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Abstract

The production of soybeans, the fourth leading crop produced globally, is projected to reach a record level in marketing year (MY) 2023/24. Combined, soybeans and their products—soybean meal and soybean oil—are the most traded agricultural commodity, accounting for nearly 9 percent of the total value of global agricultural trade. Brazil is the world's largest soybean producer and exporter, with the United States and Brazil jointly supplying 89 percent of soybean exports to the world in MY 2021/22 (USDA, Foreign Agricultural Service [FAS], 2023). Soybeans stand out as a crucial crop in the expansion of Brazil's farm sector and the country's ascent as a top global supplier of agricultural products. This report focuses on the export competitiveness for soybeans in Brazil and the United States over the MY 2017/18–2021/22 periods by comparing farm-level production costs, producer returns, the cost of internal transportation, and the cost of shipping to a common export destination. With soybean production in Brazil expected to reach a record high in MY 2023/24, a weaker value of Brazil's currency, and the country's exporting capabilities expecting a boost (from expanding transportation infrastructure), changes in the competitiveness of Brazil will have important implications for U.S. and international agricultural markets.

Keywords: soybeans, cost of production, producer returns, productivity, agriculture, trade, transportation infrastructure, shipping costs, ports, export competitiveness, Brazil, United States, China

About the Authors

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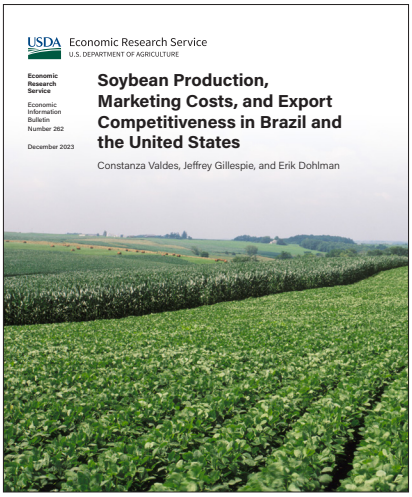


What Is the Issue?

Soybeans and their products—soybean meal and soybean oil—are the most traded agricultural commodity, accounting for nearly 9 percent of the total value of global agricultural trade. Historically, the United States was the world's largest soybean exporter, but in marketing year (a period that corresponds to when harvesting and marketing takes place) (MY) 2012/13, Brazil exported more soybeans than the United States. Since then, Brazil's share of the global soybean trade has increased. Projections indicate that the Brazilian share of global soybean trade could increase from 51.6 to 60.6 percent between MYs 2021/22 and 2032/33. Soybeans are Brazil's main agricultural commodity export by volume, and the country exports more than 60 percent of the soybeans it grows. The international market is of great importance to the U.S. agricultural economy, with soybean exports accounting for 48 percent of total production. Brazil and the United States are major export competitors; thus, a comparison of their production costs will help infer how changes to factors underlying production, marketing costs, and infrastructure affect their export competitiveness. Many aspects of the international trade dynamics of the soybean sector are rapidly changing. Some of these include changes in global demand, local currency fluctuations, transportation costs, and input availability. Brazil's recent expansion of soybean shipments during September to December and recent disruptions to fertilizer imports that were exacerbated by Russia's war against Ukraine also play a role.

What Did the Study Find?

Findings of this study describe many of the factors that affect production, marketing costs, and export competitiveness of the world's leading soybean exporters—the United States and Brazil. This study compares the differences between farm-level production costs and returns for soybeans in the United States and Brazil in 2017/18–2021/22 for the most productive growing regions in each country.

With respect to production costs, returns, and competitiveness, the study finds that:

- Costs of production differed between the United States and Brazil, partially reflecting Brazil's greater reliance on custom services to provide equipment and labor for crop field operations as opposed to farm ownership of machinery in the United States. Land costs were also higher in the United States. Overall, allocated overhead costs were lower in Brazil than in the United States.
- Total costs per bushel of soybeans in the United States exceeded total costs per bushel of soybeans in Brazil in 2021/22.
- Average national farm-level production costs per acre for soybeans in Brazil were 19.9 percent below the United States in 2021/22, largely because of lower land and capital costs. The United States had higher yields per acre than Brazil in the regions included in the study, particularly in the U.S. Heartland region, which helped offset the higher per acre costs.
- Brazilian producers had higher national average returns per bushel over total costs than the United States in 2021/22, $4.05 compared with $2.13.
- Average national returns per bushel above operating costs for soybeans were highest for the United States in 2021/22—16.4 percent above Brazil's returns.
- The U.S. Heartland was the lowest-cost exporter of soybeans. Paraná in Brazil was the next lowest-cost exporter, primarily due to its location close to a port and low internal transport costs. The Brazilian State of Mato Grosso is competitive with the United States in the export of soybeans despite higher inland transport costs due to lower soybean costs of production.
- Improvements in Brazil's overland transportation infrastructure over the past decade resulted in cost savings per metric ton for exporting soybeans from the main producing State, Mato Grosso, through southern ports. Average inland transport costs in MYs 2017/18–2021/22 decreased to $77 per metric ton, compared with $98 per metric ton in MYs 2008/09–2012/13.
- Overland transportation improvements in Central Brazil to provide access to the northern ports lowered truck rates, resulting in cost savings of $28 per metric ton, further improving Brazil's Mato Grosso's competitive position.
- Brazilian exports of soybeans from northern Mato Grosso to Shanghai, China, via the Santarém port in the north represent a savings of $25 per metric ton in landed costs, compared with exports via the traditional Santos port in the southern region.

How Was the Study Conducted?

To assess the relative competitiveness of Brazil and the United States in the global export market, this study compares farm-level production costs, as well as the cost of internal transportation and shipping costs, to a common export destination (Shanghai in China). Soybean production costs are estimated on the costs per planted acre and the costs per bushel. The soybean cost accounts are divided into operating costs and allocated overhead costs. Costs are compared at the national and regional levels for the most productive soybean growing region in each country: the U.S. Heartland and Brazil's Mato Grosso State, the largest soybean producer in Brazil since 2000. For Brazil, the State of Paraná is also included to evaluate inland transportation costs for soybeans exported through southern ports. To make the comparison less sensitive to annual price and yield variations, per-bushel costs and returns are compared using 5-year average prices and yields.

Soybean Production, Marketing Costs, and Export Competitiveness in Brazil and the United States

Introduction

Soybeans in Brazil stand out on the country's rapid rise as a top global supplier in commodity markets. Brazil is the world leader in soybean production and exports. Companhia Nacional de Abastecimento (CONAB), Brazil's national food supply agency, projects soybean farmers will produce an all-time high 154.8 million metric tons (equivalent to 5.69 billion bushels) in marketing year (MY) 2022/23, harvested on a record 43.8 million hectares (108.2 million acres) (Companhia Nacional de Abastecimento (CONAB), 2023). Brazil is projected to export 96.0 million tons of soybeans in MY 2022/23 (USDA, Foreign Agricultural Service (FAS), 2023), and exports are projected to rise to more than 130.4 million tons by 2032/33 (USDA, Office of the Chief Economist (OCE), 2023).

Brazil's strong soybean performance is based on area expansion and changes in technology and farming practices that took place over the past 25 years.[1] Brazil's MY 1997/98 then-record level soybean crop of 32.5 million metric tons plus the devaluation of the real (Brazil's official currency) that was brought on by Brazil's financial crisis in early 1999, strengthened the competitiveness of Brazilian exporters. Later, the introduction of financial reforms, deregulation, privatization, and trade liberalization led to the opening of the soybean sector to traders and processors (Cardoso, 2011). The new participants in the production, processing, and commercialization of commodities, including soybeans, were able to take advantage of economies of scale and vertical integration of markets, consolidating the Brazilian soybean chain.

The growth in the soybean sector accelerated after 2008, and soybeans in MY 2022/23 are projected to account for 51.4 percent of total Brazilian field crops output by volume. A significant share of this agricultural production expansion has been destined for exports (CONAB, 2023). Soaring demand in China—the world's largest soybean importer— has been at the root of much of Brazil's export growth. Since 2005, Brazil's share of China's soybean imports increased rapidly, and since MY 2012/13, Brazil's soybean exports consistently surpassed U.S. exports to China (Gale et al., 2019). China accounts for over 58 percent of global soybean imports; USDA projects that China will continue to account for most of the future growth in global soybean trade during the next decade (USDA, FAS, 2023; USDA, OCE, 2023).

Comparisons of production costs among countries help inform broader analysis and research on the drivers of farm and post-farm gate costs and returns associated with soybean production and international distribution. Cost of shipping data shows how a country's infrastructure affects its export competitiveness. Both real (adjusted for inflation) and nominal (not adjusted for inflation) exchange rates affect Brazil's competitiveness in international markets. A country's competitiveness in commodity markets (defined as an increasing market share in world production and exports) is rooted in its natural resources, factors of production, agro-climate conditions, technology, income, land tenure, supporting institutions, policies and regulations for agriculture, infrastructural conditions, and the structure and magnitude of input costs.

[1] While commercial production of the crop began in the 1940s, the more extensive cultivation and consolidation of soybeans in the country's southern region was achieved in the 1960s and 1970s, supported by Embrapa, the Brazilian agricultural research system, extensive domestic rural support policies, and market and institutional reforms implemented during the 1980s (Banco Central do Brasil, 2021).

Earlier USDA, Economic Research Service (ERS) studies documented the cost and returns of the world's leading soybean exporters, including a study by Schnepf et al. (2001) that examined the direction and intensity of the main soybean market forces in the 1990s. Another study documented how changes in cost and returns in the United States, Brazil, and Argentina affect each country's competitive position in the global corn and soybean markets (Meade et al., 2016). This study provides the latest statistics and analysis on U.S. and Brazilian soybeans farms across regions and the export competitiveness of soybeans for these two countries. This report also discusses key distinctions between the two countries, which underlie their cost structures and may determine future trends in their competitiveness. The report adds to existing literature with a more detailed analysis and estimates of how improvements made over the past decade to Brazilian transportation infrastructure from Mato Grosso to northern ports improved the country's trade position and significantly altered the relative competitiveness between major soybean exporters. These improvements include the completion of the paving of highway BR-163 in Central Brazil and the development of northern transshipment terminals and ports.

This study examines recent farm-level production costs in the United States and Brazil[2] and the cost of internal transportation and shipping to a common export destination. The comparison is based on the latest available production and shipping cost data for both countries in MY 2021/22. While the marketing year concept is used for the discussion of post-harvest sales and transportation, the farm-level costs and returns analysis does not follow the marketing year concept. Farm-level costs are those incurred through final harvest of the crop and the returns reflect the yields and prices received during the harvest month, which differ by country and region.[3] While this approach leads to the omission of some costs, such as storage and other post-harvest costs, these prices are used to be consistent with the source data used in this analysis.[4]

Production cost structures tend to remain relatively stable over time, unlike returns, which vary with yields and prices in response to weather and other supply and demand factors. To make the comparison less sensitive to annual price and yield variations, per bushel costs and returns are also compared using 5-year average prices and yields. The 5-year average includes MYs 2017/18 through 2021/22, which covers the timeframe when the United States and China implemented retaliatory tariffs in mid-2018, which included increased tariffs on U.S. soybeans. The higher tariffs led to significant reductions in U.S. soybean exports to China, the largest importer of U.S. soybeans. Other global economic and market circumstances that took place in MYs 2017/18–2021/22—the Coronavirus (COVID-19) pandemic, supply chain disruptions, persistent inflation, and the start of Russia's war against Ukraine also impacted exports and global market shares. To a large extent, all these factors are reflected in the prices, the cost of production, and in the shipping costs. While this report does not conduct a sensitivity analysis of market dynamics, the authors performed a review of various studies (OECD, 2022; Arita et al., 2022; OECD, 2020; Muhammad & Smith, 2018; Marchant & Wang, 2018; Taheripour & Tyner, 2018) that investigated the impacts of these factors on international trade, global market shares, and on values used in this study including averages of input costs, soybeans prices, transport, and logistics (see box, "Global Economic and Market Circumstances Influencing Soybean Export Competitiveness in MYs 2017/18-2021/22.").

