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

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Abstract

This report explores export competitiveness for soybeans and corn in Argentina, Brazil, and the United States by comparing farm-level production costs, the cost of internal transportation and handling, and the cost of shipping to a common export destination. Prices received by farmers and average yields for each crop in each country are analyzed to calculate producer returns. Cost-of-production data are for 2010/11. To smooth the impact of weather and policy factors affecting yields and prices, 5-year average yields and prices (using 2010/11 as the midpoint) are incorporated into the comparison of per-bushel costs and returns. Findings of this study describe many of the factors that impact production and export competitiveness of the world's leading corn and soybean exporters and how changes in these factors affect their competitive position.

Keywords: Cost of production, soybeans, corn, United States, Brazil, Argentina, export competitiveness

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About the Authors: Birgit Meade, William McBride, Constanza Valdes, and Linwood Hoffman are with USDA's Economic Research Service (ERS). Linda Foreman is retired from ERS, and Erik Dohlman, formerly with ERS, is now with USDA's Farm Service Agency. Estefanía Puricelli is with the Buenos Aires Grains Exchange in Argentina.

Contents

Errata

This report was revised in July 2016 by correcting table 5, which now corresponds with the text. The table includes two Brazilian regions for each commodity, additional rows that show two components of the farm price, and the correct transportation costs for Brazil.

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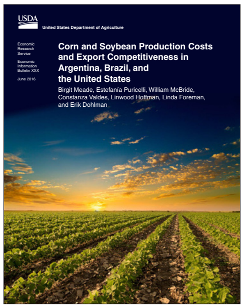

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Corn and Soybean Production Costs and Export Competitiveness in Argentina, Brazil, and the United States

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What Is the Issue?

Competitiveness in commodity markets is influenced by resource endowments and agro-climatic conditions, as well as the efficiency of institutions, the adequacy of infrastructure, the impact of policies, and the structure and magnitude of input costs. This report examines farm production costs and the export competitiveness of Argentina, Brazil, and the United States for corn and soybeans—together, these three countries represent an average of 88 percent of world soybean exports and 73 percent of corn exports.

Comparisons of production costs among countries are useful because they allow decision-makers to infer how the export competitiveness of each country and crop could be affected by changes to factors underlying production and marketing costs—e.g., land, fertilizer, seed, fuel, chemicals, transportation, handling, etc. This information also sheds light on how a country's infrastructure and export taxes and restrictions affect its export competitiveness.

What Did the Study Find?

Comparisons of international costs of production are made under the assumption that data and accounting formats, among other issues, can be harmonized across countries. Moreover, effects of agricultural policies are not explicitly quantified in such comparisons, although they are reflected in prices and costs faced by producers. This study, comparing the differences between Argentina, Brazil, and the United States in corn and soybean *production costs* over the 2008/09-2012/13 period, finds that:

- Average farm-level production costs *per acre* for corn and soybeans in Argentina and Brazil were between 11 and 28 percent below those in the United States, largely because of higher land and capital costs. The United States had higher yields per acre than Argentina and Brazil, particularly for corn, which helped offset the higher costs.
- Average production costs *per bushel* for soybeans were lowest in Brazil—8.5 percent below the U.S. cost.
- Average production costs *per bushel* for corn were lowest in the United States, followed by Argentina and then Brazil, with costs 3 and 25 percent above U.S. costs, respectively.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

Regarding the competitiveness of Argentina, Brazil, and the United States in corn and soybean *export markets* over the 2008/09-2012/13 period:

- Paraná in Brazil, a coastal State, was the lowest cost exporter of both corn and soybeans, primarily due to its location and low internal transport costs. The U.S. Heartland was the next lowest cost exporter, but has a much larger production capacity than Paraná. About 75 percent of U.S. corn and soybean production is from the Heartland, compared with no more than 25 percent of Brazilian production from Paraná.
- Despite higher inland transport costs, the Mato Grosso region of Brazil was competitive with the U.S. and Argentine Heartlands in the export of soybeans. Its competitiveness with other countries results from lower soybean costs of production. Improvements in overland transportation infrastructure would enhance the competitive position of Mato Grosso.
- The Argentine Northern Heartland would be the lowest cost exporter of both corn and soybeans were it not for policy-related export costs. Changes in Argentina's export policies will significantly alter the relative competiveness of these countries in world corn and soybean markets, improving the Argentine position.

Other factors affecting the relative production and export competitiveness of these countries follow:

- Expected profits from production, as well as government payments, are capitalized into land values, so it may not be appropriate to include the opportunity cost of land as part of production costs when comparing export competitiveness. Since land costs are much lower in Brazil than in the United States and Argentina, excluding land costs greatly improves the competitive position of these two countries relative to Brazil in both corn and soybean production.
- Lower shipping costs (including marketing, handling, and transporting) have helped the United States remain competitive with South America in international markets. However, recent changes in currency values, notably a strengthening of the U.S. dollar, have made U.S. commodities more expensive on world markets.
- The new Argentine Government recently reduced export taxes for soybeans by 5 percent (to 30 percent), eliminated export taxes for corn, and eased export restrictions. These new policies, combined with a devaluation of the Argentine currency, are improving the export competitiveness of Argentine crops. Improvements in the transportation infrastructure in Brazil has reduced inland transportation costs. These factors will further pressure U.S. competitiveness in world corn and soybean export markets.

How Was the Study Conducted?

Export competitiveness of crop production in Argentina, Brazil, and the United States was examined by comparing farm-level production costs, as well as the cost of marketing, internal transportation, and shipping to a common export destination. The comparison is based on available production cost data for all three countries in 2010/11. In order 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. The 5-year average includes marketing years 2008/09 through 2012/13, 2 years before and after the year of cost-of-production data.

Crop production costs are separated into their variable- and fixed-cost components. Farms typically consider variable costs for short-term decisions, and both variable and fixed costs for long-term planning. Costs associated with exporting crops, including internal transportation, handling, and ocean freight rates to destination ports, are added to the farm price, which includes farm production costs. Policies that support exporters in various ways are reflected in costs and prices without being explicitly quantified.

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

Introduction

Soybeans and corn are among the top five most important agricultural exports in terms of global export value. International agricultural markets are very competitive, and several commodity markets are dominated by a small number of major exporters. In this report, we compare production costs and export competitiveness of corn and soybeans among three leading exporters: the United States, Brazil, and Argentina. Between 2008 and 2012, these three countries produced an average of 88 percent of world soybean exports and 73 percent of corn exports (table 1).

Fifty years ago, the United States exported more corn, soybeans, and soybean products than any other country in the world. Since then, Brazil and Argentina have become important producers and traders of these crops and now compete with the United States in world markets. For example, Argentina has become the number one exporter of soybean meal and soybean oil, with one of the most competitive crushing sectors in the world. Brazil has also expanded soybean production and exports at an accelerated pace, fueled by strong demand from China, while Argentina's expansion in global corn markets is rooted in a strong demand for corn from Middle Eastern countries. During the 2012/13 marketing year (after a severe drought in the United States), Brazil exported more corn than the United States for the first time, and while the United States is still the biggest exporter of corn and soybeans, its share is trending down.

Table 1
Average share of world total corn and soybean production and exports (marketing years 2008-12)

	Corn		Soybean	
	Production	Exports	Production	Exports
	Percent			
Argentina	2.7	16.9	18.0	9.5
Brazil	7.6	14.0	28.1	36.8
United States	36.5	42.2	34.5	41.8
Total	**46.8**	**73.1**	**80.6**	**88.1**

Source: USDA, Economic Research Service calculations based on USDA, Foreign Agricultural Service's Production, Supply, and Distribution Online database (2014).

A 2001 report, *Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops* (Schnepf et al., 2001), described the agricultural sectors of these three countries and explored their differences and similarities with respect to economic and agricultural settings, policies, cost of production, and competitiveness (based on data for 1998/99). Our report sheds light on continued agricultural development in Argentina and Brazil by presenting new cost-of-production data for 2010/11, the first and most comprehensive dataset for Argentina that became fully available.

Comparing production and marketing costs among countries is a useful tool for decisionmakers considering crop production, investment, or policy alternatives. We explore export competitiveness in Argentina, Brazil, and the United States by comparing the farm price (which includes farm-level production costs), the cost of internal transportation and handling, and the cost of shipping to a common export destination. Policies that support production in various ways are reflected in costs and prices without being explicitly quantified. In addition, prices received by farmers and average yields for each crop in each country are analyzed to calculate producer returns. Cost of production data are for 2010[1] (a marketing year when farm survey cost data are available in all three countries), but to smooth the impact of weather and policy factors affecting yields and prices, 5-year average yields and prices (using 2010/11 as the midpoint) are incorporated into the comparison of per-bushel costs and returns. Cost comparison findings will, therefore, more likely capture the condition and performance of each country's agricultural sector rather than reflecting unique weather conditions or short-term economic fluctuations that disproportionately affected prices and yields during a single season.[2]

Production costs are separated into their variable- and fixed-cost components. Variable costs (i.e., operating costs) include seeds, fertilizer, chemicals, fuel, machine repair, interest on operating capital, and other direct costs incurred during crop production. Fixed costs (i.e., allocated overhead costs) include land rental rates or a fixed percentage of the value of production to value the opportunity cost of land (even if owned), ownership costs for capital assets, taxes and insurance costs, an opportunity cost for unpaid farm labor (such as that of the owner and family members), and other farm overhead costs.

This study also addresses each country's grain transport system (which services its export markets for these commodities), along with ocean freight costs. Each country must rely on an efficient transport system to remain competitive—an inefficient or costly transportation system can have a negative impact on a country's competitiveness. Policies, such as agricultural support programs or export taxes and restrictions, also play a key role in determining production and export incentives.[3]

[1]Costs of production for 2010 refer to the U.S. crop production planted and harvested in 2010 and marketed into 2011. Since Argentina and Brazil are both located in the Southern Hemisphere, the USDA convention is to compare with their crop grown in late 2010, harvested in early 2011, and marketed into 2012.

[2]However, input prices are for the 2010 crop year and are therefore subject to conditions prevailing during that season.

[3]Rapid changes in agriculture in Argentina and Brazil have occurred since 2012, most notably a change in Argentina's soybean and corn export policies, likely having an impact on competitiveness.

A Comparison of Economic and Agricultural Settings

The U.S. economy is considerably larger than both Brazil's and Argentina's, as is its labor force (box table 1.1). However, agriculture plays a more prominent role in Brazil and Argentina, especially as a share of exports, than in the United States. Of these three countries, Argentina, with a relatively small population but large agricultural sector, relies most heavily on international markets as a destination for its agricultural production. U.S. agriculture contributed, on average, 1 percent to the country's gross domestic product (GDP) (2008-12 average), compared with 5 percent for Brazil and 7 percent for Argentina. Similarly, agriculture accounted for 9 percent of U.S. exports, 40 percent of Brazilian exports, and 57 percent of Argentine exports.

Box table 1.1
Economic indicators for Argentina, Brazil, and the United States, 2008-12 average

	Argentina	Brazil	United States
Population (million people)	40.3	195	309
GDP (billion U.S. $)	483	2,119	15,157
GDP per capita (U.S. $)	11,938	10,837	49,003
Agriculture's share of GDP (percent)	7.2	5.2	1.2
Labor force (million people)	18.5	101.6	157.9
Agriculture's share of labor force (percent)	1	15	2
Land area (million sq. km)	2.7	8.5	9.1
Share of agricultural land (percent)	54	33	45
Total merchandise imports (billion U.S. $)	59	196	2,069
Total merchandise exports (billion U.S. $)	72	210	1,546
Agricultural exports (billion U.S. $)	41	83	146
Agriculture's share of total merchandise exports (percent)	57	40	9

Source: USDA, Economic Research Service using agricultural export data from the Global Trade Atlas (2014) and data from the World Bank's World Development Indicators Database (2015).

Crop Production at a Glance: Main Production Regions

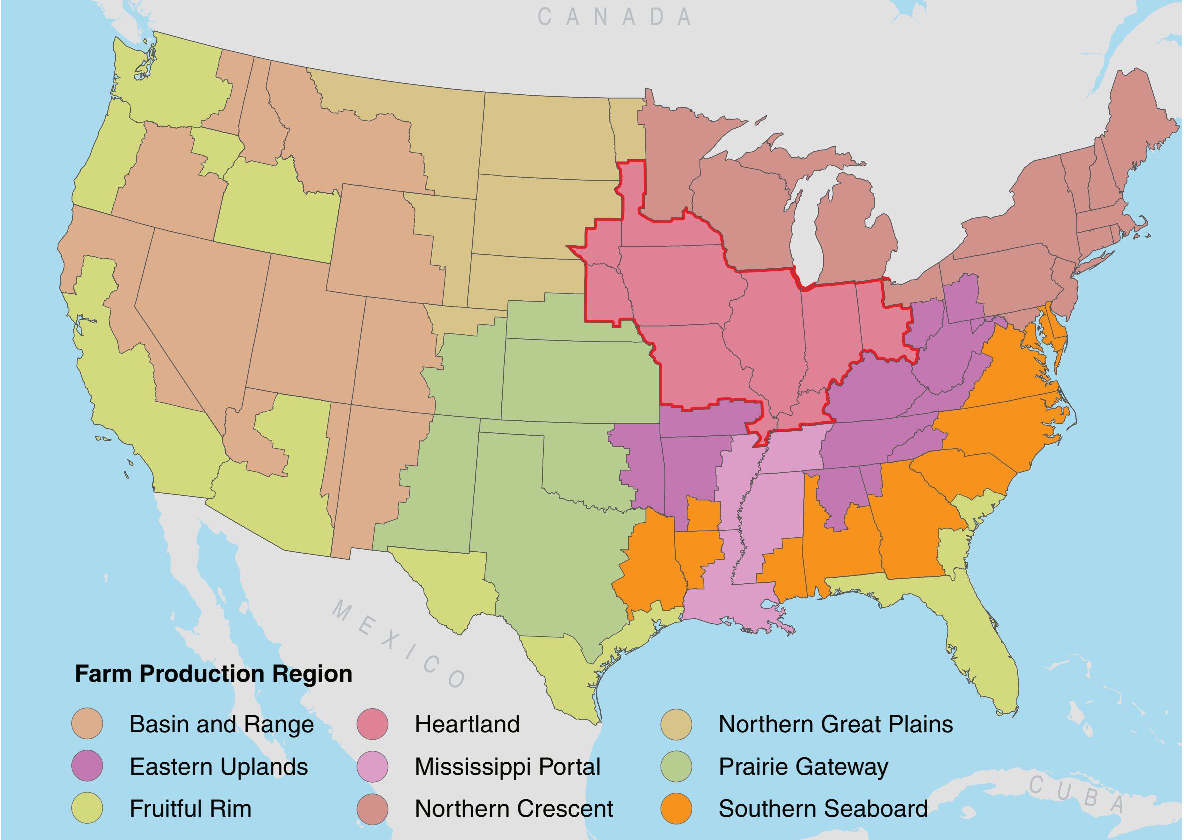
Much of the data and analysis in this report involves information from both a national average level and from the major producing regions in the United States, Argentina, and Brazil.

The United States

While U.S. agricultural producers raise a wide variety of agricultural commodities, they tend to specialize in a set of commodities that differ by region. These differences stem from factors such as climate and soil conditions, proximity to commodity markets, and transportation systems. U.S. production regions based on geographic specialization used in USDA, Economic Research Service's (ERS) cost-of-production accounts (USDA-ERS, 2015c) are in figure 1.

