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Interdependence of China, United States, and Brazil in Soybean Trade

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Abstract

Soybeans are the largest and most concentrated segment of global agricultural trade. Two land-abundant countries—Brazil and the United States—supply most soybean exports, and China accounts for over 60 percent of global soybean imports. International trade in soybeans began growing when China liberalized imports to meet demand for protein in animal feed and edible oils. A tariff structure favoring imports of soybeans, domestic policies favoring production of cereal grains, and rapid expansion of processing capacity drove China's growth in soybean imports. More flexible U.S. policies facilitated production response by U.S. farmers to supply more soybeans, and Brazil's expansion of output in its inland *Cerrado* region propelled supply growth in recent years. China imported even more Brazilian soybeans after imposing a 25-percent tariff on U.S. soybeans during 2018, but the overall volume of China's imports fell for the first time in 15 years. USDA's 10-year projections indicate that China will continue to account for most future growth in global soybean imports even if the tariff remains in place. However, USDA projects slower growth in China's imports than in the previous decade. Projections show that Brazil will again account for most of the growth in global soybean exports during the next decade, but growth will be slower.

Keywords: soybeans, exports, imports, China, Brazil, international markets

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Interdependence of China, United States, and Brazil in Soybean Trade

Introduction

China accounts for more than 60 percent of global soybean imports, and the United States and Brazil together supply over 80 percent of global exports. This report reviews the factors behind the geographic concentration of soybean trade. It discusses China's growing demand for soybean meal and oil, its policies that favor soybean imports, and rapid growth of processing capacity in the country. The report reviews soybean production trends in the United States, Brazil, and China; compares production and transportation costs; and analyzes trends and fluctuations in export prices and prices paid by importers in China. The report examines the short-term impacts of China's imposition of a retaliatory tariff on U.S. soybeans in 2018/19, and it evaluates prospects for growth in new markets and suppliers projected to 2028 by USDA (2019).

During the 1970s, author Dan Morgan's *Merchants of Grain* observed that the United States and Brazil accounted for most soybean exports and European countries were the main importers. Morgan suggested that this geographic concentration encouraged the growth of international trade by facilitating the procurement, processing and transport of soybeans across continents. Four decades later, the scale of soybean trade has grown dramatically, from 28 million metric tons (mmt) during the 1979/80 marketing year to 153 mmt during 2017/18. The United States and Brazil together still account for more than 80 percent of soybean exports, but China has been the importer driving dramatic growth in trade. China's soybean import volume surpassed the European Union's in 2002 and was six times the EU's import volume in 2017. Several companies identified by Morgan as key players in soybean trade during the 1970s continue to play an important role, but many new companies based in Asia are now active in the market.

Earlier USDA reports described how China formulated policies favoring imports of soybeans during the years leading up to its accession to the World Trade Organization (WTO) in 2001 (Crook et al., 1998; Hsu, 2001; Tuan et al., 2004). Other USDA studies examined the emergence of Brazil and Argentina as U.S. competitors in export of soybeans and corn (Schnepf et al., 2001; Meade et al., 2016) and measured Brazil's agricultural productivity growth (Rada and Valdes, 2012; Rada, 2013). Lee and colleagues (2016) observed that the volume of trade in soybeans and their products has surpassed that of wheat and coarse grains to become the most traded commodity, and soybeans account for over 10 percent of the value of agricultural trade. Beckman and colleagues (2017) cited China's rising imports of soybeans as one of the main features of recent growth in global agricultural trade. *The Financial Times* (2017) called soybeans the "crop of the century" based on the rapid growth in global trade and production.

The size of soybean trade and its geographic concentration made soybeans a focus of attention when China imposed retaliatory tariffs on nearly all U.S. agricultural products during 2018. A special issue of the journal *Choices* evaluating potential impacts of Chinese retaliatory tariffs identified soybeans as the most impacted commodity (Marchant and Wang, 2018). Taheripour and Tyner (2018) estimated that the tariff would result in a 48- to 97-percent decline in U.S. soybean exports

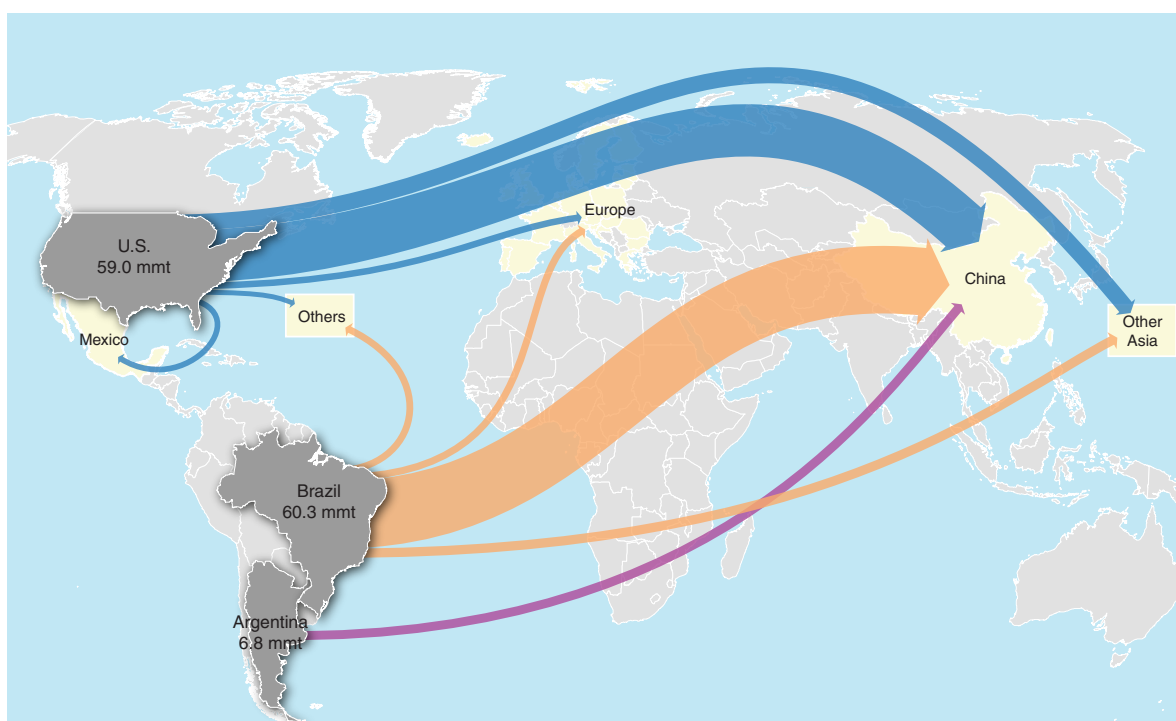
to China from 2016 base-year values using two assumptions about the flexibility of trade responses. In contrast, their model did not find significant impacts of Chinese tariffs on global markets for corn, wheat, or sorghum. Zheng et al. (2018) projected a 34-percent decline in U.S. soybean exports to China and a 3.9-percent decline in the U.S. soybean price. Muhammad and Smith (2018) also focused on soybeans and projected a \$4.5-billion decline in U.S. soybean exports to China and a \$4.4-billion increase in Brazilian exports in response to the 25-percent Chinese tariff assessed in 2018. USDA (2019) agricultural projections to 2028 assumed China's retaliatory tariffs on U.S. commodities would remain in place indefinitely and highlighted reductions in U.S. soybean production and exports and lower imports by China compared to the previous year's projections.

This report begins by profiling the geographic concentration of international trade in soybeans and discussing how short-term adjustments to China's tariff on U.S. soybeans during 2018 and 2019 were constrained by the high degree of concentration. The report discusses factors behind China's emergence as the world's top soybean importer and the growth of exports from the United States and Brazil. It reviews fluctuations in export and import prices, discussing short-term changes in soybean trade during the months after China's imposition of the tariff on U.S. soybeans. Finally, the report examines prospects for persistence of geographic concentration of soybean trade in the future.

Soybean Trade With Three Main Players

Geographic concentration of soybean importers and exporters is a distinguishing feature of the global soybean market. During 2016/17, the United States and Brazil together accounted for 83 percent of world soybean exports. The United States exported 59 mmt of soybeans and Brazil exported 63 mmt, while Argentina was the third-leading exporter with 6.9 mmt. China was the destination for 61 percent of U.S. soybean exports and 77 percent of Brazil's that year (fig. 1).¹ U.S. and Brazilian exports to China accounted for two-thirds of all soybean trade during 2016/17. U.S. soybeans were also exported to other Asian countries (19 percent), the European Union (8 percent), and Mexico (7 percent). Brazil's exports to other Asian countries accounted for 11 percent of its exports, and sales to the European Union accounted for 8 percent.

Figure 1
Leading soybean exporters and destinations during 2016/17



Note: Chart shows production of soybeans by United States, Brazil, and Argentina during 2016/17. Width of arrows represents volume of exports. mmt = million metric tons.

Source: ERS analysis of customs data from IHS Global Insight, Global Trade Atlas.

China accounted for 65 percent of all soybean imports during 2016/17. No country had such a large share of imports for any other major agricultural commodity. For example, during 2016/17 the top pork-importing country (also China) accounted for 27 percent of pork imports and the top cotton importer (Bangladesh) accounted for 18 percent of cotton imports, both much less than China's share of soybean imports (table 1). The top five importing countries' shares were 45 percent for poultry, 65 percent for cotton, and 71 percent for pork. Similarly, the 83-percent share of soybean

¹Argentina exported 31.3 mmt of soybean meal and 5.4 mmt of soybean oil in 2016/17, reflecting a tax structure that favors exports of soybean products.

exports supplied by two countries—United States and Brazil—was higher than the share of exports supplied by the top two exporters of pork (66 percent), poultry (64 percent), corn (56 percent), cotton (52 percent), and wheat (31 percent).²

Exports to China are a large component of the demand for soybeans produced in both the United States and Brazil. During 2016/17, the United States produced 117 mmt of soybeans and exported 36 mmt to China (table 2). Thus, exports to China equaled 31 percent of U.S. soybeans produced in 2016/17. Brazil's soybean producers relied even more on exports to China. Brazil produced 114 mmt of soybeans and exported 49 mmt to China. Thus, Brazil's exports to China equaled 43 percent of its 2016/17 soybean crop. Apart from Brazil and the United States, other countries produced 120 mmt of soybeans during 2016/17 but exported just 9 mmt to China.

Table 1

Shares of global trade in major commodities by top importing and exporting countries, 2016/17

Commodity	Top importing country's share of world imports	Top two exporting countries' share of world exports
	Percent	
Soybeans	65	83
Pork	27	66
Cotton	18	52
Corn	11	56
Poultry	10	64
Wheat	6	31

Note: Values reflect shares of import and export quantities.

Source: Calculated from USDA, Production Supply and Distribution data.

Table 2

Importance of China exports to U.S., Brazil, other soybean sectors, 2016/17

Item	United States	Brazil	Other countries
	Million metric tons		
Production	117	114	120
Exports	59	63	26
Exports to China	36	49	9
Share of production:	Percent		
Exported	50	55	21
Exported to China	31	43	7
Share of exports:			
Destined for China	61	78	33

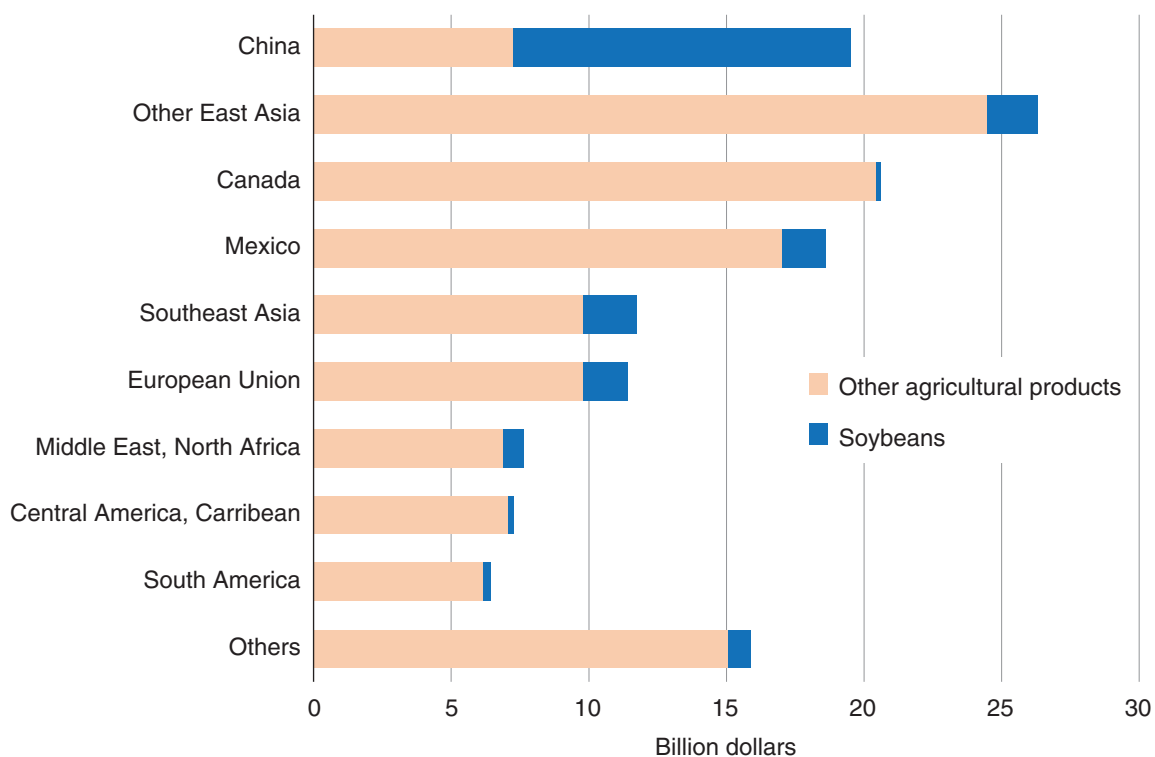
Note: Data for September–August market year. Share of production exported is based on ratio of export volume to production.

Source: USDA, Production, Supply and Distribution data; ERS analysis of U.S. and Brazil customs data accessed through IHS Markit Global Trade Atlas.

²The United States was also among the top two exporters of each of those commodities.

Soybeans are the most prominent agricultural commodity exported to China by both the United States and Brazil. During 2017, soybean exports valued at \$12.3 billion accounted for 63 percent of U.S. agricultural exports to China. Soybeans accounted for less than 20 percent of U.S. agricultural exports to other regions (fig. 2). U.S. soybean exports to Southeast Asia—the second-largest destination—were valued at \$1.95 billion but accounted for only 17 percent of agricultural exports to that region. The share of soybeans in U.S. agricultural exports was 14 percent for the European Union, 10 percent for the Middle East and North Africa, and 7 percent for other East Asian countries. The share of soybeans in Brazil’s agricultural exports to China was even larger. During 2017, \$20.3 billion of soybean exports accounted for nearly 88 percent of Brazil’s agricultural exports to China (fig. 3). Soybeans accounted for 14 percent of Brazil’s agricultural exports to the European Union—the second largest destination for Brazil’s soybeans.

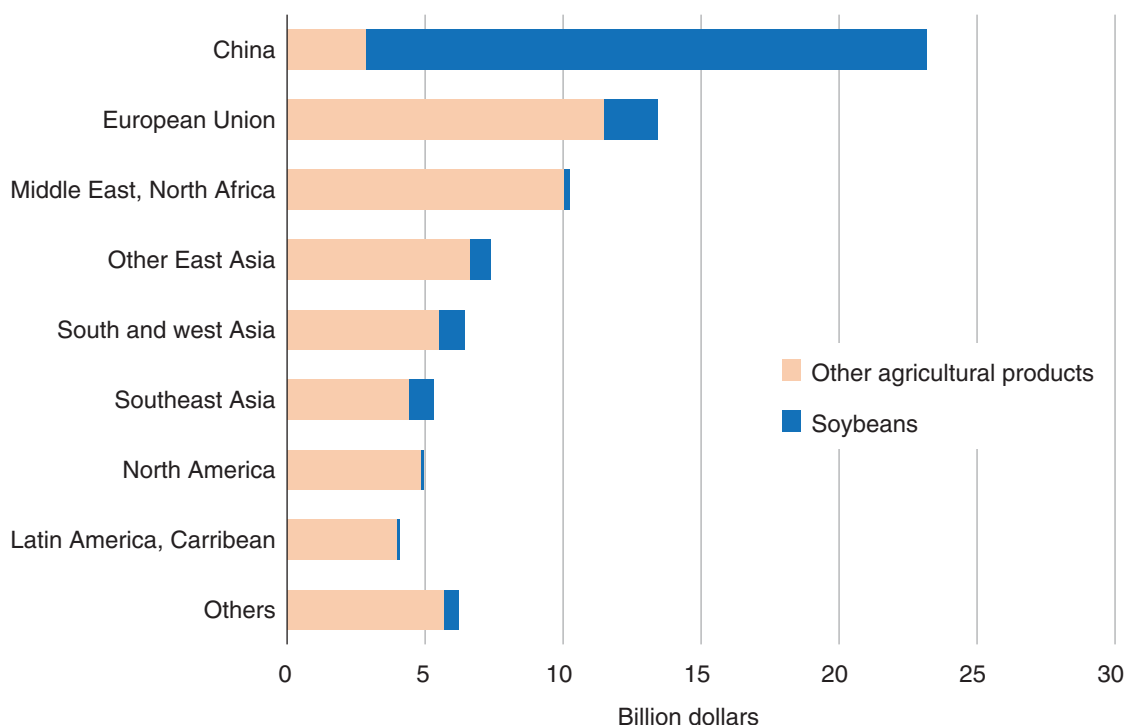
Figure 2
U.S. exports of soybeans and other agricultural products to China and other regions, 2017



Note: Data for calendar year.