[2] Cost of production for 2021/22 refers to the U.S. soybean crop production planted and harvested in 2021. For Brazil, the USDA convention is to compare with the country's crop grown in late 2021, harvested in early 2022.

[3] For the United States, production costs and returns are associated with the first year of any given marketing year—for example, production costs and returns associated with the marketing year 2021/22 refer to calendar year 2021. In the case of Brazil, planting and harvesting occurs over two calendar years; production costs during marketing year 2021/22 are incurred during two calendar years 2021 and 2022, while returns at harvest are associated with calendar year 2022.

[4] For the United States, the source is the USDA, ERS Commodity Cost and Return data. For Brazil, the source is Companhia Nacional de Abastecimento (CONAB).

Global Economic and Market Circumstances Influencing Soybean Export Competitiveness in MYs 2017/18–2021/22

This report focuses on the combination of farm-level production costs and costs associated with exporting soybeans. It incorporates comparisons of other factors that affect the competitiveness of soybeans on the world market, including transportation infrastructure and the exchange rate. Global economic and market circumstances that took place in marketing years (MYs) 2017/18–2021/22 that affected competitiveness include the Chinese retaliatory tariffs imposed on U.S. soybeans, the Coronavirus (COVID-19) pandemic, climate events, supply chain disruptions, high input costs, persistent inflation, and the start of Russia's war against Ukraine.

China's imposition of a retaliatory tariff on U.S. soybeans in July 2018 led to significant reductions in U.S. soybean exports to China and an increase in Brazilian exports in response (Muhammad & Smith, 2018; Zheng et al., 2018). The price of U.S. soybeans declined, while internal (domestic) soybean prices in Brazil increased (Marchant & Wang, 2018; Taheripour & Tyner, 2018). The Phase One trade agreement signed in January 2020 that included China's promise to increase purchases of U.S. soybeans resulted in U.S. soybean exports reaching pre-retaliatory tariff trade levels but below the commitments (Muhammad et al., 2022; Bown, 2021).

U.S. soybean exports experienced high growth in 2020 due to increased demand driven by China's recovering swine herd following outbreaks of African Swine Fever (Arita et al., 2022). That same year, the COVID-19 pandemic also disrupted global supply chains, leading to shipment delays and soaring shipping costs—which in turn increased domestic prices in various countries (Carrière-Swallow et al., 2022). In the case of Brazil, shipping costs increased 60 percent during the May 2021–January 2022 period (Salin, 2023).

Fertilizer prices started surging during the fall of 2021 and reached high levels during 2022, impacting the cost of producing soybeans in both countries during the 2021/22 crop year. The February 2022 start of Russia's war against Ukraine led to record price volatility in fertilizer markets, affecting the 2022/23 crop (Arndt et al., 2023; Fang & Shao, 2022). Prices are also influenced by exchange rate movements as soybeans are priced in U.S. dollars (USD) but paid in Brazil's real (also denoted as BRL), which depreciated 69 percent against the USD between 2017 and 2021, gaining back some value in 2022 (USDA, FAS, 2023). Prices also differ due to changes in global markets from the time U.S. soybeans are planted and harvested to the time Brazilian soybeans are planted and harvested. In the United States, soybeans are generally planted in the spring and harvested in the fall, but in Brazil, soybean planting and harvesting take place approximately 6 months later. To make the comparison less sensitive to price volatility and yield variations, this study presents 2021/22 cost estimates and 5-year average costs and returns for soybeans for each country.

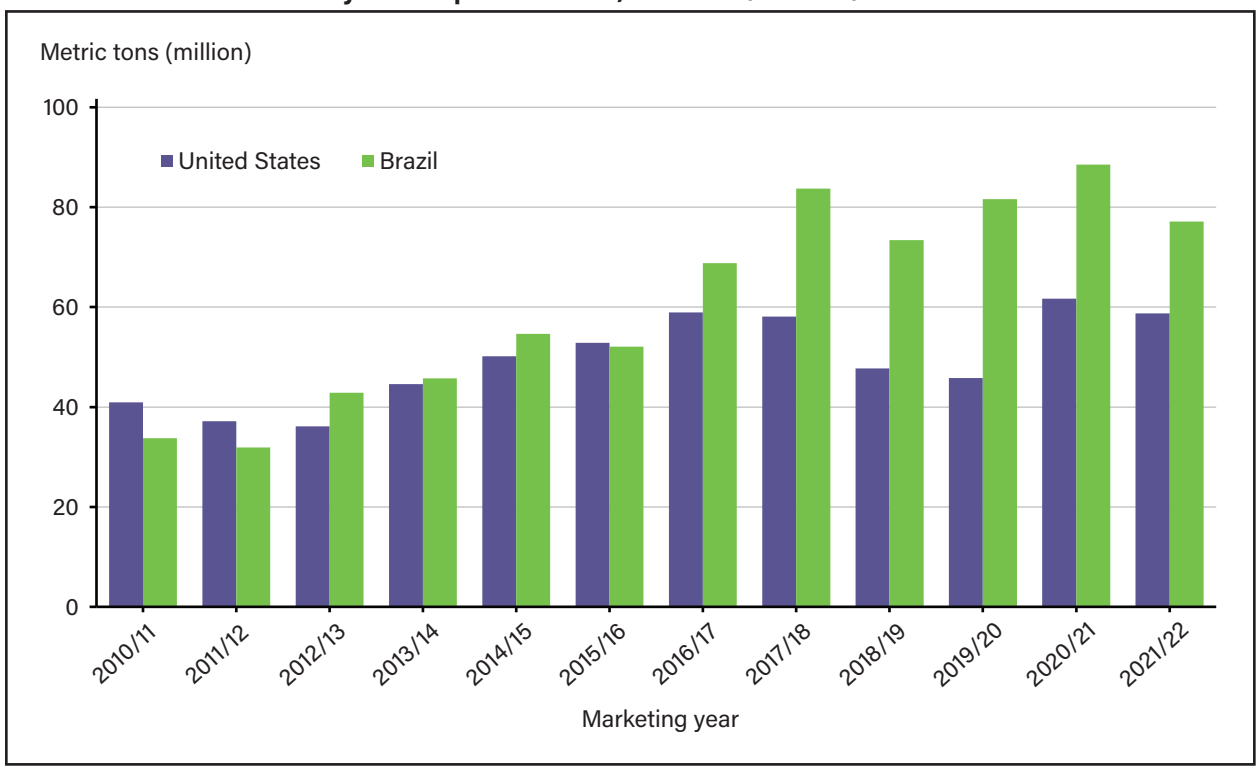
Soybean production costs are separated into operating costs (i.e., cash expenditures for purchases of seeds, fertilizers, chemicals, fuel) and allocated overhead costs (i.e., labor, interest, taxes, insurance, the opportunity cost of land). Costs associated with exporting soybeans, including internal transportation, handling, and ocean freight rates to destination ports, are added to farm production costs. This analysis covers national averages based on all soybean-producing regions in the United States and Brazil. Separate production and marketing costs for the most productive region in each country were also examined since cost structures and farm sizes differ by region. Average prices received by farmers and average soybean yields in each country were analyzed to calculate farm earnings.

The United States and Brazil Are the Largest Soybean Suppliers

The United States was the world's largest soybean exporter until MY 2012/13 when Brazil exported more soybeans than the United States for the first time. And since that marketing year, Brazil's share of the global soybean trade has grown. The *USDA Agricultural Projections to 2032* report projects that Brazil is likely to remain the world leader in soybean production and exports, with its share of global exports rising from 51.6 percent in MY 2021/22 to 60.6 percent in MY 2032/33. Based on these long-term projections (also known as "baseline" projections), the U.S. share of global soybean trade is projected to drop from 38 to 28 percent between MYs 2021/22 and 2032/33. The international market remains crucial to the U.S. agricultural economy, with combined exports of soybeans and products accounting for more than $41.5 billion in 2022.

In MY 2021/22, Brazil exported 77.1 million metric tons of soybeans while the United States exported 58.7 million metric tons (figure 1). Argentina, the world's next largest soybean trader, exported just 5.6 million metric tons of soybeans (USDA, FAS, 2023). China was the principal destination for 57.6 percent of U.S. soybean exports and 70 percent of Brazil's soybean exports that year (Trade Data Monitor [TDM], 2023). USDA's 10-year projections indicate that world soybean imports will increase by 25 percent between MY 2023/24 and MY 2032/33, with China accounting for about 75 percent of the projected increase and Brazil meeting about 86 percent of the increased demand, followed by the United States (USDA, OCE, 2023). China's Gross Domestic Product (GDP) growth and urbanization will continue to fuel animal protein demand, increasing soybean imports and soybean meal consumption for animal feed (USDA, OCE, 2023).

Figure 1
United States and Brazil soybean exports volume, MYs 2010/11–2021/22



MYs = marketing years.

Note: A marketing year corresponds to when the harvesting and marketing takes place.

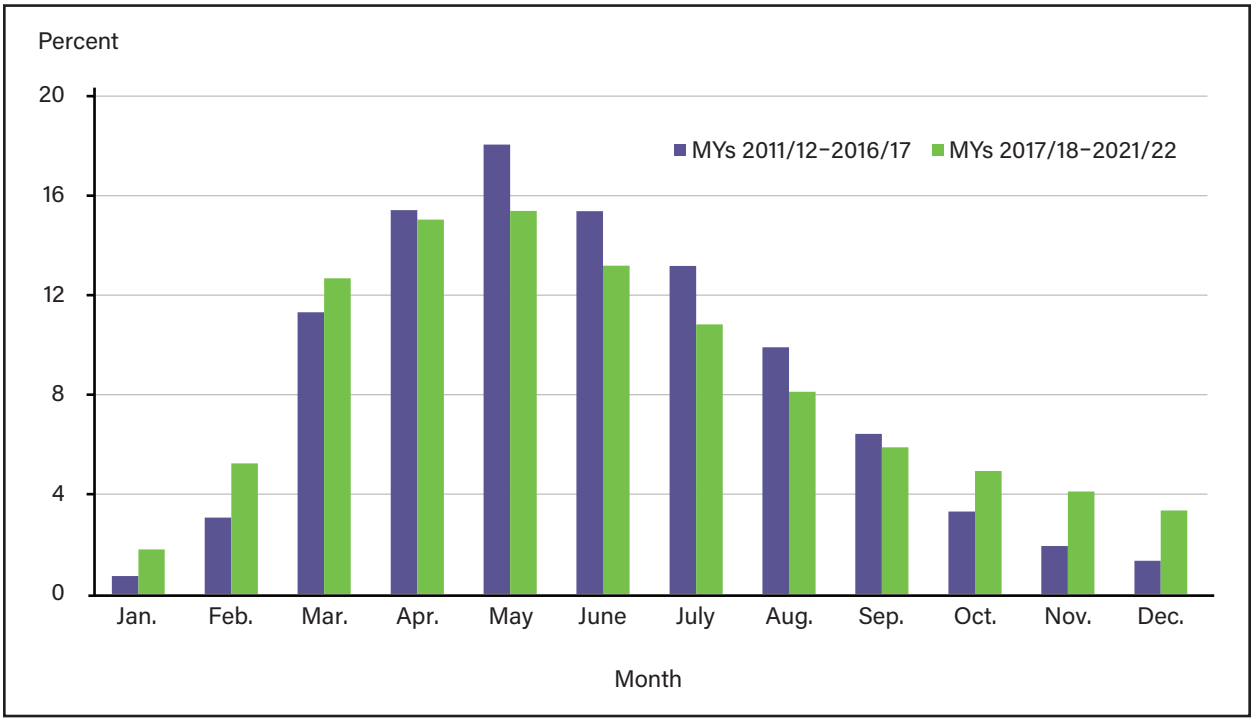
Source: USDA, Economic Research Service using data from the U.S. Department of Commerce, Bureau of the Census, as compiled by USDA, Foreign Agricultural Service, 2023.