The U.S. Heartland is characterized by rich, deep soils, and encompasses parts or all of Ohio, Indiana, Illinois, Iowa, Minnesota, Missouri, Nebraska, South Dakota, and Kentucky. This is one of the world's most productive corn and soybean growing regions, and more corn and 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. As a result, much of the analysis in this report focuses on production costs in this region, in addition to national averages.

Figure 1
U.S. farm resource regions



Source: USDA, Economic Research Service, Agricultural Resource Management Survey (ARMS): Resource Regions, 2015a.

Argentina

Argentina is the smallest country included in this analysis in land area, but it uses the largest share of its land for agricultural purposes. However, this share has been declining over the last decade. Argentina's north-south orientation covers over 30 degrees of latitude and, therefore, includes regions with very different climates and soils. The country produces a wide range of agricultural commodities, and grains and oilseeds are its main crops. The area known as Pampas (which includes the Provinces of Buenos Aires, Cordoba, Santa Fe, Entre Rios, and La Pampa) is the country's main production region for soybeans and corn (fig. 2). However, due to improvements in production technology, higher crop prices, and shifts in weather patterns, the area suitable for grain and oilseed production has expanded northward over the last few decades. Within the Pampas, the main production region for corn and soybeans, called the Northern Heartland, is near the most important ports. This is the region we focus on in this report and it includes the areas east of Cordoba, center-south of Santa Fe, and southeast of Entre Rios.[4]

Figure 2
Argentina's major field crop regions

Source: USDA, Economic Research Service.

Brazil

Brazil's climatic and topographic conditions allow for soybeans and corn to be grown throughout the country. In some States, soybeans are grown from September through January and are often followed by a second crop of corn, which is planted in February and harvested in May. During the 1970s-2000s, the country sought to stimulate expansion of agriculture into frontier areas in Brazil's

[4]The Buenos Aires Grains Exchange (2012) calls this region the Northern Heartland (Northern Core, VI); figure A1 in appendix A is a map of Argentina's 17 crop productive areas.

interior center-west region (fig. 3) and in the *cerrados* savannah lands.[5] The second corn crop in this region expanded rapidly from 22 percent of total corn production in 2004/05 to nearly 65-70 percent in recent years (USDA-FAS, 2014a); about half of this is grown in the center-west.[6] Since the late 2000s, soybean and corn production has been expanding to the new agricultural frontier of MATOPIBA, an acronym for the northern States of Maranhão, Tocantins, Piauí, and Bahia. Lower costs of land and proximity to transportation and ports infrastructure are major factors encouraging movement to this region.

We focus on the two largest soybean and corn producing States of Mato Grosso and Paraná (as well as national average data). The State of Paraná is located in Brazil's southern region, which is characterized by a humid, warm, semitropical climate. This region, where the initial agricultural settlement

Figure 3
Brazilian States and regions

Source: USDA, Economic Research Service based on data from the Brazilian Institute of Geography and Statistics (IBGE) (2014).

[5]The *cerrados,* with 197 million hectares consisting mostly of savannahs and grasslands, comprise 24 percent of Brazil's territory, irregularly distributed across 11 Brazilian States—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.

[6]Technological improvements have made it possible to cultivate two crops per year in Brazil, with first-crop corn largely destined for the domestic feed market and second-crop corn serving the export market.

in the 1950s and 1960s took place, used to be the heart of Brazil's field crop (mainly corn) production. Brazil's center-west, on the other hand, is part of South America's humid, tropical zone, characterized by poor natural soil fertility, and little seasonal variability in monthly average temperatures. During marketing years 2008-12, Mato Grosso (in the center-west region) accounted, on average, for 29 percent of Brazilian soybean production while Paraná, historically Brazil's largest corn producer and exporter, accounted for 22 percent of corn production (USDA-FAS, 2015; CONAB, 2015).

Production Costs and Export Competitiveness

Export competitiveness depends on a number of factors, some of which arise from a country's resource endowment and agro-climatic conditions (and are therefore mostly given), while others are a result of policies: macroeconomic policies (e.g., monetary policy that can have an impact on exchange rates), sector-specific policies (e.g., import tariffs or export taxes, subsidies, and access to credit), and trade policies (e.g., trade agreements). Other factors that affect competitiveness include a country's infrastructure—in particular, its transportation system and storage facilities—and institutions that support and facilitate markets and trade. The extent to which a commodity is traded also depends on domestic demand and returns to competing crops (Schnepf et al., 2001). To a large extent, all these factors are reflected first in the cost of production, and then in the shipping cost to a common destination.

Comparing Soybean and Corn Costs and Returns

To enable the comparison between the three countries, the soybean and corn cost-of-production accounts are presented for each country using the U.S. Department of Agriculture's (USDA) concept of economic production costs, which include the opportunity costs of owned resources (such as land and unpaid labor) used in production.[7] These estimates differ from accounting costs, which reflect the cash costs farmers incur from commodity production. Economic production costs provide a better indication of long-term competitiveness among countries in the production of agricultural commodities, while accounting costs provide more accurate indicators of short-term profitability.[8] However, despite efforts to standardize the accounting across countries, cost-of-production comparisons only give a rough measure of the relative country competitiveness in commodity production for a number of reasons (see box, "Methodologies of Cost-of-Production Estimates: Difficulties of Comparisons," and appendix A for a list of common problems and a more detailed description of each country's methodology).

Argentina's and Brazil's accounts are reorganized to fit the U.S. format, including operating and allocated overhead costs. Operating costs include cash expenditures for purchases of seeds, fertilizers, chemicals, fuel, and electricity. Operating costs also include the rental of machinery used on the farm, custom services, use of airplanes for farm transportation and fumigation, repairs, and interest on operating capital. Allocated overhead costs include hired labor, the opportunity cost of unpaid labor, interest paid, capital recovery of machinery and equipment, taxes, insurance, and the opportunity cost of land.[9]

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[7]Opportunity costs, in this sense, are the costs of having the resources invested in commodity production as opposed to an alternate use.

[8]Because the U.S. method (and the comparable Argentine and Brazilian approaches) includes full economic costs, it is not unusual to see negative returns. In the short term, most operators are concerned with returns over operating costs and will maintain or increase production with the prospect of revenues above operating costs. It is also possible that the owners/operators place a different value on using their assets (e.g., land, unpaid labor, capital) than that attributed by the cost methodology. In the case of Argentina, for example, returns over operating costs were positive for both corn and soybeans, but negative when including all economic costs. One possible explanation is the relatively high opportunity cost of land assumed for Argentine producers (35 percent of the value of production versus roughly 20-25 percent for the United States).

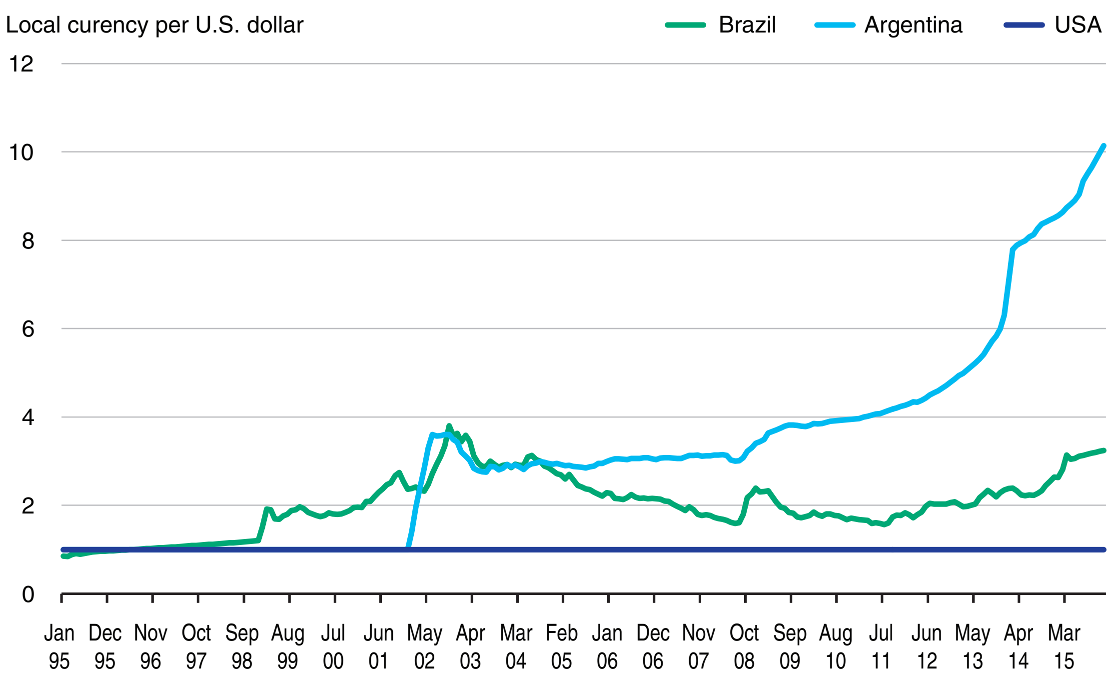
[9]Land costs are included in the cost and return accounts, but may not have much to do with relative country competitiveness. Land tends to be valued as the residual, after other costs are deducted. Land costs also rise and fall with profit margins and government payments (Harl, 2001).

Methodologies of Cost-of-Production Estimates: Comparison Challenges

Comparisons of international costs of production provide only a rough indicator of international competitiveness because it is virtually impossible to ensure that data measurement and accounting formats, among other issues, are identical across countries. Comparisons of farm-level costs of production, in particular, are difficult and potentially imprecise for a number of reasons. Different countries use different concepts, definitions, terminologies, and measurement methods to compute commodity costs and returns. Each country also chooses its own most-relevant cost categories, which are not necessarily comparable across countries. Sampling schemes for selecting farms to be included in surveys vary significantly across countries and commodities, from a panel of farms, to simple random sampling, to a multistage complex weighted-sampling scheme. Modes of data collection also vary widely, with some countries relying on conducting surveys by phone, others by requesting written responses via mail, and others collecting data from face-to-face interviews. Additionally, producer recordkeeping can vary significantly among farmers in different countries, and data quality is likely to vary with the resources allocated to data-handling procedures.

Comparisons are further complicated by exchange-rate conversion issues, especially during times of monetary policy changes that may result in exchange-rate distortions. In this study, we use official exchange rates, which have seen large changes over time and in particular since 2011 (see Box figure 2.1). Another potential difference arises if a country's published cost-of-produc-

Box figure 2.1
Nominal exchange rates for Argentina and Brazil against the U.S. dollar



Note: Data is displayed in 11-month intervals.
Source: USDA, Economic Research Service (2015d) calculations based on data from the International Monetary Fund.

tion data are based on financial versus economic accounting (the latter of which is used by this study and includes opportunity costs for owned resources, such as labor and land). Estimates of opportunity costs can vary greatly among the three countries studied in this report. Impacts of policy distortions, such as unexpected export restrictions, are typically hard to quantify but can impact prices and measures of competitiveness. In addition, data reflect production and marketing costs for regions that bear different relationships to national averages in their respective countries.

The data presented in this report may not correspond exactly with source data due to certain assumptions and the omission or reformulation of some data items to make them as comparable as possible. 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 ARMS survey for its own cost methodology. The cost data from Argentina, however, were converted (where possible) to the USDA format to facilitate the comparisons. These adjustments have been made to make this comparison meaningful despite the underlying discrepancies and difficulties in comparison. A description of the methodologies underlying the United States, Argentina, and Brazil cost-of-production estimates is in appendix A.

Detailed costs-of-production tables by country and commodity, with data from the largest production region as well as an estimated national average for 2010, are in appendix B. We also discuss key distinctions between countries, which underlie their cost structures and may determine future trends in competitiveness. Additional relevant costs are associated with internal transport, handling, costs resulting from domestic policy (such as export taxes and restrictions), costs associated with loading the crops into vessels for export, and finally, the costs of freight to ship to a common export destination.

Cost-of-production measures—Production costs can be measured *per unit of land area (acre or hectare)* and *per unit of production (bushel or ton)*. We report costs *per acre* and *per bushel*. Since yields can vary considerably across countries and regions, costs of production per bushel can vary substantially. For example, a country can have the highest per-acre costs and the lowest per-bushel costs, simultaneously, if yields are sufficiently above the yields of its competitors.

Costs beyond the farm—Farm-level production costs are not the only driver of export competitiveness. Export and transportation costs are also important determinants of the prices grain merchandisers can afford to pay crop producers. Of the three countries studied, only Argentina's farmers incur export costs. After comparing costs of production (tables 2 and 3), transportation and export policy-related costs are included in the comparison in table 5.[10]

[10]The cost and return accounts from which these data are drawn typically use only a harvest-period price for marketing year 2010/11, as found in appendix B. To facilitate more general comparisons, we use 5-year (marketing year) average prices and yields. This approach, however, leads to the omission of some costs, such as storage and other postharvest costs.

The impact of agricultural policies on costs and prices

While cost-of-production accounts reflect prevailing domestic support policies in various ways, the exhaustive discussion of those policies and their quantified impact is beyond the scope of this report. Argentina's agricultural sector did not benefit from subsidies, but instead was heavily taxed during the period of analysis. During 2010/11, the export tax for soybeans was 35 percent (32 percent for both soybean meal and soybean oil to encourage domestic processing of soybeans and the export of the value-added products) and 20 percent for corn.[11] These export taxes are reflected in lower producer prices because buyers deduct export-related costs from the prices they pay producers (see box, "Determining Farm Price in Argentina"). Argentina's export policy-related costs are included as an explicit cost in our competitiveness analysis (table 5).

The United States and Brazil supported their agricultural sectors through a variety of programs that provide both direct and indirect support to producers and consumers (and to the sector in general). Brazil has a minimum-price-support program for corn, which raises corn prices when market prices fall below the minimum price. Brazil's leading marketing support program for corn—Premium Equalizer Paid to the Producer Program (*Prêmio Equalizador Pago ao Produtor or PEPRO)*—allows farmers to receive a premium above the minimum price set by the Government. Brazil's corn

Determining Farm Price in Argentina

Farmgate prices, (the amount of money received per bushel by the farmer before shipping expenses), as collected in the United States, are not available in Argentina. The most commonly used and published prices in Argentina are domestic spot and agricultural futures prices, which are quoted as free-alongside-ship (FAS) prices and, therefore, generally reflect a lower price than the free-on-board (FOB) prices (which represent the commodity loaded on a vessel). The export taxes are calculated based on the FOB prices and paid by the exporters. However, the export taxes directly affect the price paid to producers in the domestic market since the tax is already subtracted from this price. In Argentina, export commodities are subject to domestic grain policy risk (such as export restrictions and export taxes), which can translate into considerable additional costs, depressing domestic prices and lowering prices paid to producers. The theoretical FAS price accounts for these costs, which can put the Argentine farmer at a competitive disadvantage. The quoted FAS price, a futures price, is higher than the farmgate price, as producers implicitly discount freight and marketing costs incurred in order to ship to the port.[1]

[1]Ordonez and colleagues explain in detail the differences between U.S. and Argentine pricing: "Another important difference between the United States and Argentina involves the availability of price information in the hinterland or producing region. In the United States, country elevators quote cash prices to interested producers on a daily basis. In contrast, in Argentina the producer is quoted a delivered export price rather than a local country elevator price, thus the producer must identify marketing, handling, and transportation charges for purposes of estimating a net price. Because of the numerous charges involved in the marketing and transportation of grain, it is difficult for producers to compare net prices that are available via various locations and markets. Thus, prices are less transparent in Argentina than the United States (…). It is for this reason that brokers are often used when Argentinian producers or country elevators are selling grain and oilseeds." (Ordonez et al., 2001, pp. 10-11)

[11]See Berg et al., 2014 for a more detailed discussion of Argentina's export policies. Export tax revenues were equivalent to between 1 and 2.5 percent of GDP, and soybean products (bean, oil, meal) were the biggest contributors (calculations based on INDEC, 2015).

price includes this subsidy in the years it was granted (table 2). Brazil also offered subsidized operating and investment capital credit and tax exemptions for both corn and soybean exports (Brazil's National Company of Food Supply, 2015a).[12]

During the study period, the United States operated under the provisions of the 2008 Farm Act, which included programs to support farm incomes and to preserve or enhance the environment. Crop insurance programs, where the U.S. Government subsidized premiums, also played a role in the risk management strategies of U.S. farmers. The core programs in the United States during the study period were income-support programs for farmers of certain commodities, including soybeans and corn. See USDA/ERS, 2009, for detail on U.S. support programs under the 2008 Farm Act, and Burfisher and Hopkins (2004) for information on the effects of decoupled payments such as income support.