Source: ERS analysis of USDA, Global Agricultural Trade System database.

Figure 3
Brazil's exports of soybeans and other agricultural products to China and other regions, 2017



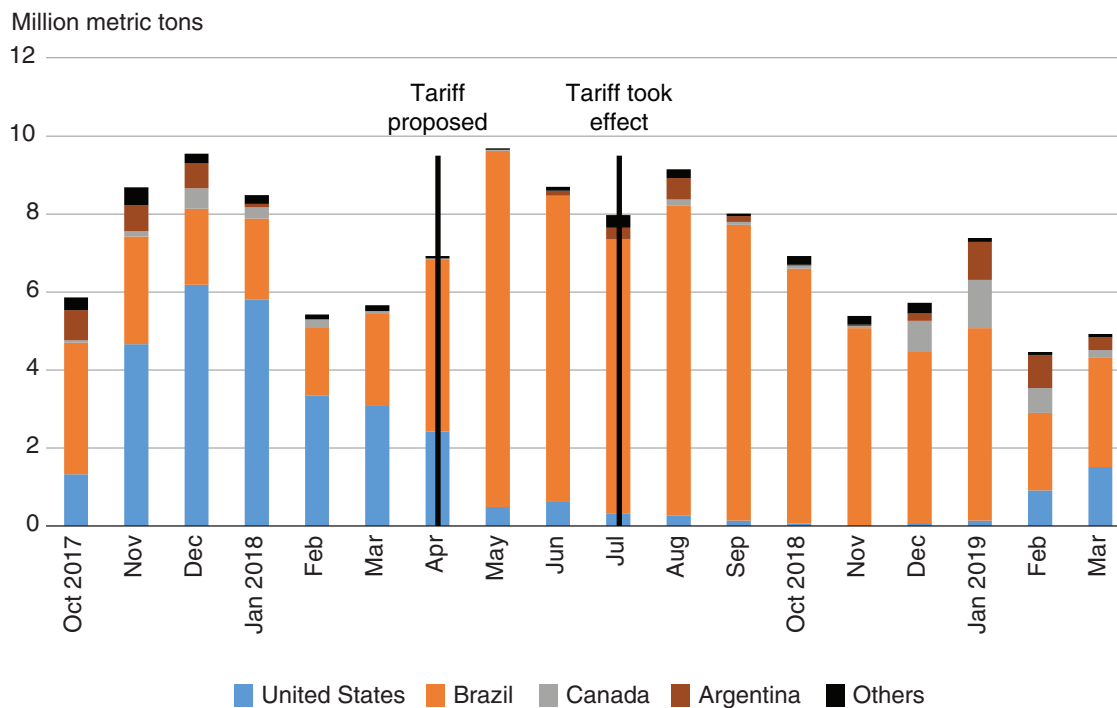
Note: Data for calendar year.

Source: ERS analysis of Brazil customs data accessed through IHS Markit Global Trade Atlas.

The concentration of soybean trade meant that Brazil was the only exporter capable of supplying China with large volumes of soybeans to replace U.S. soybeans after China imposed its tariff in 2018 (fig. 4). China's 11.5-mmt increase in imports of soybeans from Brazil during October 2018 to March 2019 compared to the same period a year earlier was larger than the increase from any other country (table 3). China increased imports of Canadian soybeans by 1.7 mmt, but imports from other countries were steady or declined. The increase in imports from Brazil only partially offset the 21.7-mmt decline in imports of U.S. soybeans. The total volume of China's soybean imports during the first 6 months of its 2018/19 marketing year was down nearly 8.8 mmt from the same period in 2017/18.

In parallel, increases in U.S. soybean exports to the European Union, Egypt, Iran, Mexico, and other countries did not fully offset the decline in exports to China during 2018 (fig. 5). During the first 6 months of the U.S. soybean marketing year 2018/19, exports to China were down 21.7 mmt from a year earlier (table 4). The relatively low price of U.S. soybeans and reduced production in Argentina (due to drought in that country) stimulated 11.8-mmt of additional demand from European Union countries, other Asian countries, Egypt, Iran, Mexico, and others. But this additional demand did not offset the year-to-year decline in sales to China. From September 2018 to February 2019, U.S. soybean exports were down 12.1 mmt from the same period a year earlier.

Figure 4
China soybean imports, monthly, October 2017–March 2019



Note: "Tariff" refers to China's 25-percent retaliatory tariff on U.S. soybeans.

Source: ERS analysis of data from China General Administration of Customs website.

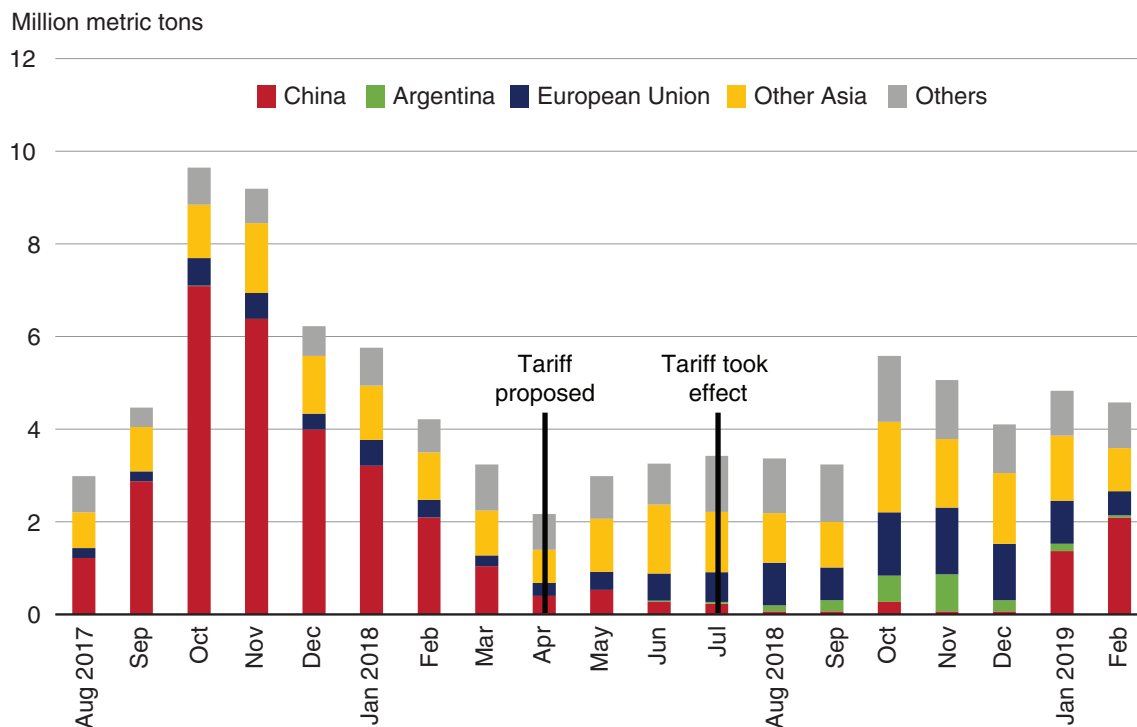
Table 3
China soybean imports, 2017–19

Country	Oct-Mar	Oct-Mar	Change
	2017/18	2018/19	
	1,000 metric tons		
United States	24,433	2,691	-21,742
Brazil	14,229	25,699	11,469
Canada	1,282	3,018	1,735
Kazakhstan	8	5	-3
Ethiopia	19	0	-18
Russia	589	469	-120
Ukraine	2	0	-2
Argentina	2,166	2,406	240
Uruguay	922	487	-435
Total	43,649.0	34,773.9	-8,875.1

Note: First 6 months of China's market year.

Source: China Customs website.

Figure 5
U.S. soybean exports, monthly, August 2017–February 2019



Note: “Tariff” refers to China’s 25-percent retaliatory tariff on U.S. soybeans.

Source: ERS analysis of U.S. customs data accessed through IHS Markit Global Trade Atlas.

Table 4
U.S. soybean exports, 2017–19

Country	Sept.-Feb. 2017/18	Sept.-Feb. 2018/19	Year-to-year change
1,000 Metric tons			
China	25,645	3,941	-21,704
Argentina	0	2,050	2,050
European Union	2,668	6,198	3,531
Other Asia	7,058	8,272	1,214
Egypt	670	1,675	1,005
Iran	0	500	500
Mexico	1,848	2,515	667
Others	4,128	6,935	2,807
Total	39,498	27,396	-12,102

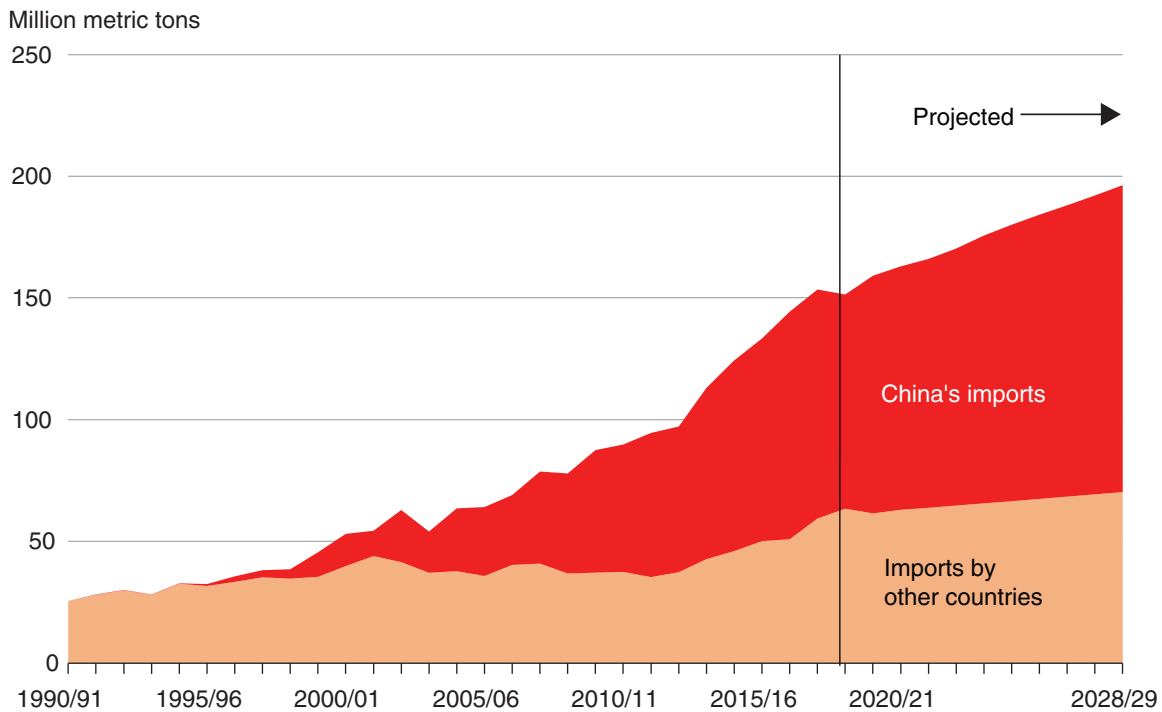
Note: First 6 months of U.S. September–August market year.

Source: ERS analysis of data from USDA Global Agricultural Trade System.

China's Soybean Imports Meet Demands for Animal Feed and Edible Oils

Since the 1990s, China has accounted for most of the growth in global soybean imports. China's 80-mmt increase in imports from 2000/01—the year preceding the country's accession to the WTO—to 2016/17 accounted for 88 percent of the growth in world soybean trade (fig. 6). After rising nearly 65 mmt from 2006 to 2016, China's soybean imports declined during 2018 for the first time in 15 years. Signs of slower import growth were already evident before trade tensions arose, and USDA's 2018 baseline projected a 46-mmt increase in China's soybean imports for 2017–27. USDA (2019) projections for 2018–28 were made after China assessed a retaliatory tariff on U.S. soybeans, and the projections assume the tariff will remain in effect indefinitely. The latest projections show a slower 38-mmt increase in China's soybean imports during 2018–28 (see box, "USDA Agricultural Projections to 2028"). Despite the slower pace of growth, China's rising imports would still account for 85 percent of the growth in global soybean trade during 2018–28.

Figure 6
Imports of soybeans, 1990–2028



Note: Data are for market years.

Source: ERS analysis of USDA, Production, Supply and Distribution data, and USDA (2019).

USDA Agricultural Projections to 2028

This report incorporates USDA (2019) long-term agricultural projections to show how soybean supply and demand may be expected to change in future years. The report includes historical data and projected values for soybean imports and exports, production, area harvested, and the consumption of soybean oil and meal through the 2028/29 market year. USDA projections are a composite of 42 country and regional linked partial equilibrium models and the judgment of USDA experts. The projections begin with short-term projections from the USDA's October 2018 report, World Agricultural Supply and Demand Estimates. Projections used in this report were made after China's 25-percent tariff on U.S. soybeans was in place, and they assume that the tariff will remain in effect indefinitely, since there was no indication of when it would be lifted. These projections indicate weaker long-term prospects for soybean trade than USDA projections issued in 2018, before trade tensions with China arose. The projections do not account for impacts of African swine fever, a livestock disease that spread rapidly in China during 2018 and may significantly reduce swine production and feed demand.

Growth in Animal Protein and Edible Oil Consumption Drives Soybean Demand

China's soybean imports are driven by demand for animal protein and edible oils, two important components of a diversifying Chinese diet that reflect rising living standards. Nearly all of the soybeans China imports are used to produce high-protein meals consumed by Chinese livestock and edible oil for Chinese consumers (see box, "How Soybeans Are Used in China"). Liberalizing soybean imports allowed China to increase the productivity of livestock production and expand the supply of edible oils that are important to most types of Chinese cuisine.

Before the 1990s, Chinese policies suppressed production and consumption of edible oils and meat (Gao and Chi, 1997). Domestic agricultural plans focused on producing cereal grains to meet basic food needs (Chao, 1970; Walker, 1981). Foreign currency generated by exports of commodities such as rice and pork was allocated to fill supply deficits of wheat, vegetable oils, and cotton (Surls, 1982; Lardy, 1986). During the 1990s, China allowed its exchange rate to be set by market forces, cut tariffs, and removed quotas on imports of soybeans, nongrain feeds, and edible oils (Gale, 2002). Pent-up demand for both protein in animal feed and edible oils led to rapid growth in soybean imports (Gale, 2015).

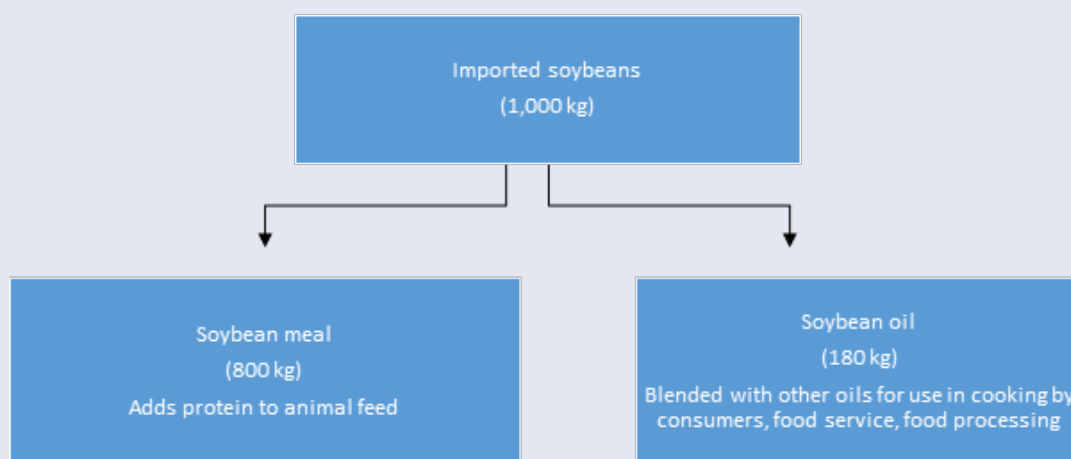
When China liberalized its foreign trade during the 1990s, its tariff structure favored imports of soybeans (Hsu, 2001; Tuan and Hsu, 2001; Gale, 2015). China's 2001 WTO accession agreement set a low 3-percent tariff on imports of soybeans, while soybean meal and oil faced slightly higher tariffs (table 5). This tariff structure encouraged imports of unprocessed beans over imports of intermediate products (soybean meal and oil). China's tariffs on final products (meats) were also set higher than soybean tariffs.³ China did not impose quota limits on soybean imports, but higher tariffs and quota protections were set for alternative crops grown by Chinese soybean farmers (corn, wheat, and rice) and for other oilseeds grown in China (rapeseed, peanuts, sunflower seeds). China's WTO accession agreement set quotas limiting imports of edible oils, but the quotas were allowed to expire in 2005. This tariff structure remains largely in place nearly two decades later.