China's increasing demand for soybeans played a key role in stimulating growth in Brazil's soybean exports. Brazilian soybean exports to China increased from 5.7 million metric tons in 2004/05 to 60.5 million metric tons in 2021/22, aided by the substantial depreciation of Brazil's real. International trade in soybeans began growing when China liberalized imports to meet demand for protein in animal feed and edible oils, which coincided with Brazil's expansion of output in its inland Cerrado region that propelled Brazil's soybean supply growth. China imported even more Brazilian soybeans after imposing a 25-percent retaliatory tariff on U.S. soybeans in 2018,[5] as Brazil was the only exporter capable of supplying China with large soybean volumes to replace U.S. soybeans. The decrease in China's soybean imports in 2019 is partially attributed to the African swine fever (ASF) outbreak that began in China in August 2018 and led to lower feed demand (USDA, FAS, 2019). In 2021/22, U.S. soybean exports to China represented 52 percent of its total soybean exports. U.S. soybeans were also exported to other Asian countries (19 percent), the European Union (EU) (8 percent), and Mexico (9 percent). Brazil's exports to other Asian countries accounted for 11 percent of its exports, and Brazil's sales to the EU accounted for 8 percent in 2021 (USDA, FAS, 2023).

Historically, Brazil's soybean exports were concentrated in post-harvest months, especially April, May, June, and July. As the volume of Brazil exports increased in line with production gains and the U.S. share of world soybean trade declined, Brazilian shipments during September–December expanded since the U.S.-China trade tensions in 2018, competing with U.S. shipments and amplifying Brazil's export window (figure 2). The trade patterns reflect a market-based response to price by importers caused by differing harvest-time lows in the United States and Brazil.

[5] In July 2018, China imposed a 25-percent additional tariff above the existing 3-percent Most Favored Nation (MFN) tariff rate on U.S. soybean exports. In September 2019, an additional 5 percent rate was added—resulting in a 33-percent tariff on U.S. soybeans. The tariff rate was adjusted downward by 2.5 percent in February 2020, making the effective rate on U.S. soybeans 30.5 percent (USDA, FAS, 2022). In March 2020, as part of the Phase One trade deal with the United States, China opened a tariff exclusion process for the retaliatory tariffs, which reduced the tariff on U.S. soybeans to 3 percent (USDA, FAS, 2020). During 2018-20, China also ordered state-owned enterprises to halt imports of U.S. soybeans (Morgan et. al., 2022).

Figure 2
Brazil's monthly soybean exports as a percent of annual soybean exports, MYs 2011/12–2016/17 and 2017/18–2021/22



MYs = marketing years.

Note: The marketing year for soybeans in the United States is September 1–August 31. For Brazil, the local marketing year is February 1–January 31.

Source: USDA, Economic Research Service using data from the U.S. Department of Commerce, Bureau of the Census, as compiled by the USDA, Foreign Agricultural Service.

Main Soybean Production Regions

The United States

The oilseed products complex is an important component of the U.S. agricultural sector, and soybeans comprise about 90 percent of U.S. oilseed production (USDA, FAS, 2023). More than 92 percent of the soybeans produced in the United States in 2022 were produced in 15 States.[6]

In 2000, almost 75 million acres were planted for soybeans, representing over 29 percent of total planted acreage for the major 8 field crops, making soybeans second only to corn in terms of acreage. Soybean acreage has increased steadily since then, reaching 87.2 million acres (equivalent to 35.3 million hectares) in MY 2021/22. This acreage increase was supported by high soybean prices and net returns, while U.S. soybean production reached 4,465 million bushels (121.5 million metric tons) (Ates & Bukowski, 2022).

U.S. production regions, based on USDA, ERS cost-of-production accounts (USDA, ERS, 2022), includes the U.S. Heartland region that encompasses parts or all of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota. This is one of the world's most productive soybean-growing

[6] Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin (USDA, National Agricultural Statistics Service, 2022).

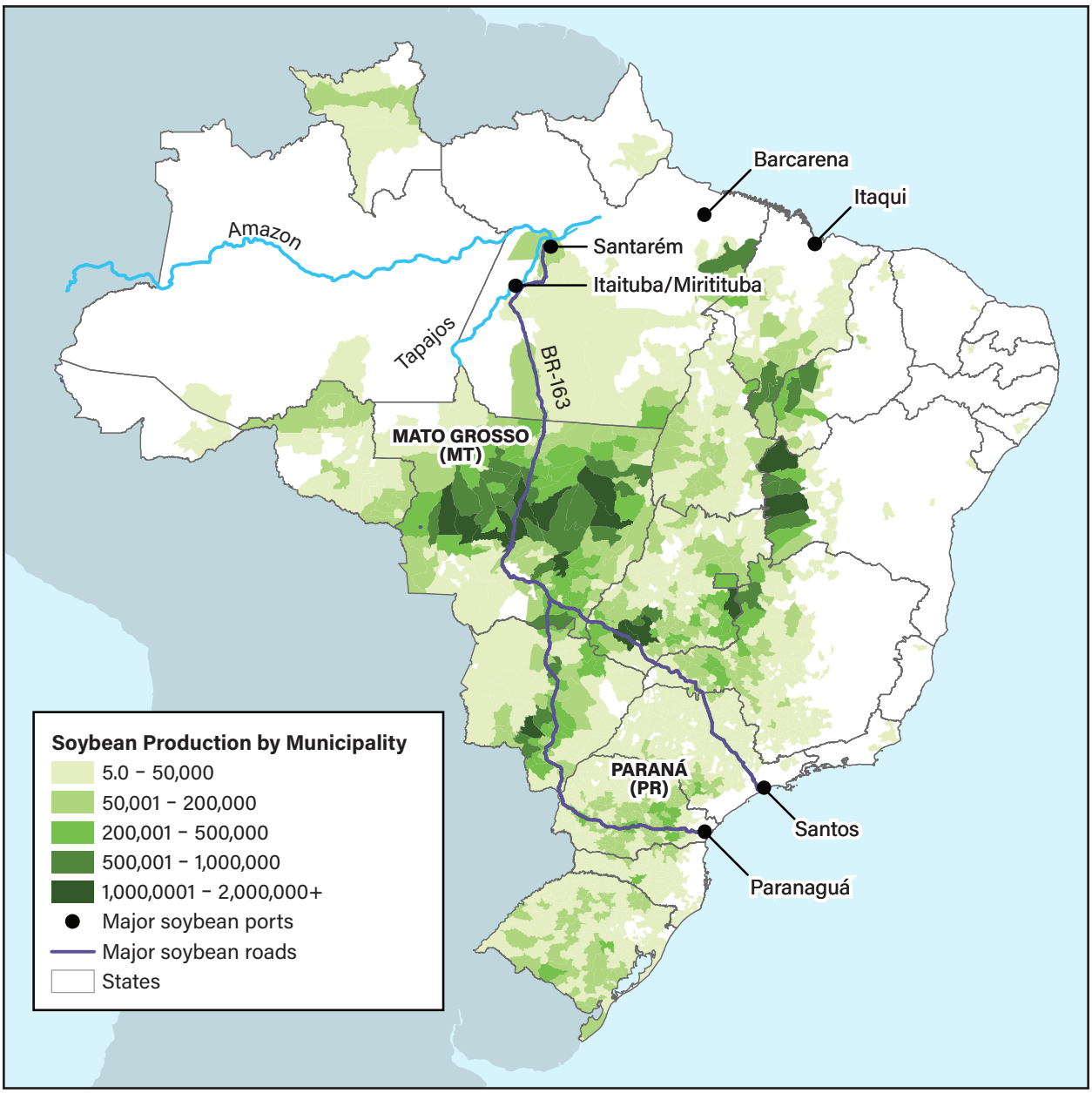
regions, and more soybeans are produced in the Heartland than in any other part of the United States because of the region's fertile and well-drained soils and moderate climate (Meade et al., 2016). As a result, the analysis in this report focuses on production costs in this region, in addition to U.S. national averages.

Brazil

Brazil's climatic and topographic conditions allow for soybeans to be grown throughout the country. In Brazil, soybeans are usually planted in October, yet in the Center-West region and specifically in Mato Grosso, soybeans are planted as early as September; harvesting occurs as early as the beginning of January and as late as April, often followed by a second crop of corn, which is planted in January-February, with early harvesting beginning in June (CONAB, 2022). Brazil initially began growing soybeans during the 1960s by double-cropping them with wheat in traditional production regions like the State of Rio Grande do Sul in the far southern part of Brazil. As part of agricultural diversification efforts during the early 1960s, soybeans were introduced as an alternative to coffee in the State of Paraná, which is to the north of Rio Grande do Sul (Brandão et al., 2005). Schnepf et al. (2001) reported that a U.S. soybean export embargo and high prices during the 1970s prompted greater investment in Brazil's soybean industry by multinational and Japanese companies. Brazil's economic and political reforms contributed to a more stable macroeconomic situation, and the mid-1990s surge in commodity prices further encouraged soybean production (Cardoso, 2011).

At the center of the large-scale soybean production is the long-term strategy of cultivating the Cerrado—an extensive tropical savannah covering central Brazil and some portions of the southeastern and northeastern regions and comprising 11 Brazilian States (Brandão et al., 2005). Figure 3 illustrates the geographical location of the soybean production, roads, and the main export ports in Brazil. For the past three decades, the Cerrado biome (which includes the State of Mato Grosso) saw great expansion of grain and oilseed production, pushing the frontier of soybean production (Colussi & Schnitkey, 2021). With help from the Brazilian Government's agricultural research institution, known as Embrapa, farmers adopted new crop varieties suited to the climate and soil conditions of Brazil's tropical Cerrado savannah. Additional expansion drivers in northeastern Cerrado include Government-sponsored programs to promote the colonization of the Cerrado region and the development of transportation and port infrastructure, and large foreign capital investments in crop and livestock production in the Cerrado region (Cardoso, 2011; CONAB, 2022).

Figure 3
Brazil's major ports, roads, and areas related to soybean production and exports



Note: The Cerrado biome is a large warm and humid tropical biodiversity area composed of savannas and grasslands and located in the highlands of central Brazil.

