Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops

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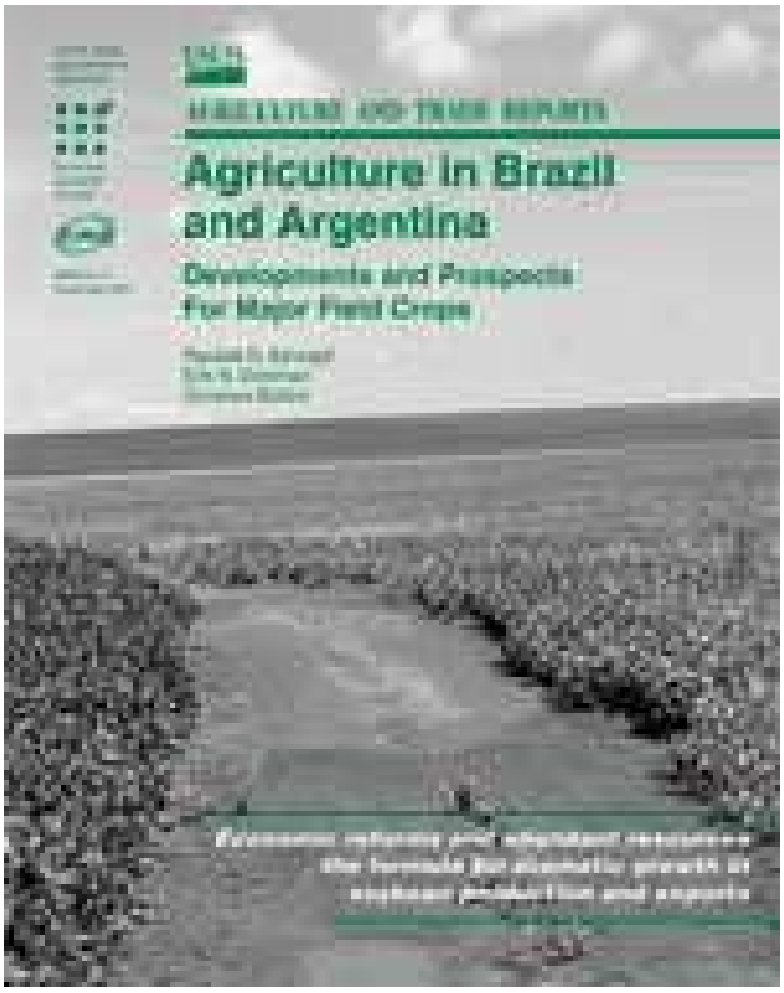
Agriculture and Trade Report No. (WRS013) 85 pp, December 2001

This report identifies key factors underlying the agricultural productivity growth and enhanced international competitiveness of Brazil and Argentina in the past decade. Economic and policy reforms, infrastructure development, and enhanced use of agricultural inputs that drove output growth during the 1990s are discussed. This report also compares Brazilian, Argentine, and U.S. soybean production costs and evaluates the combined impact of production, marketing, and transportation costs on the overall export competitiveness of each country's soybean producers. Finally, the outlook for continued growth in output and exports of key commodities is assessed.



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Introduction

Brazil's vast territory encompasses two separate and distinct regions engaged in field crop and livestock production—the temperate South and the broadly defined, tropical "Center-West." The South comprises the three States of Brazil's southeastern corner—Rio Grande do Sul, Santa Catarina, and Parana. Brazil's official Center-West region encompasses Mato Grosso, Mato Grosso do Sul, Goias, and the Federal District surrounding Brasilia.[1]

Both regions—South and Center-West—are distinguished by differences in climate, cropping patterns, and other farm characteristics, particularly farm size. Within both of these regions, the major field crops—corn, soybeans, wheat, rice, and cotton—compete for agricultural resources with livestock, tree crops (principally coffee and oranges), sugar cane, and food crops (e.g., pulses, tubers, and vegetable crops), demand for which is being driven by Brazil's huge population.

An abundant natural resource base remains a major, long-term economic strength for Brazil but, like Argentina, the development of the agricultural sector has been hindered by an historically unstable macroeconomic environment. High inflation, a heavy external debt burden, high interest rates, and periods of severe currency overvaluation created a very unfavorable investment climate for agricultural development. In addition, import tariffs on agricultural inputs and export taxes on most agricultural products distorted production incentives and constricted agricultural productivity growth.

With respect to Brazil's agricultural sector, this unstable economic environment was aggravated by social policies that tended to favor domestic consumers and processors over export-oriented producers. Brazil's burgeoning, urbanized, and predominantly lower income population traditionally pressures politicians to keep food supplies cheap and abundant. To this end, policymakers have used export and price controls and otherwise intervened, with the general effect of lowering farm-level prices and dampening producer incentives.

However, in the midst of this economic and policy tangle, Brazil's Government promoted the soybean sector for a variety of reasons and with a mixture of often conflicting policies. The result has been a sustained soybean area expansion, driven predominantly by new land entering production in the Center-West. Much of Brazil's yield growth is also associated with this region, where large-scale farms apply the full suite of modern inputs and technology and achieve significant economies of scale.

Beginning in the early 1990s, Brazil slowly began implementing economic reforms designed to reduce or eliminate government controls and interference in the marketplace and allow for a more efficient allocation of the nation's resources. The evolution of these reform policies is ongoing but, for the most part, they have helped to stabilize the economy and create a more liberal policy regime favorable to agricultural investment, production, and exports. The policy reforms have benefited the soybean industry and, with the removal of many trade barriers, have furthered Brazil's ascendance in international soybean and soybean product markets.

This chapter provides an overview of the evolution of Brazil's soybean sector, within the context of macroeconomic and agricultural policy developments from pre-reform through the reform period of the 1990s. Included is a discussion of transportation and marketing infrastructure issues vital to the expansion

[1] However, the "Center-West" may be more broadly defined as the set of interior States that include Rondonia and parts of Minas Gerais, Bahia, Tocantins, Piaui, and Maranhao since all of these States share the common feature behind the Center-West's agriculture—i.e., development of the *cerrado* land, principally for soybean production.

of the agricultural sector as well as developments in competing field crop and livestock sectors.

Brazil's Soybean Sector Grows With Strong Government Support[2]

Introduction

Brazil is the world's second-leading producer and exporter of soybeans and products (soyoil and soymeal), trailing the United States in soybean production and export and Argentina in the export of soybean products. However, soybeans were late to join the ranks of major field crops produced in Brazil. In the 1960s, soybeans (like most row crops) were grown predominantly on small farms in the South.

Brazil's soybean industry initially benefited from a period of rapid growth in world soybean demand during the 1960s and 1970s. However, the Brazilian Government (GOB) also maintained policies that facilitated industry expansion by favoring soybeans in particular, and the development of the immense interior *cerrado* region in general.