³Hsu (2001) and Crook et al. (1998) described how policy was set to favor imports of soybeans. A mid-1990s tax policy that favored soybean meal imports was reversed in 1999 after domestic soybean processors complained that imports of soybean meal and smuggling of soybean oil depressed their profit margins.

How Soybeans Are Used in China

Imported soybeans are crushed in processing plants that extract oil used for cooking and soybean meal used to add protein to animal feed. Each 1,000 kg of imported soybeans yields approximately 800 kg of meal and 180 kg of oil, and the profitability of imports is calculated by weighing the value of meal and oil against the cost of soybeans (Irwin, 2017). Nearly all of the soybean meal and oil produced from imported soybeans is consumed in China.

China's domestically produced soybeans are used mainly to produce foods such as tofu, soybean milk, soy sauce, and nutritional supplements. Consumption of these products has also grown but not as fast as consumption of edible oils and soybean meal.



The low tariff on soybeans and strong demand for soybean products is reflected in the large share of soybeans in China's agricultural imports. During 2018, soybeans comprised 30 percent of the value of China's agricultural imports, the largest category (fig. 7). By comparison, imports of cereal grains comprised only 5 percent of agricultural imports. Fats and oils (including palm, rapeseed, soybean, and various other oils) accounted for 7 percent of agricultural imports. Imports of high-protein meals (including fish meal, rapeseed meal, and palm kernel meals) are much smaller than soybean imports.⁴ Most meat consumed in China is produced domestically using feed made from soybean meal, grains, and other feed ingredients, but imports of meat have been rising. Meat accounted for another 9 percent of China's agricultural imports during 2018.

⁴China exports 1 to 2 mmt of soybean meal in most years.

Table 5

China tariffs and other trade measures for soybeans and related products, 2018

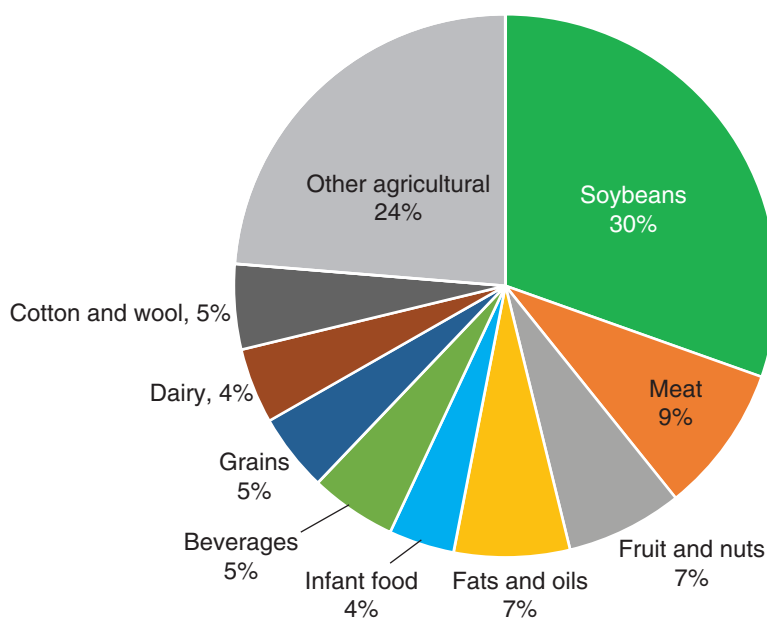
Commodity	Most favored nation tariff (percent)	Quotas, other limits on imports
Soybeans	3	No quota
Vegetable oils	9	Tariff rate quota (TRQ) expired in 2005
Soybean meal	5	No quota
Corn, wheat, rice	65	TRQs allow limited volumes of imports at 1-percent tariff
Rapeseed	9	No quota
Peanuts, sunflower seed	15	No quota
Meats	12-20	Disease-related bans, bans on feed additives, antidumping/countervailing duties on U.S. poultry

Note: Does not include retaliatory tariffs assessed on U.S. products during 2018.

Source: Tuan and Hsu (2001); World Trade Organization tariff database.

Figure 7

China's agricultural imports, by category, 2018



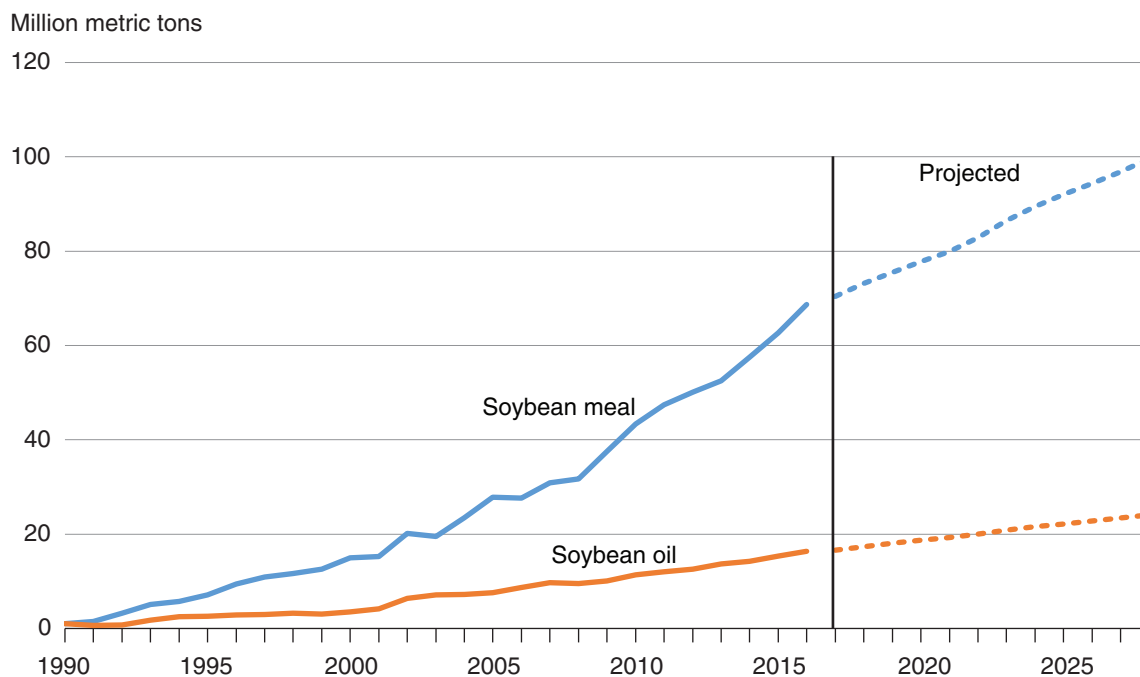
Note: Data for calendar year.

Source: ERS analysis of China customs data from Global Trade Atlas.

China's consumption of both soybean meal and oil has grown dramatically since the country began importing soybeans. Estimates from USDA's Production, Supply and Distribution database show that China used just 1 mmt each of soybean meal and oil in 1990. Estimated soybean meal use grew to 68.6 mmt, and soybean oil use grew to 16.4 mmt in 2016/17 (fig. 8). From 2007 to 2017, USDA estimates indicate that China's soybean meal use rose nearly 40 mmt, and soybean oil use grew 7.7 mmt. Consumption is expected to continue growing as consumer income continues to rise and as urbanization alters traditional consumption habits. USDA projections to 2028 show that China's consumption is expected to rise 26.4 mmt over the next decade, a slower pace than the 40-mmt increase during the previous decade. Similarly, USDA projects that China's soybean oil consumption will rise 6.7 mmt from 2018 to 2028, slower than the 7.7-mmt increase during 2007–17.

Recent projections issued by Chinese organizations also anticipated a slower pace of growth in China's consumption of soybean meal. Chinese Academy of Agricultural Sciences (2018) highlighted growth in consumption of livestock products as an influential trend, but it projected a 2-mmt cumulative increase in soybean meal consumption from 2016 to 2035. In its projections to 2028, China's Ministry of Agriculture and Rural Affairs (2019) anticipated rising demand for soybeans driven by steady growth in consumption of livestock products, soybean-based foods, and nutritional supplements, but it projected a relatively small 14-mmt increase in soybean consumption and a 500,000-metric-ton increase in vegetable oil consumption over 10 years.

Figure 8
China's estimated domestic consumption of soybean meal and soybean oil, 1990–2028



Source: USDA, Production, Supply and Distribution data and USDA (2019).

Expansion of processing capacity drives soybean imports

Another key driver of China's rapid growth in soybean imports is the expansion of China's soybean crushing sector. According to China Ministry of Agriculture and Rural Affairs (2018), soybean processing capacity expanded from 20 mmt to 160 mmt between 2001 and 2016, and crushing capacity far exceeded the volume of soybeans processed each year. Excess capacity and low profit margins attributed to rapid expansion by dozens of companies seeking to capture market share have been a recurring issue in China's soybean processing industry. Many companies import soybeans despite low margins to prevent capacity from remaining idle, maintain cash flow, and preserve market share.

During the 1990s, crushing plants owned by state-owned companies and joint ventures with multinational companies were the primary importers.⁵ Many of the processing facilities were located near ports to facilitate use of imported soybeans. After China's WTO accession in 2001, foreign companies were allowed to operate independently, and their share of imports and processing increased rapidly. A 2008 government plan for the soybean processing industry raised concerns that excess processing capacity, low share held by domestic companies, and reliance on imported raw materials affected the industry's "healthy development" (see box, "Plan Stimulated Expansion by State-owned Soybean Processors"). After the plan was issued, domestic firms added even more capacity, and the industry's current 160-mmt capacity is nearly double the ceiling targeted by the plan. Excess capacity and narrow profit margins are still commonly cited in industry reports. A 2017 speech by the chief executive of a state-owned company cited excess capacity and widespread losses as problems faced by the soybean crushing industry and noted industry dominance by the top 10 companies, which included both Chinese state-owned and multinationals (Futures Daily, 2017).

China's soybean processing sector is highly competitive. Hundreds of companies of all sizes and ownership types are engaged in processing of soybeans and other oilseeds. Processors compete with one another, and their products compete with imported edible oils as well as oils and meals produced from other oilseeds. The 2013 Economic Census conducted by China's National Bureau of Statistics reported that over 44 percent of the 9,559 enterprises in the vegetable oil processing industry had opened during 2009–13 and another 44 percent said they had opened during 2000–2007. According to the Economic Census, Chinese private companies and corporations accounted for over two-thirds of vegetable oil processing enterprises and more than half of the industry's employment in 2013 (employment was the only measure of enterprise size tabulated by ownership type in census publications) (table 6). There were 127 multinational companies and 103 state-owned companies that together accounted for about 10 percent of employment in vegetable oil processing.

Recent industry surveys report that China's top soybean processors are Singapore-based Wilmar and China's state-owned COFCO (Solidaridad, 2017; Oilcn News, 2018). Other top processors include state-owned companies Jiu San (owned by Heilongjiang Province's state farm system), Sinograin (responsible for holding national reserves of grain and edible oils), and Chinatex (state-owned cotton trading company that merged with COFCO in 2010), and multinational enterprises Bunge, Cargill, and Louis Dreyfus. Several Chinese-owned private-sector companies—Bohi, Hope Full, Xiangchi, and San Wei—are also among the top processors.

⁵Crook et al. (1998) described the operations of a variety of oilseed processors that included companies launched before 1949, processors operated by the government's grain bureau, a joint venture, and mills operated by village collectives.

Plan Stimulated Expansion by State-Owned Soybean Processors

“Guiding opinion on promoting healthy development of the soybean processing industry,” issued by National Development and Reform Commission (NDRC) of China (2008), sought to reduce excess processing capacity by consolidating companies, removing outmoded facilities, and capping production capacity at 65 mmt of soybeans by 2012. The plan also encouraged formation of large Chinese conglomerates to dilute the share of imports controlled by multinational companies.

Reports indicate that expansion by state-owned companies after the NDRC plan added even more capacity:

- Wang (2010) reported that rapid expansion of capacity during 2009 and 2010 was led by state-owned companies and construction of new plants in coastal regions by processors based in Heilongjiang Province.
- The 2010 *Yearbook of China Agricultural Products Processing Industries* listed 16 major investments in crushing plants during 2007–09 and reported that two state-owned companies had expanded their market share through the acquisition of private crushers (China Ministry of Science and Technology, 2011).
- Bai (2015) explained that Sinograin—a state-owned company that holds national reserves of grain and edible oils—became one of the country’s largest edible oil businesses as part of an initiative to compete with multinational companies and to hold an edible oil reserve equal to 25 percent of national consumption by 2020.

Table 6

China vegetable oil processing industry, enterprises, and employment by type of ownership, 2013

Type of ownership	Number of enterprises	Employment
	Number	
State-owned	103	7,225
Collective	140	3,291
Hong Kong, Taiwan, Macao	62	13,113
Multinational	127	35,610
Other limited liability company and corporation	1,591	136,297
Private	6,447	247,540
Other domestic	1,199	22,197
Total	9,669	465,273

Source: China National Bureau of Statistics, Third Economic Census.

Monthly lists of imports by individual companies analyzed by ERS found 180 distinct company names that imported soybeans during 2015 to 2017. These included edible oil processors, feed manufacturers, and various trading companies. Many were local branches or subsidiaries of larger companies. After grouping importers by their parent company (based on their names and investigations of company websites), ERS consolidated the list to 115 companies.

The two top importers were COFCO and Wilmar—the same companies that topped the processor list—with nearly equal volumes of imports. COFCO would have been the largest if its total was combined with that of Chinatex.⁶ The other companies ranked among the top processors were also among the top importers of soybeans.⁷

According to these data, state-owned companies accounted for 31 percent of soybean imports, slightly larger than the 27-percent share imported by multinationals (fig. 9). Four state-owned companies and 3 multinationals were among the top 10 importers, as were several private Chinese companies.⁸ Other companies, which include a mix of private, local government, and collective ownership, accounted for 40 percent of soybean imports. (Companies whose names were masked in the customs lists accounted for 2 percent.)

The top 10 companies accounted for 64 percent of all imports and had a nearly continuous monthly flow of soybean imports. Four importers recorded imports every month, and 21 companies imported in at least 20 out of 26 months. Many smaller companies imported small amounts sporadically. Sixty-four companies imported in only 1 out of 15 months.

Rapid expansion of state-owned companies, in particular, played an important role in propelling China's recent growth in soybean imports. Jiu San, for example, expanded from its traditional business of processing soybeans grown by State Farms in Heilongjiang to operating numerous crushing facilities along China's coast. Jiu San and COFCO facilities played a key role in making Guangxi Province one of the fastest growing soybean-importing regions. Beidahuang (Jiu San's parent company), Chongqing Grain Group, Chinatex, and COFCO undertook investments in overseas soybean farms, processing, and logistics as part of a "going out" outbound foreign investment strategy initiated by Chinese leaders in a 2008 food security plan (Gooch and Gale, 2018).

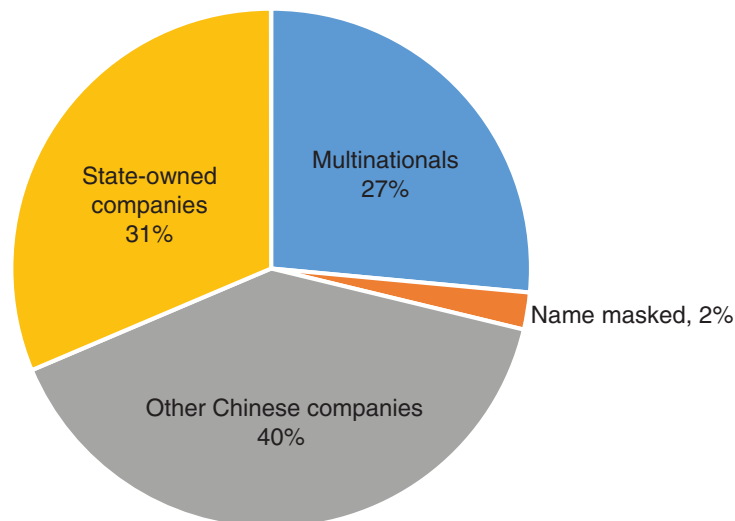
⁶ERS combined Beidahuang and its subsidiary Jiu San, which were listed separately. Both companies are operated by Heilongjiang Province's state farm system. COFCO International, a trading company headquartered in Switzerland, was not listed as a soybean importer.