Soybeans

Soybean production costs per bushel, based on cost-of-production data for 2010 and 5-year average yields (2008-12), varied from a national average cost of $7.47 in Brazil to $8.81 in Argentina (table 2 and fig. 4). Of the main production regions, Brazil's Mato Grosso had the lowest average cost per bushel at $6.60, while Argentina and U.S. Heartland producers had costs of $6.94 and $7.64, respectively. National average production costs were lowest in Brazil (8.5 percent below U.S. costs), and highest in Argentina (8 percent above U.S. costs). Brazilian producers have higher national average returns over costs than the United States, $3.71 compared with $3.39, while Argentina's returns are -$2.32. At $323, Argentina's costs per acre are almost identical to those in Brazil, and about 11 percent below those in the United States (fig. 5), even though average yields are lower (36.6 bushels per acre in Argentina compared with 43.4 in Brazil and 44.6 in the United States). Higher land costs in Argentina compared with Brazil and the United States are behind the negative returns—if returns are evaluated over operating costs alone, Argentina's returns are positive.

What stands out in the comparison is that prices received by soybean farmers in Argentina are only a little more than half the prices received by U.S. farmers, while national average Brazilian prices are just below U.S. levels (table 2 and appendix tables B1 through B6). These low prices are due to the fact that Argentine farmers are quoted a delivered export price rather than a local elevator price (as is customary in the United States). Argentine farmers, therefore, have export taxes deducted from their quoted price and they also absorb marketing, handling, and transportation costs to the port (see box, "Determining Farm Price in Argentina").[13] How can farmers in Argentina continue to produce soybeans with chronic negative returns? The answer may be that, in this cost-of-production comparison, we use the concept of economic (rather than financial) costs—i.e., opportunity costs are charged for owned resources, such as the labor and land supplied by the farmer. Argentina's

[12]See USDA/FAS 2010 for information on Brazil's agricultural support measures.

[13]Much has changed since the 2012/2013 season—Argentina has experienced massive inflation and exchange rate fluctuations that have exacerbated costs. Along with this, the new Government (under the leadership of President Maurcio Macri, elected in December 2015) proposed and partially implemented a series of agricultural policy changes that will likely have an impact on domestic and international markets. The most significant policy changes are a reduction in export taxes for soybeans by 5 percent and elimination of Argentina's export taxes, export permits (ROEs), and other taxes for all other products (USDA-FAS, 2015). The Government also lifted currency controls, which is widely expected to lead to a devaluation of the Argentine peso.

Table 2

Soybean production costs for the United States, Argentina, and Brazil, 2010, and returns for 2008-12 (marketing year average)[1]

Item	United States		Argentina		Brazil	
	Heartland	National average	Northern Heartland	National average	Mato Grosso	National average
	Dollars per planted acre					
Gross value of production*	556.83	515.22	316.83	237.65	488.82	485.44
Operating costs:	121.98	131.90	105.00	116.38	196.58	199.89
Seed	57.49	59.20	19.22	18.36	21.17	23.03
Fertilizer[2]	16.88	17.87	12.67	13.74	91.88	71.51
Chemicals	16.64	17.04	22.34	28.55	37.07	46.90
Custom operations[3]	6.10	7.23	42.11	46.12	25.38	33.58
Fuel, lube, and electricity	13.06	16.81	0.00	0.00	7.42	9.08
Repairs	11.69	13.46	0.00	0.00	4.62	7.97
Purchased irrigation water	0.00	0.16	0.00	0.00	NA	NA
Interest on operating capital	0.12	0.13	8.67	9.61	9.03	7.83
Allocated overhead:	244.90	232.19	222.31	206.51	109.40	124.44
Hired labor	1.27	2.11	23.31	23.31	1.17	1.94
Opportunity cost of unpaid labor	15.84	17.33	34.00	34.00	13.64	8.11
Capital recovery of machinery/equipment	73.90	78.18	0.00	0.00	26.73	46.57
Opportunity cost of land	129.70	110.30	114.74	98.93	36.77	40.94
Taxes and insurance	9.29	9.41	32.82	32.82	23.32	19.98
General farm overhead	14.90	14.86	17.44	17.44	7.77	6.90
Total costs	366.88	364.09	327.31	322.88	305.97	324.33
Value of production less total costs	189.96	44.60	-10.48	-85.23	182.85	161.11
Value of production less operating costs	434.85	383.32	211.83	121.27	292.24	285.55
Supporting information						
Yield (bushels per planted acre, 2008-2012)	48.0	44.6	47.2	36.6	46.4	43.4
Price (dollars per bushel, 2008-2012)	11.60	11.55	6.72	6.49	10.54	11.18
Costs per bushel (dollars)[4]	7.64	8.16	6.94	8.81	6.60	7.47
Returns per bushel above total costs (US$)[4]	3.96	3.39	-0.22	-2.32	3.94	3.71
Returns per bushel above operating costs (US$)[4]	9.06	8.59	4.49	3.31	6.30	6.58
Enterprise size (planted acres per farm)[5]	299	303	202	202	5923	504

* 5-year-average yield multiplied by 5-year-average price, 2008-2012.

[1]Refers to crop harvested in 2010 for the U.S., crop planted in 2010 and harvested in 2011 for Argentina and Brazil. [2]Cost of commercial fertilizers, soil conditioners, and manure. [3]Cost of custom operations, technical services, and commercial drying. [4]Based on production costs for 2010/11 and average yields and commodity prices for 2008-12. [5]For the U.S., developed from survey base year 2006.

NA=Not applicable.

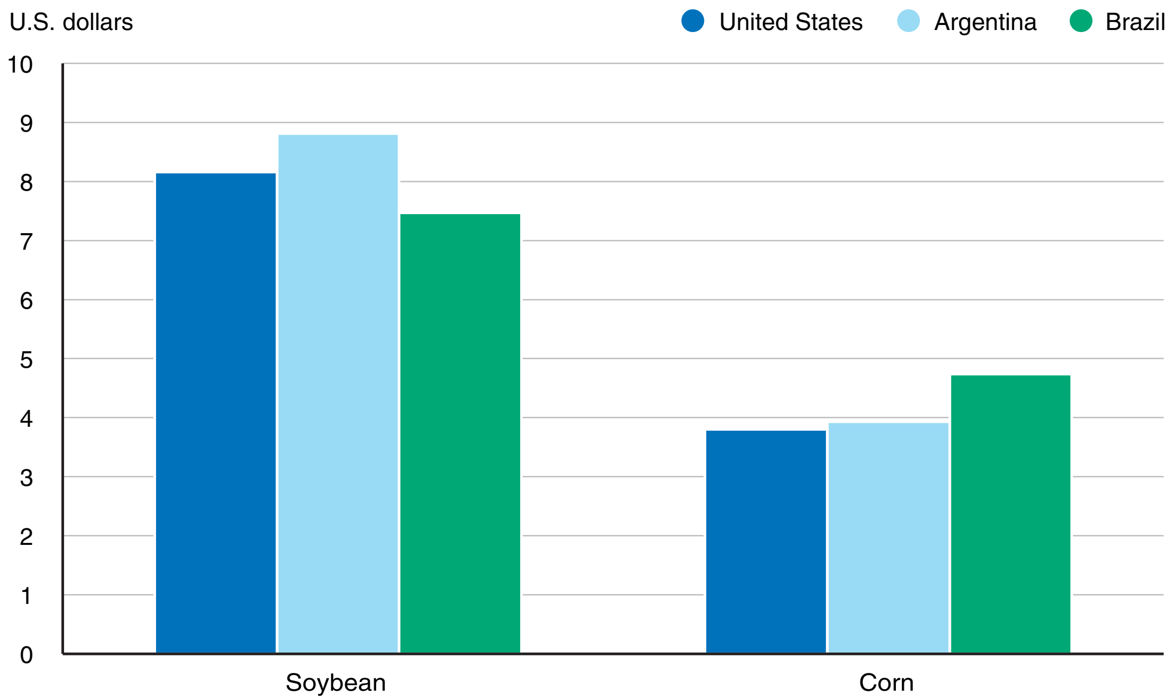
Sources: US: USDA, Economic Research Service, Commodity costs and returns (2015).

Argentina: Applied Agricultural Technology Survey (AATS) for 2010/11, Buenos Aires Grains Exchange (2012).

Brazil: Brazilian National Food Supply Company (CONAB), 2015.

Figure 4

Total economic production costs per bushel, national average*

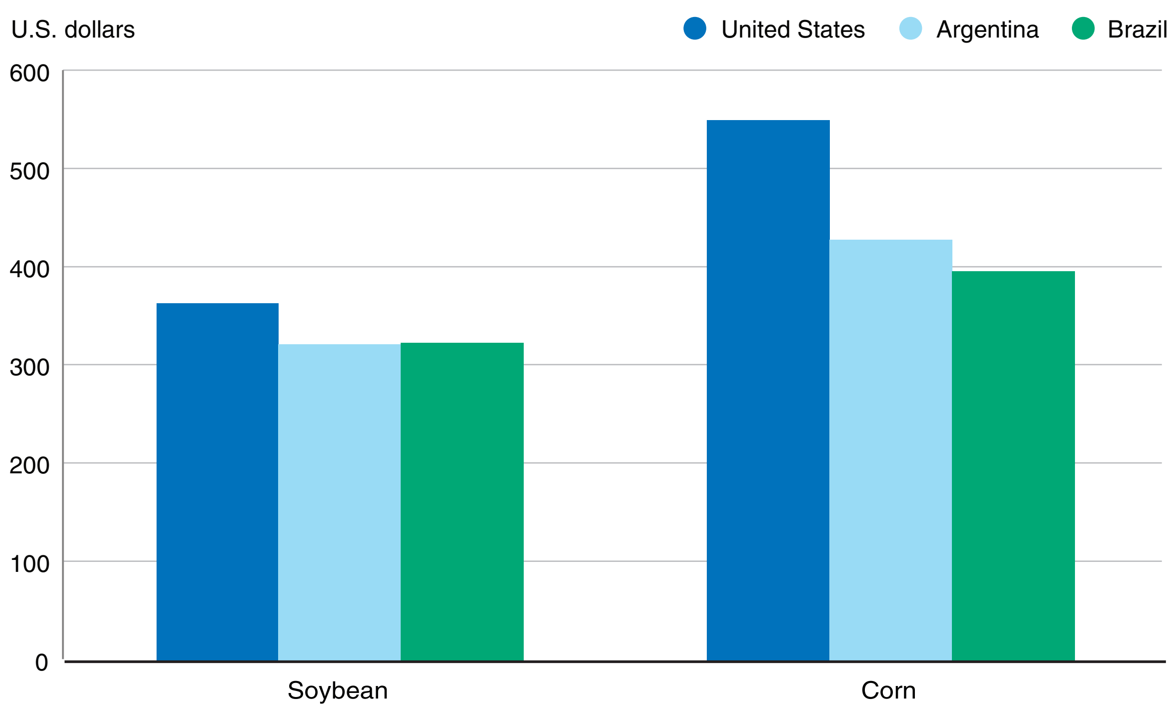


*Production costs for 2010, based on 5-year average yields (marketing years 2008-12)

Source: USDA, Economic Research Service.

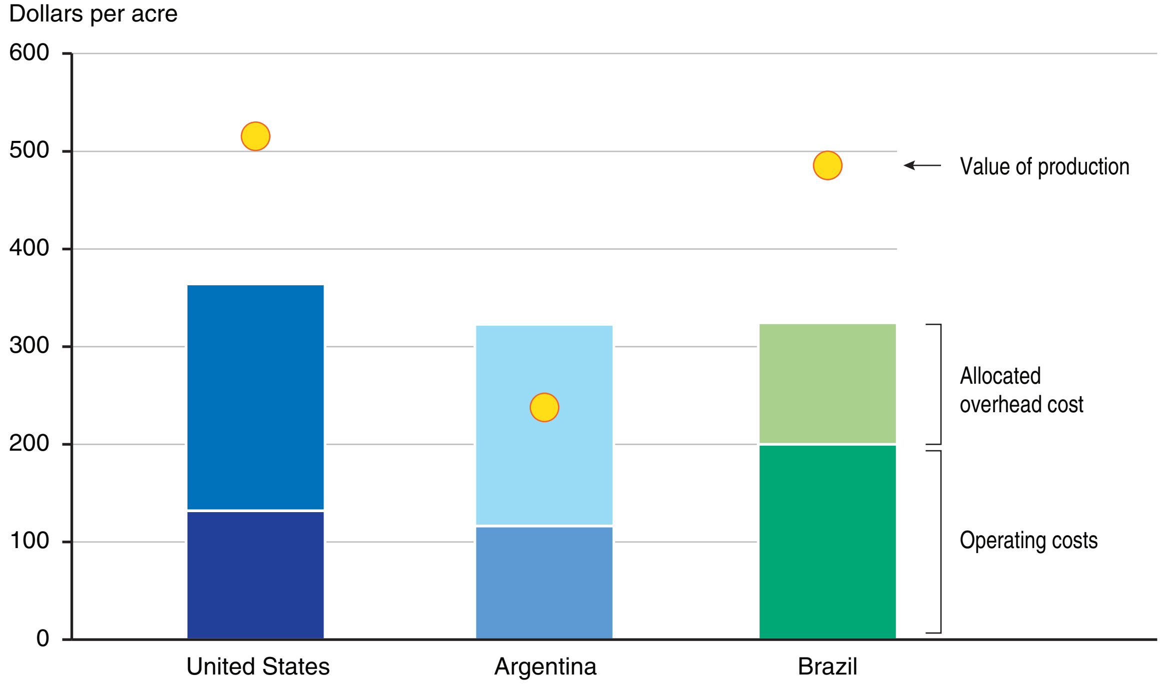
Figure 5

Total economic production costs per acre, 2010



Source: USDA, Economic Research Service.

Figure 6
Soybean national average cost structure (2010) and value of production (2008-12)*



*Value of production equals 5-year average yield multiplied by 5-year average price.
Source: USDA, Economic Research Service.

accounting rules charge land at 35 percent of the product value produced on that land, which is much higher than the land rental costs used in the other countries.[14]

Production cost structures tend to remain fairly stable over time, unlike returns, which vary with yields and prices in response to weather and other supply and demand factors. Using itemized cost-of-production data for 2010, we noticed that producers in Argentina and the United States spent similar proportions of their total per acre soybean costs that year on operating items (roughly one-third), while Brazilian producers spent roughly two-thirds of their costs on operating items (table 2 and fig. 6). In 2010, Brazil's soybean producers spent far more on fertilizers and chemicals per acre than producers in the United States or Argentina, a reflection of traditionally low-nutrient soils in the center-west agricultural region of Brazil and of increased soybean-rust disease occurrences there in 2010—these two expenditures accounted for 37 percent of total production costs per acre in Brazil.