Brazil's Government Develops Import-Substitution Strategy

Early in the post-WWII period, the GOB implemented an import-substitution strategy to promote domestic economic growth while limiting foreign debt and the use of foreign exchange. To this end, Brazil's agricultural sector was heavily taxed using both direct and indirect policies in an effort to supply the urban sector—consumers and processors—with cheap agricultural products. Export quotas and licenses, as well as prohibitions on trade, were applied sporadically, often in combination with direct export taxes, to Brazil's major agricultural commodities.

Imports of agricultural inputs were also controlled through licenses and other restrictions. As a result, the agricultural sector had to pay high prices (well above international market prices) for fertilizer, chemical, and machinery inputs produced by domestic manufacturers. In addition, GOB currency controls resulted in a highly overvalued exchange rate, adding further disincentives to agricultural production.

[2] This section draws heavily from Warnken's comprehensive book on Brazil's soybean sector (Warnken, 1999).

Various Motives Spur Government To Promote the Soybean Sector

Despite relying on the agricultural sector to finance the development of other sectors, the GOB did single out the soybean sector for special treatment. Several development-related motivations emerged during the 1960s and 1970s that favored the soybean industry (Warnken, 1999).

A primary motive was to save and increase foreign exchange. Brazil's population and food demand had grown rapidly, and vegetable oil imports began to account for an increasing share of limited foreign exchange. By the late 1960s, the GOB saw increased domestic soybean production as a means of displacing soybean oil imports. By establishing policies supportive of the domestic processing industry and soyoil production, the GOB also hoped to encourage exports of value-added agricultural products, particularly soybean meal. Growing international demand for protein feeds further encouraged this strategy.

A second motive was to hold down domestic food prices and improve diets. Soybean oil was one of the four most important food items for low- to low middle-income families, and was very influential in the calculation of Brazil's consumer price index. As a result, soybean oil prices were critical to national food policy in Brazil's highly inflationary environment. Government interest in holding down food prices begat policies to ensure domestic supplies of low-priced soybean oil. With a large, generally low-income population, the Brazilian Government also took steps to increase animal protein consumption by stimulating domestic poultry production, which expanded soymeal demand.

Third, the soybean industry was viewed by the GOB as one of the principal engines for stimulating growth in the agricultural processing and input industries. An abundant supply of cheap soybeans were needed to fuel the processing sector's growth, while expanded plantings would benefit the input industry.

A final motive for supporting soybean production was the preservation of territorial integrity. Brazil's military government saw the majority of its vast land areas as essentially uninhabited. Most of Brazil's population and agricultural production was situated along the eastern and southeastern coastline. With the increasing strength of neighboring nations, the GOB felt compelled to better integrate western States into the national economy by opening this area to agricultural production.

Soybeans Benefit From Government Policy and Land Expansion

In the 1960s, Brazil's Government began implementing policies designed to directly and/or indirectly support the soybean industry. These policies included publicly funded agricultural research and development, guaranteed minimum price supports, production and marketing credit programs, agricultural input production and use subsidies, public infrastructure programs, and supportive energy and taxation policies. In addition, several national programs oriented toward other crops (e.g., wheat, coffee, and sugar cane) also indirectly promoted soybean production.

Publicly Funded Agricultural Research and Development. Brazil's national network of agricultural research and experiment stations—EMBRAPA (Brazilian Agency for Research on Agriculture and Animal Husbandry)—working closely with private agricultural research groups, has played a critical role in the expansion of field crop and livestock production from the temperate South into the tropical Center-West. One of its greatest successes has been the development of the tropical soybean. Soybean plants are among the most sensitive of all common crop plants to day length and light intensity. The highly "latitude-sensitive" soybean varieties give best full-season production in a zone usually no wider than 150 to 250 km (90 to 150 miles). Brazil's EMBRAPA developed a soybean variety that flourishes in the tropics' shorter day length and mild, wet climate. Under optimal conditions, Brazil's tropical soybean produces yields of 4.7 to 5.4 metric tons per hectare (70 to 80 bushels per acre), compared with Brazilian national average yields of about 2.5 tons per hectare. EMBRAPA has also made important improvements in tropical corn and cotton varieties, enhancing their adaptability to *cerrado* soils and climate.

Uniform National Price Support and Energy Pricing Policy. Although agricultural inputs remained protected from imports, the Government worked to reduce the burden on the country's agricultural sector. The GOB's national price support policy and national energy price policy contributed to this effort.

Just prior to the planting season each year, the GOB announced support prices—i.e., minimum price guarantees—for primary crops, including soybeans. To shore up crop production, particularly in the Center-West, national commodity support prices were set uniformly for the entire country despite the generally lower farm-gate prices in more remote areas. This uniform support price policy remained in effect until February 1994 for corn and February 1995 for soybeans.

For soybean producers in the South near the major processors and ports, low marketing costs from farm-gate to port generally meant that local prices were above the relatively low government support price. Only in 2 years out of the past 30 has the national average soybean price fallen below the government support price; thus, the program has not been used much by farmers in the South (fig. D-1).

In contrast, Center-West soybean producers have been more isolated from southeastern seaports and usually faced very low farm-level prices due to high marketing and transportation costs. Occasionally (although still rarely), it was profitable for producers in the Center-West to sell their soybeans for the guaranteed price and let the Government pay for transporting the soybeans to market. A similar effect was obtained under a national uniform energy price for diesel fuels. Farmers in the South faced an above market official price for fuel, while producers in the interior usually found the official price to be below local market prices.

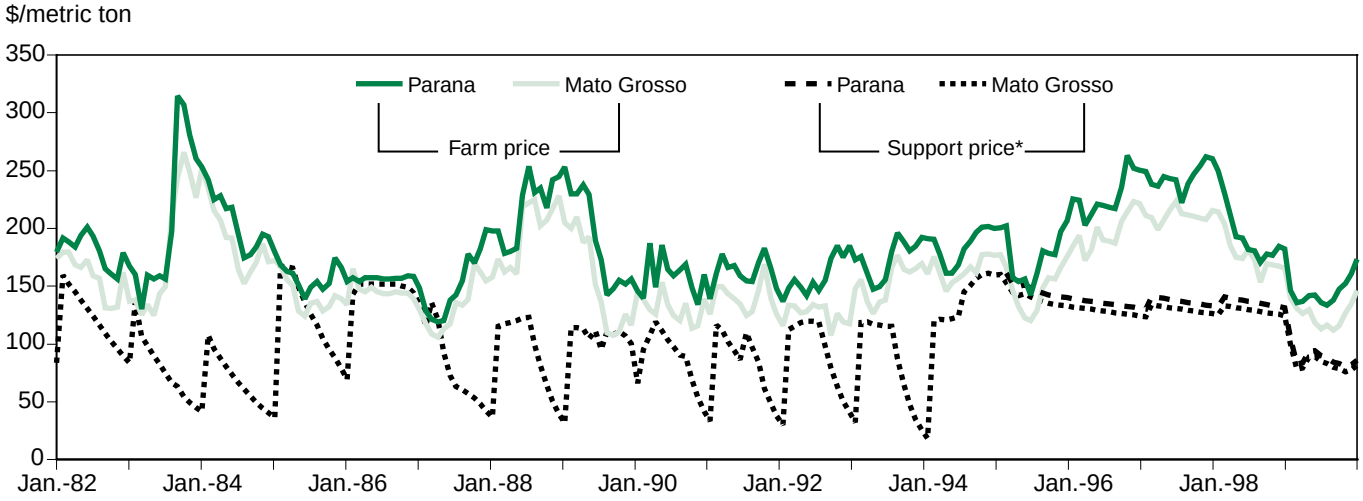
National System of Rural Credit. In 1965, a National System of Rural Credit was created with the following goals: accelerate adoption of new technology, stimulate capital formation, improve the economic position of small and medium size farmers, and increase production of agricultural commodities destined for export markets to increase foreign exchange.