⁷One of the top vegetable oil processors, Shandong Luhua, produces primarily peanut oil.

⁸Shandong Dawn, a private company that was top importer in 2012, applied for bankruptcy in July 2018; petrochemicals comprise the largest part of the company's sales (Lu, 2018).

Figure 9

China soybean imports by type of importer, 2015–17



Source: ERS analysis of lists of soybean importers derived from China customs data.

After China imposed its tariff on U.S. soybeans during 2018, representatives of state-owned companies COFCO and Sinograin expressed their resolve not to buy U.S. soybeans in interviews with state news media (*China Jingying Bao*, 2018; *People's Daily*, 2018). Later that year, when Chinese negotiators pledged to resume imports as part of efforts to resolve trade tensions, the same companies were reported to be the main buyers of U.S. soybeans.

Other Chinese measures affecting soybean demand

China's policy regarding genetically modified (GM) soybeans is an important factor shaping trade in soybeans. China allows imports of GM varieties of soybeans for use in soybean crushing after the varieties are evaluated and approved by a committee of Chinese scientists, but no GM soybeans can be grown commercially in China. This regulatory structure has led to a segmented market in China. Domestic Chinese soybeans are used mainly to manufacture soy-based food products such as tofu, soy sauce, protein supplements, and premium-priced non-GM soybean oil. Imported soybeans are the predominant raw material used in soybean crushing.

Chinese quality concerns affected imports of U.S. soybeans during the 2017/18 marketing year. Chinese importers reportedly shifted some purchases from U.S. to Brazilian soybeans due to declining protein content of U.S. soybeans (Plume, 2018). In response to requests by China's inspection and quarantine officials, USDA agreed to add a notation to phytosanitary certificates for shipments containing more than the 1-percent foreign matter that was expected to prompt testing and delays for such shipments (Iowa Soybean Association, 2018).

In October 2018, China's Feed Industry Association introduced new standards for lower protein content in feed for swine and poultry that could affect demand for soybeans (Nguema, 2018). Chinese officials said the new standards were intended to improve feed efficiency by reducing stress

on animals' metabolism and to address environmental impacts by cutting back on excretion of nutrients not absorbed by livestock. Officials also claimed, however, that the feed standards could cut use of soybean meal by 11 mmt annually and reduce China's reliance on imported protein materials (China Ministry of Agriculture and Rural Affairs, 2018a).

After China imposed the 25-percent tariff on U.S. soybeans in July 2018, Chinese officials pursued several strategies to supplement soybean meal supplies:

- China's customs administration lifted a ban on rapeseed meal imports from India (Gu and Jadhav, 2018).
- China's Ministry of Finance eliminated a value-added tax rebate for soybean meal exports as of November 1, 2018 (Reuters, 2018).
- China's Ministry of Finance announced elimination of tariffs on soybeans and soybean meal from India, South Korea, Bangladesh, Laos, and Sri Lanka as of July 1, 2018, as part of efforts to complete an Asia-Pacific trade agreement (Beijing Youth Daily, 2018).
- China's customs administration announced an agreement to open China's market to imports of Ethiopian soybeans (China General Administration of Customs, 2018).
- Chinese authorities auctioned 2 mmt of soybeans from government reserves (Nguema, 2018).
- China's customs administration added imported meals made from rapeseed, peanuts, palm kernels, sunflower seeds, cottonseed, and sugar processing to a list of items exempt from border inspections as of June 1, 2018 (China General Administration of Customs, 2018a). Soybean meal was excluded from the list.
- China's State Council announced a temporary elimination of import tariffs for plant-based oil meals beginning January 1, 2019 (Kim, 2018).

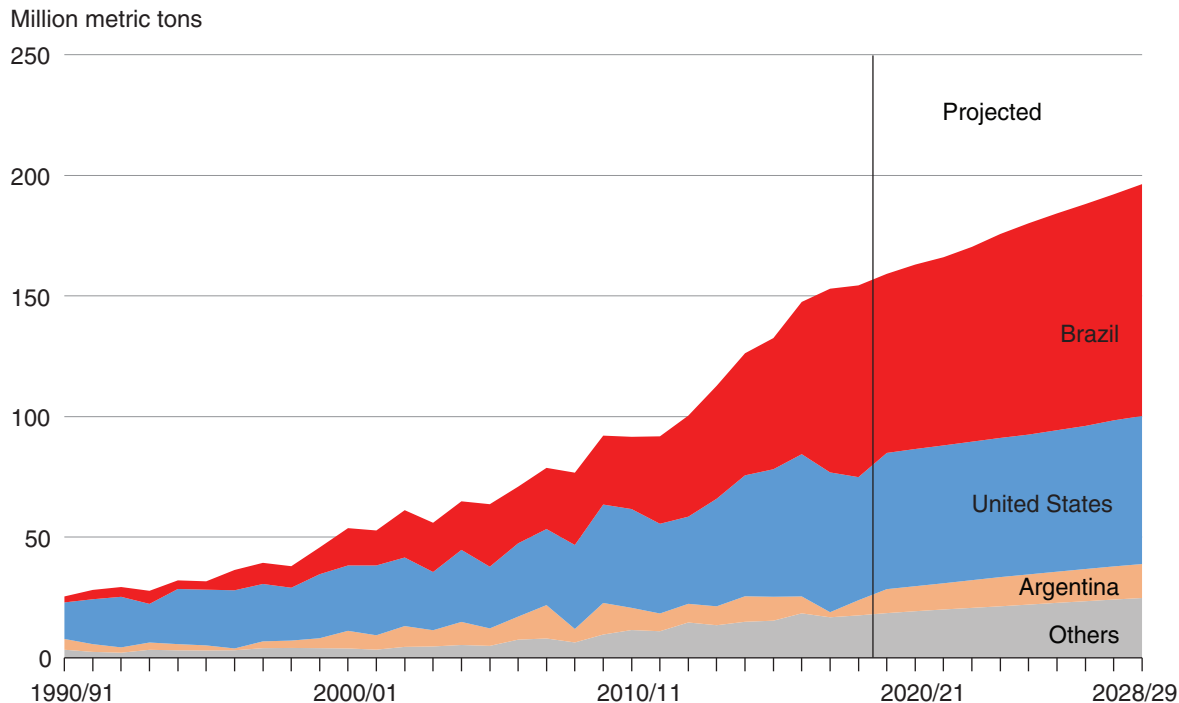
During 2018 and 2019, China's livestock production and soybean meal demand were both adversely affected by several factors, including slow economic growth, an environmental protection campaign that banned livestock and poultry farms near bodies of water and residential areas, tighter credit that caused cashflow problems for farms, and cutbacks in swine inventories by farmers worried about the spread of African swine fever (Nguema, 2019; Inouye, 2019). Requirements imposed to deal with African swine fever and to comply with more stringent environmental rules could drive out more small-scale and swill-feeding producers and shift consumer demand from pork to poultry, beef, and other animal proteins (Inouye, 2019). China Ministry of Agriculture and Rural Affairs (2019) expected African swine fever to reduce pork output and affect crushing demand for soybeans during 2019 and 2020, before resuming growth in subsequent years. Other diseases like avian influenza, new mandates from Chinese agricultural officials to reduce antibiotic use, and limits on aquaculture production to address water quality problems could also disrupt China's soybean meal demand (Tao et al., 2019).

The United States and Brazil Compete to Supply China's Soybean Imports

The United States and Brazil have accounted for most of the growth in world soybean exports. During the 1990s, the United States was the predominant exporter of soybeans. During the late 1990s, both U.S. and Brazilian exports increased to supply China's growing demand, but Brazilian exports grew fastest. From 2000 to 2016, U.S. soybean exports more than doubled from 27 mmt to 59 mmt, but Brazil's exports grew fourfold—from 15 mmt to 63 mmt (fig. 10). During 2017/18, Brazil's exports grew to 79 mmt as U.S. exports were reduced by China's tariff and Argentina's exports fell because of a serious drought. With China's tariffs assumed to remain in place, USDA (2019) projected that U.S. soybean exports would rise to 61.4 mmt and Brazil's exports would rise to 96.1 mmt in 2028.

The United States supplied more than 50 percent of China's soybean imports during the 1990s. Brazil's share first matched that of the United States in 2002 when each country supplied about 35 percent of China's soybean imports (fig. 11). From 2002 to 2011, each country's share of China's soybean imports fluctuated between 35 and 50 percent. Brazil's share rose to almost 50 percent during 2012 to 2016 as the U.S. share fell to less than 40 percent. The U.S. share fell to 30 percent in 2017 as China's tariff on U.S. soybeans took effect late in the market year. As the tariff took full effect during the first 5 months of China's 2018/19 market year, Brazil's share rose to 77 percent, while the U.S. share fell to 4 percent.

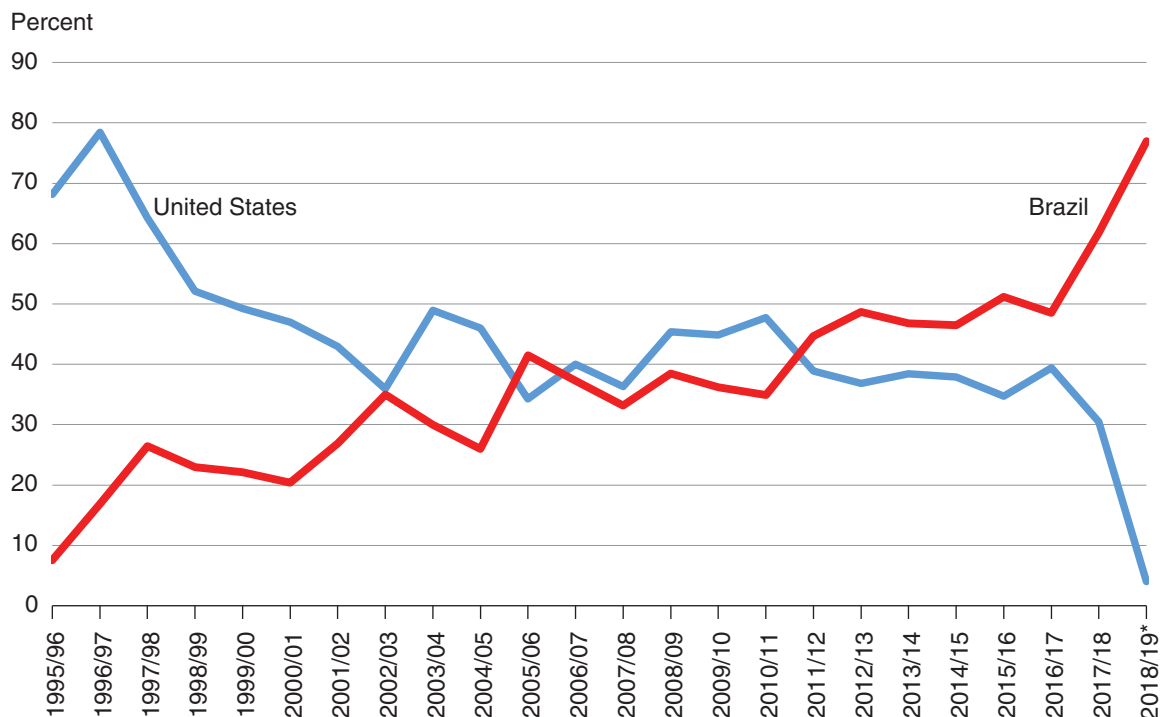
Figure 10
Soybean exports by country, 1990–2028



Note: Data are for market years.

Source: USDA, Production, Supply and Distribution data, and USDA (2019).

Figure 11
China soybean imports: Shares supplied by United States and Brazil, 1995–2019



Note: Chart shows share of soybean imports arriving in China during China’s October–September market year.

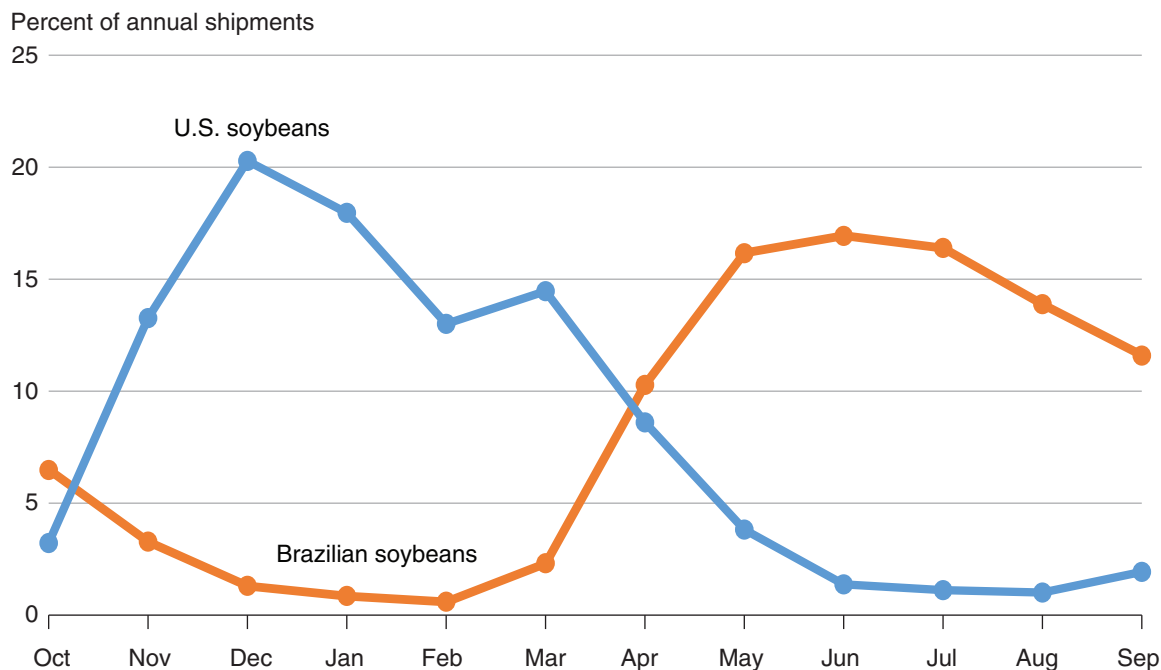
*2018/19 data for October 2018–February 2019.

Source: ERS analysis of China Customs data accessed from IHS-Global Insight, Global Trade Atlas.

China’s imports from the United States and Brazil have distinct seasonal patterns corresponding to different harvest times in the northern and southern hemispheres. Chinese customs statistics show that arrivals of U.S. soybeans in China typically peak during November to March each year, while arrivals of Brazilian soybeans peak during May to September (fig. 12). Conversely, minimal amounts of Brazilian soybeans arrive during December to February, and few U.S. soybeans arrive during June to August. During 2018, China’s imports of Brazilian soybeans continued at high volumes through August to December when China normally begins importing from the United States.

Figure 12

Seasonal patterns of China imports of U.S. and Brazilian soybeans, 10-year average



Note: Chart shows average monthly distribution of China’s soybean imports from each country. For example, over 20 percent of imports from the United States arrive in December, but only 1 percent arrive in July. Seventeen percent of imports from Brazil arrive in June, but only 1 percent arrive in December. Percentages are averages for China marketing years (October–September) 2006–16.

Source: ERS analysis of China Customs data accessed from IHS-Global Insight, Global Trade Atlas.

Growth in Soybean Output Propelled U.S. and Brazilian Exports

The predominance of the United States and Brazil as exporters reflects the emergence of soybeans as major crops in those countries during the 20th century. China was the historic center of soybean cultivation, but production there has been relatively stagnant as Chinese farmers tend to plant crops such as corn, rice, and vegetables that generate higher net returns. China’s soybean output remained relatively stagnant throughout the 20th century and grew only marginally during the 21st century despite a series of subsidies and programs to improve crop strains.

