to northeastern Brazil, as well as possible exports. The four FS Bioenergia and Inpasa plants are also located along BR-163, a fact which makes it cheaper and easier for both companies to purchase corn supplies and sell the resulting ethanol, DDGS, and corn oil.



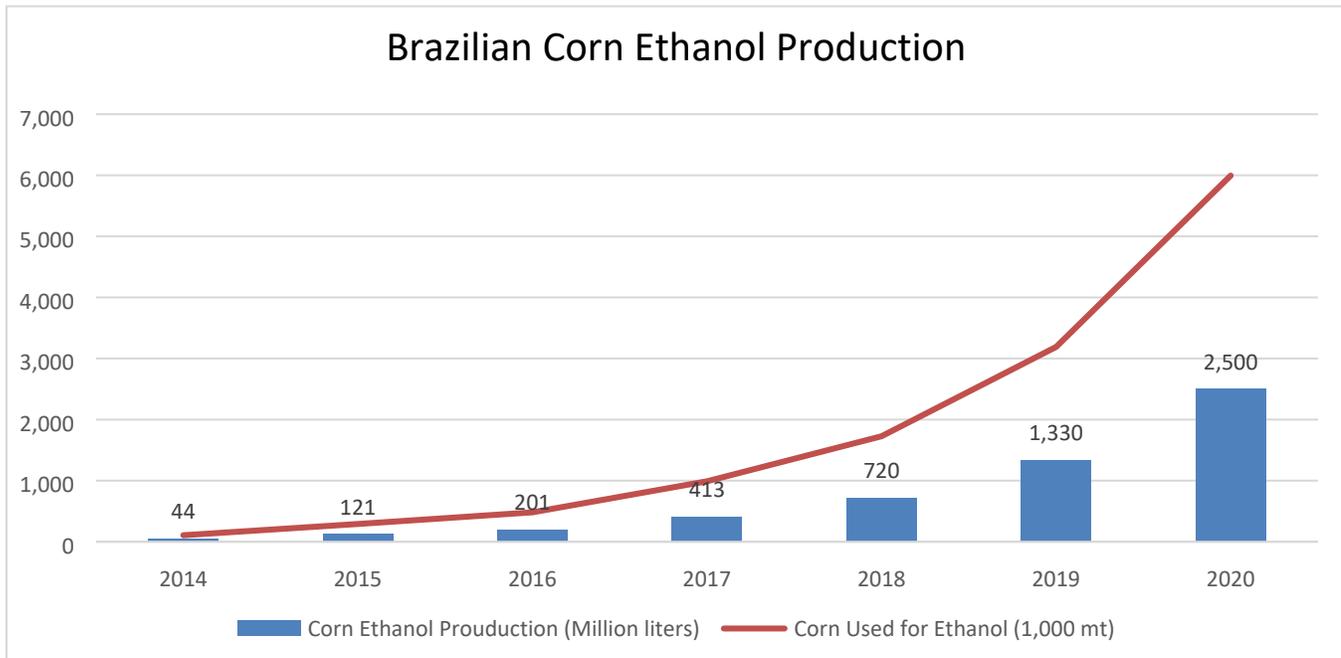
Source: *Valor Economico*

There are currently 16 plants producing ethanol from corn in Brazil, mainly in the state of Mato Grosso, but also in Goiás and Paraná, according to Post contacts. At least four units are corn-only plants, while the rest are flex-plants that produce ethanol from sugarcane and corn. The Brazilian Corn Ethanol Union (UNEM) estimates that the sector will produce about 2.5 billion liters of corn-based ethanol in market year 2020/21.

Industry sources report at least seven other corn-ethanol plant projects in the planning, development, or construction stage. These plants could potentially start operations in 2021 or 2022, including projects in the states of São Paulo and Rondonia. Even though Brazilian ethanol demand has dropped in 2020, due to the COVID-19 pandemic, investors are optimistic that the market will rebound by the time construction on the plants is completed in 18-24 months. If all these ongoing projects are built as planned, overall combined corn ethanol production capacity could grow to more than 5.5 billion liters per year, consuming more than 13 mmt of corn annually.

Total Brazilian corn-based ethanol production in 2020 is estimated at 2.5 billion liters, an increase of 1.17 billion liters compared to 2019. Post estimates that corn ethanol will represent 8 percent of Brazil's total ethanol production in 2020, given that ethanol production from sugarcane is expected to drop as the sugar market has been more attractive, and the domestic fuel market has been hit by the COVID-19 pandemic. Total corn used to produce corn-based ethanol in 2020 is estimated at roughly 6 mmt, an increase of 88 percent compared to the corn volume consumed in 2019, and representing about 6 percent of the corn crop in market year 2019/20.