In Argentina, the largest operating cost item is custom operations, which accounted for 14 percent of total costs at the national level. Most producers hire custom operators to perform field work in Argentina, while U.S. producers most often own the machinery used in crop production. While it is not true that 100 percent of Argentinian farmers have zero capital costs, the prevalence of custom operators in charge of capital-intensive tasks is so widespread that this cost allocation was deemed to best reflect the typical cost structure in this country.[15]

[14]For example, the 35 percent of production value used to assess land cost in Argentina is much like a share-to-rental arrangement in the United States, where the landlord receives 35 percent of the crop value net of landlord costs. The U.S. data indicate that land costs were equivalent to about 21-25 percent of soybean production value during 2008 to 2012, and between 17 and 22 percent of corn production value (USDA-ERS, 2015c).

[15]According to the Argentine Ministry of Agroindustry (2015), 90 percent of harvesting and 70 percent of planting and fertilizer/pesticide applications are handled by contractors; see also Nardi and Davis, 2007.

In contrast, seed costs were the largest operating expense per acre in the United States at $59, compared to $18 and $23 for Argentina and Brazil, respectively. All three countries plant genetically modified (GM) varieties. In the United States, 93 percent of soybean production used GM varieties (USDA, National Agricultural Statistics Service, 2011). In Argentina, adoption of GM varieties was estimated at 99 percent of the soybean area (Buenos Aires Grains Exchange, 2012). In Brazil, the adoption rate of GM soybeans is 93 percent (International Service for the Acquisition of Agri-biotech Applications, 2014).

A number of reasons may be behind this discrepancy in seed costs, including differences in application rates per acre and other fluctuations that can cause price differences. Even within the United States, seed costs among regions vary considerably.[16] In the case of Brazil, new seed technology developments by EMBRAPA, the State agricultural research agency, have helped to significantly reduce seed costs to farmers.

Allocated overhead costs per acre were comparatively lower in Brazil due to a larger arable land supply and the possibility of multiple cropping and double cropping in the same plot of land in a marketing year. Land costs averaged $41 per acre in Brazil, compared with about $100 in Argentina and $110 in the United States. However, agricultural land values are very hard to estimate, and countries differ in their approach to estimating these costs. In the United States, land is valued according to the average cash rental rate for land producing the commodity in the particular area being surveyed (USDA-ERS, 2015b); it averaged 23 percent of the value of soybean production in the 5-year period from 2008-12.[17] Argentina's land value is estimated as a fixed 35 percent of production value (Buenos Aires Grains Exchange, 2012), and CONAB (2010) 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.

In addition, there were significant differences in costs per acre for the capital recovery of farm machinery and equipment. At the national level, $47 per acre is allocated for these costs in Brazil and $78 per acre in the United States, compared with none for Argentina (where custom operations are used instead of farmer-owned machinery).

Corn

Using 2010 cost-of-production data and 5-year average marketing year prices and yields (2008-12), the Argentine Northern Heartland region had the lowest per-bushel corn production costs of all the main production regions in each country, at $3.31 per bushel (table 3). Low per-bushel costs in Argentina are the result of relatively high yields that offset per-acre production costs that fell between those of the United States and Brazil. However, even though it is the largest corn producing region in Argentina, the Northern Heartland has just 25 percent of total production in Argentina. In contrast, U.S. Heartland producers, with the second-lowest costs of $3.73 per bushel, account for 75 percent of U.S. production and more production than in Argentina and Brazil combined. Comparing the national average production costs for corn in the three countries, the United States had the lowest average cost at $3.80 per bushel, followed closely by $3.93 per bushel for Argentina and $4.74 per bushel for Brazil. Brazil's higher per-bushel costs are the result of low yields that erase the advantages of lower per-acre costs.

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[16]USDA data show seed costs for the U.S. Heartland as $104.96 in 2013, compared to just $67.02 in the eastern Uplands that same year (USDA-ERS, 2015c).

[17]The calculation is based on U.S. soybean production value and land cost as found at USDA-ERS, 2015c.

Table 3

Corn production costs for the United States, Argentina, and Brazil, 2010, and returns for 2008-12 (marketing year average)[1]

Item	United States		Argentina		Brazil	
	Heartland	National average	Northern Heartland	National average	Paraná	National average
	Dollars per planted acre					
Gross value of production*	794.61	749.03	375.05	281.72	486.99	428.02
Operating costs	292.25	286.41	180.56	190.92	279.01	274.85
Seed	87.72	81.58	64.75	62.16	48.28	49.82
Fertilizer[2]	118.09	112.03	44.39	44.19	125.88	100.97
Chemicals	26.95	26.29	7.43	15.14	38.08	48.46
Custom operations[3]	15.25	16.36	49.08	53.67	49.41	41.84
Fuel, lube, and electricity	22.18	25.80	0.00	0.00	0.84	14.83
Repairs	21.77	23.96	0.00	0.00	5.31	7.94
Purchased irrigation water	0.00	0.11	0.00	0.00	NA	NA
Interest on operating capital	0.29	0.28	14.91	15.76	11.20	10.98
Allocated overhead	279.67	263.79	275.77	237.87	128.21	122.17
Hired labor	2.61	2.96	23.31	23.31	1.73	2.64
Opportunity cost of unpaid labor	20.21	22.54	34.00	34.00	9.09	8.61
Capital recovery of machinery/equipment	81.22	84.40	0.00	0.00	31.15	44.49
Opportunity cost of land	150.49	127.33	166.35	128.46	58.57	41.66
Taxes and insurance	7.77	8.46	34.66	34.66	22.22	18.51
General farm overhead	17.37	18.10	17.44	17.44	5.45	6.25
Total costs	571.92	550.20	456.33	428.80	407.22	397.02
Value of production less total costs	222.69	198.83	-81.28	-147.08	79.77	31.00
Value of production less operating costs	502.36	462.62	194.49	90.80	207.98	153.18
Supporting information						
Yield (bushels per planted acre, 2008-2012)	153	145	138	109	108	84
Price (dollars per bushel, 2008-2012)	5.18	5.18	2.72	2.58	4.50	5.11
Costs per bushel (dollars)[4]	3.73	3.80	3.31	3.93	3.76	4.74
Returns per bushel above total costs (US$)[4]	1.45	1.38	-0.59	-1.35	0.74	0.37
Returns per bushel above operating costs (US$)[4]	3.27	3.20	1.41	0.83	1.92	1.83
Enterprise size (planted acres per farm)[5]	313	280	202	202	87	114

* 5-year-average yield multiplied by 5-year-average price, 2008-2012.

[1]Refers to crop harvested in 2010 for the U.S., crop planted in 2010 and harvested in 2011 for Argentina and Brazil. [2]Cost of commercial fertilizers, soil conditioners, and manure. [3]Cost of custom operations, technical services, and commercial drying. [4]Based on production costs for 2010/11 and average yields and commodity prices for 2008-12. [5]For the U.S., developed from survey base year 2006.

NA=Not applicable.

Sources: US: USDA, Economic Research Service, Commodity costs and returns (2015).

Argentina: Applied Agricultural Technology Survey (AATS) for 2010/11, Buenos Aires Grains Exchange (2012).

Brazil: Brazilian National Food Supply Company (CONAB), 2015.

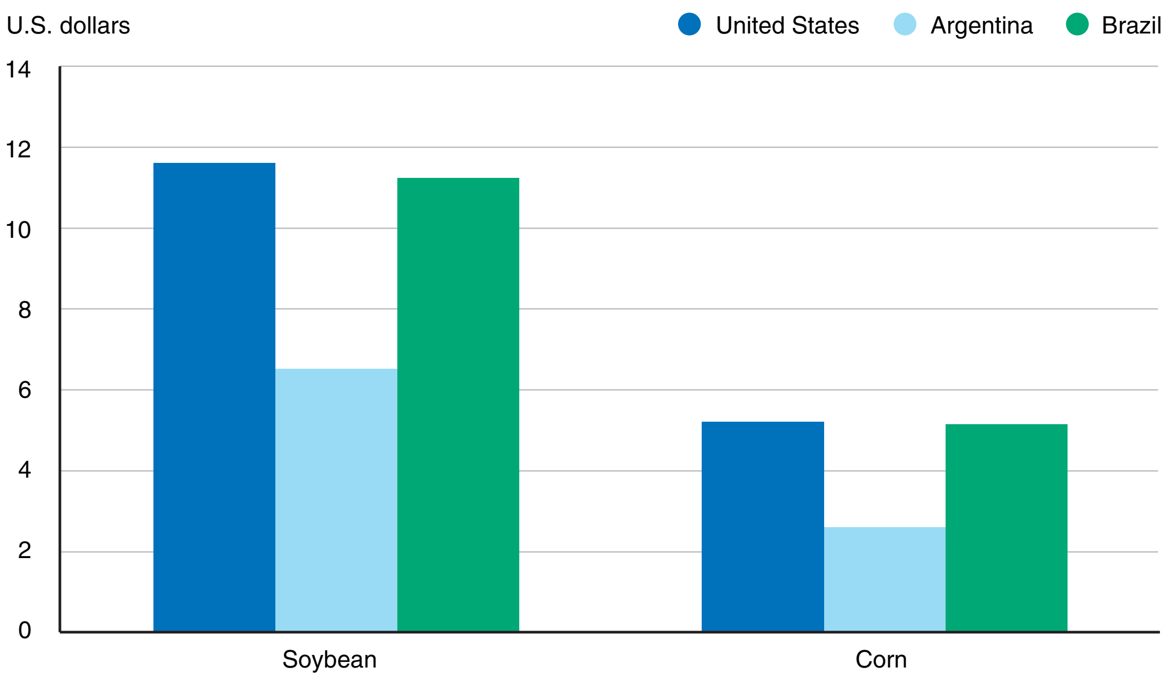
In addition to having the lowest costs, the United States also had the highest corn prices, at a 2008-12 average of $5.18 per bushel (fig. 7). For Brazil, its leading marketing support program for corn—Premium Equalizer Paid to the Producer Program or *Prêmio Equalizador Pago ao Produtor* (PEPRO), which pays farmers directly when corn prices fall below the Government-set minimum price)—resulted in an average national corn price of $5.11 per bushel in 2008/09-2012/13. This price reflects a $0.23-per-bushel premium subsidy to Brazilian corn farmers over the same period.

Returns from corn production per bushel were greater in the United States than in Argentina or Brazil. At the national level, the United States had the highest positive net returns per bushel (value of production minus total costs) at $1.38, compared with $0.37 for Brazil and -$1.35 for Argentina (fig. 8).

Since costs per acre are significantly different among the three countries for corn in 2010—U.S. costs were 22 percent higher than those in Argentina and 28 percent above those in Brazil—and these costs may change in the future, it is instructive to examine the cost structure. The proportion of total costs per acre attributed to operating costs versus allocated overhead costs varied by country and region. In the United States, operating costs and allocated overhead costs each made up roughly half of the total costs for the region and country (appendix table B4 and fig. 9). Seed and fertilizer accounted for the majority of operating expenses, while the capital recovery of farm machinery and equipment and the opportunity cost of land accounted for most of the allocated overhead costs. Land costs were high due, in part, to its high productivity.

Figure 7

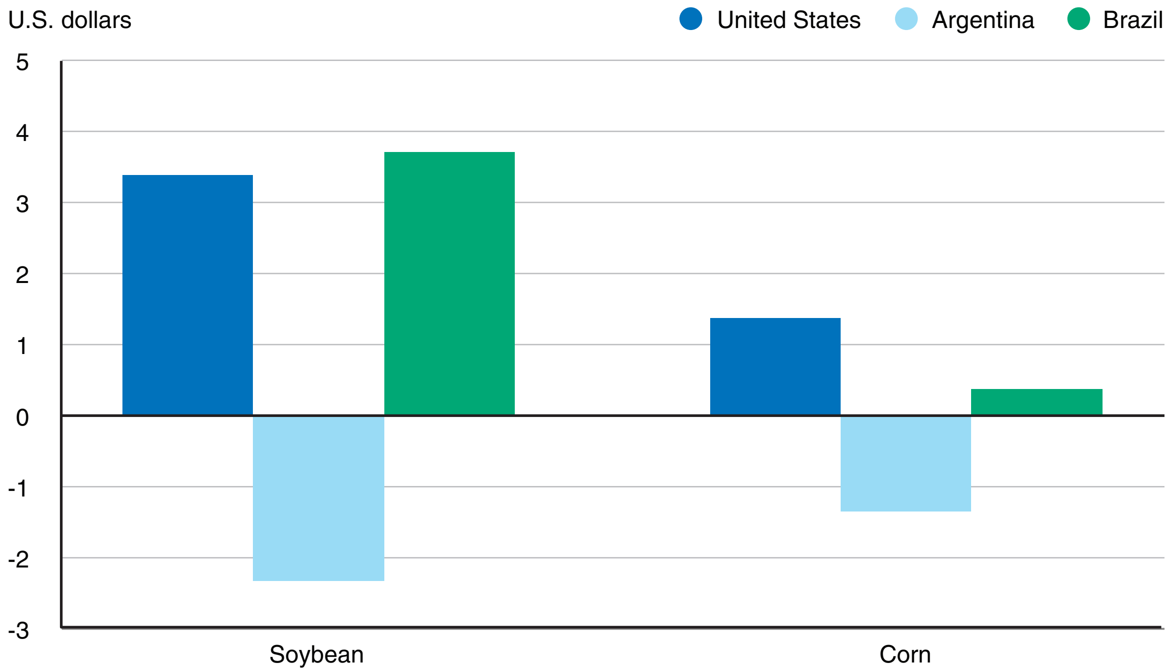
Price per bushel, national average (marketing years 2008-12)



Source: USDA, National Agricultural Statistics Service, Quick Stats: Prices and Production by State (2015) for the United States; Futures Market of Buenos Aires, MATba (2015) for Argentina; and Brazil's National Company of Food Supply (CONAB) (2015).