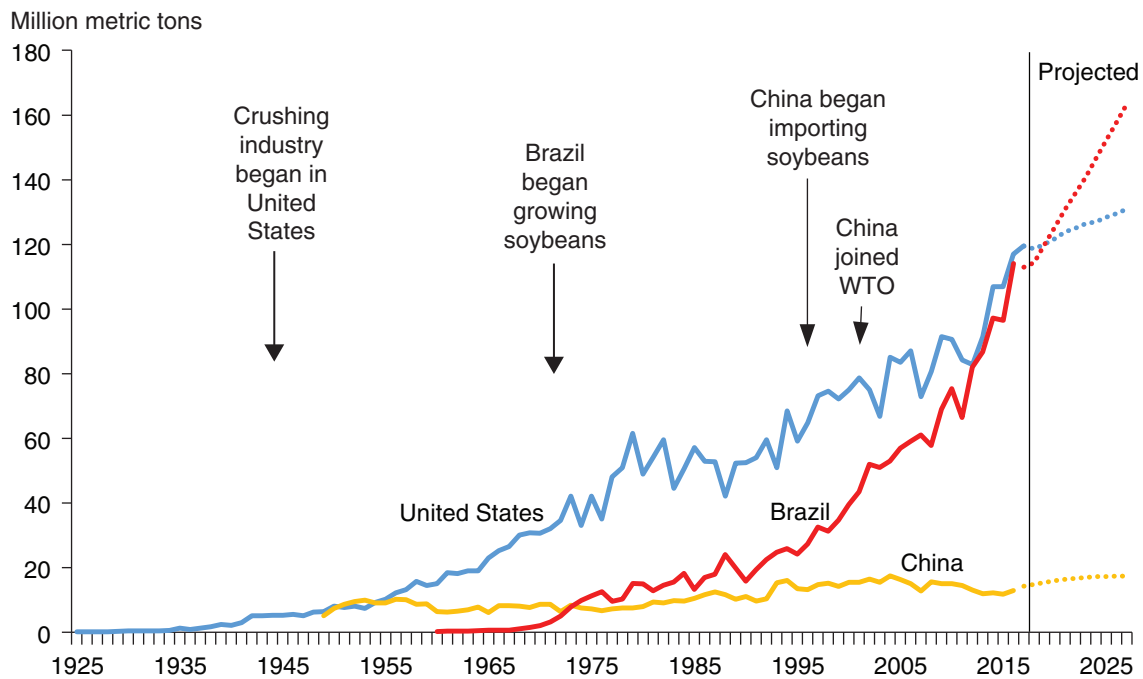
The United States became the top soybean producer during the 20th century. Soybeans were first introduced to the United States from China during the 19th century. After decades of experiments with food and industrial uses, U.S. scientists developed commercially feasible techniques to extract oil from soybeans and incorporate soybean meal in animal feed (Roth, 2018). Beginning in the 1940s, demand from the U.S. processing industry and livestock farms encouraged growth in soybean production.

U.S. soybean output first surpassed China’s during the 1950s and grew to a peak of 123.66 mmt in 2018—nearly 8 times China’s 16-mmt output that year (fig. 13). USDA (2019) projected that U.S. soybean output would fall during 2019 in response to China’s tariff. With Chinese tariffs in place, future growth in U.S. soybean output would depend on domestic demand and growth of other export markets. USDA (2019) projected a moderate rise in U.S. soybean output to 126.7 mmt in 2028.

Brazil's more recent expansion of soybean output has been critical to supporting China's rising imports. Brazil's soybean production began during the 1960s and grew rapidly as cultivation spread to the country's interior regions and as yields improved. Brazil's soybean output surpassed China's in the 1970s and caught up with U.S. output in 2012. During 2017/18, Brazil and the United States each produced about 120 mmt of soybeans. USDA (2019) projects that growth in Brazil's soybean output will outpace U.S. production through 2028/29. Brazil's soybean output is projected to reach 160.7 mmt in 2028/29, exceeding U.S. output by 34 mmt that year. Brazil's rapid growth reflects availability of land, the capacity to double-crop soybeans and corn in its tropical climate, and the assumption that China's tariff on U.S. soybeans would favor imports from Brazil if maintained throughout the projection period.

U.S. soybean production expanded through growth in yield and by shifting land from other crops such as corn and wheat to soybeans. U.S. harvested soybean area rose from under 23 million hectares in 1990 to nearly 30 million hectares in 2000 as changes in U.S. domestic support programs gave U.S. agriculture the flexibility to respond to China's demand for soybeans. Moreover, new higher yielding soybean cultivars adapted to a short growing season contributed to a northward expansion of soybean planting into traditional wheat-growing regions in the Northern Plains. Cost savings from the herbicide-tolerant varieties facilitated the expansion of soybean acreage in all regions.

Figure 13
Soybean production, U.S., Brazil, and China, 1925–2028



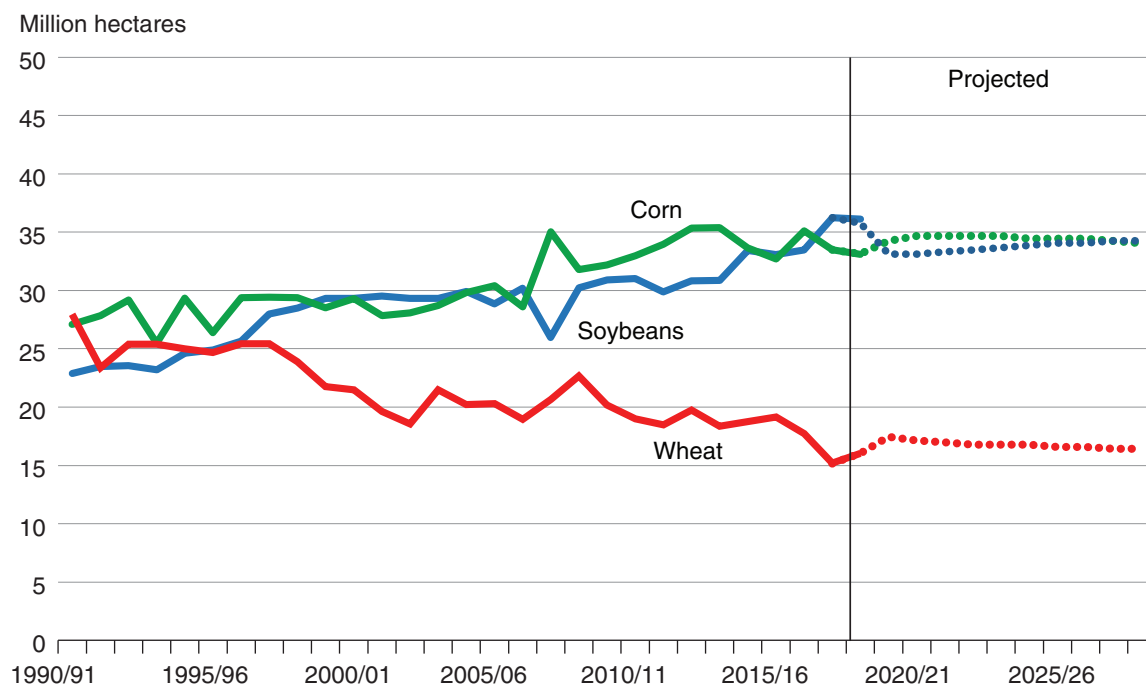
Source: Data compiled from USDA National Agricultural Statistics Service, China National Bureau of Statistics, UN Food and Agriculture Organization, and USDA (2019).

The 1990 and 1996 U.S. farm legislation replaced subsidy payments tied to corn and wheat base acres with decoupled payments that gave U.S. farmers more flexibility to make planting decisions based on market prices. This freed up farmers to plant more soybeans during the 1990s. By 2000, U.S. soybean area equaled corn area while wheat area had declined (fig. 14). U.S. farmers, attracted by ethanol demand and stronger corn prices, shifted land from soybeans to corn during 2006 to 2014. As crop prices fell during 2013 and 2014, exports of soybeans to China were a growing segment of demand for farm commodities that prompted a rebound in soybean area during 2014 to 2018, reaching a peak of 36.2 million hectares in 2017.

During 2018/19, U.S. soybean harvested area was still historically high at 35.67 million hectares, even though the possibility of Chinese tariffs loomed at planting time. U.S. soybean farmers received trade mitigation payments to offset losses from declining prices attributed to China’s tariff during 2018, but continued uncertainty about resolution of trade disputes with China weakened incentives to plant soybeans in 2019. Historically high carryover stocks of unsold U.S. soybeans and another large crop in South America put downward pressure on soybean prices.

USDA (2019) projected a decline in U.S. soybean area due to expectations that China’s tariff on soybeans would reduce net returns and induce farmers to shift land from soybeans to corn and wheat. After a drop in soybean area during 2019, soybean area was projected to rise moderately to 33.1 million hectares in 2019/20 and remain at that level until rebounding to 34 million hectares in 2025. (The previous year’s projection—made before U.S.–China trade uncertainties began—showed that soybean area would exceed corn area throughout the projection period.)

Figure 14
U.S. soybean, corn, and wheat area harvested, 1990–2027

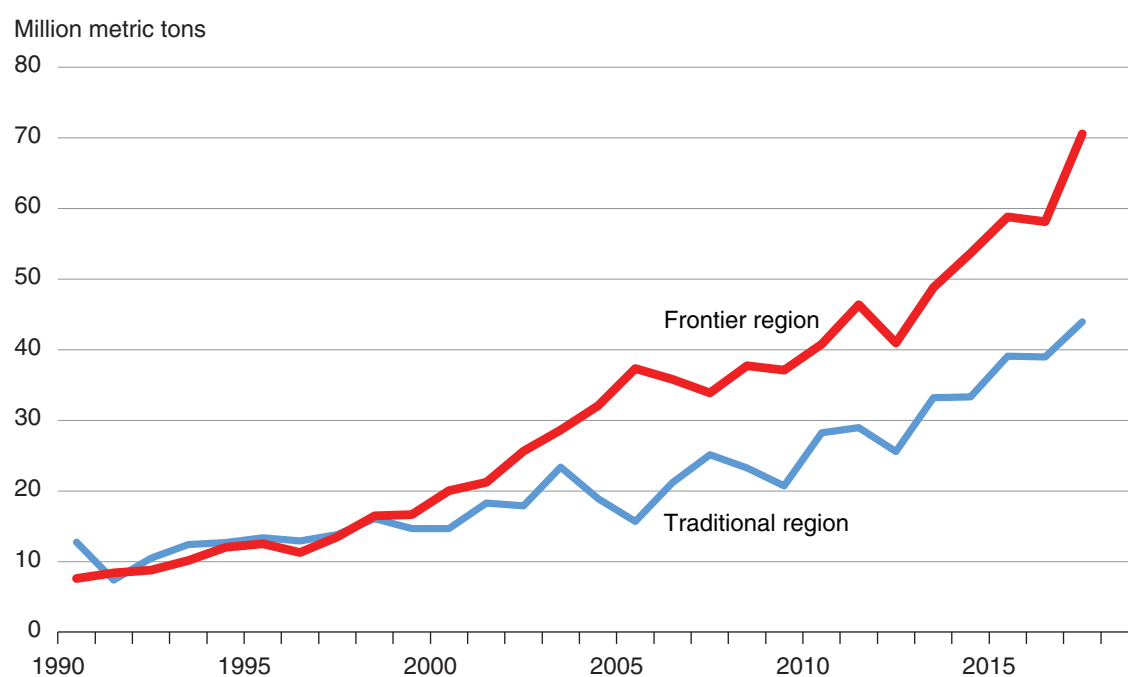


Source: ERS analysis of USDA, Production, Supply and Distribution data, and USDA (2019).

Brazil's dramatic growth in land area devoted to soybeans has been the main contributing factor to growth in global soybean supplies. 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, to the north of Rio Grande do Sul (Brandão et al., 2005). Morgan (1979) 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. Schnepf and colleagues (2001) observed that Brazil's economic and political reforms contributed to a more stable macroeconomic situation that promoted investment and integration with global markets. They also cited a mid-1990s surge in international prices for stimulating production in South America.

A long-term strategy of cultivating the extensive savanna known as the *Cerrado* pushed the frontier of soybean production into Brazil's vast inland regions. From 1997 to 2017, production increased by 57 mmt in these frontier regions comprising 11 States, accounting for 65 percent of the growth in Brazil's national soybean output (figs. 15, 16).⁹

Figure 15
Brazil soybean production by region, 1990–2017

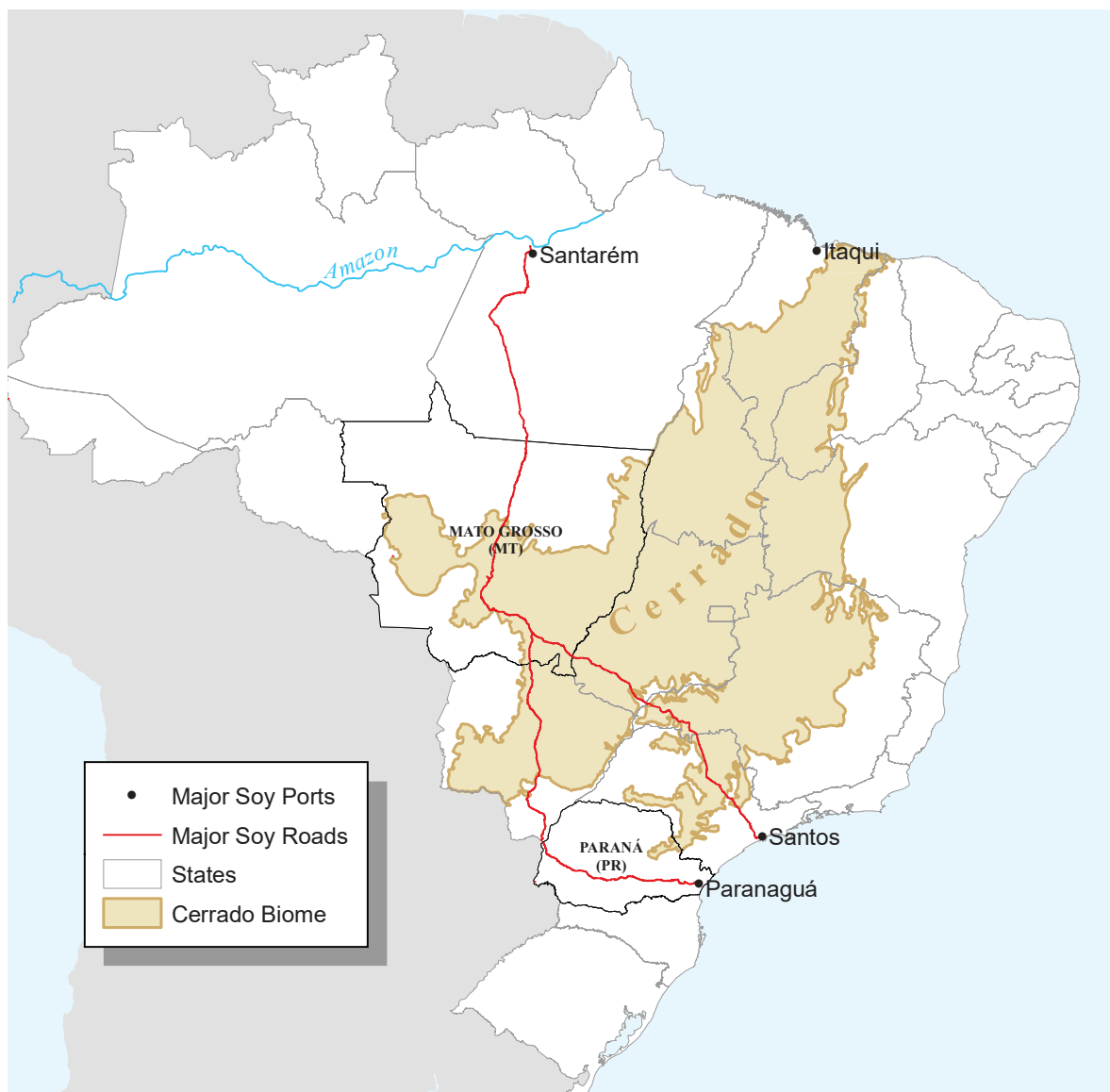


Note: “Frontier” region includes the States of Bahia, Piauí, Goiás, Mato Grosso do Sul, Mato Grosso, Maranhão, Minas Gerais, Acre, Amazonas, Amapá, Pará, Rondônia, and Roraima, encompassing nearly 93 percent of the Cerrado biome and the Amazônia biome. “Traditional” region includes the States of Paraná, Rio Grande do Sul, Santa Catarina, Espírito Santo, Rio de Janeiro, São Paulo, Alagoas, Ceará, Paraíba, Pernambuco, Rio Grande do Norte, and Sergipe.

Source: ERS calculations based on data from Brazil Ministry of Agriculture Marketing Agency (CONAB).

⁹The *Cerrado* is irregularly distributed across most of the State of Goiás and parts of the States of Mato Grosso, Mato Grosso do Sul, Paraná, Minas Gerais, São Paulo, Bahia, Piauí, Maranhão, Tocantins, and Rondônia.

