Chapter 2

A Comparison of Economic and Agricultural Settings

Introduction

Argentina, Brazil, and the United States have competed in international agricultural markets for decades. However, a very different set of demographic, geographic, and economic circumstances underlies each country's competitive position. This chapter provides some perspective to the differences and similarities that distinguish these three agricultural competitors. In addition, it sets the stage for a later discussion of agricultural development in Argentina and Brazil by comparing their population and economic characteristics, land base, the climate for each country's principal areas of agricultural production, and finally, the transportation and marketing infrastructure.

Agriculture's Economic Role Differs Sharply

The U.S. economy is both huge (in terms of aggregate GDP) and wealthy (in terms of GDP per capita). But based on GDP per capita, life expectancy, and literacy criteria, Argentina has fast closed the gap with the United States, while Brazil still lags further behind.

In the United States, agriculture accounts for only 2 percent of GDP, 10 percent of total merchandise export value, and employs about 3 percent of the labor force (table B-1). Agriculture plays a significantly more important role in Brazil, where it represents 14 percent of GDP, 33.5 percent of the value of exports, and provides jobs for 31 percent of the labor force. Argentina's agricultural sector ranks midway between the United States and Brazil in terms of economic importance, representing 7 percent of its GDP and providing jobs for 12 percent of the labor force. However, Argentina depends heavily on agriculture for export earnings—52 percent of merchandise export value comes from agricultural products.

Brazil and the United States have large domestic markets that consume most of their agricultural output. For the United States, export markets are an important but residual destination for much of its cereal and oilseed (and products) output. In Brazil's case, international markets compete more directly with domestic markets as a source of demand. With a relatively small population, Argentina relies most directly on international markets as an outlet for its grain and oilseed production.

Abundant Land Base Strikes a Common Theme

The combined total land area of 1.1 billion hectares for Argentina and Brazil is 22 percent larger than U.S. area. Yet they are almost identical to the United States in area devoted to agricultural activities—about 419 million hectares in 1998 (table B-2). However, only 78 million hectares were involved in field crop production in these two countries in 1998, compared with 177 million hectares in the United States.

The limited share of available area devoted to field crop production, particularly in Brazil, underscores the tremendous potential for expansion. Nearly 600 million hectares of land in the two countries are covered by agriculturally untouched forests and scrub land, foremost of which is Brazil's vast *cerrado* savanna in the Center-West, which represents the world's greatest remaining tract of accessible but relatively underdeveloped farmland. Warnken (1999) described the *cerrado's* agricultural potential as follows:

> *With millions of hectares of unopened virgin cerrado land, Brazil has the technical potential to increase national soybean area and production nearly tenfold. The technically viable expansion area for Brazilian soybeans is larger than the land area of all but twelve countries of the world, nearly 4 times 1995 U.S. soybean acreage (24.9 million*

Table B-1—Argentina, Brazil, and the United States at a glance

Category	Unit	Argentina	Brazil	United States
Population (2000)[1]	Million	37.0	172.9	275.6
Population growth rate*[2]	Percent/year	1.3	1.3	1.2
Life expectancy[1]	Years	75.1	62.9	77.1
Literacy rate[1]	Percent	96.2	83.3	97.0
Food consumption[3]	Calories/day	3,138	2,899	3,505
Meat consumption[3]	kgs/capita/year	100	74	124
GDP-PPP** (1999)[1]	Billion U.S. $	367	1,057	9,255
GDP-PPP** per capita[1]	U.S. $/capita	10,000	6,150	33,900
Agr. share of GDP-PPP**[1]	Percent	7	14	2
GDP-nominal (2000)[4]	Billion U.S. $	284	665	9,963
Foreign debt[4]	Billion U.S. $	150	251	7,536
Agricultural debt	Billion U.S. $	7[5]	13[5]	181[6]
Labor force (1997)[1]	Million	15	74	139
Agr. share of labor force[1]	Percent	12	31	3
Land area[3]	1,000 sq. km.	2,737	8,457	9,159
Percent in agriculture[3]	Percent	62	30	46
Total merchandise exports[2]	Billion U.S. $	23.3	48.0	695.2
Agricultural exports[2]	Billion U.S. $	12.1	16.1	69.6
Agr. share of exports[2]	Percent	51.9	33.5	10.0

Source: [1]CIA Fact Book, CIA, U.S. Government; *http://www.cia.gov/cia/publications/factbook/*.
[2]World Development Indicators, CD-ROM, World Bank; export data is 1999 f.o.b. exports of food and agricultural raw materials.
[3]FAOSTATS, FAO; [4]DRI-WEFA database; [5]FAS, USDA; [6]*Agricultural Income & Finance,* AIS-76, Feb. 2001, ERS, USDA.
*1993-99 average. **Purchasing power parity basis.

Table B-2—Animal numbers and land use patterns: Argentina, Brazil, and the United States

Category	Argentina		Brazil		United States	
	Mil. hectares	*Percent*	*Mil. hectares*	*Percent*	*Mil. hectares*	*Percent*
Total land area (1998)	**273.7**	**100**	**845.7**	**100**	**915.9**	**100**
Forest & scrub land	50.9	19	547.3	65	296.0	32
Mountains & other	53.6	20	48.2	6	201.7	22
Agriculture	169.2	62	250.2	30	418.3	46
Permanent pasture	142.0	52	185.0	22	239.3	26
Cropland	25.0	9	53.2	6	177.0	19
Permanent crops	2.2	1	12.0	1	2.1	0
	-------------------------------- Million head ----------------------------					
Livestock (2000)						
Cattle stock	55.0		167.5		98.0	
Pigs stock	3.2		27.3		59.3	
Sheep stock	14.0		18.3		7.2	
	--------------------------- Million metric tons -----------------------					
Poultry production	0.9		6.0		16.5	

Source: FAOSTATS, FAO.

hectares), and 160 percent larger than 1995 world soybean production area (61.3 million hectares).[1]

In Argentina, arid conditions may preclude any dramatic increase in the exploitation of its scrub lands, but both countries also have large areas devoted to permanent pasture (estimated at a combined 327 million hectares). Depending on improved plant genetics, water availability, cultivation practices, and livestock sector dynamics, pasture may someday be used to further expand Argentina's cropland base.