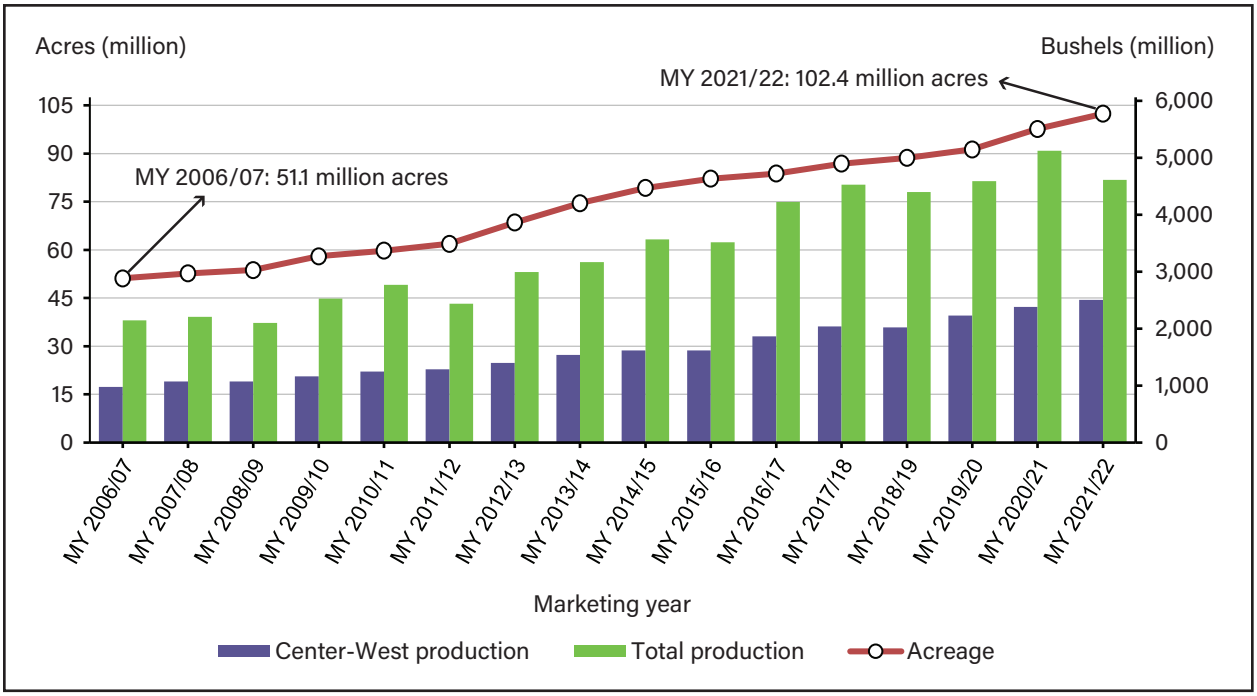
Source: USDA, Economic Research Service using data from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística [IBGE], 2022).

Total soybean production in Brazil increased 7 percent annually between MYs 2006/07 and 2021/22 from 58.4 million metric tons (2,146 million bushels) in MY 2006/07 to 125.6 million metric tons (4,613 million bushels) in MY 2021/22. Soybean acreage increased from 20.7 million hectares (51.1 million acres) in MY 2006/07 to a record high of 41.5 million hectares (102.4 million acres) in MY 2021/22 (figure 4).

The authors of this report focus on the two largest soybean producing States of Mato Grosso and Paraná (as well as national average data). Mato Grosso, in the center-west agricultural-frontier region, is a humid, tropical zone characterized by poor natural soil fertility. In MY 2021/22, Mato Grosso accounted for 33 percent

of Brazilian soybean production, while Paraná accounted for 10 percent of soybean production (CONAB, 2023). Paraná, located in the traditional agricultural southern region, is characterized by a humid, warm, semitropical climate. Paraná is Brazil's third-largest soybean producing State and was a pioneer in commercial soybean production in the 1960s due to the demand for protein feed for the growing pork and poultry sectors in the State (CONAB, 2023; CONAB, 2022).

Figure 4
Brazil soybean acreage and production, MYs 2006/07–2021/22



MY = marketing year.

Note: A marketing year corresponds to when the harvesting and marketing takes place. The Center-West region of Brazil comprises the States of Goiás, Mato Grosso, Mato Grosso do Sul, and Distrito Federal.

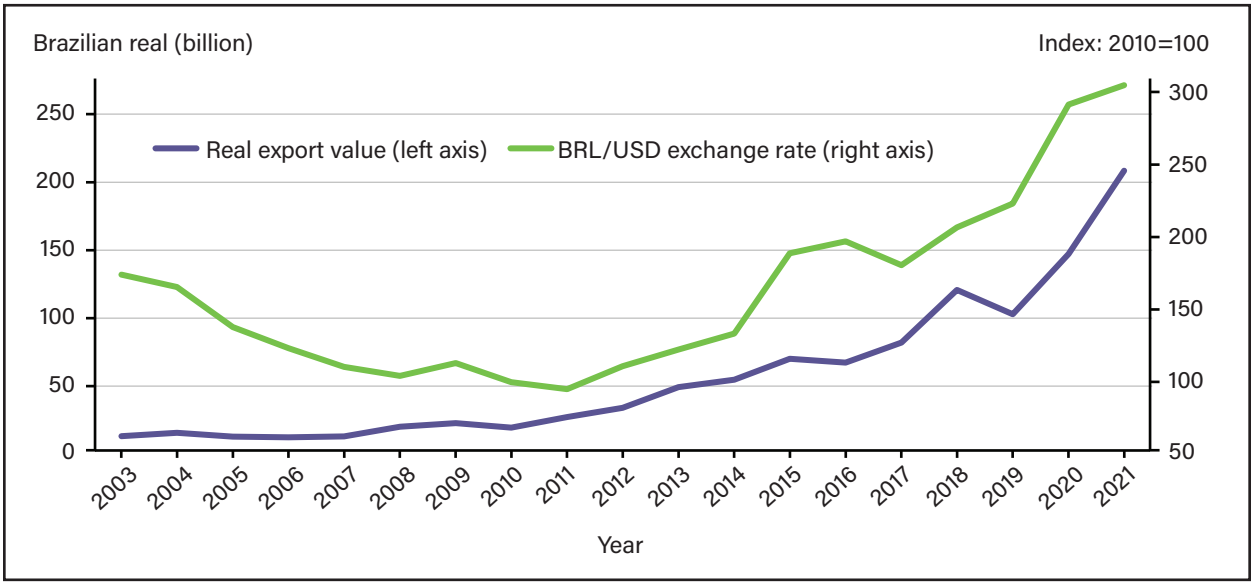
Source: USDA, Economic Research Service using data from Companhia Nacional de Abastecimento (CONAB, 2023).

Production Costs and Export Competitiveness

Production and shipping costs of an export commodity reflect a country's resource endowment, its available infrastructure, and the policies (e.g., macroeconomic, sectoral, trade) that can affect production and trade (Meade et al., 2016; Schnepf et al., 2001). Brazil has experienced a series of local currency devaluations, calculated as an increase in the exchange rate (measured in units of BRL per USD). Both real (adjusted for inflation) and nominal (not adjusted for inflation) exchange rates affect Brazil's competitiveness in international markets. A currency devaluation will affect domestic and foreign prices, production costs, and debt that is indexed in local and foreign currencies. With devaluation, prices of commodities in local currency will increase, and all costs measured in foreign currency will decrease, leading to higher profit margins and increased revenues when the increase in output prices in the local currency more than offsets the greater cost impact on imported inputs after a devaluation (figure 5).

Following an extended period of the Brazilian currency depreciation, in 2015 during the country's deep 2014–16 economic recession, and in 2020 during the Coronavirus (COVID-19) pandemic-related recession, Brazil's currency devalued significantly. The accumulated devaluation between 2015 and the peak nominal rate in mid-2020 was 103 percent. Through the end of 2021, the accumulated depreciation was 113 percent. The devaluation of the real encouraged Brazil's farmers to put more land into production and increase double cropping. Consequently, local currency-denominated prices yielded increased net returns for Brazilian farmers despite weak dollar-denominated prices in global markets. In the case of soybeans, land use increased by 38 percent between 2014 and 2022 (CONAB, 2023). The increase in area planted and higher production contributed to an 84-percent increase in soybean exports by volume. Since 2022, the Brazilian real has been relatively stable against the U.S. dollar (BCB, 2023).

Figure 5
Export value of soybeans and Brazil's BRL-USD exchange rate, 2003–21



BRL = Brazilian real; USD = U.S. dollar.

Source: USDA, Economic Research Service using data from Trade Data Monitor (2023) and Banco Central do Brasil (2023).

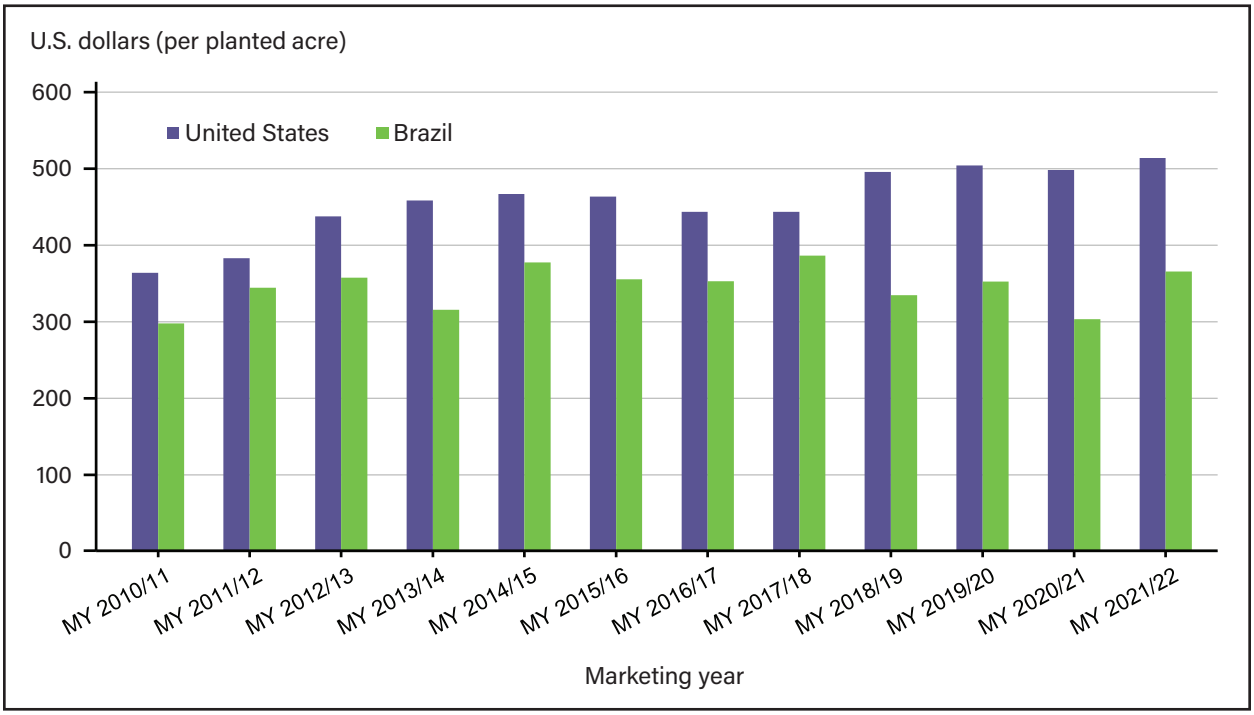
To enable the comparison between Brazil and the United States, the soybean cost-of-production accounts are presented for each country using the U.S. Department of Agriculture's (USDA) concept of economic production costs. The cost data in this report for Brazil correspond exactly to data collected and reported by the Brazilian National Company of Food Supply (CONAB), which adopted the USDA's Agricultural Resource Management Survey (ARMS) for its own cost methodology. No changes to the methodology for Brazil have been made since the last USDA, ERS cost of production comparison report.[7] To equalize cost-of-production comparisons across countries in this study, all Brazilian accounting items are reorganized to fit the U.S. format for operating and allocated overhead crop costs, as reported in the ARMS.