The graph below shows the evolution of corn used for ethanol production and total corn ethanol production in Brazil since the early stages of the industry. Note that each ton of corn can produce approximately 417 liters of ethanol, 313 kilograms of DDGS, and 18 liters of corn oil, as well as the co-generation of electric power, which most plants sell back to the grid.



Source: FAS Brazil chart based on data from UNEM and UNICA

According to a study conducted by the Mato Grosso Institute of Agricultural Economics (IMEA), the production of corn ethanol in the state has great potential, but the sector is most profitable when a producer is able to leverage a “cluster” of resources to procure inputs like corn and biomass, as well as cultivate reliable buyers of the ethanol and co-products, notably poultry and livestock operations to purchase DDGS and biodiesel or cooking oil processors. That seems to be the case for most of the large corn-only plants, which source most of their corn within 100 kilometers. The major producers have also invested time and resources to market DDGS to livestock and poultry producers who have had little familiarity with the feedstock. The companies have embarked on education programs and developed customized DDGS formulations to meet the specific protein and nutrient demands of Brazilian livestock and poultry producers. Brazil exported DDGS for the first time in late 2019, with a 27,000 mt sold to the United Kingdom. One of the large corn-only plants in the Center-West supplied the shipment by transporting the DDGS by truck over more than 2,000 kilometers from a plant in Sinop, Mato Grosso, to the Port of Paranaguá in the southern Brazilian state of Paraná.

Flex vs. Full Plants

Brazilian corn ethanol plants come in two varieties: full and flex. Full plants are dedicated to processing only corn year-round, whereas flex plants typically process sugarcane at the height of that crop’s harvest season but switch to corn for about three months of the year during the “inter-harvest” period. According to UNEM, flex plants have higher operating costs than corn-only units. That is because flex

plants have the cost and time burden of switching over operations when the sugarcane harvest begins. Although the cost of building a flex facility can be 30 to 40 percent higher than a corn-only plant, flex plants see better revenues than sugarcane-only plants, which typically sit idle for several months of the year. Owing to the production cycle and inability to store the feedstock, sugarcane-based ethanol can be produced for only 8 months of the year. Flex plants can run for a longer period, but a corn-only ethanol plant can run virtually year-round without having to take the time to switch material input.

Roughly speaking, only about one-third of sugarcane-based ethanol plants are financially healthy, whereas corn-only ethanol plants are more likely to have low debts due to higher levels of outside investment. Flex plants may also carry additional debt burdens from the sugarcane industry. Sugarcane as a raw material for ethanol production has heavy agricultural costs (crop management, replanting of sugarcane fields, harvest, transportation, etc.). The crop must be harvested and processed in a short time frame to prevent losing ethanol production potential of the feedstock. Corn, on the other hand, can be stored for months or years if kept at the proper temperature and moisture level. Brazil's large corn-only ethanol plants have massive storage silos that can supply several months of the feedstock needed to operate the plant. These large storage facilities also give the plant flexibility to purchase corn supplies at times of the year with more favorable prices, without having to rely only on spot purchases. In fact, several corn ethanol plants in Mato Grosso sold off a portion of their corn stocks earlier this year when ethanol use dropped in response to the pandemic. They were able to improve profitability by curbing ethanol production in line with market demand while also taking advantage of record-high corn prices due to surging internal demand from the livestock and poultry sector.

There are some disadvantages of corn-based ethanol production compared to processing only sugarcane. Plants processing only corn can only produce ethanol, but sugarcane-only and flex plants can produce both ethanol and sugar. That flexibility allows the plant to calibrate the most profitable production ratio. When ethanol prices are low, plants can switch to product more sugar (as has been the case in 2020) and vice versa.

Additionally, ethanol plants processing sugarcane are powered by using the biomass from sugarcane bagasse to generate energy. Brazilian corn ethanol plants, however, rely on burning eucalyptus or other types of biomass to power operations. Eucalyptus, which is also grown in the Center-West region, is a rapidly growing fuel source and is generally ready to harvest in five to six years after planting. However, needing to purchase eucalyptus or other biomass for use as a fuel source drives up costs and could prove to be one of the limiting factors in how fast the corn ethanol industry can expand in Brazil. Post's contacts estimate that that the sector needs to plant at least 100,000 additional hectares of eucalyptus to keep up with expansion plans. Corn ethanol plants are reportedly starting to source eucalyptus from greater distances (eating into profit margins), as well as experiment with other faster-growing types of biomass, such as bamboo, saw dust from the wood industry, corn straw, and cotton straw.