All three countries have large livestock sectors—Brazil has the largest commercial cattle herd in the world. However, the cattle industries in Argentina and Brazil are almost entirely "grass fed," and depend on permanent pasture for maintenance. As a result, pasture has traditionally been an important component of crop rotations in Argentina and Brazil, and much of the permanent pasture in both countries lies within major field-crop producing regions. In contrast, cattle in the United States are fed primarily concentrated feed rations once they go to feedlots, and permanent pasture is primarily limited to highly marginal land not easily converted to crop production.

The United States and Argentina Have Temperate Climates; Brazil is More Tropical

A region's agro-climatic setting encompasses the physical characteristics of its climate and natural resource endowment. Key characteristics include temperature, precipitation, sunlight, growing season, day length, latitude and seasonal variations, soil types, topography, and elevation. These features determine the agronomic feasibility of producing certain crops as well as their potential yields.

United States

The United States lies entirely within a temperate zone, but agro-climatic variations result in important regional specialization. For example, the rich, deep soils of the U.S. *Corn Belt*—stretching from Ohio westward through Indiana, Illinois, Iowa, southern Minnesota, and northern Missouri to Nebraska—make it one of the world's most productive corn-and soybean-growing regions (fig. B-1). The warm, humid conditions of the U.S. *Cotton Belt* stretch from the Carolinas westward across the southern U.S. through the Delta States and into northern Texas, while a *Hard Wheat Belt* encompasses the arid Northern and Southern Plains States. Soft wheat production is spread throughout the wetter environments of both the Corn and Cotton Belts and the Pacific Northwest.

Livestock activities in the United States are also determined, in large part, by a region's resources and climate: the most marginal lands serve as a base for cow-calf operations, while hog, poultry, and cattle feeding operations are determined by the interplay of feed availability, proximity to markets, land opportunity costs, and (more recently) animal waste management and environmental considerations. These same forces are at work in Argentina and Brazil, although pasture management plays a more important role in field crop rotations and cattle production than in the United States. Animal waste management and environmental concerns are not major production constraints in Argentina and Brazil.

Argentina

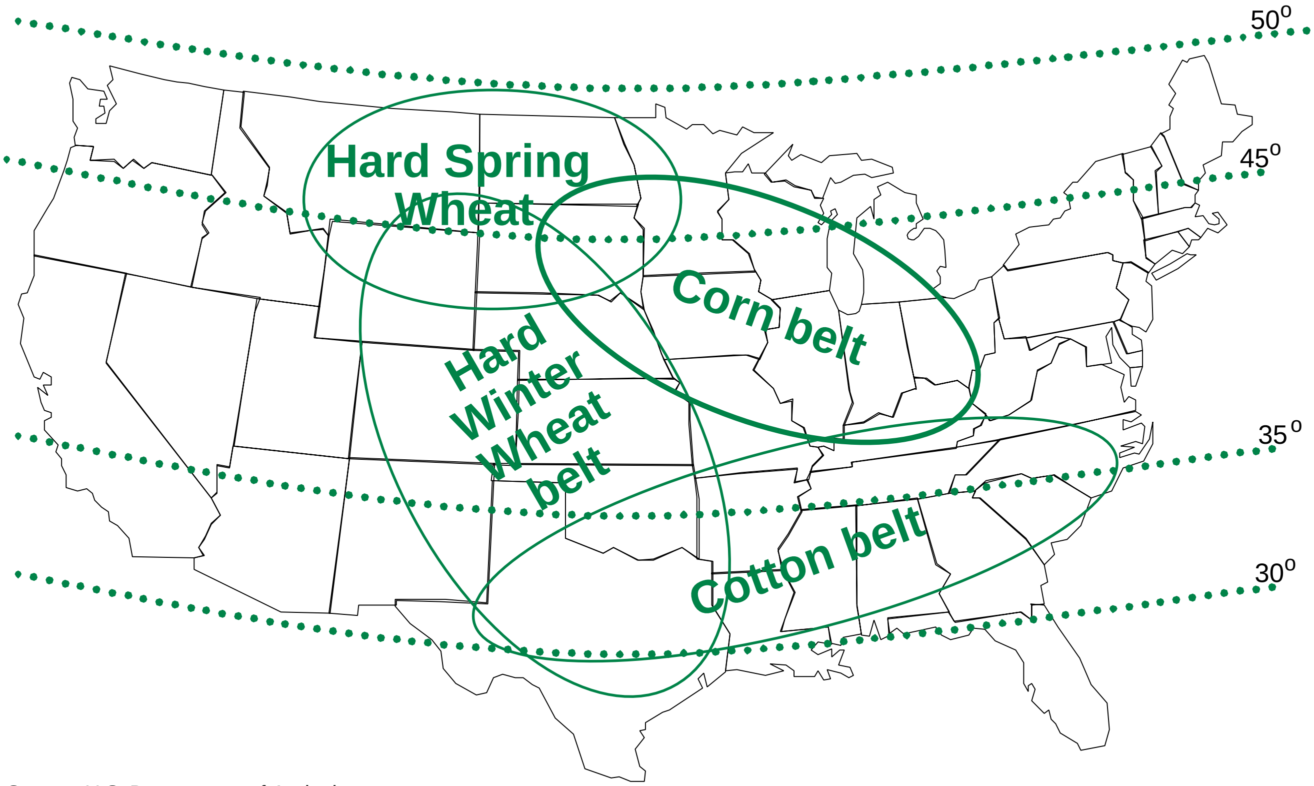
In Argentina, nearly all field crop production and most livestock activity occurs in the northeastern third of the country (fig. B-2). This is a humid, warm temperate zone similar in climate to the U.S. Southeast, but with more fertile soils. This rich agricultural zone is centered on the fertile *Pampas*—an area of slightly more than 50 million hectares—but extends into Argentina's northern tier of provinces that share a warmer, semitropical climate with the bordering regions of Bolivia, Paraguay, Brazil, and Uruguay (fig. B-3). It is bounded along the west by the Andes mountains, to the south by the rolling arid plateau of *Patagonia*, and to the north by the *Gran Chaco*—a region of hot temperatures, poor drainage, and thorn-infested scrub.