Figure 8

Return above costs per bushel,* national average (marketing years 2008-12)



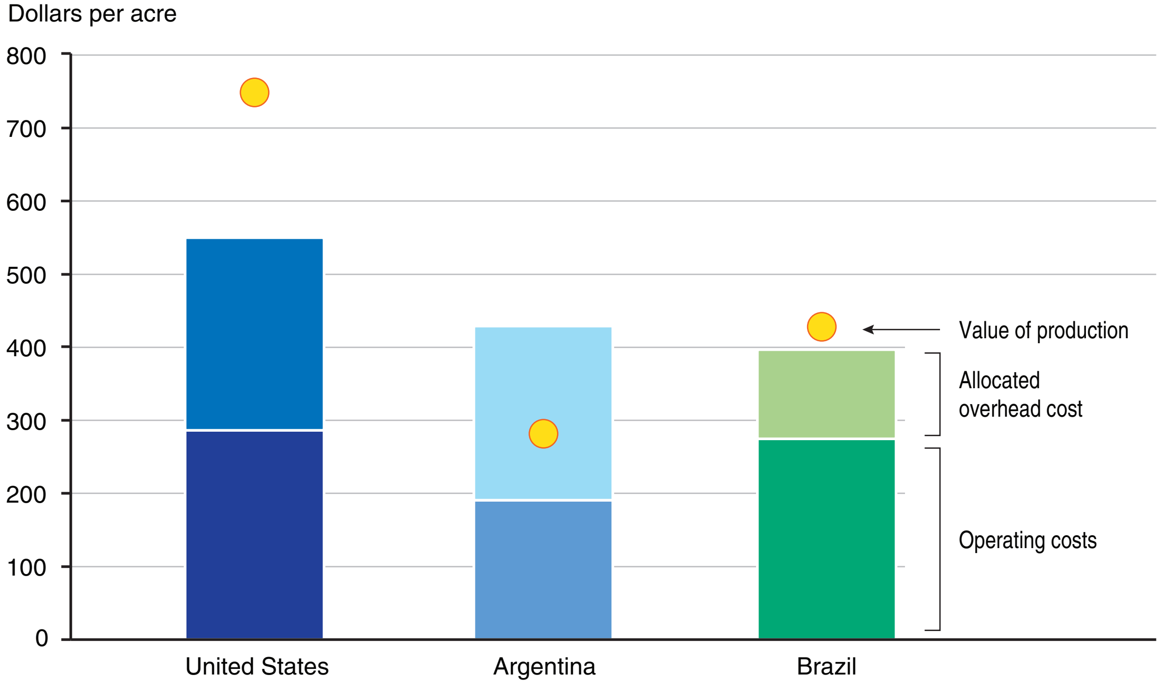
*Return is calculated as average harvest price per bushel for marketing years 2008-12, minus cost per bushel (which is calculated as total cost for 2010 divided by 5-year average yields).
Source: USDA, Economic Research Service.

In Argentina, overhead expenses accounted for 56 percent of production costs in 2010, with land accounting for most of the costs (appendix table B5). Argentina's capital recovery costs are zero since producers typically rely on custom operations for most farm work (appendix A). Each of the following operating costs—seed, fertilizers, and custom work—accounted for more than 10 percent of total costs. The widespread use of no-till farming is related to the use of GM seed varieties, such as herbicide-tolerant corn and soybeans and Bacillus thuringiensis (Bt) corn. No-till farming reduces costs because it eliminates the expense of tilling machinery and labor and relies on herbicides to control weeds (an option made feasible thanks to herbicide-resistant GM crop varieties). According to results from the *Applied Agricultural Technology Survey (AATS) 2010/11* from the Buenos Aires Grain Exchange (2012), 95 percent of corn was sown with no-till technology in 2010 when adoption of GM varieties was estimated at 91 percent of corn area.[18]

In Brazil, operating costs comprise close to 70 percent of the total corn costs in 2010 (table 3 and appendix table B6). Fertilizers accounted for about 30 percent of total costs for Mato Grosso. Allocated overhead costs were lower in Brazil compared with the United States and Argentina, due mainly to Brazil's lower opportunity costs of land. Operators' willingness to pay for farmland rental is partly a function of its productivity. Average corn yields of 84 bushels in Brazil during 2008-12 are significantly lower than U.S. yields of 145 bushels and Argentine yields of 109 bushels. However, yields are not the sole factor in determining rents. For example, in Mato Grosso, soybean yields compare favorably with the Heartland regions in the United States and Argentina. At the same time, farmers there can grow two crops a year—an advantage not enjoyed by many U.S. farmers.

[18]Agricultural Resource Management Survey (ARMS) data from the United States indicate that 24 percent of planted corn acreage was no till in 2010, and 40 percent of soybean acreage was no till in 2012 (USDA-ERS, 2015b).

Figure 9
Corn cost structure (2010) and value of production (2008-12)*



*Value of production equals 5-year average yield multiplied by 5-year average price.
Source: USDA, Economic Research Service.

Nevertheless, cash rents and land values in Mato Grosso are still far lower than in the Heartland regions in the United States and Argentina because another important factor in determining land rents is the *accessibility of markets*, both domestic and export.[19]

[19]An important determinant of rental rates and land values is net returns from growing crops. The low prices received for crops in Mato Grosso mostly reflect the higher costs of delivery to domestic and foreign buyers. If these transportation costs can be reduced, cash rents and land values could increase in this region.

Factors Affecting Cost of Shipping

Exports are an important share of domestic production—for example, soybean exports accounted for an average of 44 percent of soybean production in the United States, 37 percent in Brazil, and 10 percent in Argentina (USDA-FAS, 2014b).[20] Export shares are affected by a number of factors (such as distance between source country and destination), but also by trade agreements, which can affect costs by changing easily quantifiable items such as tariffs, as well as harder to quantify factors like nontariff barriers. We focus on transportation costs to assess the relative competitiveness of each country when exporting soybeans and corn. While farm-level costs are an important determinant of the ability to compete in export markets, a study of competitiveness in the international markets for soybeans and corn needs to consider transportation, handling, and marketing systems and costs to move the commodities from within the country to the port for export. Because of the relatively low value of these commodities per metric ton, these costs can account for a significant percentage of the cost of delivery to overseas markets.

To compare the various cost factors contributing to the overall cost of exporting soybeans and corn, we ranked each country's main export destinations and then chose one or two common destinations for each commodity (table 4). We limit the analysis to costs associated with transportation from the main domestic production area to the main port, plus export policy costs, and then add ocean freight. In the case of Brazil, the largest export share of soybeans originates in Mato Grosso, whereas the largest share of Brazilian corn exports originates in Paraná. We included these two regions since they are important for both commodities. In reality, production occurs in many areas, the crop is shipped from multiple ports, and the farm prices and modes of internal transportation will vary considerably. However, by focusing on the cost of moving crops from the main production regions to a common destination, this approach highlights advantages and weaknesses in each country's respective export competitiveness.

For soybeans, China is a natural common destination for all three countries, being the number one destination for each country and also accounting for the majority of total exports in each country (on average during the marketing years of 2008-12). Corn exports are less concentrated. Japan was a main destination for both the United States and Brazil, and a destination of minor importance for Argentina; all three countries also ship to Egypt.

[20] Most of the remaining production of soybeans in Argentina is exported in the form of soymeal and soy oil, both of which have a lower export tax rate compared to soybeans.

Table 4
Major destinations for exports, ranked by exports in 2008/09-2012/13

	United States		Brazil		Argentina	
		Percent		Percent		Percent
Soybeans	China	57	China	68	China	81
	Mexico	9	European Union	18	Egypt	6
	Japan	6	Japan	1	Iran	2
Total		72		87		89
Corn	Japan	30	Iran	14	Colombia	13
	Mexico	18	Japan	11	Algeria	12
	South Korea	13	Taiwan	10	Peru	8
	Egypt	5	Egypt	6	Malaysia	7
			Morocco	5	Egypt	7
			Malaysia	5	South Korea	5
					Iran	5
					Japan	5
Total		66		51		62

Source: Global Trade Atlas, 2014.

The 5-year (2008-12) marketing year average farm prices for the selected regions and port (*free on board* or FOB)[21] prices for these countries and commodities are in table 5. For the United States and Brazil, a proxy for all inland transportation, handling, marketing, and other costs was established by subtracting the average farm price from the average FOB price of the commodity after it has been loaded onto the vessel. In the case of Argentina, actual transportation and handling cost estimates are separated from export policy costs because Argentina alone levies export taxes and irregularly issues export restrictions, which lead to additional costs for farmers. Ocean freight costs are also presented, but these rates tend to be relatively uniform at any given time and the differences are relatively small between the exporting countries when shipped to a common destination. These comparisons are also subject to fluctuations in many different variables (global market conditions, exchange rates, policy changes, etc.), but they provide an indirect view of the strengths and weaknesses each country may have in its internal transportation/handling costs and policy-related costs.

Comparing across countries points to stark differences in costs and prices across regions (table 5). Argentina's Northern Heartland has the lowest costs in corn production and is among the lowest cost producers for soybeans (after Mato Grosso). The region's inland transport costs are also competitive. However, the country's high export policy-related costs, 36 percent of its FOB corn port price and 46 percent for soybeans, push Argentina's Northern Heartland's landed cost above that of its competitors. Paraná in Brazil has the highest farm price for soybeans and a higher farm price for corn than Argentina's Northern Heartland, but thanks to its low domestic transport and handling costs ($33), its landed cost is the lowest among the four regions for both commodities. Mato Grosso has the lowest cost of production for soybeans, but high inland transportation costs—three times the cost in Paraná—push its landed cost above that of the United States.

At $57 per metric ton or 11.7 percent of port value, U.S. inland transportation and handling costs for soybeans are slightly above Argentina's (10.2 percent), but far lower than Brazil's Mato Grosso (20.1

[21]The free-on-board (FOB) price includes costs associated with loading a shipment onto a vessel.

percent). In the case of corn exports, U.S. landed cost is above that of Paraná, but below Argentina's Northern Heartland region (high other policy-related costs) and Mato Grosso (high inland transport cost). However, Paraná accounts for only 22 percent of Brazil's corn production during 2008-12, while the U.S. Heartland accounts for about 75 percent. Ocean freight costs tend to be similar across countries, so they don't have the same impact on competitiveness as inland transport/handling costs and other policy-related costs.[22]

Comparing landed costs for soybeans (table 5) shows Mato Grosso's cost to be about 1.5 percent above that of the United States, while Paraná's cost is 2.8 percent below. Brazil has expanded its market share in recent years as the Brazilian real has experienced a gradual and persistent devaluation since 2012, thus making Brazilian soybeans relatively cheaper for China (its main export market). Between 2010/11 and 2014/15, Brazil's soybean world market share increased from 33 to 44 percent. Argentina's high landed cost for corn, about 17 percent above the U.S. costs, and landed costs for soybeans (which are 1.7 percent above U.S. costs) might seem incompatible with its world market share. However, Argentina did lose market share in recent years, from 18 percent for corn in 2010/11 to 13 percent in 2014/15 and from 10 percent for soybeans to 8 percent. With the election of a new president in Argentina, who in December 2015 eliminated export restrictions and export tariffs for corn and reduced export taxes for soybeans and soybean products, Argentina may become much more competitive starting in 2016 (USDA/FAS, 2015).

While U.S. farm prices for both soybeans and corn are considerably higher than those in Argentina's Northern Heartland and Brazil's Mato Grosso, its landed soybean cost to China is 2 to 3 percent lower (table 5), thanks to lower inland transportation/handling costs than Mato Grosso and no policy-related costs like those faced by Argentina in the form of export costs. Maintaining this advantage into the future would require improvements to the U.S. infrastructure from the farm to the port.[23] When comparing corn exports to Japan and Egypt, Paraná in Brazil has the lowest landed price (table 5), about 10 percent below the U.S. cost, thanks to lower farm prices and inland transportation costs.

[22]Salin and Somwaru (2015) came to the same conclusion based on their model-driven analysis.

[23]A recent study by Salin and Somwaru (2015) quantifies the changes of the U.S. soybean world market shares over time using a dynamic model. They concluded that improvements in the U.S. infrastructure from the farm to the port were essential to avoiding loss in market share.

Table 5
Estimated costs of transporting corn and soybeans to common destinations, marketing 5-year average (2008 -2012)

	Soybeans to China				Corn to Egypt				Corn to Japan			
	United States	Argen-tina	Brazil		United States	Argen-tina	Brazil		United States	Argen-tina	Brazil	
	Heart-land	N. Heart-land	Mato Grosso	Paraná	Heart-land	N. Heart-land	Mato Grosso	Paraná	Heart-land	N. Heart-land	Mato Grosso	Paraná
Regional production share, percent	74	25	29	19	75	18	19	22	75	18	19	22
	U.S. dollars/MT											
(1) Farm price (1a + 1b)	426	266	387	429	204	138	182	178	204	138	182	178
(1a) Total cost of production	281	255	243	269	147	130	150	148	147	130	150	148
(1b) Farm price minus total cost of production	146	11	145	160	57	8	31	30	57	8	31	30
(2) Inland transport/ handling cost	57	50	98	33	39	43	102	33	39	43	102	33
(3) Other policy-related costs	NA	177	NA	NA	NA	104	NA	NA	NA	104	NA	NA
(4) FOB Port price	483	493	485	462	243	285	284	210	243	285	284	210
(5) Ocean transport cost	51	50	57	57	34	37	37	37	53	61	57	57
(6) Landed cost	534	543	542	519	277	322	320	247	296	346	341	268
	Percent											
(7) Inland transport/handling costs as a percent of Port Value (2)/(4)	11.7	10.2	20.1	7.1	16.0	15.1	35.9	15.8	16.0	15.1	35.9	15.8
(8) Inland transport/ handling/other costs as a percent of Port Value ((2)+(3)/(4))	11.7	46.0	20.1	7.1	16.0	51.5	35.9	15.8	16.0	51.5	35.9	15.8
(9) All transport/handling/other costs as a percent of landed cost ((2+3)/(6))	20.2	50.9	28.6	17.3	26.3	57.1	43.2	28.3	31.1	60.1	46.7	33.8

NA=not available. Total cost of production from appendix tables C1-6, based on 5-year-average yields, converted into cost per metric ton.
Sources: For the United States: Regional production share from USDA-NASS, 2015b. Farm price represents Heartland MY annual average farm price, 2008-2012, (USDA/NASS, 2015b), and author's calculations. Inland transport/handling data calculated, (5)-(1). FOB gulf port price represents monthly MY averages, 2008/12 (International Grains Council, 2015). Ocean freight rates represent monthly MY averages, 2008/12 (USDA/AMS, 2015).
For Argentina: Regional production share based on data from Ministry of Agroindustry, 2015. Author estimated farm price, 5-year MY average, 2008/12, (Buenos Aires Grain Exchange, 2012, and Márgenes Agropecuarios Magazine (2008/12). Costs for freight (inland and ocean freight), handling, and other policy-related costs from Margenes Agropecuarios Magazine (2008/12). FOB price and ocean freight rates from Ministry of Agroindustry, 2015.
For Brazil: Regional production share based on data from IBGE, 2014. Farm price calculated as MY monthly average farm price, 2008/12, (Brazil's National Company of Food Supply, 2015).
Inland transport/handling cost from same locations reported in cost of production tables (SIFRECA, 2015). From Sorriso (MT) to Paranagua Port and from Campo Morau (PR) to Paranagua Port in the MY monthly averages, 2008-2012. FOB price from Brazilian Institute of Geography and Statistics, 2015. Ocean freight average rates from Paranagua to Shanghai-China, Japan, Egypt, for 5-year MY average, 2008/12 (USDA/AMS, 2015).