Prospects for Growth

While corn ethanol production still accounts for only a small fraction of Brazil's overall ethanol production, the abundant supply of corn and growing domestic demand for ethanol, especially in the center of the country, where gasoline prices are higher, likely mean that Brazil's corn ethanol production will continue to expand. According to the Minister of Mines and Energy/Energy Research Enterprise

(MME/EPE), Brazilian consumption of ethanol is forecast to grow to 43 billion liters by 2029, supported by the country’s new carbon credits program, RenovaBio. The expected increase in demand should encourage expansion in the corn ethanol industry. Indeed, UNEM projects that corn based ethanol is projected to expand to 8 billion liters by 2028.

Expansion potential for Brazil’s corn ethanol industry is currently limited by local fuel demand, profitability, and logistical challenges. Corn ethanol production in Brazil is mostly concentrated in Brazil’s Center-West region, close to relatively cheap corn supplies and poultry operations that consume some of the DDGS produced as a co-product of ethanol distillation. Corn prices in the Center-West region are consistently lower than in the South. The chart below demonstrates the price spread for corn in Brazil’s southernmost state, Rio Grande do Sul, and the Center-West state of Mato Grosso, which is the country’s largest corn producer. Due to these abundant and relatively low-priced corn supplies, the state has also become the country’s leading producer of corn-based ethanol.

Corn Price Spread Between Rio Grande do Sul and Mato Grosso

Corn prices in the Center-West are consistently lower than in the South



Source: FAS Brazil chart based on CONAB data

Most of the corn-based ethanol is also consumed in the region or distributed to buyers in 10 states in western and northern Brazil. One major limitation for growth of the corn ethanol sector is the low population density of the region, which corresponds to little fuel demand in general. Moreover, the options to transport ethanol out of the region are limited, with most ethanol needing to travel 1,000 kilometers or more by truck before potentially being placed on barges or larger ocean-going vessels. It should be noted, however, that the state of Mato Grosso recently made its first foreign sales of corn-

based ethanol, with about 10 million liters of fuel ethanol shipped to the Netherlands in May and June, as well as about 23,000 liters of ethanol for industrial use exported to Chile in June.

While corn ethanol is currently primarily supplied to Brazil’s sparsely populated interior, producers are exploring options to sell to the population centers in northeastern Brazil. Although the country’s northeastern states produce sugarcane-based ethanol, the region is usually a net importer of the biofuel, with the United States as the largest supplier. U.S. ethanol exports to Brazil were not subject to an import duty until 2017 when Brazil limited tariff-free imports to a quota, despite the fact that Brazilian ethanol enjoys near duty-free access to the U.S. market. When the quota expired in August 2020, UNEM and the Brazilian Corn Producers Association (Abramilho) were vocal in opposing any duty-free access for ethanol imports. According to press reports, the two groups claimed that allowing imports from the United States is “commercially and environmentally inconsistent.” Notably, Brazil’s corn ethanol sector is pushing for government-backed infrastructure projects that would improve transportation logistics and, along with it, the profitability for corn ethanol producers. The industry is not eager to compete with imports of U.S. ethanol as they expand the distribution of corn ethanol produced in the Center-West.

States in southern Brazil are another target market for corn ethanol producers. Currently, corn ethanol can be moved south from the Rondonopolis rail terminal in southern Mato Grosso. While ethanol needs to be trucked from the production site to Rondonopolis, the railway provides a connection to the Port of Santos, more than 1,000 kilometers away. There are projects underway to expand the railway north from Rondonopolis to Lucas do Rio Verde, which would bring a rail connection even closer to the major corn ethanol production region.

Logum Ethanol Pipeline



Source: Logum

Brazil has one ethanol pipeline, which is operated by Logum. The map above illustrates the Logum pipeline system, which currently connects Brazil's principal sugarcane-based ethanol-producing regions with major fuel consumer centers in the cities of Sao Paulo and Rio de Janeiro. The pipeline is already used to move corn ethanol from Uberaba to the state of Sao Paulo. The closest Logum terminal to the corn-based ethanol-producing areas in the Center-West is Uberaba, in southwestern Minas Gerais state,

but there are plans to extend the pipeline to Rondonopolis in the future. Logum transports about 2.5 billion liters of ethanol annually, but the company is looking to expand capacity to 6 billion liters to meet an expected increase in demand driven by the requirements of the RenovaBio program. Construction could take years to complete, but If the pipeline is indeed extended to the state of Mato Grosso, that could significantly change the market dynamics for corn ethanol production.