Argentina's primary agricultural region produces a variety of temperate crops, including most grains and oilseeds. Traditionally, most row-crop producers include some livestock operations as part of their activities. The central Provinces of Buenos Aires, Cordoba, Santa Fe, and western Entre Rios—located in the heart of the *Pampas*—dominate row-crop production. Over 90 percent of Argentina's soybean production takes place in these provinces. Between 80 to 90 percent of corn, wheat, sorghum, and barley production is also centered on these same Provinces, but extends farther south and west into the more arid Provinces of La Pampa and San Luis. The majority

[1]Warnken, Phillip F. *The Development and Growth of the Soybean Industry in Brazil*, Iowa State University Press, Ames, IA, 1999, p. 151.

Figure B-1

The *Corn Belt* is the principal corn and soybean production zone in the United States



Source: U.S. Department of Agriculture.

of sunflower production is also in the *Pampas*, but spreads into the Southwest and the warmer, wetter Provinces of the North. Argentina's rice production has traditionally been in the northeastern corner of the agricultural zone, while most cotton production is in the north-central States bordering the *Gran Chaco* scrubland.

Row-crop production has recently been developing in Argentina's northwestern provinces of Salta, Tucuman, and Santiago del Estero, spurred by the development of new varieties suited to their climates, improvements in the transportation infrastructure (via the river port of Resistencia on the Parana River), and improved access to export markets.

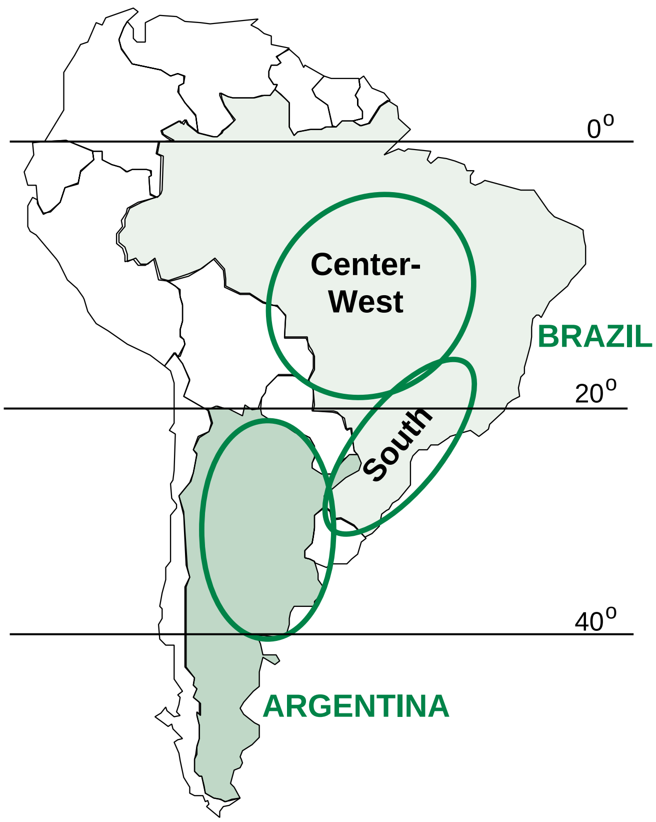
Brazil's South

In Brazil, agricultural production is focused on two regions—the South and the Center-West. Brazil's South lies principally within the same humid, warm semitropical latitudes as the northern portions of Argentina's agricultural region. As a result, many of the livestock activities and field crop production—e.g., rice, corn, soybeans, and wheat—occur in both regions. Brazil's South has been among the world's most productive agricultural zones for decades. For most of Brazil's history, field crop production was centered in this region's densely populated coastal states of Parana, Santa Catarina, and Rio Grande do Sul. Proximity to major urban centers, as well as the country's three major ports—Santos, Paranagua, and Rio Grande—give producers in this region easy access to markets. In addition, about half of Brazil's soybean crushing capacity is situated in the South.

In addition to row crops, several important food crops—i.e., legumes, pulses, tubers, and vegetables—compete with range land for the South's limited arable land. Parana's northern hillsides also produce an important share of the world's coffee. Rio Grande do Sul is home to most of Brazil's irrigated crop acreage and produces an important share of Brazil's rice. In recent decades, increasing population density in the South has parcelized family farms and reduced farm size. Smaller farm size and abundant labor have combined to inhibit economies of scale that ensue from larger farms, which can more readily adopt mechanization and other technological developments. This problem has contributed to the stagnation of field crop yields in the region.