[7] More detailed information on the specific methods for estimating cost of production and how they compare for both countries can be found in Meade et al., 2016.

Comparing Soybean Costs and Returns

On the aggregate, the estimates of USDA's ERS and CONAB indicate that total economic costs per acre to produce soybeans in the United States and Brazil increased by 2.6 and 0.5 percent (nominal value) annually, respectively, over 2010/11–2021/22 (figure 6). The main factors for the increase in per-acre costs in the United States were higher fertilizer, pesticides, machinery, repairs, and land costs. For Brazil, fertilizer costs increased by 16.8 percent, and pesticide costs increased twofold over 2010-22. With its vast supply of arable land, Brazil has considerably lower land costs compared with U.S. producers (Schnitkey & Swanson, 2022; USDA, ERS/ARMS, 2022; CONAB, 2022b).

Figure 6
Soybean production costs per acre in the United States and Brazil, MYs 2010/11–2021/22



U.S.=United States.

Note: A marketing year corresponds to when the harvesting and marketing takes place.

Source: USDA, Economic Research Service (ERS) using data from Companhia Nacional de Abastecimento (CONAB, 2023) and USDA, ERS Cost of Production database.

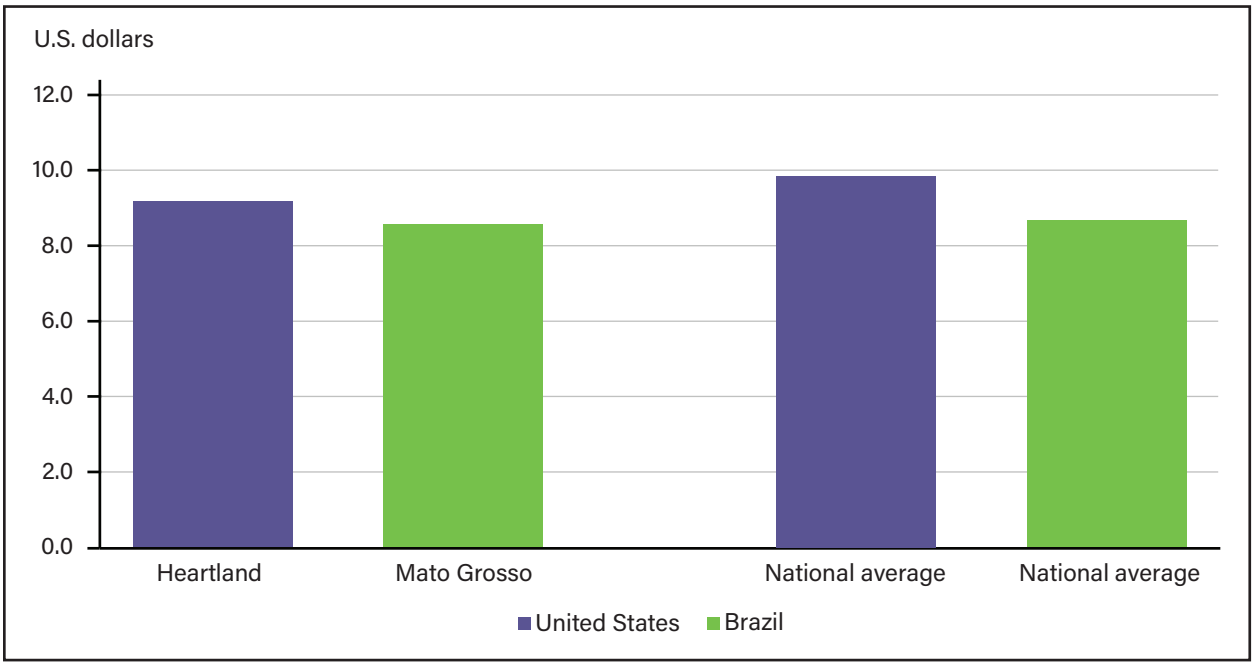
Detailed soybean cost-of-production tables by country, with data from the largest production region and an estimated national average for 2017/18 to 2021/22, are presented in the next section. In the United States, soybeans are generally planted in the spring and harvested in the fall, but in Brazil, soybean planting and harvesting take place approximately 6 months later. Price changes can occur during the period. For example, in the United States, soybean prices increased from September 2021 to March 2022, and fertilizer prices increased from March 2021 to September 2021. While detailed MY 2021-22 cost estimates for soybeans are presented in this report, the authors also present 5-year average costs and returns for each country and region based on the average yields and prices that prevailed during 2017/18 to 2021/22. Operating costs include cash expenditures for purchasing seeds, fertilizer, chemicals, fuel, lube, and electricity. Operating costs also include custom services, repairs, and interest on operating capital. Allocated overhead costs include hired labor, the opportunity cost of unpaid labor, capital recovery of machinery and equipment, taxes, insurance, general

farm overhead, and the opportunity cost of land. Results of recent U.S. surveys indicate that land costs tend to rise and fall with profit margins and government transfers to soybean farmers (Plastina & Edward, 2023).

Farm Cost-of-Production Measures

Farm-level production costs in this report are measured in terms of per unit of land area and per unit of production. The authors report farm level production costs per acre and per bushel. Based on cost-of-production data for 2021/22, the national average soybean total production costs per bushel was $8.67 in Brazil and $9.85 for the 2021 crop in the United States[8] (figure 7). Brazil's Mato Grosso State had an average cost per bushel of $8.57, while U.S. Heartland producers had a cost of $9.18 (figure 7). Brazilian national average harvest-month soybean prices of $10.68 per bushel in 2017/18–2021/22 are above U.S. levels (figure 8). During this same period, prices received by soybean producers in Mato Grosso State ($10.21 per bushel) were 4.4 percent lower than the national average but 5.6 percent higher than U.S. Heartland soybean prices (figure 8).

Figure 7
Total economic production costs per bushel in the United States and Brazil, MY 2021/22



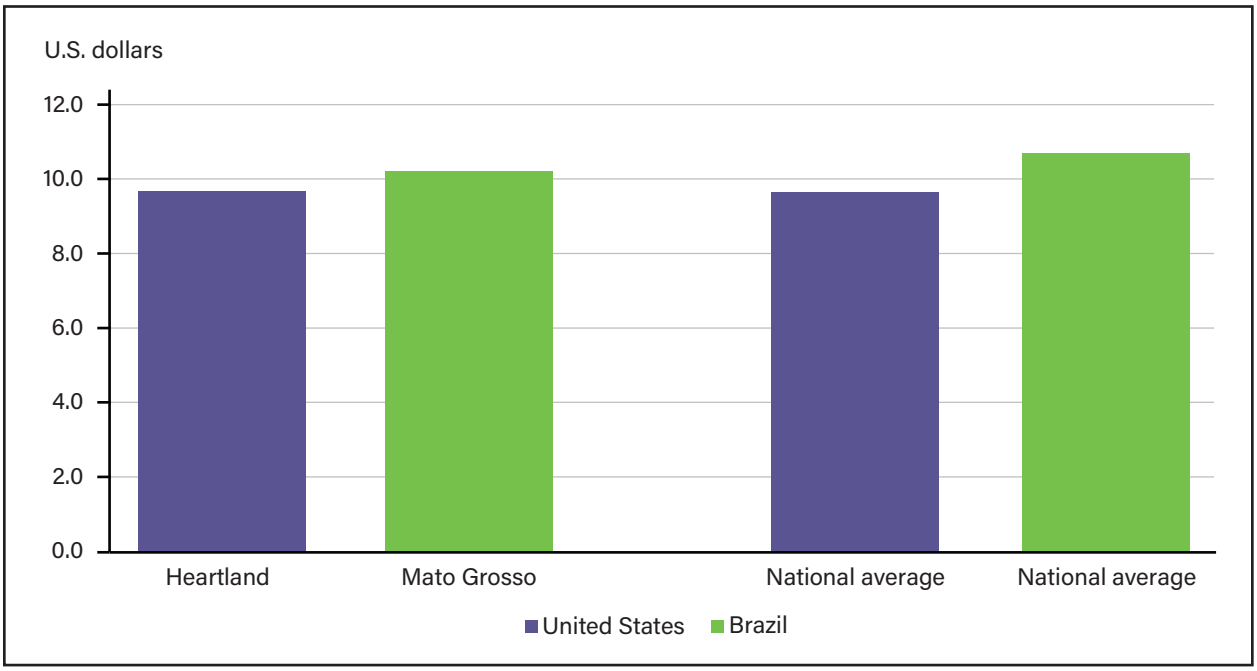
MY = marketing year; U.S.=United States.

Note: A marketing year corresponds to when the harvesting and marketing takes place. Production costs are incurred to produce the crop, which can then enter the market during the marketing year. The Heartland region comprises parts or all of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota.

Source: USDA, Economic Research Service.

[8] In the United States, planting and harvesting the crop is done in 2021, whereas it takes place across 2 calendar years in Brazil, being planted in 2021 and harvested in 2022. In addition, U.S. cost and return estimates assume the crop is sold the month it is harvested, thus the price of soybeans in the month the crop is sold is used.

Figure 8
Regional and national average soybean price per bushel in the United States and Brazil, MYs 2017/18–2021/22



MY = marketing year; U.S.=United States.

Note: A marketing year corresponds to when the harvesting and marketing takes place. Prices are the harvest month price received for the marketing years, for each country. The Heartland region comprises parts or all of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota.

Source: USDA, Economic Research Service.

For Brazil, cost structures are converted to U.S. dollars using yearly changes of real (adjusted for inflation) exchange rates. Using itemized cost-of-production data for 2021/22, results indicate that producers in the United States spent about 36.5 percent of their total per acre soybean costs that year on operating costs, while Brazilian producers spent 63.6 percent of their total costs on operating costs (tables 1 and 2).

Per acre operating costs for soybean production were lower in the United States ($193.95), compared with operating costs in Brazil ($270.85), while fixed costs were significantly higher, mainly due to the higher cost of land (tables 1 and 2). Capital recovery of machinery and equipment is a major contributor to higher allocated overhead costs in the United States (tables 1 and 2). In 2021/22, Brazil's soybean producers spent far more on fertilizers and chemicals per acre than producers in the United States, a reflection of traditionally low-nutrient soils in the center-west agricultural region, high pest prevalence in tropical weather, and the cost to transport by truck imported fertilizers and chemicals to the major production regions of the center-west.[9] In Brazil, most soybean producers hire custom operators to perform field work, while U.S. producers (as is the case for Mato Grosso soybean farmers) most often own the machinery used in crop production. This is reflected in higher custom services and lower capital recovery costs in Brazil relative to the United States. In contrast, seed costs were the largest operating expense per acre in the United States at $63, compared with $43 for Brazil (tables 1 and 2). Both countries plant genetically modified (GM) varieties.[10] Several reasons are behind the discrepancy in seed costs, most notably Brazil's structure of seed production. Brazilian farmers

[9] Global fertilizer prices increased during 2021 from the time U.S. soybeans were planted until Brazilian soybeans were planted.