Figure 16
Brazilian States and regions

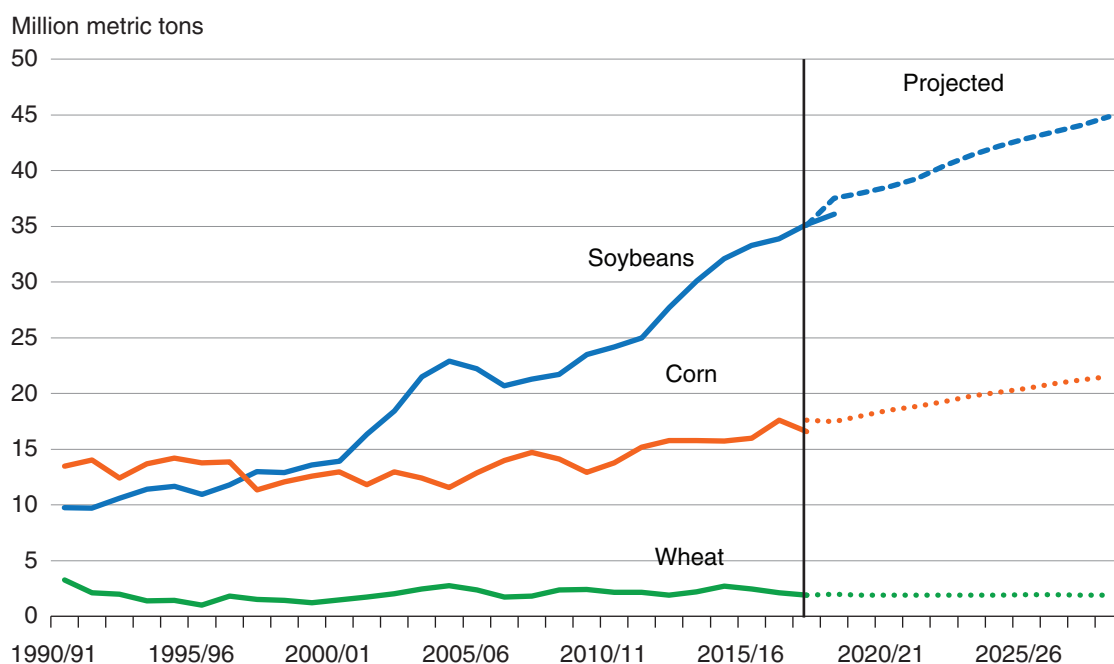


Source: ERS analysis using data from the Brazilian Institute of Geography and Statistics (IBGE), 2006.

The Economist (2010) called the expansion of soybean production in Brazil's inland states "the Miracle of the *Cerrado*." Growth in the region's soybean output was spurred by high international prices for soybeans during the 1980s, rising Asian demand for soybeans, and the desire of Brazilian decision makers to maintain territorial sovereignty by integrating the country's western and northern regions into the national economy (Schnepf et al., 2001; Goldsmith and Hirsch, 2006). Publicly supported development of soybean cultivars tolerant of the tropical climate and poor soils of the Cerrado was a critical component of the strategy. Preferential credit and tax policies, subsidies for fuels, use of chemicals to overcome soil problems, low land costs, and migration of farmers from traditional production regions also promoted the opening of new soybean land in Brazil. Additional factors contributing to Brazil's emergence as a soybean supplier included a more stable macroeconomic environment and receptivity to foreign investment that allowed multinational companies to become key players in the country's soybean industry.

Brazil's abundant land resources, diverse regions, and its capacity to grow two crops per year allowed it to increase soybean production without sacrificing corn or wheat output. Goldsmith and Montesdeoca (2017) found that the safrinha system of growing soybeans and corn in succession during a single year was a key factor increasing the output and revenue of land in Brazil's tropical regions. Brazil's soybean area grew from under 10 million hectares in 1990 to 35 million hectares in 2017, far outpacing growth in corn and wheat area (fig. 17). Area planted in corn rose from 13.5 million hectares to 17.6 million hectares between 1990 and 2017, while wheat area remained relatively low (less than 2 million hectares). USDA projects continued increase in Brazil's soybean area to 44.8 million hectares in 2028 while corn area rises to 21.5 million hectares. This potential for expansion ensures abundant supplies and likely means that Brazil will remain the primary supplier of China's soybean imports.

Figure 17
Brazil soybean, corn, and wheat area harvested, 1990–2028



Source: ERS analysis of USDA, Production, Supply and Distribution data, and USDA (2019).

Low production costs propel Brazil's soybean exports

The international competitiveness of U.S. and Brazilian soybeans is determined largely by costs of producing soybeans and transporting them to final markets. Previous ERS studies by Schnepf, Dohlman, and Bolling (2001) and Meade et al. (2016) found that Brazilian producers had lower land costs than in the U.S. Midwest. Production of soybeans in acidic soils in Brazil's Cerrado region requires soil treatments, fertilizer, and other agricultural chemicals (usually imported) that add to costs (Rada and Valdes, 2012; Rada, 2013). Transportation of soybeans to ports also adds to the cost of soybeans paid by overseas buyers.

The principles of economic geography influence the location of soybean production. Production of soybeans tends to concentrate in regions like the U.S. Midwest and Brazil's Cerrado, where abun-

dant land is available at relatively low cost. Farms in soybean-producing regions are typically large scale and mechanized. Cropland in densely populated and industrialized regions like China tends to be devoted to crops that generate high value per unit of land. In China, about 40 percent of its soybeans are produced in Heilongjiang Province, one of its least densely populated regions that borders eastern Russia.

Table 7 displays an updated comparison of soybean production costs for 2017 in the major growing regions of Brazil (Mato Grosso), the United States (the Heartland region that encompasses much of the Midwestern Corn Belt), and China's Heilongjiang Province (see box, "Cross-Country Comparison of Soybean Production Costs"). The costs are reported in two broad categories: (1) operating expenses directly associated with soybean production and (2) general farm overhead allocated to the farm's soybean enterprise. Note that U.S. farms often grow soybeans, corn, and other crops, and many Brazilian farmers grow soybeans and corn in succession during the same season, so many general farm expenses must be allocated among the various crops produced by farms.¹⁰ In China, many farmers also grow multiple crops, and many farmers have off-farm employment.

The cost comparison is consistent with Meade et al.'s (2016) finding that average soybean production costs in Mato Grosso are lower than costs in Argentina and the U.S. Heartland. This comparison also shows that China's production cost is much higher than costs in both the United States and Brazil. The total production cost is estimated to be \$839 per ha in Mato Grosso, \$1,095 per ha in the U.S. Heartland, and \$1,458 per ha in China's Heilongjiang Province (table 7). Dividing these costs by average yields shows unit costs were \$254 per metric ton of soybeans in Mato Grosso and \$313 per metric ton in the U.S. Heartland, a difference of nearly \$60 per metric ton. The low yield in Heilongjiang (33 percent less than in Mato Grosso) magnified the per-metric-ton cost disadvantage for growers in China. The unit cost in Heilongjiang Province was \$655 per metric ton, more than double the costs in Brazil and the United States.

The cross-country difference in production cost is attributed largely to differences in land rents and the opportunity cost of farm labor. Fertilizer and chemical expenses in Mato Grosso are relatively high, consistent with need for soil treatments discussed above and consistent with findings by Meade et al. (2016). China's \$229-per-ha expense for custom services reflects the common practice of hiring other farmers or cooperatives to cultivate and harvest fields in a region where few farmers own machinery. This expense is nearly equal to the "machinery and equipment" overhead expense reported for U.S. Heartland farmers who typically own their equipment (but U.S. farmers also incur higher expense for fuel and repairs).

¹⁰Goldsmith and Montesdeoca (2017) discuss allocation of expenses to crops for Brazilian farms.

Table 7

Comparison of soybean production costs in 2017, Brazil, United States, and China

Item	Brazil, Mato Grosso	United States, Heartland	China, Heilongjiang Province
	Dollars per hectare		
Operating expenses	583	390	478
Fertilizer, chemicals, seed	489	272	216
Custom services	44	25	229
Fuel, electricity, repairs	31	91	4
Other operating costs	20	2	29
Allocated overhead	258	742	1,008
Land	92	390	653
Labor	7	56	338
Machinery and equipment	85	225	1
Taxes, insurance, other overhead	74	71	16
Total cost per hectare	839	1,095	1,458
	Metric tons per ha		
Yield per hectare	3.30	3.50	2.23
	Dollars per metric ton		
Total cost per metric ton	254	313	655
Price received	299	341	540

Note: The table shows 2017 costs. China and Brazil costs were converted to U.S. dollars; China and U.S. estimates were converted to per-hectare values.

Source: China National Development and Reform Commission; USDA Economic Research Service, Commodity Costs and Returns; CONAB (Brazil Ministry of Agriculture Marketing Agency).

Rents for agricultural land tend to be driven by profitability of crops and subsidies tied to land use (Burns, et al., 2018), and differences in land rents across regions tend to reflect competition from residential and industrial uses (Kueth, Ifft, and Morehart, 2011). Land rents tend to be low in sparsely populated regions like Mato Grosso, and they tend to be high in densely populated countries such as China where land is at a premium. Land cost in Mato Grosso is estimated at \$92 per ha, about one-fourth of the \$390-per-ha land cost in the U.S. Heartland region. Land cost is especially high in Heilongjiang (even though it is one of China's most sparsely populated regions), at \$653 per ha.¹¹

Similarly, labor costs are lowest for soybean producers in Mato Grosso (\$7 per ha) than in the U.S. Heartland (\$56 per ha) and highest in China's Heilongjiang Province (\$338 per ha). Labor costs per hectare tend to be inversely related to the scale of farms and degree of mechanization. Although mechanization and farm size are increasing in China, farms are still smaller and more labor intensive than those in the U.S. Heartland and Brazil's Mato Grosso.

¹¹In Chinese currency, the Heilongjiang land cost is reported to be 294 yuan per mu. China has no statistics on land rents, but news media and research investigations often report cropland rents in the range of 300 to 500 yuan per mu, depending on location and crop. Rents for high-value uses such as vegetables and fish ponds can be more than 1,000 yuan per mu.

Cross-Country Comparison of Soybean Production Costs

ERS compared 2017 soybean production costs for key production regions:

- China's Heilongjiang Province
- U.S. Heartland region
- Brazil's State of Mato Grosso

The analysis is based on cost estimates from Government agencies in each country: China's National Development and Reform Commission, the USDA Economic Research Service "Commodity Costs and Returns," and Brazil's CONAB, the Brazil Ministry of Agriculture Marketing Agency.

Brazil's cost accounting is modeled after the U.S. template. China also uses a similar approach, but some categories were regrouped to make them similar to those reported by U.S. and Brazilian data. China's production costs were converted to dollars per hectare using the exchange rate and converting data from costs per Chinese mu to costs per hectare (15 mu = 1 hectare). For the United States, costs were converted to dollars per hectare (2.47 acres = 1 hectare). The Brazilian costs in reals per hectare were converted to dollars per ton using the exchange rate at harvest time.

In each country many farm families supply their own labor and land—which has no cash expense—to grow soybeans. In these instances, production costs are imputed using locally prevailing wages and land rents. The increase in China's labor and land costs, in particular, reflects rapid increases in imputed costs that exceed the growth in cash expenses. Many farmers are able to continue farming because their cash income exceeds cash expenses even though the opportunity cost of the labor and land that they supply indicates that they are incurring large losses.

The high production costs in China imply large net losses for soybean growers of -\$290 per hectare that raise the question of why Chinese farmers grow soybeans at all (the China data have shown losses each year since 2014).¹² The costs reported here exceed cash expenses for Chinese farmers who own their land and do not hire workers. China's National Development and Reform Commission also reports an estimate of *cash* expenses that exclude opportunity costs (\$816 per hectare) and a positive net *cash* return (\$353 per hectare). The estimates of revenue do not include a subsidy payment for soybean producers in Heilongjiang reported to be \$263 per hectare in 2017 and over \$700 per hectare in 2018.¹³ Positive cashflow and subsidies may allow farmers with few alternatives to continue growing soybeans, but high land rents and opportunity cost of labor are restraints on expansion of China's soybean planting. Farmers with good prospects for off-farm earnings are more inclined to quit farming and rent out their land to neighbors. Thus, the portion of cropland

¹²Meade et al. (2016) attributed negative net returns for soybeans in Argentina to the use of economic costs instead of accounting expenses in the calculation.

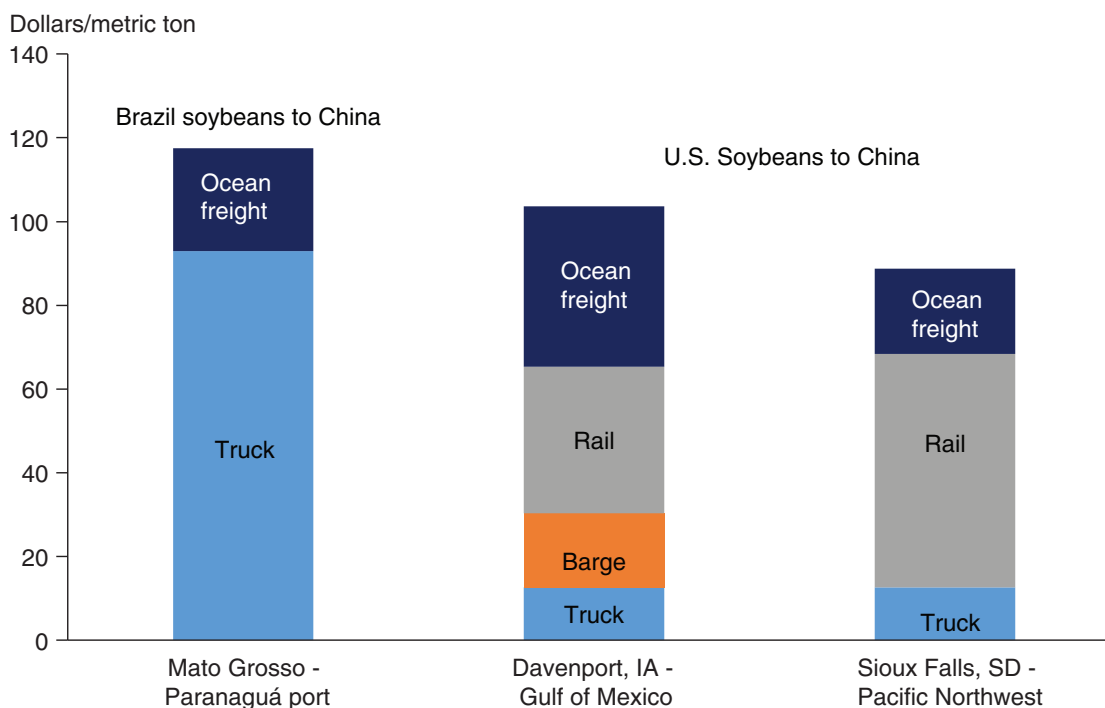
¹³Chinese news media reported Heilongjiang Province's soybean producer subsidy was 117 yuan per mu for the 2017 crop and 320 yuan per mu for the 2018 crop. Some farmers also received a 150 yuan subsidy for switching from corn to soybeans.

rented in China has increased rapidly.¹⁴ High land rents prompt Chinese farmers to devote land to crops such as corn and rice, greenhouses, and fish ponds that have higher net returns per hectare than soybeans.

The concentration of soybeans in sparsely populated regions means that transportation costs to markets play an important role in determining the final cost of soybeans to importers in China. Soybeans produced in the U.S. Midwest historically have benefited from relatively low-cost transportation on rivers to ports on the Gulf of Mexico or by rail to ports in the Pacific Northwest. Relatively low production costs in Brazil's inland states are offset to a high degree by the cost of transporting soybeans to coastal ports and northern terminals on the Amazon River by truck, rail, or a combination of the two modes.

Figure 18 summarizes transportation costs from production regions to ports in Brazil and the United States. During 2017, hauling soybeans by truck from northern Mato Grosso to the Brazilian port of Paranaguá cost \$93 per metric ton. Transporting soybeans from Davenport, Iowa, to the Gulf of Mexico by truck, rail, and barge cost \$65 per metric ton, \$28 less than the internal transport costs in Brazil. Shipping soybeans by truck and rail from Sioux City, South Dakota, to the U.S. Pacific Northwest cost \$68 per metric ton. That year, ocean freight to China from Pacific Northwest ports was less than freight from the Gulf of Mexico, prompting increases in shipments through Pacific Northwest ports.

Figure 18
Soybean transportation costs to China, selected locations, 2017



Note: Transportation costs to Shanghai, China, are shown.

Source: Data taken from Salin (2018).