During the 1970s and 1980s, enormous amounts of government agricultural credit were disbursed through separate production, investment, and marketing credit programs. About 85 percent of total credit to agricultural producers during this period was provided by the official credit system because private sector credit was not very developed.

The interest rate on government credit was heavily subsidized. Interest rates were usually set at a fixed, nominally low rate. In a highly inflationary economy, this resulted in an average real interest rate of -12.5 percent between 1970 and 1990 (fig. D-2). The interest rate subsidy to soybean producers is estimated to have averaged nearly $200 million per year during this period, peaking in the late 1970s and early 1980s (Warnken, 1999).

Figure D-1

Soybean farm prices in Parana and Mato Grosso rarely fall below the government support price

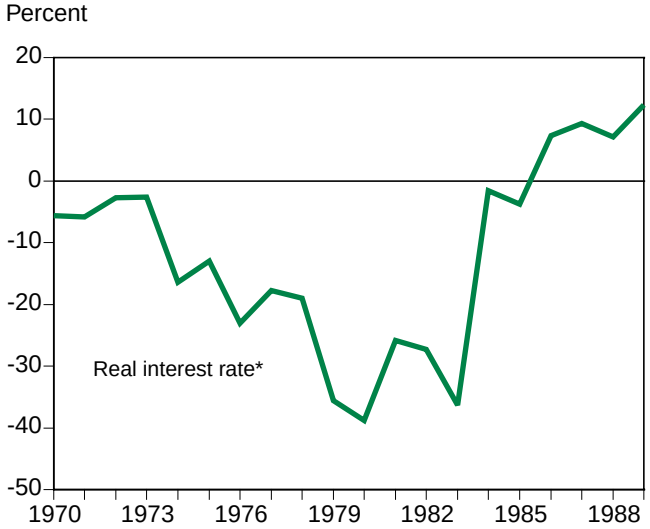


*Starting in February 1995, separate monthly price guarantees were established for Mato Grosso and Parana.

Source: Monthly prices; CONAB (for minimum price support); Fundacao Getulio Vargas (for farm price).

Figure D-2

Fixed nominal interest rates on government soybean production credit and high inflation combined to produce negative real interest rates



*Official interest charge minus nominal inflation rate.

Source: Fogarty (1991).

Production credit was closely linked to the national support prices. Although the support price is below market prices in most years, it affects soybean production since the availability of credit for current production expenses is tied to the minimum price for soybeans. Prior to 1978, medium- and large-sized soybean producers could finance up to 60 percent of the value of their expected revenue (support price times expected yield). In 1978, large producers were limited to no more than 48 percent of the projected revenue.

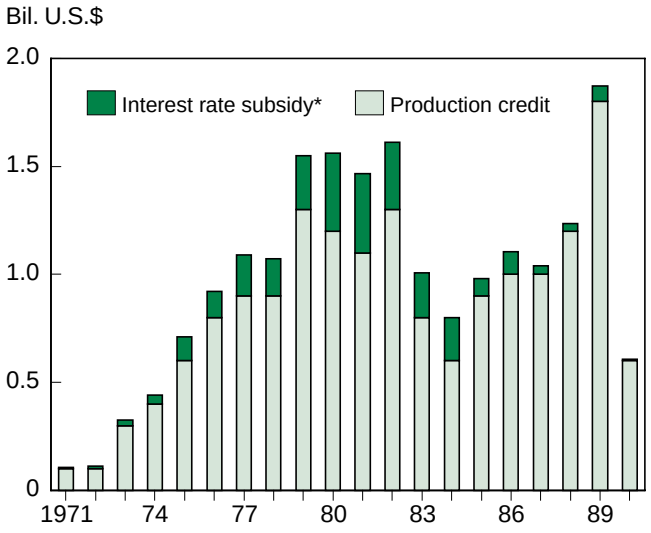
Between 1970 and 1990, the GOB distributed nearly $28 billion in official credit to soybean producers, mostly (60 percent) in the form of production credit (fig. D-3). In 1975 alone, the value of publicly disbursed agricultural credit exceeded the value of total agricultural production (Fogarty, 1993). By law, the subsidized credit could go only to landowners. As a result, production and marketing credit favored the large farms of Brazil's Center-West.

The GOB's credit program proved to be highly inflationary and, due to the fungibility of credit, there is some question about what share of disbursements were actually devoted to the agricultural sector. Substantial "slippage" likely occurred as many nonfarm sector investments offered higher returns. The credit program was eventually pared down in the late 1980s under pressure from the international donor community.

Wheat Policy. Starting in 1962, the Brazilian Government began an aggressive program of self-sufficiency in wheat via high support prices—nearly double world market prices, making wheat the only domestic crop for which the GOB tried to offset the effects of the overvalued exchange rate. Exceptions to trade barriers for importing equipment and other inputs were made for wheat. Also, the GOB furnished extensive credit to wheat producers (primarily in Rio Grande do Sul).

Figure D-3

Brazil's government channeled billions of dollars of production credit to the soybean sector during the 1970s and 1980s



*Implicit value of subsidy due to negative real interest rates on soybean production credit.

Source: Fogarty (1991).

Soybeans benefited by being planted as a second crop after wheat production. Sequentially growing the two crops on the same land increased the productivity of inputs and the input/output marketing systems. Eventually the wheat program proved expensive and inefficient, and was abandoned, but not before expanding soybean output. Furthermore, by stimulating surplus production of soybeans, markets and trade channels had been established, reinforcing the likelihood of continued soybean production.

Coffee Eradication Program. In the 1950s and 1960s, coffee was a preferred crop and received considerable government support (although export taxes and an overvalued exchange rate lowered producer incentives). However, recurring freezes in the 1960s stimulated a coffee eradication program in western Sao Paulo and Parana. The primary crop planted on the cleared coffee land was soybeans. Thus, the coffee eradication program resulted in expansion of soybean area in the South.

Fuel Alcohol (ProAlcool) Program. During the 1970s and 1980s, sugar cane production received considerable GOB support under a national program to promote domestic production of fuel alcohol. Under the program, some of the most productive agricultural land in Parana and Sao Paulo was diverted to sugar cane production, reinforcing soybean production's westward expansion into the Center-West.