Figure B-2

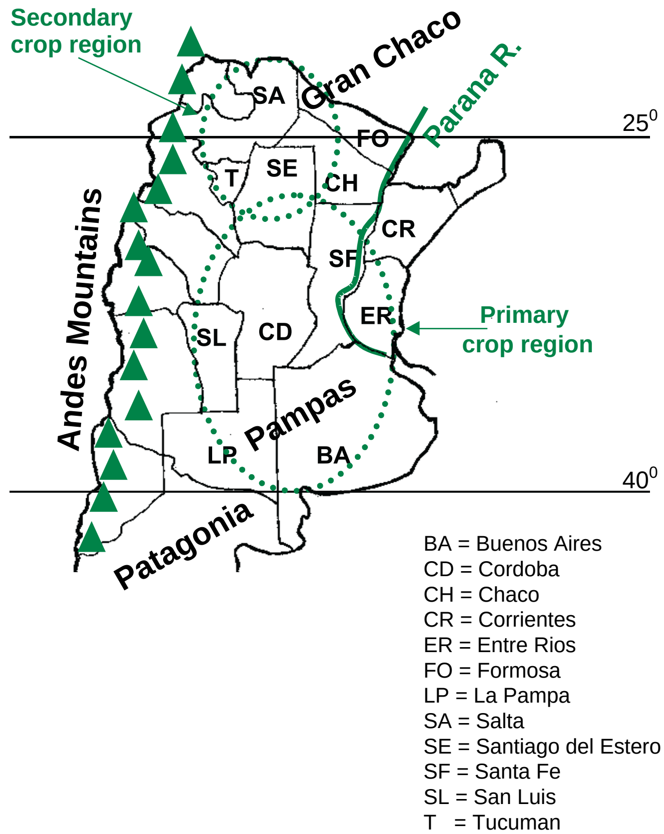
Breakout of Argentina's and Brazil's main agricultural production zones



Source: Economic Research Service, USDA.

Figure B-3

Argentina's major field crop regions



Source: Economic Research Service, USDA.

Brazil's Center-West

In the 1960s, under a variety of government incentives, agriculture began to expand into the *cerrado* lands of Brazil's interior States. Today, the Center-West rivals the South as the principal region of agricultural production within Brazil. The region lies entirely within South America's sprawling humid, tropical zone. As a result, Brazil has had to develop field crop varieties adapted to the lower variability of day length and temperature associated with tropical agriculture. Until recently, agricultural development in the interior region was also hindered by poor natural soil fertility and inaccessibility to the country's three major ports.

In accordance with Brazil's official regional designations, the Center-West sprawls across the tropical States of Mato Grosso, Mato Grosso do Sul, Goias, and the Federal District surrounding Brazilia. However, Rondonia, western Minas Gerais, and parts of the northeastern States of Bahia, Tocantins, Piaui, and Maranhao may be clumped into a more broadly defined "Center-West" since all of these States share the common feature of the Center-West's agriculture—development of the *cerrado* land, principally for soybean production (fig. B-4).

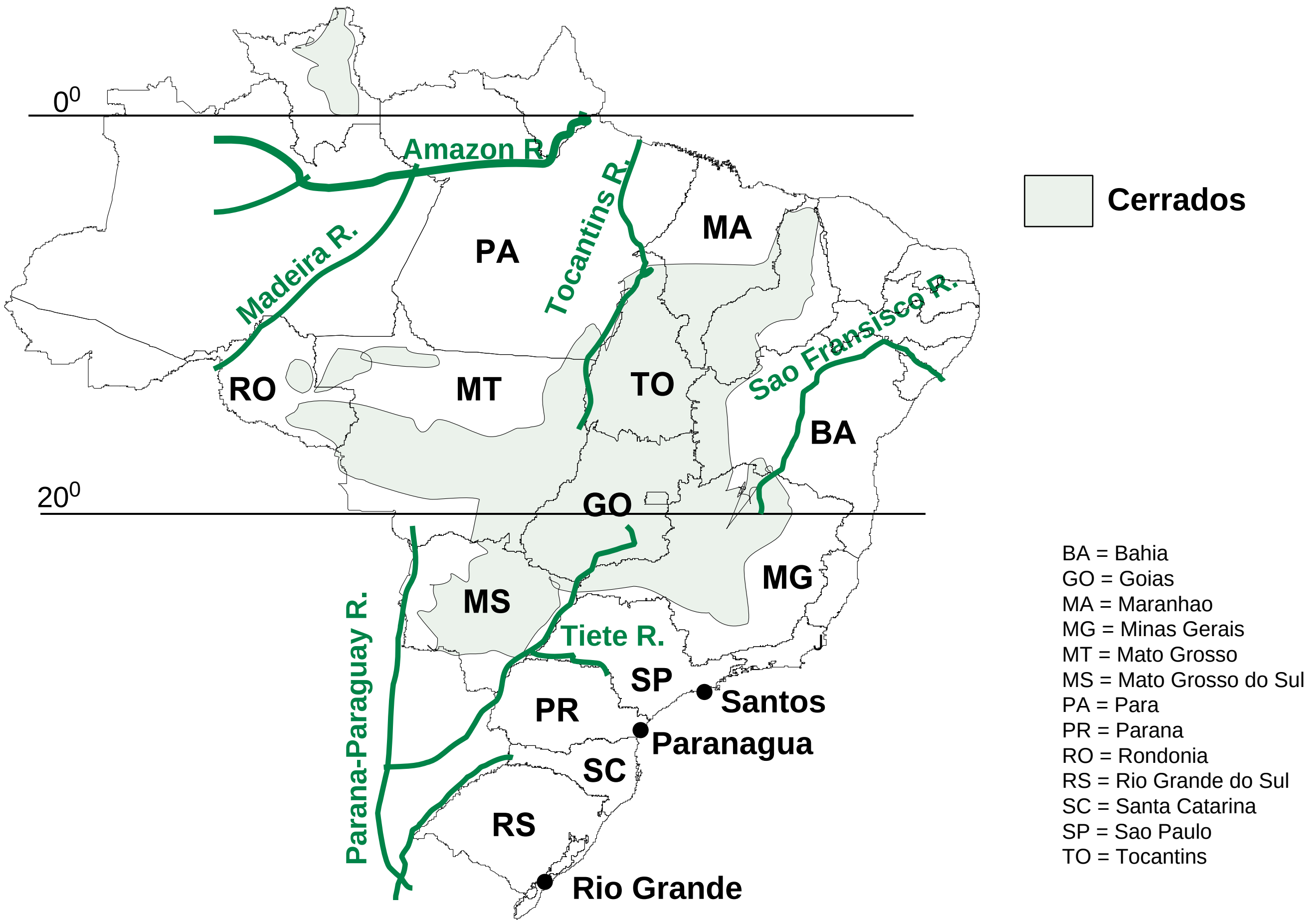
Today, most wheat production still takes place in the South. Corn production is more widespread. Double-cropping corn after early soybeans is fairly common in Parana and is rapidly expanding into the Center-West. Traditionally, most cotton production occurred in the South and Northeast, but in the past decade cotton production has been shifting rapidly to the Center-West. Soybean area is nearly evenly divided between the South and the Center-West.