[10] In the United States, 95 percent of soybean production uses genetically modified (GM) varieties (Dodson, 2023). The adoption rate of GM soybeans in Brazil is 98 percent (CONAB, 2022).

are legally allowed to produce their own seeds—precluding the need to purchase new seeds from seed companies every year, which reduces seed costs (ABRASEM, 2021). An issue that arises (and avoids the payment of royalties), according to the Brazilian Association of Soybean Seed Producers, is the use of pirated seeds from trading the surplus saved seeds with other producers, estimated to account for 29 percent of seeds used for production (ABRASEM, 2021). Land costs averaged $61 per acre in Brazil, compared with about $155 in the United States (tables 1 and 2). In the United States, land is valued according to the average cash rental rate for land producing the commodity in the area being surveyed (USDA, ERS, 2022; Meade et al., 2016). Cash rental rates for cropland are generally correlated with the gross revenue produced by the crop (Plastina & Edwards, 2023). In Brazil, CONAB (2021) estimates the opportunity cost of land in Brazil to be 3 percent of the average market selling price for the land used in the production of the commodity in a particular region. For the United States, the rental rate as a percentage of land value for the 10-year period, 2013–2022 ranged from 2.9 percent to 3.6 percent, with an average of 3.3 percent (USDA, NASS, 2022)

Soybean Cost of Production in Selected Regions of the United States and Brazil

Detailed costs of production are presented in this report, with estimates for each country's most important production region, as well as a national average for each country. Since 56 percent of the 2021/22 U.S. soybean production occurred in the Heartland, the authors focused on soybean production costs for this region, in addition to providing a U.S. average. In the case of Brazil, in 2021/22, the States of Mato Grosso (in the frontier[11] agricultural region) and Paraná (in the traditional southern agricultural region) accounted for 43 percent of the 125.5 million tons of soybeans produced in Brazil in that year, 33 percent and 10 percent of total soybean production, respectively (CONAB, 2023).

Total economic costs per acre to produce soybeans in the U.S. Heartland averaged $560.25 in 2021/22—about 5.4 percent higher than the U.S. national average. In Brazil, the total cost to produce soybeans in Mato Grosso averaged $419.30 per acre—about 1.6 percent below the national average per acre cost to produce soybeans in Brazil (figure 9).

[11] Brazil's frontier agricultural region reflects the westward expansion of agriculture into the forest frontier, which includes the Amazonia, one of the world's largest tropical ecosystems, and the surrounding Cerrado savannah.

Table 1

U.S. soybean production costs per planted acre, Heartland and U.S. total, MY 2021/22

Item	Heartland		U.S. national average	
	Costs	Share of total costs	Costs	Share of total costs
	U.S. dollars per planted acre	Percent	U.S. dollars per planted acre	Percent
Operating costs:	**190.68**	**34.03**	**193.95**	**36.48**
Seed	63.32	11.30	63.37	11.92
Fertilizer	33.02	5.89	33.34	6.27
Chemicals	38.07	6.80	35.72	6.72
Custom services	12.77	2.28	13.10	2.46
Fuel, lube, and electricity	13.75	2.45	16.92	3.18
Repairs	29.69	5.30	31.43	5.91
Purchased irrigation water	0.00	0.00	0.01	0.00
Interest on operating capital	0.06	0.01	0.06	0.01
Allocated overhead:	**369.57**	**66.0**	**337.72**	**63.5**
Hired labor	3.26	0.58	5.37	1.01
Opportunity cost of unpaid labor	17.48	3.12	18.77	3.53
Capital recovery of machinery and equipment	123.64	22.07	125.39	23.58
Opportunity cost of land	190.89	34.07	154.97	29.15
Taxes and insurance	13.25	2.37	13.25	2.49
General farm overhead	21.05	3.76	19.97	3.76
Total costs	560.25	100.0	531.67	100.0
Supporting information, MY 2021/22				
Yield (bushels per planted acre)	61.00	NA	54.00	NA
Price (U.S. dollars per bushel)	11.97	NA	11.98	NA
Costs per bushel (U.S. dollars)	9.18	NA	9.85	NA
Operating	3.13	NA	3.59	NA
Allocated overhead	6.06	NA	6.25	NA
Comparison with 5-year average, MYs 2017/18–2021/22				
Yield (bushels per planted acre)	57.00	NA	52.00	NA
Price (U.S. dollars per bushel)	9.67	NA	9.63	NA
Costs per bushel (U.S. dollars)	9.83	NA	10.22	NA
Enterprise size (planted acres per farm)[1]	288.00	NA	314.00	NA

NA = not applicable; MY = marketing year.

[1]Developed from survey base year 2018.

Note: A marketing year corresponds to when the production and harvesting takes place. Costs reflect those incurred through harvest and the prices are the harvest month price received for that marketing year. The Heartland region comprises parts or all of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota. The 5-year average cost per bushel is based on production costs for 2021/22 and average yields and prices for 2017/18–2021/22.

Source: USDA, Economic Research Service using data from USDA, Economic Research Service Commodity Costs and Returns.

Table 2

Brazil's soybean production costs per planted acre—Mato Grosso, Paraná, and Brazil total, MY 2021/22

Item	Mato Grosso		Paraná		Brazil national average	
	Costs	Share of total costs	Costs	Share of total costs	Costs	Share of total costs
	U.S. dollars per planted acre	Percent	U.S. dollars per planted acre	Percent	U.S. dollars per planted acre	Percent
Operating costs:	**291.34**	**69.48**	**284.54**	**58.42**	**270.85**	**63.58**
Seed	30.85	7.36	41.32	8.48	43.46	10.20
Fertilizer	107.30	25.59	82.90	17.02	96.09	22.56
Chemicals	113.16	26.99	95.03	19.51	81.75	19.19
Custom services	17.91	4.27	41.33	8.48	28.38	6.66
Fuel, lube, and electricity	16.82	4.01	11.16	2.29	12.58	2.95
Repairs	0.96	0.23	8.83	1.81	3.49	0.82
Purchased irrigation water	0.00	0.00	0.00	0.00	0.00	0.00
Interest on operating capital	4.34	1.04	3.97	0.82	5.10	1.20
Allocated overhead:	**127.96**	**30.52**	**202.56**	**41.58**	**155.12**	**36.42**
Hired labor	8.11	1.93	8.74	1.79	9.46	2.22
Opportunity cost of unpaid labor	1.23	0.29	21.54	4.42	7.39	1.73
Capital recovery of machinery and equipment	39.00	9.30	44.86	9.21	42.31	9.93
Opportunity cost of land	48.91	11.66	80.67	16.56	61.18	14.36
Taxes and insurance	14.69	3.50	33.74	6.93	22.94	5.39
General farm overhead	16.02	3.82	13.01	2.67	11.84	2.78
Total costs	419.30	100.0	487.10	100.0	425.97	100.0
Supporting information, MY 2021/22						
Yield (bushels per planted acre	49.00	NA	54.00	NA	49.00	NA
Price (U.S. dollars per bushel	12.54	NA	12.71	NA	12.72	NA
Costs per bushel (U.S. dollars)	8.57	NA	8.94	NA	8.67	NA
Operating	5.95	NA	5.22	NA	5.51	NA
Allocated overhead	2.62	NA	3.72	NA	3.16	NA
Comparison with 5-year average, MYs 2017/18–2021/22						
Yield (bushels per planted acre	50.00	NA	52.00	NA	49.00	NA
Price (U.S. dollars per bushel	10.21	NA	10.89	NA	10.68	NA
Costs per bushel (U.S. dollars)	8.37	NA	9.37	NA	8.69	NA
Enterprise size (planted acres per farm)[1]	3,086.00	NA	125.00	NA	321.00	NA

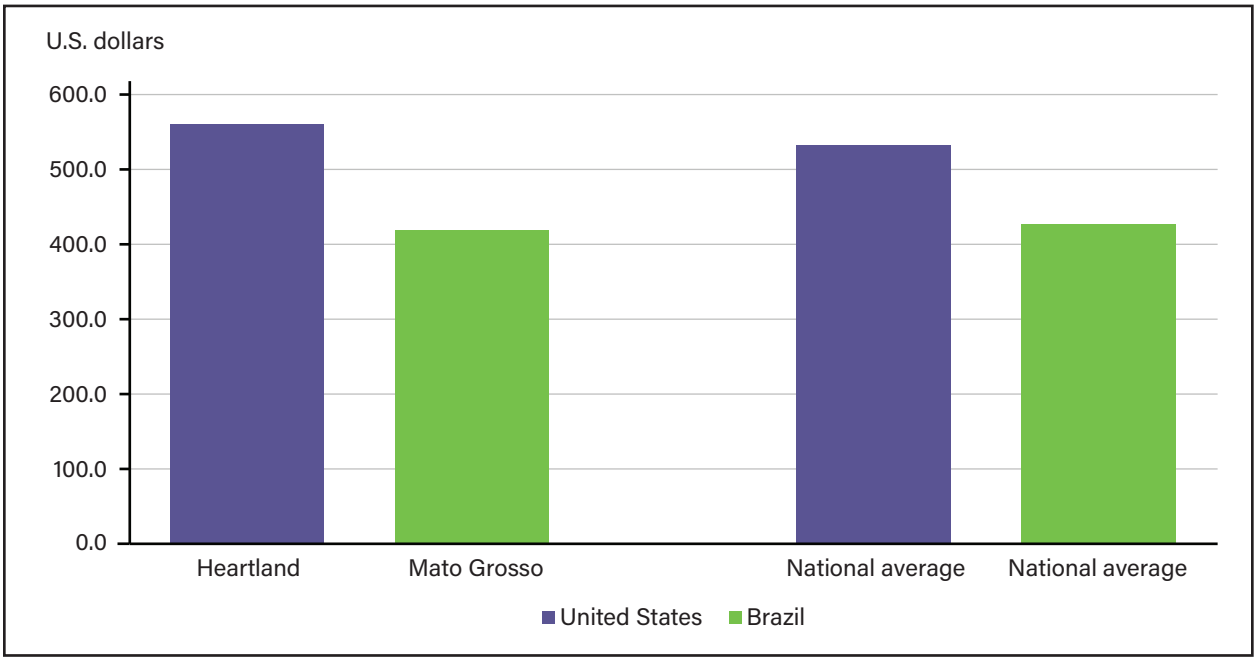
NA = not applicable; MY = marketing year.

[1]Developed from USDA's 2017 Census of Agriculture.

Note: A marketing year corresponds to when the production and harvesting takes place. Costs reflect those incurred through harvest and the prices are the harvest month price received for that marketing years. The 5-year average cost per bushel is based on production costs for 2021/22 and average yields and prices for 2017/18–2021/22.

Source: USDA, Economic Research Service using data from Companhia Nacional de Abastecimento (CONAB, 2022b).

Figure 9
Soybean production costs per acre, MY 2021/22



MY = marketing year; U.S.=United States.

Note: A marketing year corresponds to when the production and harvesting takes place. Costs reflect those incurred through harvest. The Heartland region comprises parts or all of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota.