Other Influential Programs. Several policies aimed at territorial integrity had the indirect effect of promoting soybean expansion into the Center-West. The nation's capital was moved from Rio de Janeiro to interior Brasilia in 1960. The Government invested in the construction of the Trans-Amazon highway. A government-financed migration program was established to encourage landless or near-landless agricultural workers from the South to move to the Center-West to obtain free tracts of government land.

In the 1970s, the GOB initiated an "Export Diversification Push," accompanied by a series of currency devaluations. At the same time, the GOB strengthened export controls and quotas on raw agricultural products to ensure adequate supplies of food and raw materials for consumers and domestic industry. However, the GOB was also interested in using agriculture to generate foreign exchange and to help pay down the country's international debt. Consequently, unprocessed agricultural exports were taxed, while export subsidies were given to processed exports. As a result, domestic commodity prices fell well below world market levels, stifling producer incentives.

Quantitative export restrictions on certain food products (e.g., soyoil) also helped to enforce domestic consumer price ceilings and to ensure a positive crushing margin for oilseed processors. Varying differential export taxes and subsidies on soybeans, soymeal, and soyoil have often been used to maintain incentives supportive of the domestic crushing sector.

International Events Propel Global Oilseed Demand

In the early 1970s Brazil's soybean sector was aided by international events. A surge in world demand from growing populations and incomes, combined with a series of weather-related crop shortfalls in major grain and oilseed producing countries and a drawdown of global stocks, generated historically high international market prices for most major commodities.

The crises began with the failure of the Peruvian anchovy catch in 1972, which led to a precipitous decline in world fish meal production—then a major source of high-protein meal— and a very precarious international supply of high-protein feedstuffs. That

same year, the United States, the premier producer and exporter of soybeans and products, suffered a weather-damaged soybean harvest just as its exports of soybeans and soymeal were increasing rapidly. Despite sharply higher prices, U.S. exports were bolstered by a devaluation of the dollar in early 1973, which partially offset the impact of high prices on foreign buyers.

International soybean prices hit their historic peak in June 1973 at $393 per metric ton. Concerns about global food shortages and vulnerability to weather shocks were complicated by skyrocketing petroleum prices and fears of global resource depletion. Unfortunately, the U.S. policy response to domestic price runups and diminishing supplies had the effect of worsening the global supply deficit.

In 1973, the U.S. imposed an export embargo on soybeans, cottonseed, and their products, in response to rapid increases in domestic oilseed prices. When the embargo was announced in June 1973, U.S. farm prices of soybeans had hit a record $10 per bushel—triple the harvest-time low of the previous fall—reflecting unprecedented demand. The embargo was replaced by export licenses and was extended further to cover most of the oilseed complex. As a result, U.S. prices fell, but international prices rose sharply during the few weeks that U.S. export controls were in place. The real damage to U.S. producers was not the temporary lower domestic prices, but the loss of confidence in the United States as a reliable supplier of agricultural products on the part of one of the United States' most important agricultural markets—Japan.

Following the embargo, Japan began looking for alternative sources for soybeans and products. Brazil provided the perfect opportunity and Japan began investing in Brazil's emerging soybean industry.

Soybean Area Heads West

Brazil's farmers rapidly expanded their production of soybeans and other field crops in response to the strong international market signals of the early 1970s. During 1970-1990, Brazil's soybean production grew by over 10 percent per year, driven predominantly by area expansion (8.3 percent per year). Harvested soybean area increased five-fold, jumping from an average of under 2 million hectares in 1969-71 to over 10 million hectares in 1989-91 (table D-1). In the South, curtailment of the national wheat program, reduced coffee area, and improving relative returns for soybeans contributed to a shift into soybeans throughout the 1970s. Meanwhile, government policies and programs designed to facilitate soybean expansion into the Center-West brought new area under cultivation throughout the 1970s and 1980s (fig. D-4).

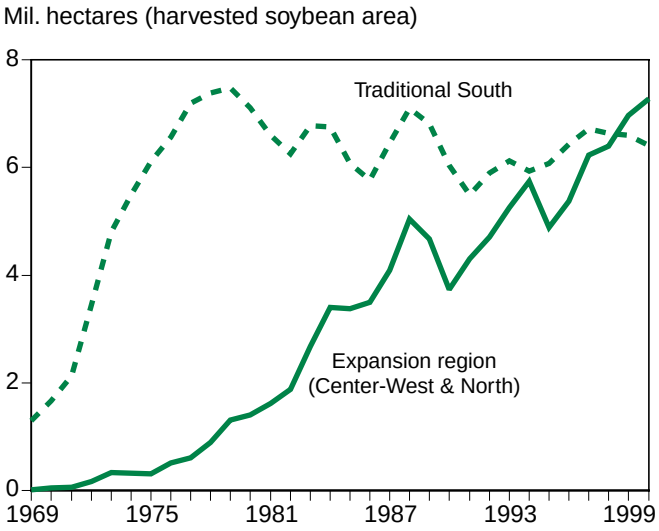
Brazil's soybean yields grew nearly 2 percent annually during the 1970s and 1980s, further propelling output growth. However, at 1.8 tons per hectare by 1989-91, average yields still lagged U.S. and Argentine yields by about 20 percent. Policy-imposed barriers to acquisition of international technology and inputs, coupled with high domestic transportation costs, appear to have constrained yield growth, particularly on the acidic tropical soils of Brazil's Center-West. Yet, improving access to cheap, abundant land continued to fuel the region's expansion of commercial agricultural production.

It was not until 1978, after government programs encouraging soybean expansion into Brazil's interior States had been in place for more than a decade, that the Center-West's soybean sector accounted for as much as 10 percent of either national harvested area or production. However, once underway, the Center-West's soybean industry has accounted for an ever-increasing share of national production (fig. D-5).

By 1989-91, 41 percent of national soybean area and 46 percent of national production were located outside

Figure D-4

Brazil's soybean area has expanded onto the *cerrado* soils of interior States, but has stagnated in the traditional South



Traditional region=Rio Grande do Sul, Santa Catarina, Sao Paulo, and Parana; Expansion region=Mato Grosso, Mato Grosso do Sul, Minas Gerais, and others.

Source: USDA; July 2001.