Drivers of transportation costs: United States

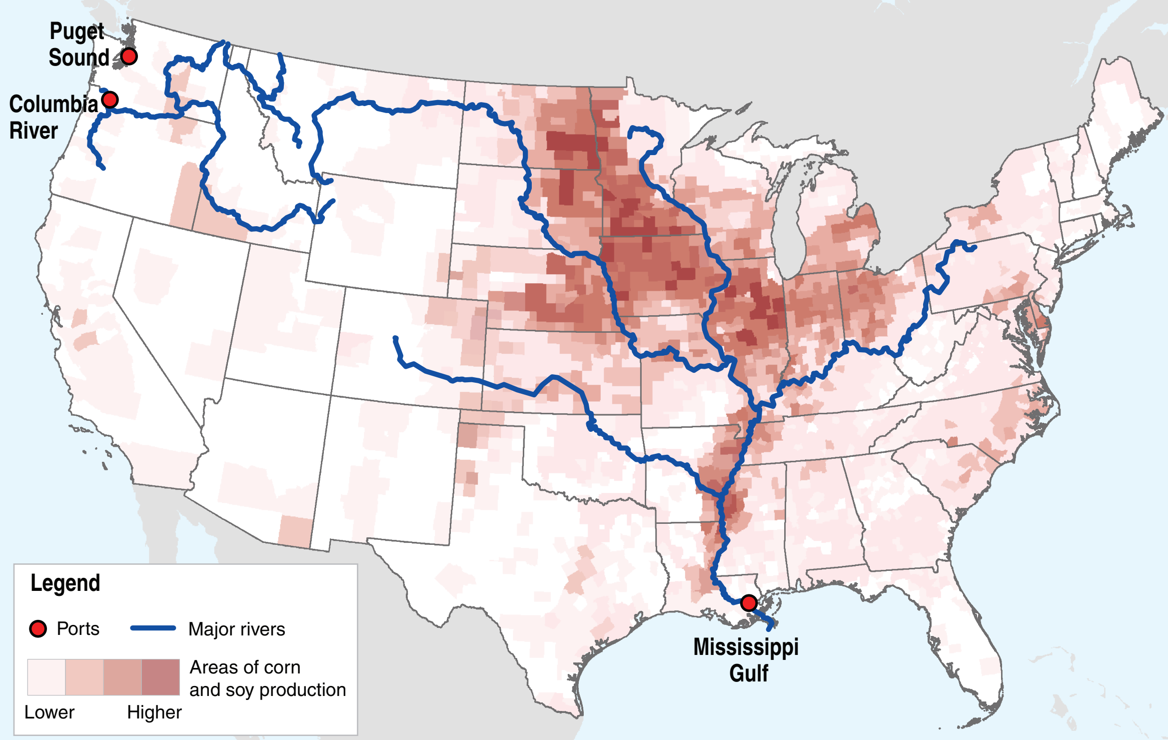
The **United States** grain transportation system provides a competitive transport link between the regions of grain production and consumption (domestic and export). This grain transportation system consists of overlapping rail lines, inland waterways, and highways. Exports are more dependent on lower cost rail and barge, whereas domestic shipments are more dependent on higher cost trucking (table 6). The U.S. inland waterways provide shippers with a low-cost energy-efficient mode of transportation to grain export terminals (Casavant et al., 2010). Rail provides the lowest cost long-haul transport for regions lacking barge transport availability. The northern Plains States of Montana, North Dakota, South Dakota, and Wyoming, for example, rely mostly on rail transportation for long-haul shipments. However, areas in southern Minnesota, eastern Iowa, or areas of Illinois can use barges for long-haul transportation.

Table 6
U.S. transport share for corn and soybeans (marketing year average, 2008-12)

Commodity shipment type	Transport mode (percent)		
	Rail	Barge	Truck
Corn			
Export	37	54	9
Domestic	20	1	79
Soybeans			
Export	38	49	13
Domestic	13	3	84

Source: USDA, Agricultural Marketing Service, Transportation of U.S. Grains: A Modal Share Analysis, 2015b.

Figure 10
Production regions for U.S. corn and soybeans and major ports



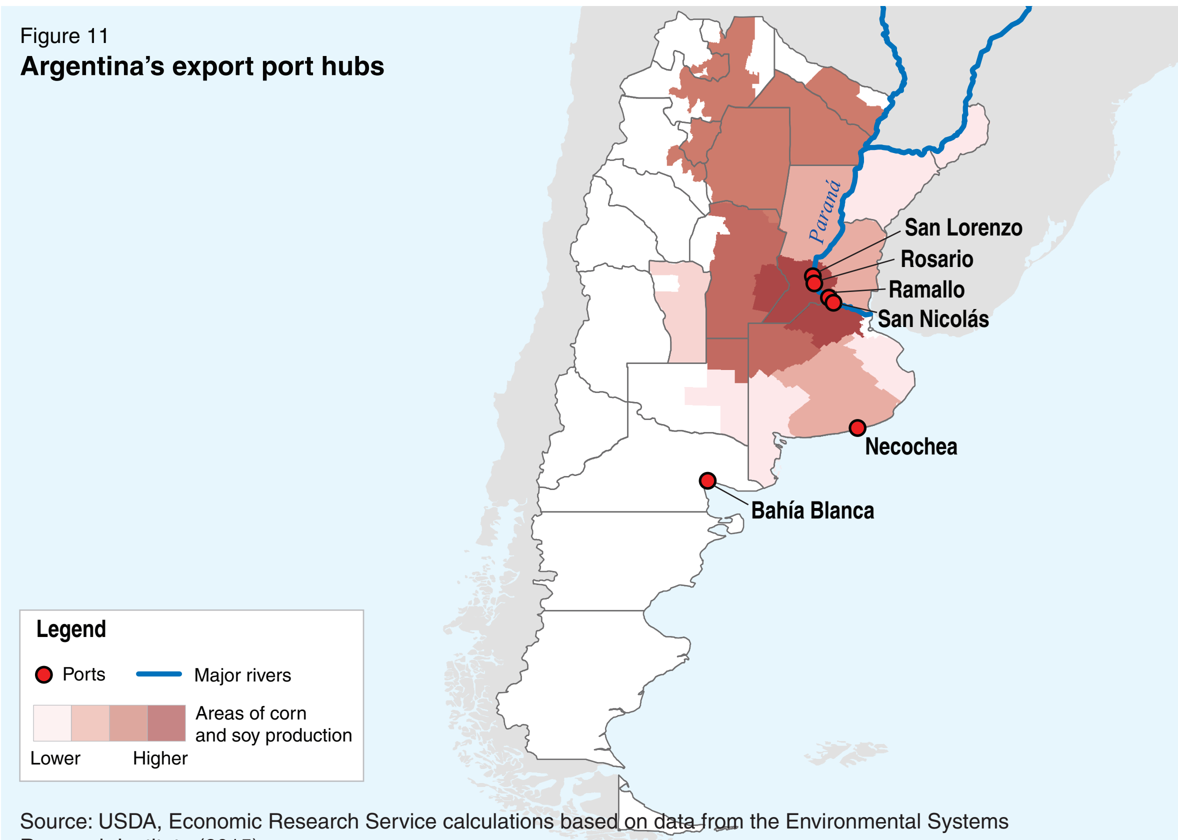
Source: USDA, Economic Research Service calculations based on USDA, National Agricultural Statistics Service, Agricultural Statistics 2012.

Corn is grown in most U.S. States, but production is concentrated in the Heartland region (fig. 10), which accounts for an average of 76 percent of U.S. corn grain production (an average 13 percent of all corn production is exported). U.S. soybean production is also concentrated in the Heartland—an average of 72 percent of all U.S. soybeans are grown there (and about 44 percent of U.S. soybean production is exported).[24] Much of the corn and soybeans for export is destined for the Gulf ports. Overall, U.S. corn and soybean exports rely on barge (54 percent and 49 percent, respectively) and rail (37 percent and 38 percent, respectively) for long-distance shipments (table 6). (For a detailed discussion of U.S. corn and soybean transportation, see Denicoff et al. (2014a, b).)

Drivers of transportation costs: Argentina

While **Argentina's** costs of production (table 5) are significantly below those in the United States and in Brazil (except for soybeans grown in Mato Grosso), its export price (FOB port price) is higher. The reason for this gap is the impact of fees (export taxes) and extra costs (risk of export restrictions), which lower the prices paid to producers. Inland transportation for soybeans, however, is competitive with Mato Grosso and that of the United States because the main soybean production regions in Argentina, as well as the country's main crushing complex, are near the most important (i.e., efficient) port hubs: the Paraná River (which includes the port of Rosario), Necochea Port, and Bahia Blanca Port (fig. 11) (Ordonez et al., 2001).

Figure 11
Argentina's export port hubs



Source: USDA, Economic Research Service calculations based on data from the Environmental Systems Research Institute (2015).

[24]The percentages are 5-year averages over 2008/09 to 2012/13, as reported by USDA-NASS, 2015b.

In Argentina, the largest share of crop production by far (85 percent) is transported to the ports by truck, while train transport makes up 13 percent and the Paraná river system accounts for the remaining 2 percent (López, 2012). Unlike the United States and Brazil, where the main production areas can be more than 1,000 miles from the port areas, the average distance in Argentina is less than 200 miles. Although the agricultural frontier has moved to inland Provinces such as Salta (about 600 miles from the Rosario Port), prices in the port areas remain the reference points—putting pressure on the margins of producers in inland areas who need to be even more efficient to compete with producers closer to the port.

A considerable share of the extra cost in Argentina arises due to export taxes, which were 35 percent for soybeans and 20 percent for corn during the study period. In addition, there were also export authorizations that, in the case of corn, act mostly as an export restriction, which could cause considerable extra costs (such as storage costs and low domestic prices) and lower the prices paid to domestic producers. Argentina's inland transport and handling costs amount to 10 percent of the FOB port value for soybeans, and 15 percent of the FOB port value for corn (table 5). Thus, inland transport, handling, and other costs totaled 46 percent of FOB port value for soybeans and 52 percent of FOB port value for corn. Export taxes imposed by the Government put the Argentine farmer at a competitive disadvantage, as farmers bear much of the burden for these costs.

Drivers of transportation costs: Brazil

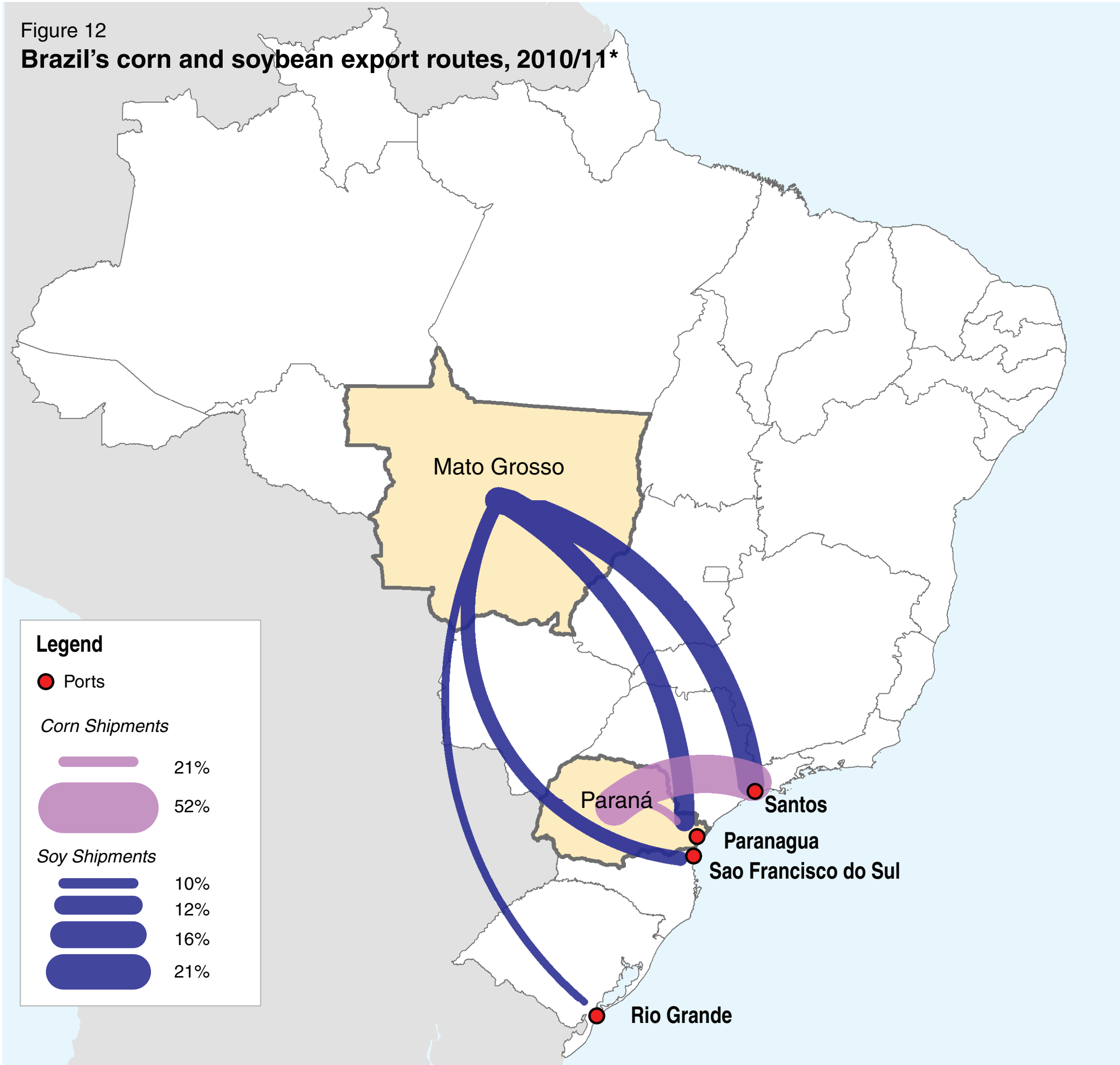
Although soybeans and corn are produced throughout **Brazil**, the States of Mato Grosso and Paraná account for a large share of Brazil's production, and these States form the basis of comparisons with transportation costs in the U.S. and Argentine Heartlands.[25] Paraná is close to the main Atlantic ports of Santos and Paranáguá (fig. 12); Mato Grosso is roughly 1,000 miles from the coastal ports. In 2010/11, 40 percent of soybean production was exported while the share for corn was 20 percent. Most transport is by road (63 percent), with rail transport making up 22 percent. About 12 percent of those shipments are at some point transferred to a barge and only 3 percent are transported entirely by river.

Similar to the main soybean and corn production regions in Argentina, Paraná's proximity to large ports keeps internal transportation/handling costs relatively low. From Paraná, these costs for corn and soybeans are $33 per ton, much below those in the United States and Argentina. Paraná accounted for 22 percent of soybean production and 19 percent of corn production during 2008-12. In contrast, the distance of Mato Grosso from ports on the Atlantic coast or alternate ports along the Amazon River, combined with the lack of a barge or well-developed rail system, put this region at a disadvantage compared with both the United States and Argentina. Internal transportation costs for soybean exports from Mato Grosso of $98 represent an average of about 20 percent of the port price, compared to 12 percent from the U.S. Heartland and 10 percent from the Argentine Northern Heartland (table 5). Transport costs are even higher ($102) and account for a larger share (36 percent) for Mato Grosso's corn exports. The region accounted for 29 percent of soybean production and 19 percent of Brazil's corn production during 2008-12. It should be noted that transportation costs are quite variable over time, and farm prices vary even more as they respond to supply and demand forces and changes in currency valuations.[26] In Brazil, the percentage of transport as a share

[25]In 2010/11, Mato Grosso accounted for 27 percent of Brazilian soybean production and 15 percent of corn production. Paraná accounted for 21 percent of soybean production and 25 percent of corn production.

[26]Brazil has also been affected by an economic crisis in the last 2 years, which has caused a depreciation of the cur-

Figure 12
Brazil's corn and soybean export routes, 2010/11*



*Since 2010/11, the second-crop corn (*safrinha*) grown in Mato Grosso has come to represent the bulk of Brazil's corn exports.
Source: USDA, Economic Research Service calculations based on data from the Brazilian Institute of Geography and Statistics (IBGE) (2014).

of landed cost has declined steadily over time in all regions. For soybean shipments originating from north Mato Grosso to Santos, that share declined from 45.4 percent in 2006 to 28.4 percent in 2012 (Salin, 2013).