¹⁴In 2017, China's Ministry of Agriculture reported that 35 percent of collectively owned land was leased out or otherwise transferred (*People's Net*, 2017).

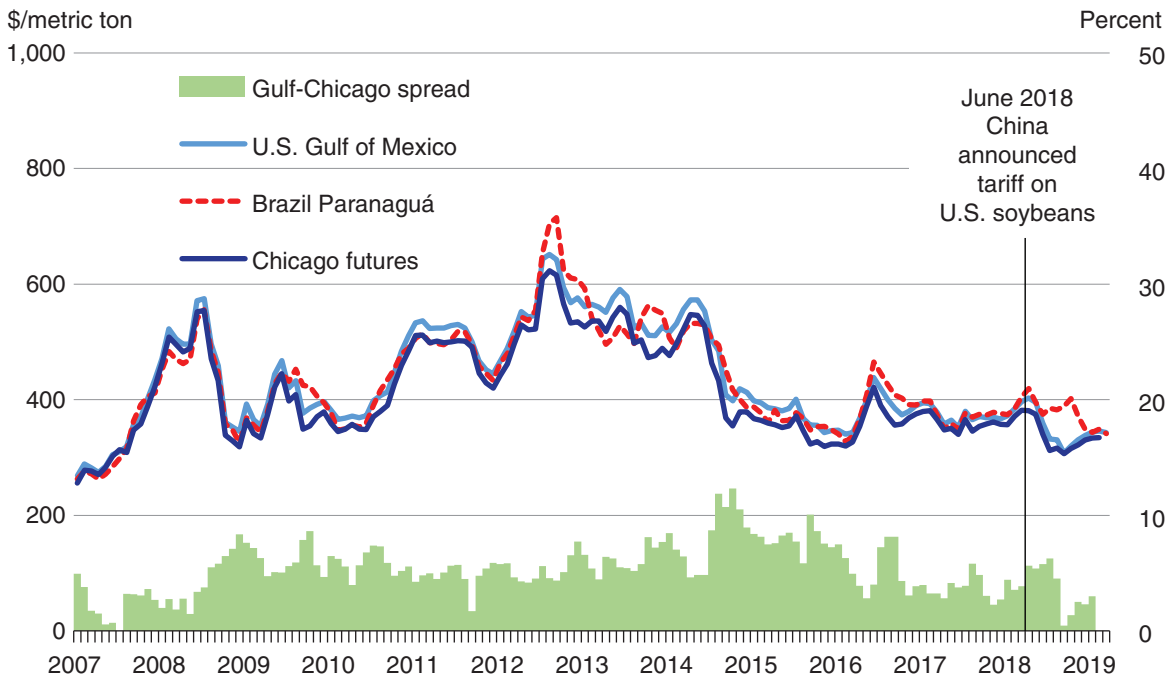
Salin and Somwaru (2018) observed that the U.S. transportation system's multiple modes and low cost of transport from farms to export markets is key to the competitiveness of U.S. soybeans in the global market. Competitiveness of U.S. soybeans will be reduced if Brazil is able to reduce internal transportation costs. Salin (2018) described a Brazilian initiative underway since 2007 that aims to build a more efficient intermodal transportation system that will move more soybeans by rail and waterways and expand port capacity. According to Salin (2018), the Brazilian Government's plan to pave 100 kilometers of a road known as BR-163 could cut the time needed to truck soybeans from Mato Grosso to the northern terminal Miritituba from 3 days to 1.5 days. According to USDA/AMS (2018), 5.3 mmt of soybeans were transported on a new intermodal truck-rail export route from Mato Grosso to the Santos port in 2017. Meyers (2018) noted a surge of Chinese investment in Latin American infrastructure including several rail and road projects linking inland Brazilian states with ports, and COFCO's acquisition of terminals at the Santos port through its acquisitions of the trading companies Nidera and Noble Agri (Gooch and Gale, 2018). Despite progress in construction, a Brazilian truckers' strike during 2018 briefly disrupted shipments and led to setting of minimum truck rates. During the early months of 2019, heavy rains and congestion brought soybean trucks on BR-163 to a standstill.

Fluctuation in Global Soybean Prices Reflects Competition

Export competition tends to equalize U.S. and Brazilian prices

Competition between U.S. and Brazilian soybean exporters for sales to Chinese buyers tends to equalize the two countries' soybean export prices. The price of soybeans shipped from both countries is usually negotiated with reference to the futures market price at the Chicago Board of Trade with a premium or discount that varies across ports. Three monthly price data series—the Chicago futures price, the cash price at U.S. export elevators at the Gulf of Mexico, and the price at the Brazilian port of Paranaguá—display broadly similar fluctuations as all three prices passed through similar rising and falling phases from 2007 to 2019 (fig. 19). All three prices rose rapidly during 2007 to 2008, 2012, and 2016, and all three peaked at approximately the same time. Rapid declines occurred in 2008 and 2009 and 2014.

Figure 19
U.S. and Brazilian soybean prices, monthly 2007-2019



Note: Monthly averages converted to dollars per metric ton.

Sources: Brazil Paranaguá soybean cash price, CEPEA (Center for Advanced Studies on Applied Economics); U.S. Gulf cash bids at export elevators, USDA Agricultural Marketing Service, "Market News"; Chicago Futures monthly average, IMF Primary Commodity Prices.

There was no long-term secular increase in soybean prices from 2007 to 2018 despite China's sustained growth in demand for imported soybeans. The price at U.S. Gulf ports in early 2019 was \$350/metric ton, less than the 2007–18 average of \$420/metric ton. Export prices reached the \$500–\$600/metric ton range for several months in 2007 and 2008 and returned to that range during most of 2011 to 2014. However, prices fell to \$300–\$400/metric ton in 2015 and remained below \$400 per metric ton during most months from 2015 to 2019. The extended period of low prices reflects abundant supplies due to Brazil's rapid increase in production and exports. Low prices may have helped sustain China's growth in soybean imports during 2015 to 2017.

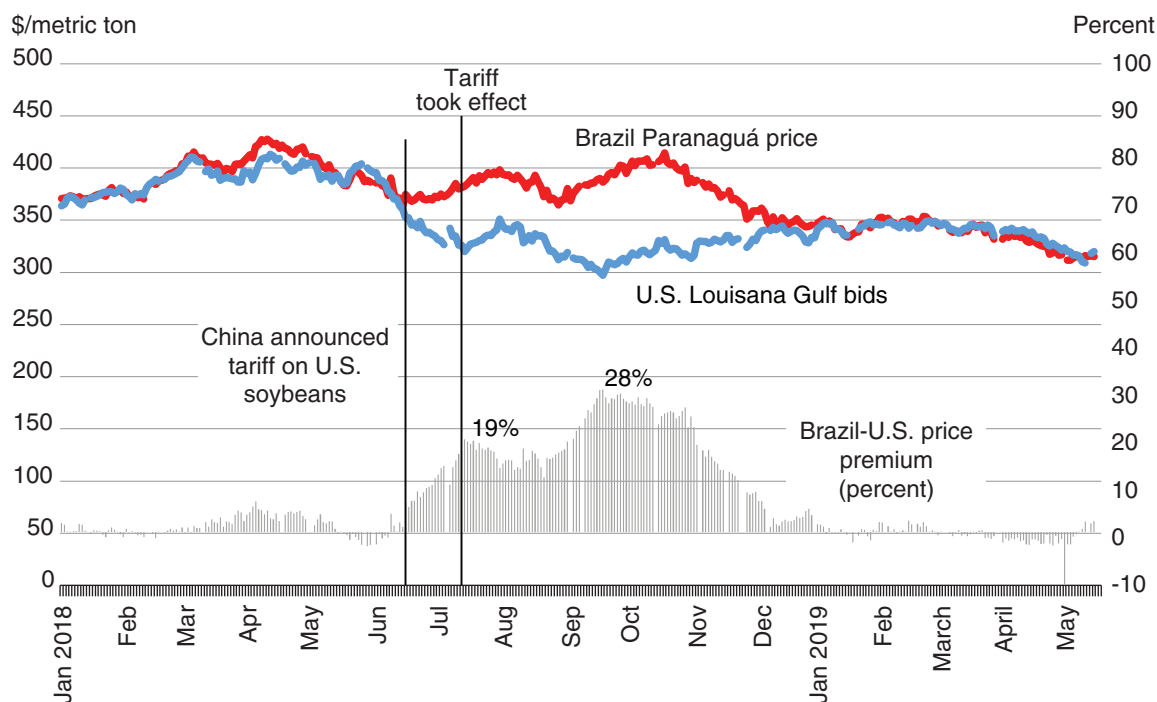
The tendency for U.S. and Brazilian prices to equalize suggests a high degree of competition between exporters. Monthly prices for soybeans at U.S. Gulf ports and prices at the Brazilian port of Paranaguá rarely deviated from one another for more than 1 or 2 months during 2007 to 2019. Fluctuations in both prices tend to mirror changes in the Chicago futures price. U.S. Gulf prices tend to have the closest relationship to the Chicago futures price. The monthly average U.S. Gulf price, on average, was 5.5 percent higher than the monthly Chicago futures price. The Gulf–Chicago spread had a standard deviation of 2.3 percentage points. The price at Paranaguá was, on average, 5.1 percent above the Chicago price, but the Paranaguá–Chicago spread had a much larger standard deviation of 6.6 percentage points that reflects a greater tendency for Brazilian prices to deviate from the Chicago price.

China tariff caused temporary divergence between Brazil and U.S. export prices

Economic logic suggests that China's tariff on U.S. soybeans in 2018 would cause U.S. soybean prices to fall and Brazilian soybean prices to rise. USDA (2019) anticipated that U.S.–China trade tensions would create a two-tier price structure: a high price for Brazilian soybeans exported to China and a lower price for U.S. soybeans exported to other regions. Taheripour and Tyner (2018) and Zheng et al. (2018) projected long-term reductions in U.S. soybean prices of 4 to 5 percent.

Brazilian and U.S. prices did diverge after China's tariff was announced in 2018, but the divergence lasted only 6 months. Daily soybean prices for Paranaguá and U.S. Gulf ports from January 2018 to March 2019 show Brazilian and U.S. prices clearly diverged after China announced its tariff on U.S. soybeans in June 2018 (fig. 20). U.S. export prices and Chicago futures prices for soybeans began to fall in early June. Export prices had already fallen to about \$320 per metric ton when the tariff went into effect July 6. U.S. prices reached a low of \$300 per metric ton in September. The cumulative decline was about 25 percent from the price of about \$400 per metric ton that prevailed in March before trade tensions began. The premium for Brazilian soybeans over U.S. Gulf soybeans peaked at 28 percent—slightly more than the tariff on U.S. soybeans—in October 2018.

Figure 20
U.S.-Brazil soybean prices, 2018-19



Note: Daily averages converted to dollars per metric ton.

Sources: Brazil Paranaquá soybean cash price, CEPEA (Center for Advanced Studies on Applied Economics); U.S. Gulf cash bids at export elevators, USDA Agricultural Marketing Service, "Market News."

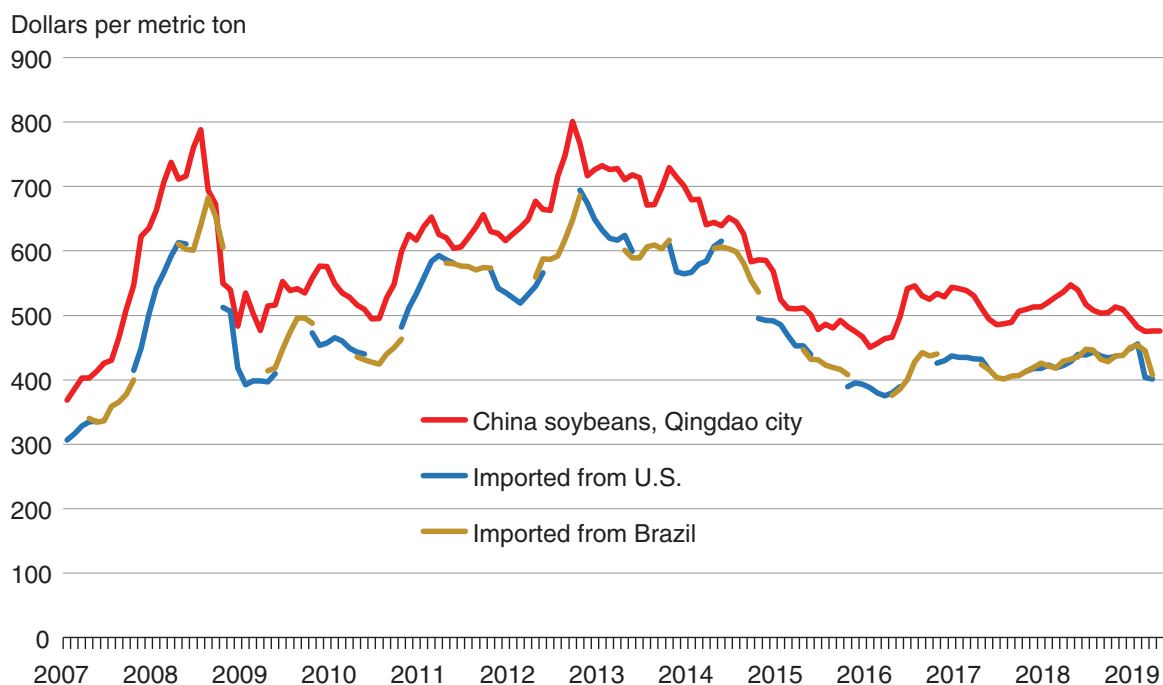
The usual spreads between spot export prices and Chicago futures prices were also changed by the Chinese tariff. As export demand for U.S. soybeans shrank, the spread between Gulf cash export prices and the Chicago futures price narrowed to about 0.5 percent in September. China's demand for Brazilian soybeans pushed the Paranaquá price to 27 percent above the Chicago futures price in September and October. However, by December the spreads had returned to values closer to their long-term averages. In December 2018, the Gulf–Chicago price spread had rebounded to 2 to 3 percent, and the Paranaquá–Chicago spread had fallen to 5.5 percent.

U.S. and Brazilian soybean prices converged again in December 2018 even though the Chinese tariff was still in place. The Brazilian price began to fall in late October as it became evident there would be another big South American crop to add to record-high soybean stocks held by U.S. farmers and traders. Chinese demand for soybeans was weakening due to a slow economy and reduction of China's hog production during an African swine fever epidemic. U.S. soybean prices rebounded somewhat in October and November due to farmers' willingness to hold stocks and larger exports to non-China destinations lured by low prices. Anticipation that China might resume U.S. soybean purchases contributed to a rebound in futures prices. China bought limited volumes of U.S. soybeans in the early months of 2019, but the tariff on U.S. soybeans remained in place and no trade deal was announced. U.S. Gulf and Paranaquá prices nevertheless converged again in December—6 months after they first diverged in June—at approximately \$350 per metric ton and remained at that level through March 2019.

Chinese soybean prices reflect fluctuations in export prices

The price of soybeans for Chinese importers tends to follow the same fluctuations as those observed for export prices. The value of soybeans arriving in China tends to exceed the Chicago futures price by the amount of freight and other costs. Soybean prices paid by processors in coastal areas like Qingdao in Shandong Province tend to exceed the landed cost of imported soybeans due to the 3-percent tariff and 13-percent value-added tax (the value-added tax was reduced to 10 percent in July 2018). The average price for soybeans in Qingdao reported by China's National Grain and Oils Information Center fluctuated around an average of \$575 per metric ton during 2007 to 2018 (fig. 21). The Qingdao price peaked at near \$800 per metric ton in 2008 and 2012. The Qingdao price fell from over \$700 per metric ton in December 2013 to \$450 per metric ton in January 2016, a cumulative decline of 36 percent. The Qingdao price rebounded in 2016 and fluctuated between \$500 and \$550 per metric ton from 2016 to 2018. The average price in Qingdao was 19 percent higher than the average landed price of U.S. soybeans calculated from customs data for those years and 17 percent higher than the average landed price of Brazilian soybeans. The Qingdao price was, on average, about 37 percent higher than the \$420 average price for soybeans at U.S. Gulf ports.