Table D-1—Shifts in regional soybean production in Brazil

Period averages	Brazil	South-Southeast[1]	Center-West[2]	North-Northeast[3]
		Million hectares		
Harvested area				
1970-74	3.698	3.510	0.157	0.031
1975-79	7.678	6.946	0.598	0.134
1980-84	8.890	6.683	1.858	0.349
1985-89	10.594	6.445	3.309	0.840
1990-94	10.639	5.869	3.701	1.069
1995-99	12.370	6.472	4.575	1.323
		Million metric tons		
Production				
1970-74	5.616	5.347	0.216	0.053
1975-79	11.735	10.603	0.947	0.186
1980-84	15.321	11.284	3.404	0.633
1985-89	18.672	10.801	6.389	1.482
1990-94	21.630	11.356	8.132	2.141
1995-99	29.090	14.189	11.802	3.099
		Metric tons/hectare		
Yield				
1970-74	1.460	1.464	1.352	1.532
1975-79	1.539	1.538	1.569	1.346
1980-84	1.713	1.687	1.814	1.798
1985-89	1.756	1.669	1.931	1.749
1990-94	2.018	1.935	2.188	1.994
1995-99	2.382	2.191	2.565	2.347

[1]South-Southeast = Rio Grande do Sul, Santa Catarina, Parana, Sao Paulo, Minas Gerais.

[2]Center-West = Mato Grosso, Mato Grosso do Sul, Goias, Federal District.

[3]North-Northeast = Rondonia, Tocantins, Maranhao, Piaui, Bahia, and others.

Source: CONAB and unofficial USDA data.

of the South. Higher yields in the Center-West reflected greater economies of scale in production due to significantly larger farm sizes, more modern cultivation practices, and whenever feasible, greater use of chemical inputs. In contrast, land in the South has become increasingly parcelized, which has inhibited adoption of mechanization, and is also subject to significantly greater variation in rainfall, thereby increasing yield and production risk (fig. D-6).

Downward Spiraling Economy Builds Up to Reform

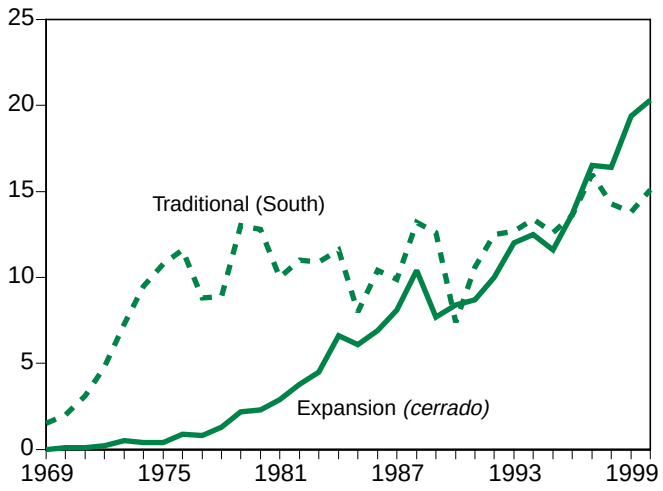
Brazil's macroeconomic environment provided an unlikely backdrop for the soybean sector's rise to preeminence. By 1979, Brazil's foreign debt exceeded $100 billion, equivalent to 28 percent of national GDP. In the early 1980s, rising interest rates created an escalating cycle of new borrowing to pay current interest payments, and by 1982, Brazil could no longer service its debt. Brazil's external debt, relative to GDP, peaked at over 33 percent.

In the mid-1980s through the mid-1990s, Brazil experienced dramatic variations in annual inflation rates, a ballooning external debt, and years of sluggish or negative economic growth. The annual inflation rate soared upward, exceeding 100 percent by 1980 and 200 percent in 1983, before oscillating up to hyperinflation with annual rates over 1,000 percent (fig. D-7). This inflationary phenomenon explains, in large part, why Brazil's soybean economy evolved a market system whereby inputs and outputs are priced either in U.S. dollars or in terms of "bags of soybeans."

Brazil spent most of the 1980s adjusting to debt-related problems, escalating inflation, and the transition to a democratic government. Trade restrictions were once again tightened. Government spending, including agricultural support, was cut. Wages, prices, and interest rates on agricultural credit were indexed to the general inflation rate, and the import-competing and export sectors were promoted to increase foreign exchange earnings for debt reduction.

Figure D-5

Continued expansion onto high-yield *cerrado* soils is the driving force behind Brazil's rapidly growing soybean output

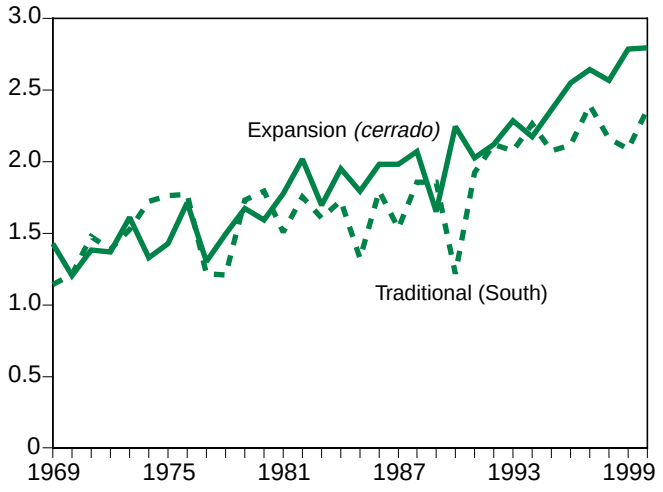


Traditional region=Rio Grande do Sul, Santa Catarina, Sao Paulo, and Parana; Expansion region=Mato Grosso, Mato Grosso do Sul, Minas Gerais, and others.

Source: USDA; July 2001.

Figure D-6

Soybean yields are rising fastest in the "expansion areas" on *cerrado* soils



Traditional region=Rio Grande do Sul, Santa Catarina, Sao Paulo, and Parana; Expansion region=Mato Grosso, Mato Grosso do Sul, Minas Gerais, and others.

Source: USDA; July 2001.

In 1985, military rule was replaced by a populist democratic coalition. The new government introduced several reforms favoring small producers—i.e., producers of food crops such as corn and dry beans—and consumers over producers of export-oriented crops. The nation's research and extension programs were also reorganized to focus on food crops instead of soybeans.