Hemisphere Location Results in Counterseasonal Crop Pattern and Supply Availability

One of the most obvious and important differences between agricultural production in Argentina and Brazil compared with the United States is the nearly opposite seasonal timing of crop production. Latitudes

Figure B-4

Brazil's *cerrado* sprawls across a wide band of central, northern, and eastern States



Source: Adapted from Thorne and Thorne (1979), Warnken (1999), and the Dorling Kindersley *World Atlas* (2000).

in the Southern Hemisphere experience seasons with about a 6-month offset from northern latitudes. For example, the United States' primary spring-planted field crop growing period extends from April through September, compared with September-March in Argentina and Brazil's South (table B-3).

This counterseasonal pattern provides some advantage to Southern Hemisphere exporters of corn, soybeans, and wheat—all crops for which the United States has traditionally been the principal force in international price formation. U.S. and international prices generally reach their lows at U.S. harvest time (September-October) when supplies are most plentiful. Prices then gradually rise into the spring with carrying charges and accumulating demand. Argentine and Brazilian producers are able to benefit from this price recovery during February to April, their traditional growing and harvesting period.

U.S. Growing Season Generally Shorter

Corn and soybean production in the U.S. Corn Belt occurs at higher latitudes (35º- 48º North) than in Argentina (25º- 40º South) or Brazil's South (20º- 30º South) and tropical Center-West (0º- 20º South). As a result, the production zones of Argentina and Brazil all have significantly longer frost-free growing seasons.

The U.S. Corn Belt has a growing season of only about 4 ½ months in the northern portions and nearly 6 months in the southern extremities. In the Delta and South, the growing season extends for about 7 months, and the double-cropping of winter wheat with a spring crop (usually soybeans) is more common.

In contrast, Argentina's potential growing season extends a full 9 months from September through May.

Table B-3—Principal field crop production stages for corn, soybeans, and wheat in Argentina, Brazil, and the United States

Soybeans:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
U.S.					[---Plant---]		[Flower]	[---Fill---]		[---Harvest---]		
Argentina (1st)		[Flower]	[Fill]	[---Harvest---]							[---Plant---]	
Argentina (2nd)	[Plant]		[Flower]	[Fill]	[---Harvest---]							
Brazil[1]	[Flower]	[Fill]	[-------Harvest-------]							[----------Plant---------]		
Corn:												
U.S.				[---Plant---]			[-Silk-]		[---Harvest---]			
Argentina	[Silk]	[Fill]	[---------Harvest---------]						[---------Plant---------]			[Silk]
Brazil (1st)[1]	[---Silk---]			[-------Harvest-------]						[--------Plant-------]		
Brazil (2nd)[1]						[---Plant---]					[---Harvest---]	
Winter Wheat:												
U.S.					[Head]	[---Harvest---]			[------Plant-----]			
Argentina					[----------Plant----------]				[---Head---]		[---Harvest---]	
Brazil[1]				[--------Plant---------]				[---Head---]		[-------Harvest-------]		

[1]Because Brazil's agriculture covers such a vast agro-climatic setting, it is overly simplistic to assign a uniform seasonal pattern of production activity, but like Argentina, Brazil's seasonal crop production pattern generally runs countercyclical to that of the U.S.

Source: WAOB, USDA. *Major World Crop Areas and Climatic Profiles*, Agricultural Handbook No. 664; revised September 1994: Brazil's 2nd crop corn is from Hinrichsen.

Given Argentina's extended frost-free period and highly fertile soils, a preferred cropping strategy in terms of relative returns is double-cropping winter wheat with soybeans.

However, the opportunity to plant a second crop is limited to the central States of Buenos Aires, Cordoba, and Santa Fe due to the strong seasonal nature of precipitation. In addition, due to declining rainfall toward the end of the growing season, double-cropped soybean yields are generally much lower than first-crop soybeans. In Brazil's South, water is also the principal constraint to double-cropping. Brazil's Center-West lies entirely within the frost-free tropics and can technically produce three crops per year.

Apart from the longer frost-free period, Argentina's average growing-season temperature and precipitation levels nearly mirror the U.S. Corn Belt, except for the winter months (figs. B-5, B-6). During the growing season, average rainfall in Argentina's central Provinces ranges from 80 to 120 millimeters per month (about 3-5 inches), slightly higher than the U.S. Corn Belt, while the average temperature range at 20–24º Centigrade (68-75º Fahrenheit) is slightly milder. Argentina's rainfall and temperature distributions tend to increase in mean level and decrease in variability from the southwestern corner (La Pampa and San Luis where rainfall is least abundant and most variable) toward the northern Provinces (where average precipitation and temperature levels are highest).