Figure 21
China's prices of soybeans, monthly, 2007-19



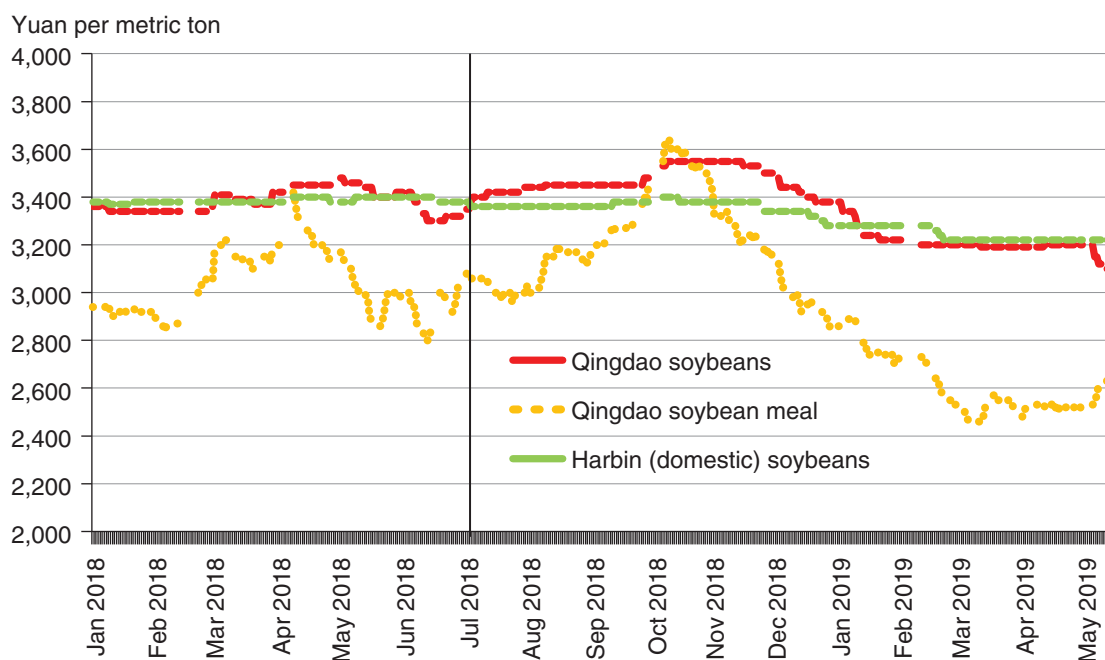
Note: Qingdao is a leading port for imported soybeans.

Sources: Qingdao monthly average of price paid by processing plants, China National Grain and Oil Information Center; prices of soybeans imported from U.S. and Brazil are monthly average unit values of soybean imports calculated from customs statistics.

Economic logic suggests that China's tariff limiting imports from the United States would increase Chinese soybean prices. Daily data show a modest impact on China's soybean price during the first 4 months after the tariff was imposed. The soybean price in Qingdao (a port where large volumes of soybeans are imported and processed) rose from 3,400 yuan/metric ton in early July to 3,620 yuan/mt in October 2018, a cumulative increase of 6 percent (fig. 22). This increase was relatively modest in comparison with past fluctuations. The price remained well below the average for the past decade. The price of soybean meal rose at a more robust pace, from 3,000 yuan/metric ton to 3,600 yuan/metric ton between July and October 2018, an increase of 20 percent.

Contrary to expectations, the price increases were reversed during November 2018 to March 2019 at the same time the flow of soybean imports fell from a year earlier. Qingdao soybean prices fell 12 percent from November 2018 to February 2019. The Qingdao soybean meal price peaked at 3,600 yuan/metric ton in October and fell to 2,460 yuan/mt in March 2019, a 30-percent decline. These price declines more than offset the increases during July to October. The combination of declining prices and shrinking supply suggests that demand for final products of soybeans weakened considerably.

Figure 22
China's daily soybean and soybean meal prices, January 2018- May 2019



Note: Qingdao is a leading port for imported soybeans; Harbin is a major soybean production region in China.
 Source: China National Grain and Oils Information Center.

China Tariff Would Reduce Volume of Soybean Trade

The geographic concentration of soybean trade is unlikely to change in the future, even if China's tariff on U.S. soybeans were retained indefinitely. The high yields, cost advantage, and established marketing channels would make it difficult for new countries to increase exports of soybeans that could effectively compete with Brazilian and U.S. producers. A new soybean exporting country needs a combination of supportive agricultural policies, low land costs, large-scale farms, and a stable macroeconomic environment and logistics to be competitive in the global market. Brazil took decades to align these factors and become a major exporter in the 1990s. Argentina is a major producer of soybeans, but its policy of favoring exports of soybean meal and oil clashes with China's policy that favors imports of whole soybeans for processing in China. While China has initiatives to nurture new exporters through investment by Chinese companies, such ventures will take many years to increase exports significantly. Many Chinese ventures in Latin America have stalled or failed (see box, "Chinese Investments in Latin American Soybean Farming Met Obstacles").

In parallel, China is likely to remain the dominant source of demand growth for soybeans, making it difficult for U.S. exporters to develop new soybean markets as alternatives to China. Other countries are not likely to replicate China's robust demand for both soybean meal and oil, government support for investment in soybean crushing, and tariff structure favoring imports of soybeans.

Chinese Investments in Latin American Soybean Farming Met Obstacles

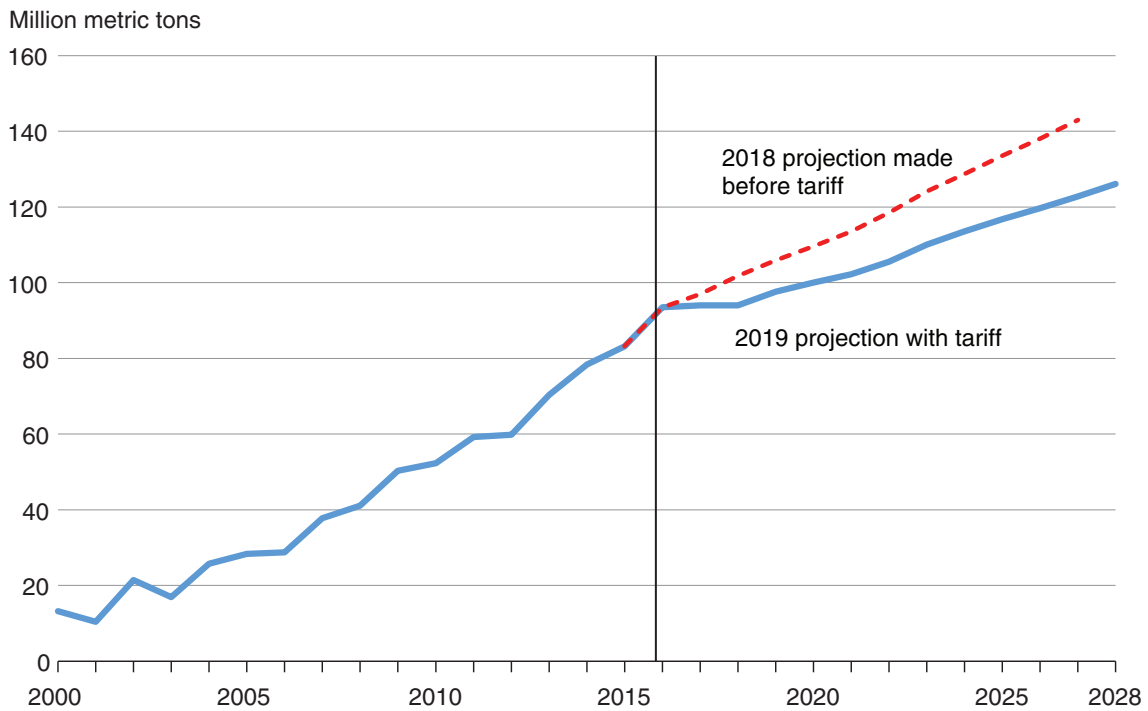
Solidaridad (2017) observed that a number of ventures by Chinese companies in Brazil's soybean industry had stalled or failed. Some examples drawn from Oliveira (2015) and Meyers and Jie (2015) are briefly summarized here:

- Chinatex explored acquisition of farmland and logistics in Brazil as early as 2003, but its investments are limited to a trading office and relationships with farmer cooperatives.
- During 2007 and 2008, two Chinese companies launched a project to grow soybeans in Brazil, but plans to expand the farming operation and to export soybeans were curtailed. One of the companies sold off its share in 2011.
- Chongqing Grain Group announced a \$2.4 billion investment in 2010 that was scaled back dramatically following disagreements over the construction of a railroad and processing plant and Brazil's introduction of regulations limiting foreign ownership of farmland. Political upheaval in Chongqing, more cautious lending by Chinese state banks, and unanticipated engineering challenges undermined the project's success. The investment's original plans for farming were apparently exaggerated by journalists.
- Another project planned for Goiás State in 2009 and 2010 was abandoned after delays in financing and railroad construction. A second project in southern Brazil was delayed by environmental concerns.
- A joint venture to grow soybeans and other crops on 300,000 hectares in Argentina announced in 2010 was scaled back after being opposed by environmental groups.

USDA 10-year projections released in 2019 assumed the Chinese tariff on U.S. soybeans would be retained indefinitely since there was no way to predict when the policy would change. Comparing these projections with the previous year’s USDA projections, which were made before U.S.–China trade tensions began, provides an indication of how China’s tariff might affect soybean trade in the future.

The USDA projections show that China’s soybean imports would resume growing, but the volume of future soybean trade would be less than previously projected. The projections assuming the tariff is kept in place show China would import 122.8 mmt of soybeans by 2027, about 20 mmt less than the previous year’s projected imports of 143 mmt for 2027 (without the tariff assumption) (fig. 23). Soybean imports by other countries are projected to reach 69 mmt in 2027, about 7.5 mmt more than was projected the previous year before the China tariff was imposed (fig. 24). Thus, the increase in imports by non-China countries would offset less than half of the 20-mmt reduction in China’s imports, reducing the overall volume of soybean trade.

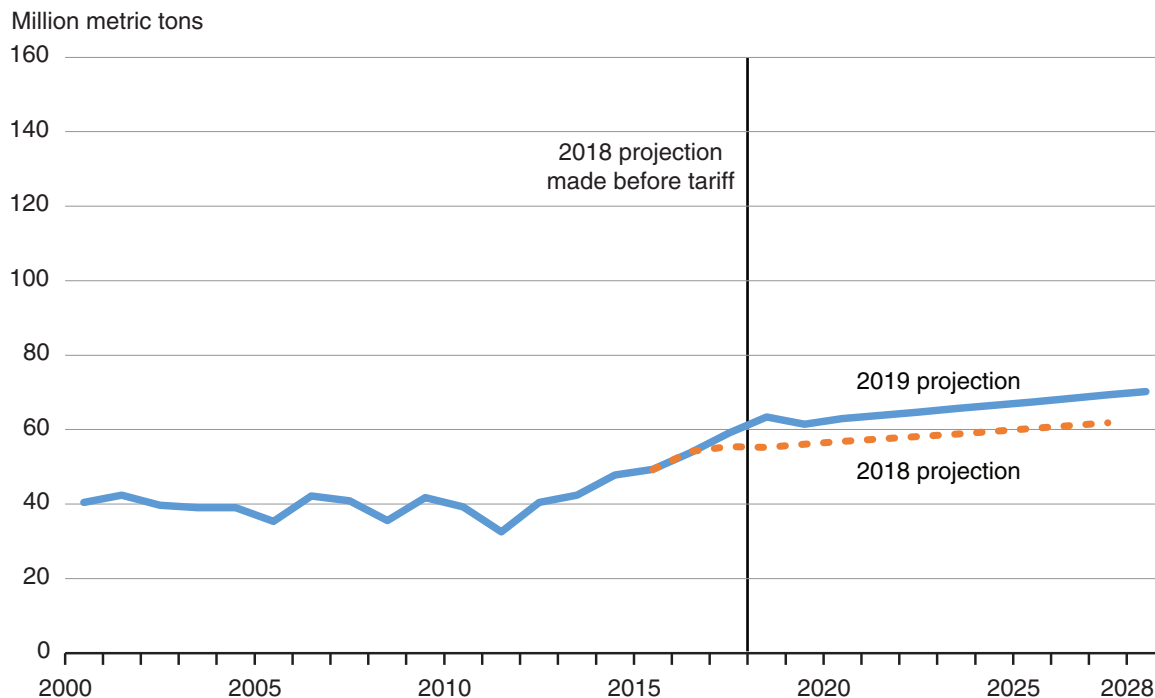
Figure 23
China’s projected soybean import growth is lower with tariff on U.S. soybeans in place



Source: USDA Baseline Projections to 2027/28 and 2028/29.

Figure 24

Projected soybean imports by other countries are higher in 2019



Source: USDA Baseline Projections to 2027/28 and 2028/29.

Although the tax on U.S. soybeans would reduce China’s imports, China would still account for most of the growth in soybean imports. With U.S. soybeans taxed in the largest import market, Brazil would account for two-thirds of soybean export growth. The 2019 USDA projections show China’s 32.6-mmt increase in soybean imports between 2016/17 and 2028/29 would represent 66 percent of the projected 49-mmt growth in total soybean imports (table 8). The 16-mmt increase in imports by all other regions would be spread over many countries. According to the projections, only Egypt and Pakistan would increase their imports by more than 2 mmt. Projections suggest that Brazil will increase exports by 33 mmt, accounting for 67 percent of the growth in exports. Argentina’s exports were projected to rise by 7 mmt, and U.S. soybean exports were projected to rise by just 2.4 mmt.

Table 8

Projected changes in soybean imports and exports, 2016/17 to 2028/29

Regions	2016/17	2028/29	Change
Importers	Million metric tons		
Total imports	147.4	196.3	49.0
China	93.5	126.1	32.6
Non-China regions	53.9	70.2	16.4
Top importers			
European Union	13.4	14.9	1.5
Mexico	4.1	5.8	1.7
Egypt	2.1	4.8	2.7
Pakistan	1.7	3.9	2.3
Thailand	3.1	3.9	0.8
Indonesia	2.6	3.7	1.1
Vietnam	1.6	3.0	1.4
Iran	1.9	3.4	1.5
Turkey	2.3	3.3	1.0
Japan	3.2	3.3	0.1
Exporters			
Total exports	147.4	196.3	49.0
Brazil	63.1	96.1	33.0
United States	59.0	61.4	2.4
Argentina	7.0	14.1	7.1
Other South America	9.4	11.8	2.4
Canada	4.6	7.6	3.0
Ukraine	2.9	3.7	0.8
Others	1.4	1.6	0.3

Source: USDA Baseline Projections to 2028/29.

Outlook: Persistent China–U.S.–Brazil Interdependence

The interdependence of China, Brazil, and the United States in soybean trade is likely to persist. China's demand for soybeans is expected to continue growing, and there are no major alternative suppliers in the near term. In parallel, alternate markets for U.S. soybeans can only absorb a fraction of the soybeans exported to China before trade tensions began. Lower U.S. prices stimulated additional demand by a number of countries, but these markets are not likely to absorb the entire volume displaced from China.

The geographic concentration of trade in soybeans resulted from unique confluences of political and economic factors that are not likely to be replicated in other countries. Brazil's emergence as a global supplier took decades, beginning with ambitions to populate territory in the Cerrado during the 1960s. Brazil had to develop cultivars suited to local climate and soil, achieve a stable political and macroeconomic environment, improve access to credit and inputs, and construct transportation infrastructure to become the world's largest supplier. China's pent-up demand for both edible oils and protein for animal feed encouraged political leaders to make soybeans a focal point of trade liberalization as China sought WTO membership during the 1990s. China's surge of foreign investment and broad-based economic growth after WTO accession led to its expansion of soybean processing capacity. Growth in domestic capital availability led to even more expansion by Chinese companies. China set low tariffs for imported soybeans and maintained trade protection and subsidies for cereal grains. During the 1990s the United States and Brazil adopted more market-oriented agricultural policies that made soybean production more responsive to global market demand.

The main short-term impacts of China's retaliatory tariff on U.S. soybeans were to reduce soybean prices for U.S. farmers and to increase China's reliance on Brazil as a soybean supplier. Large soybean production in Brazil allowed China to shift purchases from U.S. to Brazilian soybeans with minimal impact on China's purchase prices during the first months after imposing the tariff on U.S. soybeans. Low soybean prices could induce U.S. farmers to shift plantings from soybeans to corn and wheat. In Brazil and Argentina, farmers receiving high prices from China purchasers are expected to plant more soybeans.

If China maintained its tariff on U.S. soybeans for an extended period, its growth in demand for soybean imports would depend on the capacity of producers in Latin America to expand output. The United States would need to find alternative markets for soybeans. Chinese officials have ambitions to replace imports of U.S. soybean with imports of soybeans, other oils, and meals from new suppliers such as Kazakhstan, Russia, and Ukraine. USDA projections anticipate little potential for increased soybean exports from new suppliers. Creating new soybean exporters is a slow and costly process that would take years, even decades, to succeed.

If China eliminates the tariff on U.S. soybeans, the global market is likely to have a severe glut as U.S. soybeans are released from storage, Brazil produces another large harvest, and Argentina's production rebounds from a 2018 drought. A drop in soybean prices could prompt China's importers to resume rapid growth in purchases.

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