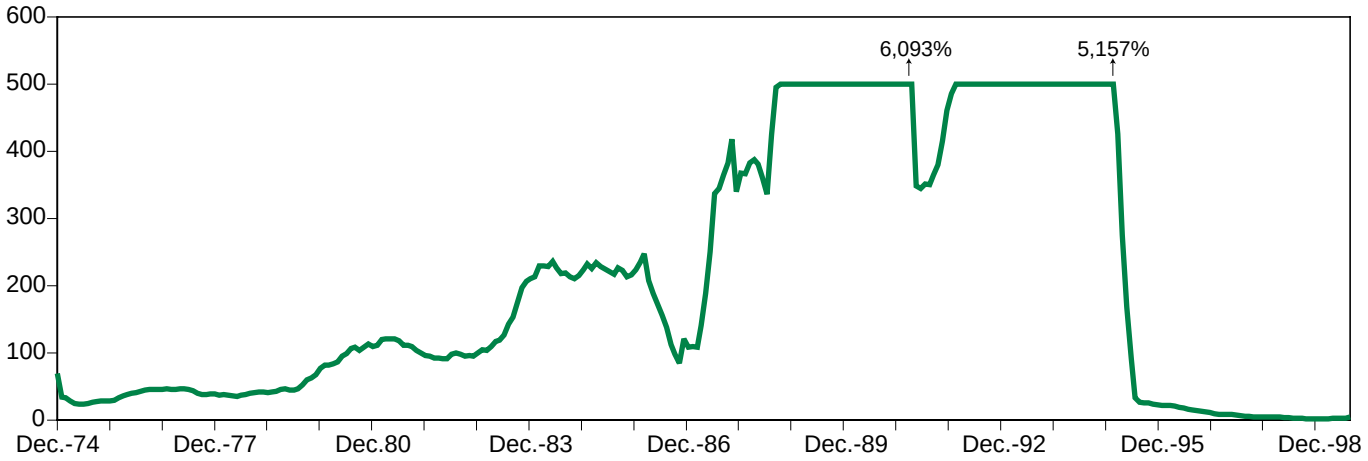
Despite this reorientation, Brazil's soybean production hit a then-record 23.6 million tons in 1988 after 4 years of relatively strong domestic commodity prices. Exports of soybeans and soymeal also hit records of 5.1 and 9.6 million tons (approximately 17 million soybean-equivalent tons in total). However, production declined by 33 percent in the following 2 years (to 15.8 million tons in 1990) due to low domestic prices and poor growing conditions. Nevertheless, Brazil remained an important exporter of soybeans and products—average soybean exports of 3.2 million tons in 1989-91 garnered a 12-percent share of world trade; average soyoil and soymeal exports of 0.7 and 8.2 million tons earned 17 and 31-percent shares of world trade. However, relatively higher export taxes on whole soybeans, compared with soyoil and soymeal, continued to favor domestic processors and the export of soybean products.

By mid-1989, Brazil had an unserviceable foreign debt of $120 billion, and its economy entered the 1990s with declining real growth and runaway inflation. In addition, the economy remained highly regulated, inward-looking, and protected by substantial trade and investment barriers. Import tariffs averaged nearly 45 percent and the currency was severely overvalued (fig. D-8). In short, Brazil's economy was not investment friendly.

In March 1990, the Collor government assumed power and immediately launched reforms designed to modernize and reinvigorate the economy. To stabilize prices, government spending was cut, thousands of government workers were laid off, and the GOB froze two-thirds of the country's financial assets for 18 months. In an effort to deregulate the economy, some state-owned enterprises were privatized and a state monopoly on wheat marketing and trade was eliminated. The economy was opened to increased foreign competition by liberalizing trade and investment policies. The foreign exchange market was converted to a floating exchange rate. The import market was deregulated, and many nontariff trade barriers, including trade licensing, were removed.

Figure D-7

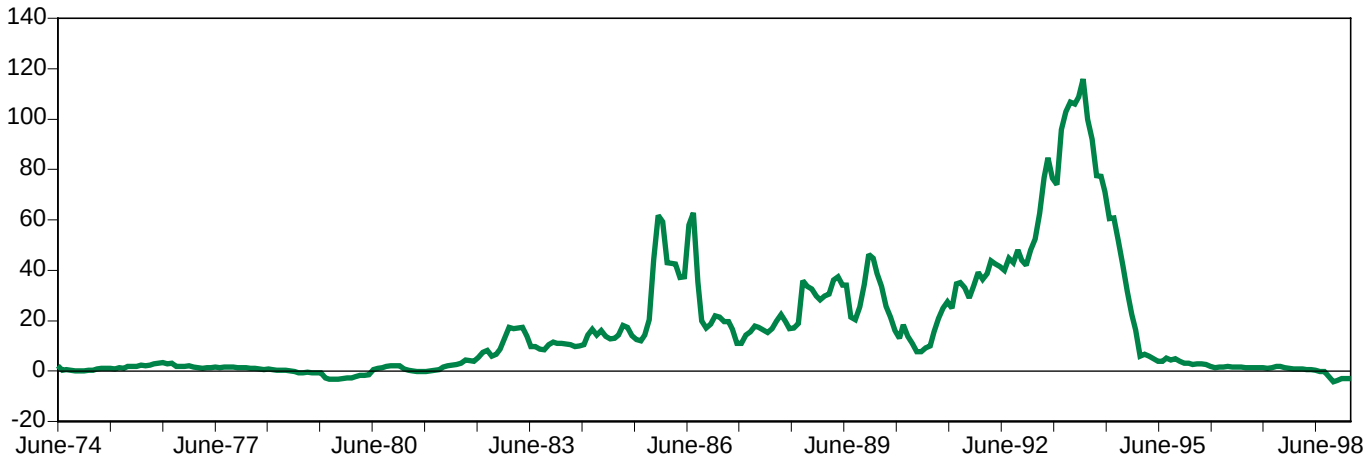
Brazil experienced hyperinflation from the mid-1980s to the mid-1990s*



*Monthly observed annual rate of inflation based on consumer price index data. Capped at 500 percent to improve presentation.
Source: IFS/IMF.

Figure D-8

Prior to the 1994 Real Plan, Brazil's exchange rate was often highly overvalued*



*Rate of change of Official Exchange rate minus rate of change in a purchase power parity index comparing Brazil and U.S.; 11-month moving averages of both series used to smooth data.
Source: IFS/IMF data; authors' calculations.

In an attempt to spur agricultural investment, the GOB instituted new farm income taxes to be assessed only on profits not reinvested in the sector. In contrast, taxes on export profits were raised from 18 to 30 percent. By 1991, import tariffs had declined to about half of 1989 levels, averaging about 21 percent. In 1992, import tariffs were reduced further.

Cardoso Launches Brazil's "Real Plan"

By June 1994, the annual inflation rate was again over 5,000 percent and once more undermined economic stability. Finance minister Cardoso launched the first phase of his stabilization plan known as the *Real Plan*. Effective July 1, 1994, the plan introduced a new currency, the real (*R$*), which was pegged to the U.S.

dollar using a "mini-band" mechanism that allowed only small daily changes in the value of the currency. This policy change improved market confidence. The exchange rate policy, along with tight monetary policy, began to dramatically lower inflation.

In 1995, the newly elected President Cardoso called for sweeping market-oriented reform, including deregulation of the private sector, expanded privatization of state-owned enterprises, fiscal reform, and elimination of barriers to increased foreign investment.

The psychological "mind set" of reform was reinforced in January 1995, with the almost total elimination of trade restrictions within the MERCOSUR trade zone encompassing Argentina, Brazil, Uruguay, and Paraguay.[3] Members now engage in trade with few duties between member states and a common set of external tariffs.

Since January 1997, Brazil's annual inflation rate has been under 10 percent, the lowest in 30 years, and dipped below 5 percent in late 1998. Although inflation abated, Brazil's agricultural sector remained heavily indebted, and high real interest rates sharply increased borrowing costs and, consequently, costs of production. However, limited access to public and private sector credit likely poses a greater constraint to the agricultural sector than indebtedness.