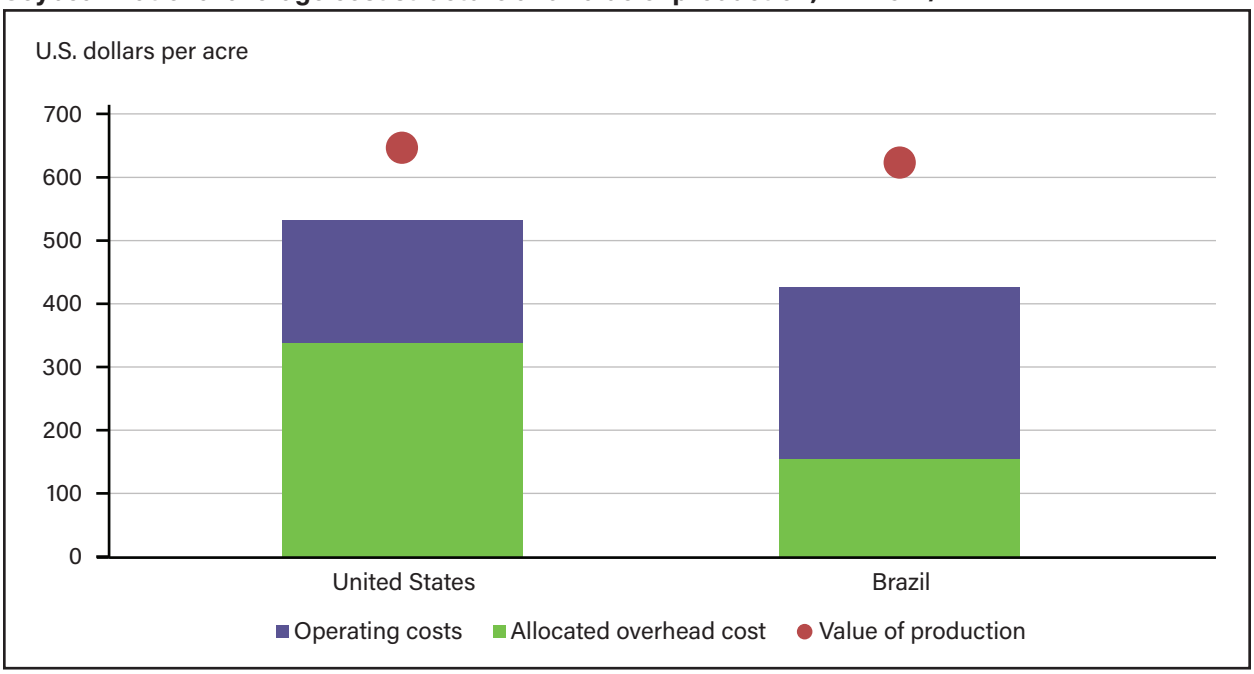
Source: USDA, Economic Research Service.

Average soybean yields differ between both countries: averaging 49 bushels per acre in Brazil and 52 bushels per acre in the United States in MYs 2017/18–2021/22 (tables 1 and 2). U.S. soybean yields were 7 bushels per acre higher in the Heartland than in Mato Grosso in the same period. In MY 2021/22, the average soybean yields in the U.S. Heartland and Brazil's Mato Grosso were 61 and 49 bushels per acre, respectively (tables 1 and 2). While Mato Grosso soybean yields (per harvest) are lower than the U.S. Heartland region, farmers in Brazil can grow two or more crops per year in the same area, which allows farmers to allocate the land cost across crops planted (CONAB, 2021).

The average harvest-month sales price in MY 2017/18–2021/22 for the soybean crop sold by U.S. producers was $9.63, compared with $10.68 received by Brazilian farmers (tables 1 and 2). Soybean prices in the northern Mato Grosso agricultural frontier were 4.4 percent lower than average Brazilian soybean prices in MYs 2017/18–2021/22 (table 2). Limited accessibility of soybean producers in most distant regions of the country, including Mato Grosso State, to domestic and export markets is reflected in the increased transportation costs, which then resulted in lower farmgate prices.

The gross value of soybean production in Brazil and the United States is calculated by valuing the soybean yields by harvest-month crop prices in each year. The national gross value of production per acre averaged $623.28 in Brazil but $646.92 in the United States—about 11.4 percent lower than the U.S. Heartland average for soybean crop returns obtained by U.S. farmers in MY 2021/22 (figure 10). Brazilian producers had higher national average returns per bushel over costs than the United States—$4.05 compared with $2.13 (figure 11). Average returns per bushel above total costs for soybeans in the U.S. Heartland were 29.7 percent below Brazil's returns in Mato Grosso State (figure 11).

Figure 10
Soybean national average cost structure and value of production, MY 2021/22

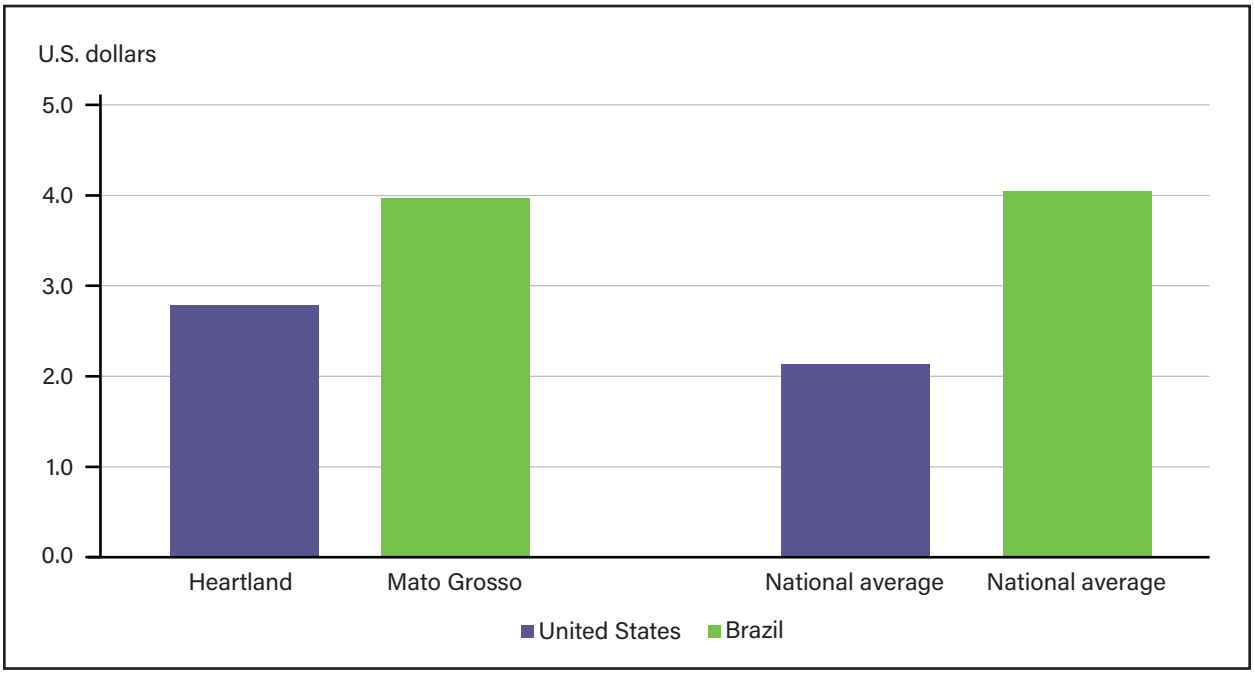


MY = marketing year; U.S.=United States.

Note: A marketing year corresponds to when the production and harvesting takes place. Costs reflect those incurred through harvest and the prices are the harvest month price received for that marketing year.

Source: USDA, Economic Research Service.

Figure 11
Return above costs per bushel of soybeans, regions, and national average, MY 2021/22



MY = marketing year; U.S.=United States.

Note: A marketing year corresponds to when the production and harvesting takes place. Costs reflect those incurred through harvest and the prices are the harvest month price received for that marketing years. The Heartland region comprises parts or all of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota.

Source: USDA, Economic Research Service.

Factors Affecting Cost of Shipping

Brazil has an inland modal share highly dependent on the road mode for total volume of agricultural cargo handling. For soybeans, the freight mode for total volume transported is 60 percent by road, 33 percent by rail, and 7 percent by waterway (CONAB, 2022; Caixeta-Filho & Péra, 2020). Brazil's history of underinvestment in transportation infrastructure and port terminals has long been seen as a key bottleneck for export competitiveness (USDA, FAS, 2014). In 2013, a year after Brazil surpassed the United States to become the world's largest soybean exporter, the Government accelerated the development of the Arco Norte (Northern Arc), an area that consists of river and ocean ports in the northern and northeast regions of Brazil.[12] The Brazilian Government sought private sector involvement in infrastructure developments to reduce transportation costs, overcome logistics bottlenecks, and to improve port operating efficiency. To this end (and with the support of firms seeking cost reductions through increases in logistics efficiency), the Government implemented deregulation and privatization efforts (BCB, 2020).

In 2013, the Brazilian Government enacted a framework for private investments in ports and the paving of 850 kilometers (528 miles) of the BR-163 highway in the center of the country's grain belt (ANTAQ, 2015). The paving of BR-163, the main highway through the landlocked State of Mato Grosso, was seen as crucial to providing soybean farmers more efficient access to northern ports on the Atlantic Ocean and the Panama Canal, increasing the country's export competitiveness to North America, the EU, Africa, and Asia (ANTAQ, 2015). Moreover, the simultaneous development of the BR-163 highway and the northern ports would alleviate logistical bottlenecks caused by the rapid surge in agricultural production in the center-west while reducing trucking freight cost for hauling soybeans 2,171 kilometers (1,349 miles) from Mato Grosso, which accounts for a third of the country's total soybean exports to the Santos and Paranaguá ports in the south (CONAB, 2022; ANTAQ, 2015).

The development of the north corridor brought new barging operations in Santarém, linking the ports of Barcarena and Miritituba on the Tapajós-Amazon waterway in the Pará State (Salin, 2017). These ports are operated by Brazilian and transnational companies: Amaggi, Bunge, Cargill, Louis Dreyfus, and the leading Chinese agribusiness trading company COFCO (ANTAQ, 2022), With the completion of BR-163 in 2019, the 1,067-kilometers (663 miles) hauling of soybeans from north Mato Grosso to the northern Port of Miritituba resulted in significantly lower costs for soybean exports but also for backhauling fertilizer imports (Salin, 2021). The share of soybeans exported through northern ports expanded, accounting for one-third of Brazil's soybean exports in 2021 (Ministério do Desenvolvimento, Indústria e Comércio Exterior (MDIC), 2022).

China plays a large role in Brazil's landscape of transport and infrastructure development, supported by the fact that a large share of Brazil's agricultural supply has been linked to China's import demand growth since the early 2000s (Caixeta-Filho & Péra, 2020; CONAB, 2022). China's involvement in Brazilian agribusiness is particularly important to the soybean supply chain (CONAB, 2022). In 2013, China's Development Bank provided $1.2 billion to COFCO for the expansion of the soybean supply chain, including the construction of a processing plant in Mato Grosso and 19 storage facilities throughout the country (Ray & Myers, 2023). In 2022, COFCO was awarded a 25-year terminal concession for the Port of Santos (CONAB, 2022). Chinese banks (China Development Bank and China Export-Import Bank) lending to Brazil in the 2003–22 period totaled $31 billion for agriculture, infrastructure, and energy projects. This amount corresponds to half of the total Chinese investment in Brazil (BCB, 2022; Ray & Myers, 2023). Under China's Belt and Road Initiative, various infrastructure projects are being developed, including the $4 billion China Railway

[12] These ports are located along the Amazon River, the Tapajós River, and the northern Atlantic Coast of Brazil: Porto Velho in Roraima State, Miritituba, Santarém, and Barbacena in Pará State, Itacoatiara and Manaus in Amapá State, and Itaqui in Maranhão State (ANTAQ, 2015).