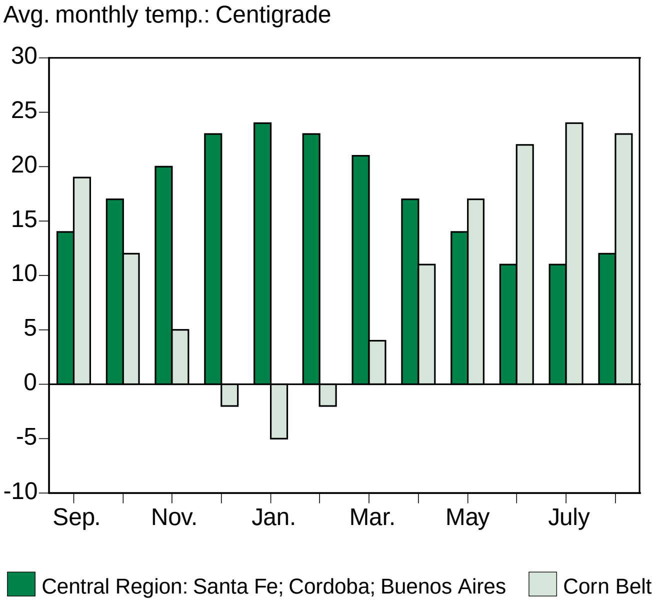
Brazil's Climate is Generally Milder and Wetter

Compared with Argentina and the United States, Brazil's main agricultural production regions are generally milder and wetter. The South benefits from a moderating coastal influence, while the Center-West lies entirely within the frost-free tropics. As a result, monthly average temperatures exhibit very little seasonal variation throughout the year (fig. B-7). In Parana—one of the principal producer States in Brazil's South—average monthly temperatures have an annual range of only 17-24º C (63-75º F). In Mato Grosso—located in the heart of Brazil's Center-West region—the mean monthly temperature stays within the narrow band of 23-28º C (73-82º F).

Both the South and Center-West regions receive much more average precipitation during the growing season than either Argentina or the United States (fig. B-8). Monthly average growing-season precipitation ranges from 114 to 183 millimeters (4 ½ to 7 inches) in Parana, and 125 to 204 mm (5 to 8 in.) in Mato Grosso. However, Mato Grosso precipitation patterns are monsoonlike in that they drop to almost zero during the offseason months (June-August).

Figure B-5

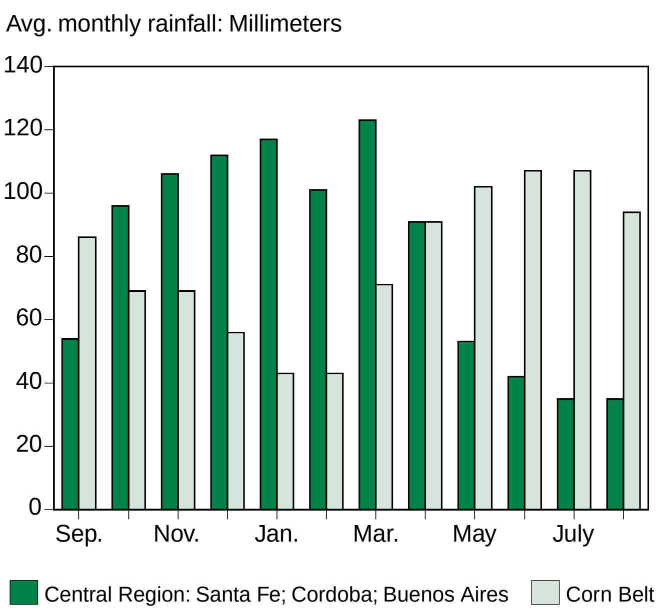
Growing season temperatures are very similar in the U.S. and Argentina, but with a 6-month offset



Source: Calculated using data from Joint Agricultural Weather Facility, USDA and NOAA.

Figure B-6

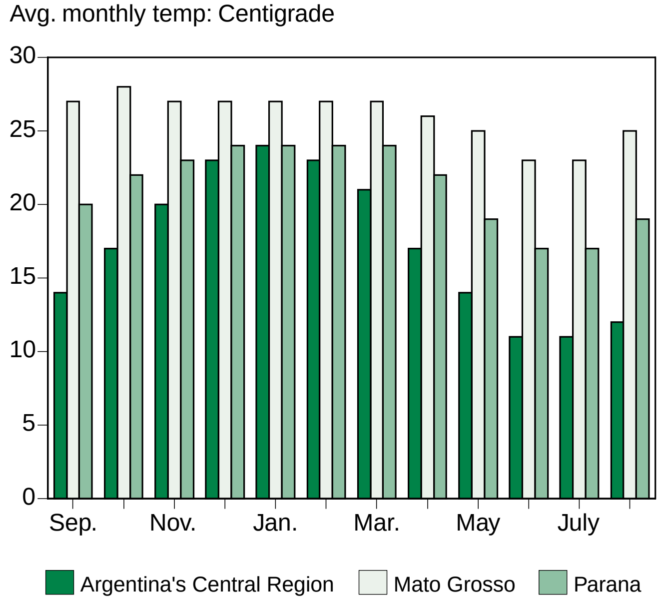
Primary corn-soybean areas in the U.S. and Argentina receive comparable rainfall, but with a 6-month offset



Source: Calculated using data from Joint Agricultural Weather Facility, USDA and NOAA.