As the Government has reduced the availability of public credit in recent years, more credit has originated from private sources. Nevertheless, agricultural credit from all sources (public and private) averaged only $7.6 billion between 1995 and 1998, compared to a yearly average of about $8.3 billion in official credits alone between 1970 and 1990. In addition, by the end of the 1990s, the official credit system was mostly oriented toward small farmers, while larger farmers had to seek credit from private banks. However, credit remains costly and limited. Interest rates, once 25-30 percent in the late 1990s, still averaged nearly 18 percent in 2000.

Intrastate Tax (ICMS) Distortions

Since 1994, Brazil's soybean industry has operated with far less direct and indirect government intervention. However, the ICMS (*Imposto sobre Circulacao de Mercadorias e Servicos*), a value-added tax imposed on the movement of all goods (including soybeans and products) remains. ICMS tax rates are set by the GOB at nationally uniform rates (ranging from 5 to 13 percent) that vary depending on the product and whether it is sold within the State, to another State, or exported. Since the taxes are collected by State governments, the cost has tended to vary by State and by product due to manipulation of payment terms, interest charges, and other fees.

In general, the ICMS tax system raises the cost of moving agricultural commodities through market channels and ultimately reduces farmgate prices and incentives to produce. For some commodities, the rate also varies depending on the degree of processing, thereby introducing other market distortions. For example, until 1996, soybeans moving to export were assessed an ICMS tax of 13 percent, but soybean meal and oil exports were charged just 11 and 8.5 percent. This inequity encouraged domestic processing at the expense of whole bean exports.

Because ICMS taxes represent a principal source of state revenue, the GOB has been unable to remove them but has attempted to mitigate their distortive effects. Perhaps the most significant policy development for Brazilian soybean farmers since implementation of the Real Plan was national Law 87, enacted in September 1996, which exempted foreign-bound exports of raw materials and "semi-manufactured" products from the ICMS taxes. This action created new incentives to export agricultural products, since interstate movements of commodities destined for domestic consumption remained subject to this tax. Since the ICMS export tax had imposed higher taxes for less processed goods, its removal had the largest impact on whole soybean exports. In the 3 years prior to elimination of the ICMS export tax—1992 to 1995—Brazilian soybean exports averaged 4.2 million tons. In the 4 years following its removal—1996 to 1999—average soybean exports more than doubled to 9.6 million tons per year.

The ICMS tax continues to cause distortions in the domestic crushing industry. Crushers must pay the ICMS when they buy soybeans from other States, then recover (at a later date) the ICMS paid on soybeans if the resulting product is exported. However, the ICMS recovery system does not appear to be functioning well. For crushers who source their raw material

[3] MERCOSUR is a Spanish acronym for "Common Market of the South." The Portuguese acronym is MERCOSUL. MERCOSUR is actually a customs union. While free trade reigns within the union, the pact is often very protectionist toward nonmember trade.

across a State border (but within Brazil), this implies an accumulation of tax rebates until they actually export the final product. To avoid this cash-flow constraint, crushers compete for raw material within their own State, which may subsequently increase local prices if crush capacity within a State is large relative to supply. Since their "squeezed" margin does not allow them to pay the same price for the soybean as traders on the international market, small Brazilian crushers are disadvantaged. Large multinational firms that both crush and trade are less affected.

A peculiarity of Brazil's ICMS tax system has been the encouragement of Brazilian investments in soybean farms in nearby Paraguay and Bolivia. Soybeans imported into Brazil are not charged the ICMS if the products are re-exported. This has encouraged the importation of Paraguayan and Bolivian soybeans to Brazilian plants. In years of low production, drawback provisions have even encouraged soybean imports from the United States, including nearly 800,000 metric tons in (calendar year) 1997.

Input Use Grows Rapidly During the Real Plan

In the early 1990s, fertilizer, pesticide, and agricultural machinery use in Brazil lagged well behind use in the United States, partially explaining lower corn, wheat, and to a lesser extent, soybean yields. Brazil's national average application rate of all fertilizers had peaked in 1980 at 76 kg per hectare when significant amounts were being applied to the sugar cane crop. By 1990, the rate had fallen to 55 kg (compared with 187 kg in the United States)—due in large part to lower usage rates for sugar cane—but recently surpassed 1980 levels. For soybeans alone, application rates have shown steady growth over the last several decades.

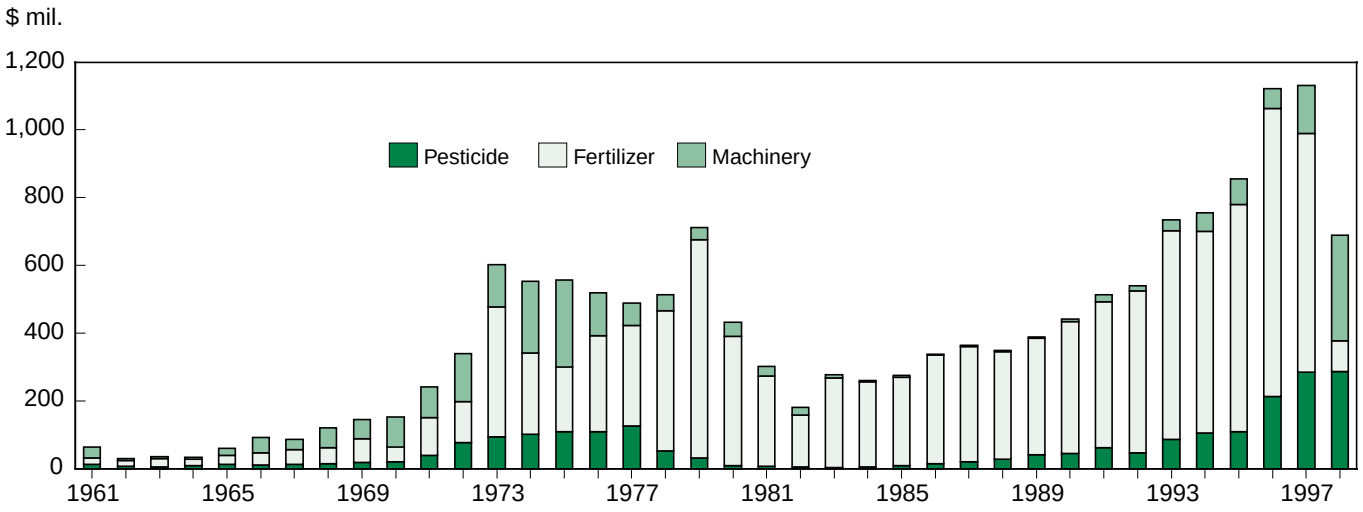
Following the reduction and/or elimination of import barriers on agricultural inputs during the 1990s, imports of agricultural inputs and their use increased dramatically (fig. D-9). Total fertilizer imports (nitrogen, phosphate, and potash) jumped from an average of about 1.4 million tons in 1989-91 to a record 3.5 million tons in 1997. Nitrogen imports more than tripled to 686,000 tons. Phosphate imports increased almost seven-fold to 713,000 tons, and potash imports jumped by 87 percent to about 2.1 million tons. Phosphate and potash are important for soybean production in the *cerrado*.