20 Bureau Group partnership in the Ferrogrão project (also known as EF-170 Railway) to transport soybeans and corn from Mato Grosso to the northern State of Pará (BCB, 2022).

To assess the relative competitiveness when exporting soybeans, the authors considered all costs associated with transporting soybeans from producing regions to an export destination. These include inland transportation, handling costs, and ocean freight rates. To estimate port (free on board or FOB) prices, farm-level per bushel costs of production in each country were converted into costs per metric ton (tables 3 and 4). For Brazil, a separate estimate was made between the costs to move the soybeans from the State of Mato Grosso to the Port of Santos in the south and the costs to move the soybeans through the newly developed northern ports.

Table 3 presents the estimated costs of transporting soybeans from Brazil's Mato Grosso and Paraná to Shanghai, China, for the 5-year average of MYs 2008/09–2012/13 and 2017/18–2021/22. In MY 2008/12, about 83 percent of soybeans from Mato Grosso were exported via southern ports at an inland transport/handling cost of $98 per metric ton—representing 20.1 percent of the FOB port price (table 3). The high inland transportation costs in Brazil reflected the existing inefficiency of infrastructure and the large distances that Brazilian soybeans had to travel from the farm to Atlantic ports—either by trucks and/or waterways and ports along the Amazon River, a situation further worsened by the lack of barges or well-developed rail systems (ANTAQ, 2022).

Internal transport and marketing costs for Brazil decreased substantially over the past decade because of improved transportation efficiencies and infrastructure developments. These improvements led to an estimated 5-year average of $77 per metric ton for shipping soybeans during MYs 2017/18–2021/22. This represents a $21 cost savings per metric ton and further improves the competitive position of Brazil's Mato Grosso (table 3). In Mato Grosso, transportation costs in MYs 2017/18–2021/22 were 23.0 percent of the total landed costs of shipping to Shanghai through the Port of Santos, compared with 28.6 percent in MYs 2008/09–2012/13 (table 3).

Table 3
Estimated costs of transporting Brazil's soybeans to China, actual and historical, MYs 2008/09–2021/22

	MYs 2017/18–2021/22		MYs 2008/09–2012/13	
State shipped from	Mato Grosso	Paraná	Mato Grosso	Paraná
U.S. dollars/metric ton				
Farm price	375	400	387	429
Cost of production	308	344	243	269
Inland transport/handling cost	77	34	98	33
FOB port price	452	434	485	462
Ocean transport cost	35	35	57	57
Landed cost	487	469	542	519
Percent				
Inland transport/handling costs as a percent of port value	17.0	7.8	20.1	7.1
All transport/handling costs as a percent of landed cost	23.0	14.7	28.6	17.3

MYs = marketing years; FOB = free on board.

Note: A marketing year corresponds to when the production and harvesting takes place. For farm price and farm cost of production measures, costs reflect those incurred through harvest and the prices are the harvest month price received for that marketing years.

Source: USDA, Economic Research Service using data from Brazil's Companhia Nacional de Abastecimento (CONAB, 2022); Brazil's Freight Information System (Sistema de Informações de Fretes para Cargas Agrícolas [SIFRECA), 2012; Salin, 2023; and Brazilian Institute of Geography and Statistics, 2022.

Brazil's improvements of overland transportation following the completed paving of road BR-163 in central Brazil to access the northern Port of Miritituba in Pará State led to lower trucking costs and a savings of $28 per metric ton at the port when compared with soybean exports via southern ports. Consequently, the export price (FOB port price) for soybeans grown in Mato Grosso was lower at northern ports (table 4, items 4 and 4b).

Between 2010 and 2022, soybean exports through the Arco Norte expanded from 6 to 35 million tons per year, doubling its share of total Brazilian exports from 14 percent to 28 percent (ANTAQ, 2022). Paraná's proximity to large ports keeps internal transportation costs relatively low. Paraná's inland transport costs for soybeans of $34 per metric ton were lower than inland costs from north Mato Grosso to northern ports and inland costs for the U.S. Heartland (table 4). Despite these improvements, many farmers still face challenges, including issues with sourcing trucks, transportation distances, and rising fuel costs (IMEA, 2023).

Historically, the United States has held the competitive edge in international freight costs. All transport and handling costs, including internal transport and marketing costs plus ocean transport costs, represented about 23.2 percent of landed costs for the U.S. Heartland during MYs 2017/18–2021/22. However, the U.S. advantage diminished in MY 2021/22, as logistics constraints arising from the COVID-19 pandemic, particularly on sea cargo, led to higher shipping costs for the United States compared with sea cargo shipping costs for Brazil (table 4). As a result, higher transportation costs caused by the COVID-19 pandemic led to U.S. producers having a slight cost disadvantage over Mato Grosso producers.[13] Mato Grosso's transport and handling costs averaged 23.0 percent of landed costs in the same period, and Paraná's transportation and handling costs represented 14.7 percent of landed costs (table 4).

Brazilian exports of soybeans through newly developed northern ports represented a saving of $25 per metric ton in landed costs, compared with exports via the traditional Port of Santos in the southern region—and closing the gap with landed costs in the U.S. Heartland during the 5-year average period between MY 2017/18–2021/22 (table 4, items 6 and 6b).

[13] Landed costs do not include any tariffs that are assessed on either U.S. or Brazilian exports to China.

Table 4
Soybean shipping costs from the U.S. Heartland and Brazil to a common destination in China, MYs 2017/18–2021/22

	Heartland	Mato Grosso	Paraná
Regional production share, percent	56	29	14
Costs	U.S. dollars/metric ton		
(1) Farm price	355	375	400
(2) Cost of production	361	308	344
(3) Inland transport cost	58	77	34
(3b) Inland transport cost - north Mato Grosso	NA	49	NA
(4) FOB port price	414	452	434
(4b) FOB port price - Brazil northern port	-	424	-
(5) Ocean transport cost	49	35	35
(5b) Ocean transport cost - Brazil northern port	-	38	-
(6) Landed cost	463	487	469
(6b) Landed cost - Brazil northern port	-	462	-
Costs	Percent		
(7) Inland transport percent of port value	14.1	17.0	7.8
(7b) Inland transport percent of port value - Brazil northern port	-	11.5	-
(8) All transport percent of landed cost	23.2	23.0	14.7
(8b) All transport percent of landed cost - Brazil northern port	-	18.8	-

MYs = marketing years; NA = not applicable; FOB = free on board; U.S. = United States.

Note: A marketing year corresponds to when the production and harvesting takes place. For farm price and farm cost of production measures, costs reflect those incurred through harvest and the prices are the harvest month price received for that marketing years. The Heartland region comprises parts or all of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota.

Source: USDA, Economic Research Service using data from Brazil's Companhia Nacional de Abastecimento (CONAB, 2022); Brazilian Institute of Geography and Statistics, 2022; Salin, 2023; U.S. Department of Agriculture, Agricultural Marketing Service, 2022; and International Grains Council, 2022.

Conclusion

Despite substantial growth in U.S. soybean production and exports in the past 25 years, the U.S. share of global exports has steadily diminished as Brazilian soybean output now exceeds that of the United States. The U.S. share of global soybean exports is projected to decline from 38.1 percent in MY 2021/22 to 28.0 percent by MY 2032/33, while Brazil is expected to remain the largest exporter of soybeans (USDA, OCE, 2023).

The devaluation of Brazil's currency stimulates Brazilian production of export-oriented crops, including soybeans and soybean products. Increased revenues for farmers in domestic currency from a weaker Brazilian real outweigh increases in the cost of imported inputs. USDA's long-term projections to MY 2032/33 reflect the continuing expansion of soybeans in Brazil. Soybean production in Brazil is projected to increase from 127 million tons in MY 2021/22 to 214 million tons in MY 2032/33. Brazil's soybean exports are expected to reach 130 million tons by MY 2032/33. USDA's 10-year projections indicate that China will account for about 72 percent of the projected increase in global soybean imports (USDA, OCE, 2023).

The comparison of production costs in Brazil and the United States allows for inferences on how the export competitiveness of soybeans in each country could be affected by changes to factors affecting production and marketing costs, including seed, fertilizer, land, fuel, chemicals, credit, transportation, handling, and storage. Average farm-level production costs for soybeans per acre were higher in the United States than in Brazil in 2021/22, largely because of higher land and capital costs. These higher costs, however, were largely offset by higher yields over the 5-year period between 2017/18–2021/22. The United States has higher yields than Brazil, leading to higher returns per bushel above operating costs. The U.S. Heartland had higher returns per bushel than the national average. Soybean prices received by farmers were highest in Brazil compared to the United States as substantially higher harvest time prices in early 2022 benefited Brazilian soybean farmers.

Farm-level costs have long been seen as important determinants of farmer's participation and ability to compete in global markets (Meade et al., 2016; Schnepf et al., 2001). This analysis indicates that while there is not a large difference in total costs of production across both countries, the share of variable and fixed costs of total costs differs in Brazil and the United States. The analysis also shows that as transportation accounts for a large share of the total cost of soybean exports, transportation is a major factor in export competitiveness. In the United States, more agricultural commodities are moved to ports using lower-cost barge and rail transport, while 60 percent of soybeans are moved to ports using higher-cost truck transport in Brazil. An assessment of the relative competitiveness when exporting soybeans needs to include all costs of transporting soybeans from producing regions to the ports for export and onto overseas destinations.

This study also sheds light on continued agricultural development in Brazil. Improvements made over the past decade to Brazilian transportation infrastructure, including roads, railways, waterways, and ports, have improved the Brazilian trade position, significantly altering the relative competitiveness between these two major soybean exporters. Improvements in Brazil's overland transportation infrastructure have resulted in a $21 per metric ton decrease in transport costs over the past decade, enhancing the country's competitive position. Brazil's developments in roads to access northern ports have resulted in cost reductions of $25 per metric ton when compared with transportation through southern ports, further improving the competitive position of Mato Grosso and narrowing the historical gap with U.S. Heartland landed costs. Despite the progress achieved, Brazil's transportation infrastructure and ports still face challenges when it comes to increasing efficiency, reducing operating costs, and effectively attracting investment to sustain the projected expansion of the agricultural sector.

For Brazil, incentives for continued expansion of soybean production and exports remain based on the large natural resources in agriculture and long-term baseline projections that China will continue to increase imports of soybeans to meet the demand for animal feed and edible oils (USDA, OCE, 2023). Accordingly, the USDA long-term baseline projects continued expansion of Brazil's soybean area—particularly in Mato Grosso with the future development of transportation infrastructure—with China playing a role in financing or building such infrastructure. Brazil is likely to remain the world leader in soybean production and exports, followed by the United States and Argentina. Improvements to Brazilian transportation infrastructure, particularly in Mato Grosso, will significantly alter the relative competitiveness of Brazil and the United States in world soybean markets, further improving the Brazilian position. U.S. soybean exports will be affected in the longer term by the continued presence of Brazil as a major competitor.

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