Figure B-7

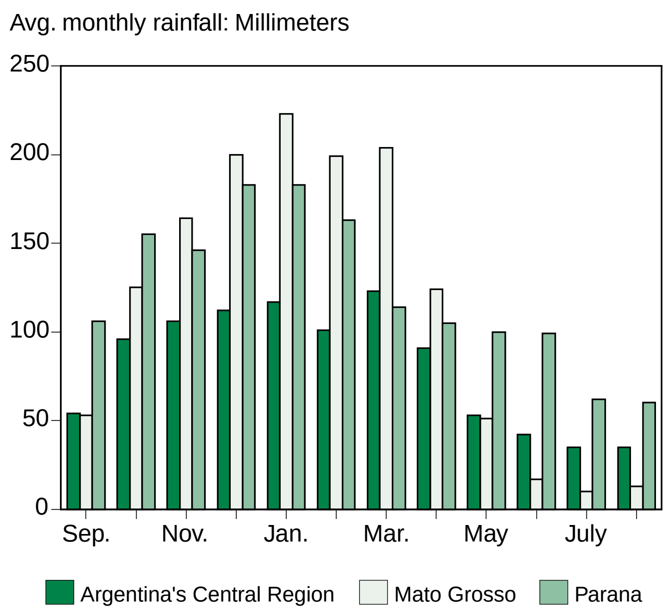
Mato Grosso's tropical climate has very little seasonal variation in temperature



Source: Calculated using data from Joint Agricultural Weather Facility, USDA and NOAA.

Figure B-8

Parana and Mato Grosso receive significantly more "growing season" rainfall than Argentina's primary agricultural zone



Source: Calculated using data from Joint Agricultural Weather Facility, USDA and NOAA.

Brazil's *Cerrado* Land Potential

The single most distinguishing feature between the South and the Center-West regions of Brazil is the latter's tremendous potential for continued growth of cultivated land area. In 1990, Brazil's national institute for agricultural research—EMBRAPA—estimated that 136 million hectares of the interior *cerrado* savanna were suitable for large-scale mechanized agriculture based on a rotation system of improved pasture, grains, and oilseeds (table C-4). At the time, 47 million hectares were already involved in production agriculture, leaving 89 million hectares of savanna land available for development as farmland.

In the past, poor natural soil fertility limited both the extent and range of agricultural development. *Cerrado* soils, although deep and well-drained, are generally beset with acidity, aluminum toxicity, and deficiencies of phosphorus and nitrogen. The prevalence of clay soils, with their high phosphorus retention capacity, limits phosphorus availability to plant growth. Aluminum toxicity also inhibits crop rooting depth. When short-term droughts occur, the shallow-rooted crops are unable to draw moisture from the subsoil and are thus even more challenged than they normally would be.

However, soil management techniques have been developed to elevate these soils to among the world's most productive. ***Liming*** helps to neutralize soil acidity, adds calcium and magnesium, and reduces aluminum toxicity. As much as 5 tons of lime per hectare are needed to prepare *cerrado* soils for field crop cultivation. For high concentrations of clay,

Table B-4—Cerrado area's agricultural potential: 1990 and projected use

Agricultural activity	Estimated use (1990)	Projected use	Undeveloped
	--- *Million hectares* ---		
Cropland	12	76	64
Irrigated	0	10	10
Dryland	10	60	50
Perennials	2	6	4
Pasture	35	60	25
Total use	47	136	89

Source: EMBRAPA as cited in Warnken (1999).

large initial amounts of ***phosphorus*** must be added to help promote plant growth. In addition, ***crop-breeding*** programs have successfully produced varieties that are more tolerant to high aluminum and low phosphorous levels in the soil.

Nevertheless, the economic feasibility of these solutions depends on the availability and cost of needed fertilizers and lime, and on a transportation infrastructure adequate to move agricultural inputs and market outputs to these inland producing areas. Most agricultural land of the interior States is far removed from markets, and the infrastructure is poorly developed. As a result, infrastructure development remains a primary determinant of the pace of agricultural expansion for Brazil's Center-West.

Argentina and U.S. Soil Fertility Superior to Brazil's Center-West

The U.S. Corn Belt is famous for its deep, rich soils, but Argentina's *Pampas* soils are equally fertile and have produced bountiful grain and oilseed crops for decades with very low fertilizer use. However, most of Argentina's cereal yield gains of the 1990s have resulted from increased use of chemical inputs and improved seeds.

Like its precipitation pattern, soil fertility in Argentina's main agricultural region tends to increase in a northeasterly direction from the Rio Negro across the northern half of Argentina and into Brazil's South. As a result, there is a west-to-east distribution of soils and climatic conditions that become progressively more favorable to intensive field crop production. Just to the east of the Andes Mountains, a wide band of generally dry soils runs the length of the country dividing Argentina down the middle and permitting only seasonal grazing at best. Moving eastward, increasing precipitation allows for grazing or crop-fallow rotations with drought-hardy small grains and oilseeds. Further eastward into Cordoba and Buenos Aires, highly fertile soils—mollisols similar to those found in the western U.S. Corn Belt—combine with more favorable moisture to promote intensive corn and soybean production.

Similar to Argentina's central region, highly fertile soils in Brazil's South allow for a wide range of intensive crop and livestock activities. However, soils in Brazil's Center-West are significantly inferior to soils found in the South or Argentina's *Pampas* region. The tropical soils—oxisols and ultisols—of Brazil's Center-West are naturally acidic, as well as highly oxidized and leached of many plant nutrients. Thus, they become rapidly depleted and infertile when placed under crop production.

However, the *cerrado's* soils possess several features attractive to agricultural production. They are generally deep and permeable with excellent water filtration and drainage, and proper soil management can elevate this naturally infertile soil to among the world's most productive. *Cerrado* soils are at a moderate elevation of 300-900 meters with only a slight grade, thus making them easily accessible to mechanization. Unlike the South, agriculture in the Center-West is characterized by much larger farms capable of adopting the full suite of modern production technology. Two-thirds of the *cerrado* is in farms that are larger than 1,000 hectares, compared with an average farm size of about 30 hectares in the South's principal soybean-producing State of Parana (and 120-150 hectares in the U.S. Corn Belt).