The phenomenal growth in Brazil's trade, with a 65-percent increase in agricultural exports between 2005-14 and a 36-percent increase in agricultural imports during the same period, has meant that, despite intense development and modernization of highways, railroads, waterways, and ports, the country still requires huge investments in that sector to maintain competitiveness. Despite the progress achieved, Brazil's transportation infrastructure and ports face many challenges when it comes to increasing efficiency, reducing operating costs, and effectively attracting investment to sustain expansion of the agricultural sector.

rency, making the exports of corn and soybeans more attractive (USDA-FAS, 2014a).

Conclusion

Average farm-level production costs for corn and soybeans *per acre* were higher in the United States than in Argentina and Brazil in 2010, largely because of higher land and capital costs. These higher costs, however, are offset to a large extent by higher yields (over the 5-year period between marketing years 2008 and 2012), particularly for corn. National average production costs *per bushel* for soybeans were lowest in Brazil and highest in Argentina. On the other hand, the United States has the lowest farm-level production costs *per bushel* for corn at the national average level. While Argentina's Northern Heartland region has even lower costs, this production region accounted for only 25 percent of total Argentine corn production.

One variable that can distort production costs when comparing across countries is land value. Land values in the United States and Argentina are 2 ½ to 3 times those in Brazil. Given land's unique nature among inputs and the difficulty of determining comparable land values, we also compared returns over costs excluding the charge for land—in that case, the United States and Argentina are considerably more competitive in both corn and soybean production.

Transportation is also a major factor in export competitiveness. In the United States, more grain is moved to ports using lower cost barge and rail transport, while higher cost truck transport is more common in South America. In Argentina, high export policy costs due to taxes and risks of export restrictions lowered prices paid to producers, erasing their cost advantage from low cost of production and inland freight costs (due to proximity of the main production areas to ports). Brazilian producers had lower farm level production costs than the United States in soybean production in 2010. Moreover, the Paraná region of Brazil had the lowest marketing and transportation costs to the common destination (China). However, Paraná accounts for only 19 percent of soybean production in Brazil, while the U.S. Heartland, the second most competitive region, accounts for 74 percent of U.S. soybean production.

U.S. average national costs per bushel of soybeans, in turn, were lower than in Argentina, where returns were negative as a result of export policies resulting in low farm-level prices. U.S. Heartland returns were almost equal to those in Mato Grosso even though U.S. national average returns were below those in Brazil. Soybean prices paid by grain merchandizers were highest in the United States, closely followed by Brazil, and lowest in Argentina. The same patterns hold for corn, where higher U.S. per acre costs are more than offset by much higher yields, leading to considerably higher returns. The higher farm prices received by U.S. producers may reflect generally better infrastructure for marketing and transporting grain.

Long-term changes and adjustments in production, shipping, and handling costs, as well as costs associated with export policies and fluctuations in exchange rates, can have a profound impact on export competitiveness. As mentioned, Argentina's competitiveness could be greatly enhanced by reductions in export taxes and export restrictions, which depress prices paid to producers. The new Government that took power in December 2015 has already eliminated all agricultural export taxes (except for soybeans and soybean products, which have been reduced by 5 percentage points) and export restrictions. Argentina's agricultural sector is entering a new competitive environment which should be monitored and assessed further in the coming years. Brazil's costs can be reduced further if inland transportation costs can be decreased. These changes would further pressure U.S. competitiveness in world corn and soybean export markets.

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Appendix A: Methodology in Calculating Production Costs

This appendix presents information on data and cost components used in this report's comparison of cost of production of corn and soybeans. For each country, we provide background information on the surveys used, the structure of accounts, and the methods for estimating certain cost components.

The United States

The U.S. Department of Agriculture (USDA) has estimated annual production costs and returns and published accounts for major field crop and livestock enterprises since 1975. These historical accounts are based on the actual costs incurred by producers—they differ from projected accounts, which are often referred to as enterprise budgets and are reported by most U.S. land-grant universities to assist in farm planning. The costs and returns of all participants in the production process, including farm operators, landlords, contractors, and contractees, are included in the USDA accounts.

Survey/data—Data used to establish the cost and return estimates are based on producer surveys conducted every 4-8 years for each commodity and updated each year with estimates of annual price, acreage, and production changes. Commodity-specific surveys as part of the annual Agricultural Resource Management Survey (ARMS) are used to collect the data. These surveys gather detailed information about input use, field operations, and production costs of a particular commodity. Field enumerators personally interview farmers using questionnaires developed by USDA's National Agricultural Statistics Service (NASS) and the Economic Research Service (ERS).

Each farm sampled in the ARMS represents a known number of farms with similar attributes so that weighting the data for each farm by the number of farms it represents provides a basis for calculating estimates for the target population. Target populations for crop commodities include all farms producing one or more acres of the commodity. The survey data are supplemented with price and production data from other sources, mainly from USDA-NASS (2015b) to create the indices needed to develop estimates for nonsurvey years.

Structure of accounts—The commodity cost and return accounts are divided into operating costs and allocated overhead costs.[27] Operating costs are mainly cash expenditures incurred when factors of production are purchased or rented. Allocated overhead costs include many noncash costs that occur when factors are owned. For example, if a farmer fully owns the land used to produce a crop, he/she would have no expenditure for land rental or for loans to pay for the purchase of land. Yet, an economic cost arises because production resources are limited and have alternative uses. For example, by owning the land and using it to grow a crop, the farmer foregoes income from other uses of the land, such as renting it to another producer. Additionally, if a farmer uses savings to pay for operating inputs, such as seed, fertilizer, chemicals, and fuel, and thus pays no interest on operating loans, the farmer still incurs an economic cost because the savings could have earned a return in another use. Likewise, the farmer has an opportunity cost of his/her labor used in the production of the commodity because it could have been used on another farm or in off-farm employment.

[27]This format conforms to that recommended by the American Agricultural Economics Association Task Force on Commodity Costs and Returns (2000).

Estimating costs and returns—Methods recommended by the American Agricultural Economics Association Task Force on Commodity Costs and Returns (2000) are used to estimate the commodity costs and returns.[28] The following is an overview of the estimation methods.

The gross value of crop production is calculated by valuing the survey crop yields by harvest-month crop prices in each year. The crop production accounts include only costs incurred in the production of each crop commodity, excluding costs for marketing and storage. Secondary products are also valued.

Four basic approaches are used to estimate the commodity costs: direct costing, valuing input quantities, indirect costing, and allocating whole-farm expenses. The choice among approaches used to estimate particular cost items is mainly driven by the ability of farmers to report commodity-specific costs for that item. For example, most farmers can report the cost of seed purchased for a commodity, but cannot report the fuel cost for a commodity because fuel is typically used to produce several commodities on the same farm.

Argentina

Since agricultural statistics in Argentina are scarce compared to the United States, the Buenos Aires Grains Exchange developed the *Applied Agricultural Technology Survey (AATS) 2010-11*, mainly to assess the amount of inputs used at a regional and national level, and to obtain data for each crop, using 2010 as the benchmark.

The survey/data—The AATS collected data related to grain production, including information on soybeans, wheat, corn, sunflower, sorghum, and barley, through surveys carried out with the help of Qualified Informants[29] with knowledge of different aspects of the agricultural sector. The survey included variables such as input use and the adoption of various forms of crop management, such as no-till production, and covered 17 regions (figure A1).

Qualified Informants were interviewed by specially trained and experienced staff members of the Buenos Aires Grain Exchange. Consultations were conducted and structured around a nonprobabilistic sample, through deliberate and strategic sampling of each zone, to efficiently and representatively cover the entire agricultural area. Phone consultations were complemented by site visits.

Estimating costs and returns—For Argentina, the structure of accounts was modeled after the U.S. template. Input use was evaluated with respect to type of tillage, seeds or materials utilized in the planting period, amount and type of fertilizers, herbicides, insecticides, fungicides, and seed treatments. The production profile of each region is characterized by different quantities of fertilizers, seeds, and herbicides used for the production of soybeans and corn. Production practices were classified into three technological levels, and a matrix was prepared for each level for each region.

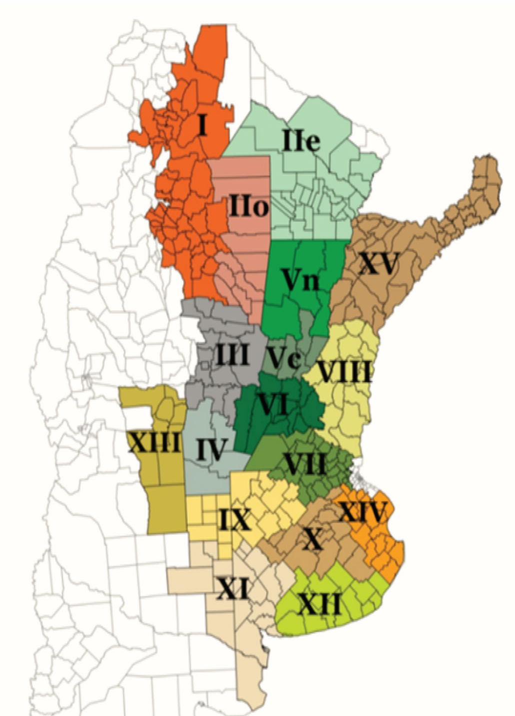
Data differences with United States—The Argentine data are similar to those of the United States with several exceptions. Irrigation expenses are not included in Argentina since that practice is

[28]Specifics of the recommendations and more details about the methodology used to construct USDA accounts can be found in the USDA-ERS Commodity Costs and Returns documentation (2015c).

[29]Qualified Informants are mostly agricultural advisors with knowledge of the production and management requirements of each crop across production regions. They might be input or custom-service providers, operating across large production areas.

Appendix figure 1

Argentina's crop production areas - 17 agro-ecological regions



Surveyed areas

I	Northwestern Argentina (NOA)
IIe	Northwestern Argentina (east)
IIo	Northwestern Argentina (west)
III	North-Central Córdoba
IV	South of Córdoba
Vn	Santa Fé (north)
Vc	Santa Fé (central)
VI	Northern Core
VII	Southern Core
VIII	East-Central Entre Ríos
IX	North of La Pampa - west of Buenos Aires
X	Downtown Buenos Aires
XI	Southwest Buenos Aires - La Pampa south
XII	Southwest of Buenos Aires
XIII	San Luis
XIV	Salado River Basin
XV	Corrientes - Misiones

Source: Applied Agricultural Technology Survey (AATS) 2010-11, Buenos Aires Grain Exchange, 2012.

uncommon, but some tax and insurance costs are included.[30] The most noteworthy difference is in calculating the costs of planting and harvesting. In Argentina, it is common to outsource planting and harvesting because of prohibitively high capital costs. For farmers, outsourcing services are less expensive than the capital investment and cost of maintenance, in addition to fuel and other related inputs. Hence, the cost of planting, fertilizing, and harvesting is reflected in the payments to custom operators. For this reason, fuel, electricity, and repairs, as well as capital recovery of machinery and equipment costs, are not calculated separately because they are captured within the custom operations cost estimate.

Data sources and methods—Direct costs were calculated based on input quantities presented in regional production matrixes. Operating costs were calculated based on quantity data from the AATS, complemented with price data from the publication *Márgenes Agropecuarios* (2008-15). The regions analyzed are those where most production is concentrated. The national average cost of production was calculated as a weighted average of regional values.

Brazil

Brazil's National Company of Food Supply (*Companhia Nacional de Abastecimento*, CONAB) has estimated annual production costs for major field crops since 1976. Cost accounts are constructed

[30]The interest rate for 2010 was calculated as 9 percent. Allocated overhead costs were based on the size of representative farms and information from the most recently available data from the Agricultural Census (INDEC, 2015) (at the time of this report, 2002 data were used because data from the 2008 Census were not fully available). The opportunity cost of land was calculated as a rental rate equal to a fixed percentage of the gross value of production (35 percent). Taxes include property, fuel, and income taxes. Insurance was not calculated.

using technical coefficient matrices to represent the resources used in the production of each commodity and the prices of the inputs used during each marketing year. The technical coefficient matrices include inputs, hand tools, and machinery for individual commodities, with the corresponding market prices. Information on area harvested, systems of production (conventional, transgenic, organic, no till), and type of technology used (manual, mechanized) are also included in the cost calculations. A representative municipality/region is selected based on the importance of that municipality's production, area, and yields for the specific crop, as reported by IBGE (2014) for several States (CONAB, 2010).

The survey/data— For Brazil, the structure of accounts was modeled after the U.S. template. Each marketing year, CONAB's field enumerators visit representatives from the selected municipalities to interview farmers and collect the cost-of-production data. For soybeans and corn, the production practice and cost data are collected in May, after harvest. The accuracy of the cost results is evaluated by a panel of representatives of all participants in the production process, including farm operators, input industry representatives, brokers, contractors, and lenders.[31]

Estimating costs and returns—Costs are updated annually for soybeans, corn, and all the field crops. Given the regional differences in the planting of the crops, cost estimates are separately estimated for the summer harvest, the winter harvest, and the dry-season harvest. The gross value of crop production is calculated by valuing CONAB's survey crop yields by State-average harvest-month crop prices in each year.

[31]Price data for inputs and services are calculated by a panel of representatives and from surveys conducted monthly by CONAB (*Companhia Nacional de Abastecimento)*. The cost of labor includes market wages for a total of 220 hours per month plus social security charges. Diesel and other energy expenses are calculated as a percentage of the machines' power, and capital is given a 6-percent annual rate of return. Maintenance/repairs and insurance are calculated as a set percent of the equipment's value or the value of the equipment being insured.

Appendix B: Costs of Production of Soybeans and Corn in the United States, Argentina, and Brazil, 2010/11

Detailed costs of production are presented by commodity and country, with estimates for each country's most important production region for each commodity, as well as an average for each country. Data for each country are presented in the original format, using 2010 production costs, and comparing costs and revenues using 2010/11 yields and harvest period prices.

Soybean costs of production

The United States—Since 74 percent of the 2010 U.S. soybean production occurred in the Heartland, we focus on soybean production costs for this region, in addition to providing a U.S. average (USDA-NASS, 2015b).

Argentina—During the 2010/11 season, soybeans covered 44.7 million acres (18.5 million hectares) (Ministry of Agroindustry, 2015). Soybean production is distributed throughout the country's agricultural regions in a variety of conditions. In addition to a national average, this study presents costs of production for the Northern Heartland,[32] where most production (21 percent) took place and the highest level of technology was used.

Brazil—In 2010/11, the States of Mato Grosso (in the frontier[33] agricultural region) and Paraná (in the traditional agricultural region) accounted for 48 percent of the 75.3 million tons of soybeans produced in Brazil in that year—27.1 percent and 20.5 percent of total soybean production, respectively. We provide soybean production costs for Mato Grosso and Paraná, as well as a national average soybean cost (IBGE, 2014).

[32]The following counties are included in this region: San Martin, San Jeronimo, Diamante, Victoria, Rosario, San Lorenzo, Caseros, Marcos Juarez, Belgrano, Iriondo, and Union.

[33]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 forest ecosystems, and the surrounding cerrados savannah.