Moving corn from the Center-West to more populated states to produce ethanol where demand is higher seems like an unlikely scenario to expand corn-based ethanol production because of the complex Brazilian tax system and lack of sufficient infrastructure. Different states charge varying levels of value-added taxes, also known as the Goods and Services Circulation Tax (ICMS – “Imposto de Circulacao de Mercadorias e Servicos”) for the same products crossing state lines. That factor, coupled with transportation challenges, makes moving grain for ethanol production financially unfeasible. Thus, post expects Brazil’s corn ethanol industry will continue to be concentrated in the Center-West region, where the bulk of the country’s corn crop is harvested.

Corn Ethanol and RenovaBio

Brazil’s newly implemented carbon credits program, RenovaBio, was designed to support the country’s commitments formulated at the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC). Design of the RenovaBio program was launched in December 2016 by the Ministry of Mines and Energy (MME) and was instituted as the “National Biofuels Policy” through a congressional act a year later.

The goals of RenovaBio include helping to meet Brazil's commitments under the COP21 Paris Agreement; contributing to the reduction of greenhouse gas (GHG) emissions in the production, commercialization, and use of biofuels; promoting expansion of the production and use of biofuels in the national energy matrix, emphasizing the continuity of the fuel supply; and contributing to the predictability of various biofuels in the national fuel market. The program is driven by annual carbon intensity reduction targets for a minimum period of 10 years. RenovaBio provides the framework to certify biofuel production by its efficiency in reducing GHG emissions and allows for the sale and trade of decarbonization credits, known as CBios. Each CBio represents one metric ton of carbon saved through the utilization of biofuels versus fossil fuels.

In November 2018, the National Petroleum, Natural Gas, and Biofuels Agency (ANP) adopted Resolution #758/2018, which defines the standards for the efficient production or importation of biofuels; sets up the criteria to calculate the Energetic-Environment Efficiency Score/Rank for domestic biofuels producers and importers; defines the requirements for accrediting certification inspectors and the certification of individual plants; and established Renovacalc, the analytical tool to measure the biofuels carbon intensity score to compare biofuels to the equivalent fossil fuel. In June 2019, MME’s National Council for Energy Policy (CNPE) approved the compulsory targets to be met by fuel distributors for the 2020-2029 cycle. The RenovaBio program was officially launched in late December 2019. Note that compulsory reduction targets were decreased in September 2020 as a consequence of the COVID-19 pandemic and the negative impact on Brazilian Otto-cycle fuel consumption in the next couple of years.

Under RenovaBio, certified producers and importers of biofuels are able to sell CBios, which aids a producer's profitability. The program is voluntary for biofuel producers and importers but mandatory for fuel distributors, which are required to achieve individual decarbonization goals based on their market share. The number of CBios that each party is able to sell depends on the volume of biofuel sold and the party's environmental/energy efficiency rating, provided by Renovacalc. CBios are sold and traded on Brazil's B3 stock exchange. While fuel distributors are obligated to purchase CBios, producers and investors can trade them as well. As of June 30, there were 223 biofuels plants (sugarcane ethanol, corn ethanol and biodiesel) plants certified and authorized to request the issuance of CBios to trade at B3. All together, these plants have the potential to generate approximately 33.87 million CBios, and according to the B3 stock exchange, 7.8 million CBios had been registered by the end of August.

According to Post contacts, there are already several large corn ethanol plants certified to issue CBios. The certification process was onerous, requiring an ethanol producer to supply comprehensive data about every corn supplier to an ethanol plant. Many corn ethanol producers in the Center-West make direct contracts with corn producers, making the certification process relatively easy compared to the United States where corn supplies are commonly mixed at grain elevators. Thus, it is virtually impossible for U.S. ethanol producers to meet the certification requirements to make them eligible to send CBios for ethanol exported to Brazil.

Under Renovacalc, sugarcane-based ethanol producers generally receive the best scores, while Brazilian corn-based ethanol producers are not considered quite as efficient. Notably, Brazilian corn ethanol plants are likely to score better than U.S. plants, due to the use of biomass to generate power. UNEM recognizes that although Renovabio was initially tailored toward sugarcane ethanol producers, which still represent the vast majority of biofuels production in Brazil, the program is likely to increase overall consumption of biofuels and increase profitability for corn ethanol producers. UNEM has been working closely with the Brazilian government to adapt Renovacalc, the analytical tool to rank biofuels units in terms of Energetic-Environment Efficiency, considering the particularities of the corn-ethanol based industry.

For more detailed information about RenovaBio and biofuels production in Brazil, please see the [2020 Brazil Biofuels Annual Report](#).

Attachments:

No Attachments.