U.S. Infrastructure Vastly More Developed

The transportation and marketing infrastructure for agricultural products in Argentina and Brazil has played a critical role in determining their international competitiveness. Both Argentina and Brazil possess long coastlines with major seaports providing outlets to international markets. Argentina has an important internal waterway, the Parana-Paraguay River system located close to the major grain-and-oilseed producing region. Brazil also possesses enormous internal waterway potential, including the world's largest river system—the Amazon River and its many tributaries. Development of the Amazon's tributaries is just beginning to open Brazil's interior agricultural areas to the ocean portal provided by the Amazon River.

Yet, despite considerably shorter average distances to ports from both Argentina's Pampas and Brazil's South, transportation and marketing costs for bulk agricultural product exports have historically been much higher for Argentina and Brazil than for the United States. This has generally reflected an inefficient or underdeveloped barge and railroad transportation system, and a heavy reliance on more expensive truck hauling. A Southern Hemisphere-Atlantic coast orientation and, in the past, export taxes and high port charges have also contributed to higher marketing and transportation costs to major international markets in Europe and East Asia.

In contrast, the United States has a widespread internal transportation network, centered on the Mississippi waterway and its many tributaries, to move bulk commodities to international markets cheaply and efficiently. The U.S. grain transport system relies heavily on barges that are unrivaled as the cheapest, most efficient mode for moving bulk commodities to export (table B-5).

Paved highways are more limited in Argentina and Brazil than in the United States, and even less prevalent in agricultural regions. Only 10 percent of Brazil's highways and 30 percent of Argentina's highways are paved, making transportation from farmgate to elevator or assembly point difficult, slow, and costly.

The availability of rail lines clearly favors the United States. The United States benefits further from a single standard gauge for its railways, in contrast with the cumbersome multiple gauges of Argentina and Brazil. Multiple gauges require costly transshipment stops when transporting across different-gauged tracks. U.S. railways also have substantially heavier railtrack than most rail lines in Argentina and Brazil. This allows for larger railcars and locomotives and higher load densities, which further reduce U.S. rail shipping costs.

Historically, Brazil and Argentina had underdeveloped storage systems, both on and off-farm, that forced output through the marketing channels at harvest time when local prices are usually at their lowest. In addition, insufficient storage capacity frequently forced open-air storage of in-transit grain and oilseeds. Such exposure to the elements and rodents often resulted in losses of both quality and quantity. The rush to bring harvested grains to the country elevator during harvest also generated significant delays, as trucks waited up to several days to unload their cargo. Limited storage capacity at elevators and river terminals has been cited as the single greatest bottleneck in Argentina's logistics systems (Goldsby, 2000).

However, policy changes initiated in the early 1990s—including the privatization and deregulation of railways and ports—have fostered a more favorable

Table B-5—Infrastructure indicators for Argentina, Brazil, and the United States

Item	Unit	Argentina	Brazil	United States
Infrastructure (2000)[1]:				
Total highways	1,000 km	215.4	1980.0	6331.0
Paved highways	1,000 km	63.6	184.1	3732.8
Total rail track	1,000 km	38.3*	27.9*	240.0
Navigable waterways	1,000 km	43.0	50.0	41.0
Average distance to export postition	Kilometers	300	300[2,5] - 1,500[2,6]	1,400[7]
Average cost (1998)[3]				
Barge	$/mt/1,000 km	10	8[2,5] – 13[2,6]	5
Rail	$/mt/1,000 km	50	25[2,5] – 30[2,6]	25
Truck	$/mt/1,000 km	60	33[2,5] – 50[2,6]	45
Average share of exported grain and oilseed by mode (1998)[3]				
Barge	Percent	n.a.	n.a.	61
Rail	Percent	n.a.	n.a.	23
Truck	Percent	82	40[2,5] – 80[2,6]	16
Weighted average transport cost per 1,000 km (1998)[2]	$/mt/1,000 km	63	26[2,5] – 43[2,6]	16
Weighted average transport cost to export position[2]	$/mt	25	8[2,5] – 65[2,6]	16
Average port charges (1998)[3]	$/mt	3-5	9-12	3
Grain storage capacity[4]	Million tons	49	n.a.	534.9[8]

*Multiple gauges. n.a. = not available; mt = metric ton. [1] CIA Fact Book, CIA, U.S. Government; *http://www.cia.gov/cia/publications/factbook/.*
[2] Authors' approximations. [3] Verheijden and Reca, 1998. [4] Goldsby, 1999. [5] South. [6] Center-West. [7] Approximate distance Chicago to Gulf Ports.
[8] Onfarm = 307.8 million tons; off-farm = 227.1 million tons (NASS, Dec. 1, 2000).

climate for infrastructure development. During the past decade, Argentina and Brazil have cut transportation and marketing costs considerably, narrowing the transport-cost gap with the United States (see chapter 5). In addition, significant investment in Argentina's storage capacity has removed much of the need for harvest-time sales. Argentina's total grain storage capacity in 1998 was estimated at 49 million tons, compared with 30 million tons in 1984 (Agriculture and Agri-Food Canada, 1999). The combined average production for corn, soybeans, and wheat during 1999-2001 was 57.6 million tons. However, other factors such as congestion at specific ports, the timing of shipments, prolonged demurrage periods, and low onfarm storage capacity (only 27 percent of total capacity) continue to add to marketing costs.

Both countries (but particularly Brazil) still have further cost-reduction potential vis-à-vis improvements in their transportation and marketing infrastructure. If realized, such cost savings would further raise producer returns and heighten incentives to expand production. Recent infrastructure developments are discussed in chapters 3 and 4.