Appendix table B1

U.S. soybean production costs and returns per planted acre, 2010/11[1]

Item	Heartland		U.S. national average	
	Costs	Share of total costs	Costs	Share of total costs
	Dollars per planted acre	Percent	Dollars per planted acre	Percent
Operating costs	121.98	33.2	131.90	36.2
Seed	57.49	15.7	59.20	16.3
Fertilizer[2]	16.88	4.6	17.87	4.9
Chemicals	16.64	4.5	17.04	4.7
Custom operations	6. 10	1.7	7.23	2.0
Fuel, lube, and electricity	13.06	3.6	16.81	4.6
Repairs	11.69	3.2	13.46	3.7
Purchased irrigation water	0.00	0.0	0.16	0.0
Interest on operating capital	0.12	0.0	0.13	0.0
Allocated overhead	244.90	66.8	232.19	63.8
Hired labor	1.27	0.3	2.11	0.6
Opportunity cost of unpaid labor	15.84	4.3	17.33	4.8
Capital recovery of machinery and equipment	73.90	20.1	78.18	21.5
Opportunity cost of land	129.70	35.4	110.30	30.3
Taxes and insurance	9.29	2.5	9.41	2.6
General farm overhead	14.90	4.1	14.86	4.1
Total costs	366.88	100.0	364.09	100.0
Supporting information				
Yield (bushels per planted acre, 2010/2011)	51	NA	47	NA
Price (dollars per bushel, 2010/2011)	9.91	NA	9.56	NA
Costs per bushel (dollars), 2010/11	7.19	NA	7.75	NA
Operating	2.39	NA	2.81	NA
Allocated overhead	4.80	NA	4.94	NA
Comparison with 5-year average, 2008-2012				
Yield (bushels per planted acre, 2008-2012)	48	NA	45	NA
Price (dollars per bushel, 2008-2012)	11.60	NA	11.55	NA
Costs per bushel (dollars), 2008-2012	7.64	NA	8.16	NA
Enterprise size (planted acres per farm)[3]	299	NA	303	NA

[1]Refers to the crop harvested in 2010.
[2]Commercial fertilizer, soil conditioners, and manure.
[3]Developed from survey base year, 2006.
NA = Not applicable.
Source: USDA, Economic Research Service, Commodity Costs and Returns, 2015.

Appendix table B2

Argentina soybean production costs and returns per planted acre, 2010/11[1]

Item	Northern Heartland		Argentina national average	
	Costs	Share of total costs	Costs	Share of total costs
	Dollars per planted acre	Percent	Dollars per planted acre	Percent
Operating costs	105.00	32.1	116.38	36.0
Seed	19.22	5.9	18.36	5.7
Fertilizer[2]	12.67	3.9	13.74	4.3
Chemicals	22.34	6.8	28.55	8.8
Custom operations	42.11	12.9	46.12	14.3
Fuel, lube, and electricity	0.00	0.0	0.00	0.0
Repairs	0.00	0.0	0.00	0.0
Purchased irrigation water	0.00	0.0	0.00	0.0
Interest on operating capital	8.67	2.6	9.61	3.0
Allocated overhead	222.31	67.9	206.51	64.0
Hired labor	23.31	7.1	23.31	7.2
Opportunity cost of unpaid labor	34.00	10.4	34.00	10.5
Capital recovery of machinery and equipment	0.00	0.0	0.00	0.0
Opportunity cost of land	114.74	35.1	98.93	30.6
Taxes and insurance	32.82	10.0	32.82	10.2
General farm overhead	17.44	5.3	17.44	5.4
Total costs	327.31	100.0	322.88	100.0
Supporting information				
Yield (bushels per planted acre, 2010/2011)	45.20	NA	40.15	NA
Price (dollars per bushel, 2010/2011)	7.25	NA	7.04	NA
Costs per bushel (dollars), 2010/11	7.24	NA	8.04	NA
Operating	2.32	NA	2.90	NA
Allocated overhead	4.92	NA	5.14	NA
Comparison with 5-year average, 2008-2012				
Yield (bushels per planted acre, 2008-2012)	47.17	NA	36.64	NA
Price (dollars per bushel, 2008-2012)	6.72	NA	6.49	NA
Costs per bushel (dollars), 2008-2012	6.94	NA	8.81	NA
Enterprise size (planted acres per farm)[3]	202.34	NA	202.34	NA

[1]Refers to the crop harvested in 2010.

[2]Commercial fertilizer, soil conditioners, and manure.

[3]Developed from survey base year, 2002.

NA = Not applicable.

Source: Applied Agricultural Technology Survey (AATS) for 2010/11 conducted by the Buenos Aires Grains Exchange (2012), Argentina.

Appendix table B3

Brazil soybean production costs and returns per planted acre, 2010/11[1]

	Mato Grosso		Paraná		Brazil national average	
	Dollars per planted acre	Percent	Dollars per planted acre	Percent	Dollars per planted acre	Percent
Operating costs	196.58	64.2	185.80	56.3	199.89	61.6
Seed	21.17	6.9	20.73	6.3	23.03	7.1
Fertilizer	91.88	30.0	50.52	15.3	71.51	22.0
Chemicals	37.07	12.1	51.88	15.7	46.90	14.5
Custom operations	25.38	8.3	34.09	10.3	33.58	10.4
Fuel, lube, and electricity	7.42	2.4	12.03	3.6	9.08	2.8
Repairs	4.62	1.5	9.08	2.8	7.97	2.5
Purchased irrigation water						
Interest on operating capital	9.03	3.0	7.47	2.3	7.83	2.4
Allocated overhead	109.40	35.8	143.97	43.7	124.44	38.4
Hired labor	1.17	0.4	3.54	1.1	1.94	0.6
Opportunity cost of unpaid labor	13.64	4.5	7.96	2.4	8.11	2.5
Capital recovery of machinery and equipment	26.73	8.7	51.47	15.6	46.57	14.4
Opportunity cost of land	36.77	12.0	58.57	17.8	40.94	12.6
Taxes and insurance	23.32	7.6	19.06	5.8	19.98	6.2
General farm overhead	7.77	2.5	3.37	1.0	6.90	2.1
Total costs	305.97	100.0	329.77	100.0	324.33	100.0
Supporting information						
Yield (bushels per planted acre, 2010/2011)	44.6	NA	44.6	NA	42.9	NA
Price (dollars per bushel, 2010/2011)[2]	11.08	NA	12.53	NA	11.93	NA
Costs per bushel (dollars), 2010/11	6.86	NA	7.39	NA	7.55	NA
Operating	4.41	NA	4.17	NA	4.66	NA
Allocated overhead	2.45	NA	3.23	NA	2.90	NA
Comparison with 5-year average, 2008-2012						
Yield (bushels per planted acre, 2008-2012)	46.4	NA	45.0	NA	43.4	NA
Price (dollars per bushel, 2008-2012)	10.54	NA	11.68	NA	11.18	NA
Costs per bushel (dollars), 2008-2012	6.60	NA	7.32	NA	7.47	NA
Enterprise size (planted acres per farm)[3]	5,923	NA	192	NA	504	NA

[1]Refers to the crop planted in 2010 and harvested in 2011.
[2]Average price during Brazilian corn harvest months January, February, March.
[3]Developed from farm census 2006.
NA = Not applicable.
Source: Brazilian National Food Supply Company (CONAB), 2015.

Corn costs of production

The United States—In addition to presenting a U.S. average, this report focuses on corn production costs in the Heartland since this region has long dominated U.S. corn production due to the region's favorable growing conditions (which lead to high yields). Heartland corn production accounted for 75 percent of the corn bushels produced in the United States in 2010 (USDA-NASS, 2015b).

Argentina—During the 2010/11 crop year, corn covered 9.4 million acres (3.8 million hectares), producing 964 million bushels (24.5 million metric tons), according to the Buenos Aires Grain Exchange (2012). Corn production is distributed among 17 growing regions. Along with presenting a national average, a special focus is placed on the Northern Heartland,[34] since it is the largest corn producing region (17 percent) and uses the highest level of technology.

Brazil—For the 2010/11 crop year, the States of Paraná (in the traditional agricultural region) and Mato Grosso (in the frontier agricultural region) jointly accounted for 34.6 percent of the 57.4 million tons of corn produced—21.3 percent and 13.3 percent of total corn production, respectively.

[34]The following counties are included in this region: San Martin, San Jeronimo, Diamante, Victoria, Rosario, San Lorenzo, Caseros, Marcos Juarez, Belgrano, Iriondo, Union.

Appendix table B4

U.S. corn production costs and returns per planted acre, 2010/11[1]

Item	Heartland		U.S. national average	
	Costs	Share of total costs	Costs	Share of total costs
	Dollars per planted acre	Percent	Dollars per planted acre	Percent
Operating costs	292.25	51.1	286.41	52.1
Seed	87.72	15.3	81.58	14.8
Fertilizer[2]	118.09	20.6	112.03	20.4
Chemicals	26.95	4.7	26.29	4.8
Custom operations [3]	15.25	2.7	16.36	3.0
Fuel, lube, and electricity	22.18	3.9	25.80	4.7
Repairs	21.77	3.8	23.96	4.4
Purchased irrigation water	0.00	0.0	0.11	0.0
Interest on operating capital	0.29	0.1	0.28	0.1
Allocated overhead	279.67	48.9	263.79	47.9
Hired labor	2.61	0.5	2.96	0.5
Opportunity cost of unpaid labor	20.21	3.5	22.54	4.1
Capital recovery of machinery and equipment	81.22	14.2	84.40	15.3
Opportunity cost of land	150.49	26.3	127.33	23.1
Taxes and insurance	7.77	1.4	8.46	1.5
General farm overhead	17.37	3.0	18.10	3.3
Total costs	571.92	100.0	550.20	100.0
Supporting information				
Yield (bushels per planted acre, 2010/2011)	167	NA	159	NA
Price (dollars per bushel, 2010/2011)	4.33	NA	4.33	NA
Costs per bushel (dollars), 2010/11	3.42	NA	3.46	NA
Operating	1.75	NA	1.80	NA
Allocated overhead	1.67	NA	1.66	NA
Comparison with 5-year average, 2008-2012				
Yield (bushels per planted acre, 2008-2012)	153	NA	145	NA
Price (dollars per bushel, 2008-2012)	5.18	NA	5.18	NA
Costs per bushel (dollars), 2008-2012	3.73	NA	3.80	NA
Enterprise size (planted acres per farm)[4]	313	NA	280	NA

[1]Refers to the crop harvested in 2010.
[2]Commercial fertilizer, soil conditioners, and manure.
[3]Cost of custom operations, technical services, and commercial drying.
[4]Developed from survey base year, 2006.
NA = Not applicable.
Note: Crop production is valued for farms in each State using the State price in the month in which most of the crop in the State is typically harvested. Typical harvest months vary among States and among crops, and are obtained from USDA, National Agricultural Statistics Service (NASS), Field Crops: Usual Planting and Harvesting Dates, 2010. Monthly State prices are published in USDA-NASS, Quick Stats: Prices and Production by State, 2015.
Source: USDA, Economic Research Service, Commodity Costs and Returns, 2015.

Appendix table B5

Argentina corn production costs and returns per planted acre, 2010-11[1]

Item	Northern Heartland		Argentina national average	
	Costs	Share of total costs	Costs	Share of total costs
	Dollars per planted acre	Percent	Dollars per planted acre	Percent
Operating costs	180.56	39.6	190.92	44.5
Seed	64.75	14.2	62.16	14.5
Fertilizer[2]	44.39	9.7	44.19	10.3
Chemicals	7.43	1.6	15.14	3.5
Custom operations[3]	49.08	10.8	53.67	12.5
Fuel, lube, and electricity	0.00	0.0	0.00	0.0
Repairs	0.00	0.0	0.00	0.0
Purchased irrigation water	0.00	0.0	0.00	0.0
Interest on operating capital	14.91	3.3	15.76	3.7
Allocated overhead	275.77	60.4	237.87	55.5
Hired labor	23.31	5.1	23.31	5.4
Opportunity cost of unpaid labor	34.00	7.5	34.00	7.9
Capital recovery of machinery and equipment	0.00	0.0	0.00	0.0
Opportunity cost of land	166.35	36.5	128.46	30.0
Taxes and insurance	34.66	7.6	34.66	8.1
General farm overhead	17.44	3.8	17.44	4.1
Total costs	456.33	100.0	428.80	100.0
Supporting information				
Yield (bushels per planted acre, 2010/2011)	135	NA	108	NA
Price (dollars per bushel, 2010/2011)	3.51	NA	3.39	NA
Costs per bushel (dollars), 2010/11	3.37	NA	3.96	NA
Operating	1.33	NA	1.76	NA
Allocated overhead	2.04	NA	2.20	NA
Comparison with 5-year average, 2008-2012				
Yield (bushels per planted acre, 2008-2012)	138	NA	109	NA
Price (dollars per bushel, 2008-2012)	2.72	NA	2.58	NA
Costs per bushel (dollars), 2008-2012	3.31	NA	3.93	NA
Enterprise size (planted acres per farm)[4]	202	NA	202	NA

[1]Refers to the crop harvested in 2010.

[2]Commercial fertilizer, soil conditioners, and manure.

[3]Cost of custom operations, technical services, and commercial drying.

[4]Developed from survey base year, 2002.

NA = Not applicable.

Source: Applied Agricultural Technology Survey (AATS) 2010/11 from Buenos Aires Grain Exchange (2012), and Márgenes Agropecuarios magazine (2008-15).

Appendix table B6

Brazil corn production costs and returns per planted acre, 2010-11[1]

	Mato Grosso		Paraná		Brazil national average	
	Dollars per planted acre	Percent	Dollars per planted acre	Percent	Dollars per planted acre	Percent
Operating costs	277.35	70.0	279.01	68.5	274.85	69.2
Seed	63.81	16.1	48.28	11.9	49.82	12.5
Fertilizer	123.22	31.1	125.88	30.9	100.97	25.4
Chemicals	22.62	5.7	38.08	9.4	48.46	12.2
Custom operations	37.07	9.4	49.41	12.1	41.84	10.5
Fuel, lube, and electricity	15.38	3.9	0.84	0.2	14.83	3.7
Repairs	7.39	1.9	5.31	1.3	7.94	2.0
Purchased irrigation water	NA	NA	NA	NA	NA	NA
Interest on operating capital	7.86	2.0	11.20	2.7	10.98	2.8
Allocated overhead	118.65	30.0	128.21	31.5	122.17	30.8
Hired labor	5.31	1.3	1.73	0.4	2.64	0.7
Opportunity cost of unpaid labor	6.82	1.7	9.09	2.2	8.61	2.2
Capital recovery of machinery and equipment	65.44	16.5	31.15	7.6	44.49	11.2
Opportunity cost of land	20.06	5.1	58.57	14.4	41.66	10.5
Taxes and insurance	15.85	4.0	22.22	5.5	18.51	4.7
General farm overhead	5.18	1.3	5.45	1.3	6.25	1.6
Total costs	396.00	100.0	407.22	100.0	397.02	100.0
Supporting information						
Yield (bushels per planted acre, 2010/2011)	95.6	NA	111.5	NA	98.6	NA
Price (dollars per bushel, 2010/2011)[2]	4.10	NA	3.74	NA	4.28	NA
Costs per bushel (dollars), 2010/11	4.14	NA	3.65	NA	5.09	NA
Operating	2.90	NA	2.50	NA	3.52	NA
Allocated overhead	1.24	NA	1.15	NA	1.56	NA
Comparison with 5-year average, 2008-2012						
Yield (bushels per planted acre, 2008-2012)	103.6	NA	108.3	NA	83.7	NA
Price (dollars per bushel, 2008-2012)	4.62	NA	4.50	NA	5.11	NA
Costs per bushel (dollars), 2008-2012	3.82	NA	3.76	NA	4.74	NA
Enterprise size (planted acres per farm)[3]	898	NA	87	NA	114	NA

[1]Refers to the crop planted in 2010 and harvested in 2011.

[2]Average price during Brazilian corn harvest months January, February, March.

[3]Developed from farm census 2006.

NA = Not applicable.

Source: Brazilian National Food Supply Company (CONAB), 2015.