Imports contributed to an increase in total fertilizer consumption from about 3.3 million tons yearly during 1989-91 to a record 5.7 million tons in 1998. By 1998, Brazil's total fertilizer use of 103 kg/hectare, although significantly higher, still lagged the United States (196 kg/hectare).

Total pesticide imports also rose sharply from an average value of $38.4 million in 1989-91 to almost $285 million in 1998. Imports of agricultural machinery (i.e., tractors, harvesters, threshers, and milk machines) jumped from an average of $10 million in 1989-91 to slightly over $200 million in 1998. Current national average usage rates likely

Figure D-9

Brazil's imports of agricultural inputs accelerated in the mid-1990s following economic reforms



Source: FAO, FAOSTATS.

understate input growth in the Center-West, where larger farm sizes and less fertile soils encourage higher input application rates than in the South.

Despite the inflow of foreign machinery, postharvest losses were still excessive in the late 1990s. A 1998 EMBRAPA study found that Brazilian soybean growers left an average of 102 kilograms of soybeans per hectare (or 1.3 million tons) on the ground from the 1996/97 crop due to faulty operation or maintenance of soybean harvesters. Another 8 percent of production was lost due to breakage or crushing of the grains during harvest.

Spurred by policy changes, Brazil's soybean production and exports accelerated during the latter part of the 1990s on the strength of both area and yield growth (averaging 2.9 and 3.9 percent annually during the 1990s). Brazil's soybean exports rose to an average 10.3 million tons in 1999-2001, capturing over a quarter of world market share. Brazil's soy product exports also increased during the 1990s, particularly soyoil exports which doubled to over 1.3 million tons. Soymeal exports rose more modestly (about 20 percent) to 10.2 million tons, but have also fed value-added poultry exports, which nearly tripled between 1990 and 2000 to 950,000 tons.

Brazil's Soybean Processing Industry In Transition

Favored by fiscal incentives and highly subsidized rural investment credit, Brazil's soybean crushing sector and agricultural input sector both underwent rapid growth during the 1970s and 1980s. Large soybean-only crushers replaced small multiple-product crushers, and industrial technologies shifted from inefficient mechanical presses to state-of-the-art hexane extraction. This occurred with the help of government subsidies from the National Economic and Social Development Bank (BNDES). However, capacity was built up with little regard for cost considerations or location. As a result, much capacity has become out-of-date and inefficient (Vieira and Williams, 1996).

The removal of the ICMS export tax on whole soybeans in 1996 exacerbated the problem for inefficient crushers. Several crushing plants in Brazil closed during the 1990s as the sector shifted to greater soybean exports at the expense of meal and oil exports. Brazil's crushing capacity fell from about 125,000 tons per 24-hour day in 1992 to 106,000 tons in 1999/2000 (J.J. Hinrichsen, 2000; Vieira and Williams, 1996). More than one-quarter of capacity was unused in 1999/2000, compared with about 12 percent in 1996/97. Smaller, less efficient crushers have dropped out. In 1999/2000, over 60 percent of the soybeans were processed in plants processing over 1,500 tons per day, compared with 50 percent in 1993. Plants processing less than 600 tons per day were less than 10 percent of the total capacity in 1999/2000.

Rio Grande do Sul and Parana in the South and Sao Paulo in the Southeast house more than two-thirds of Brazil's processing capacity, while the Center-West's Mato Grosso and Mato Grosso do Sul have only 13 percent of the total (as of 2000). However, the industry is slowly following soybean production to the Center-West and North to create new integrated centers of grain and meat production.

Since the reforms of the early 1990s, the crushing industry in Brazil has become concentrated and denationalized, with major U.S. and EU players moving in or increasing their market share. Exchange rate policy changes have accelerated this consolidation. Currently, the five largest companies—Bunge, Cargill, Coimbra (Louis Dreyfus), ADM, and Granoleo—own about 60 percent of total crushing capacity. The presence of multinationals in the major food processing subsectors may mean more efficient use of facilities across countries.

Brazil's Exports Benefit From Currency Depreciation

Under the reforms of the early 1990s, the Brazilian real—much like the Argentine peso—was also closely linked to the U.S. dollar, but under a crawling peg with a mini-band mechanism. Through much of the 1990s, this currency linkage held. Unfortunately, a rapidly strengthening U.S. dollar resulted in inflated real-priced commodities in international markets. By late 1998, the appreciating U.S. dollar and fears of a "contagion effect" following the Russian financial crisis plagued the real. In January 1999, Brazil's Government delinked the real from the U.S. dollar and allowed it to float freely. The real responded by depreciating sharply—32 percent in the first month—against a strengthening dollar.

The currency depreciation benefited Brazil's export sector by lowering the price of its export products in world markets. For Brazil's soybean producers, the depreciation raised farm prices in local currency terms and continued to boost soybean plantings despite declining world prices. Since its initial plunge in January 1999, the value of the real has continued to decline

against the dollar, and now carries only half the value it had prior to the devaluation. A countervailing effect came from increased costs of dollar-denominated fertilizer and herbicide imports, but producers and input suppliers have sidestepped this problem by pricing most inputs in terms of bags of soybeans. The direction of Brazil's exchange rate will continue to be an important determinant of its export competitiveness.

Many additional costs and policy distortions—often referred to as "the Brazil Cost"—are still in effect in Brazil. These include an inefficient infrastructure that raises marketing costs, high interest rates that discourage investment, and state-level taxes (ICMS) on the movement of goods and services. Nevertheless, the Brazilian economy's performance continues to improve, with strong GDP growth in 2000, and a slight decline in the current account deficit and net public debt. A recent IMF report concluded that Brazil is better placed than in the early 1990s to withstand external economic shocks and that strong fiscal discipline should help put Brazil on a sustained trajectory of dynamic private sector-led growth (IMF, November 2000).

Brazil's Infrastructure Development Holds the Key to Agriculture's Future

Brazil possesses a long coastline with several major seaports, yet nearly 80 percent of Brazil's agricultural exports, including soybeans and products, traditionally have been handled by the three principal southeastern ports of Santos, Rio Grande, and Paranagua (table D-2). From a logistical perspective, soybean production located within a small radius of these ports remains highly competitive with U.S. soybeans in European markets. However, as Brazilian production moves into the interior, the high cost of getting soybeans to market erodes competitiveness. Navigable waterways of the eastern portion of the Center-West all flow west and south, draining into the Parana-Paraguay River system (which runs through Argentina). The sole exception is the Sao Francisco River, which runs north through Minas Gerais, then east to the coast through Bahia (fig D-10). Only in the past few years have Amazon tributaries such as the Madeira undergone development as viable export waterways.

Under the reforms of the 1990s, Brazil's transportation strategy was to cut costs by privatizing the nation's inefficient railways, upgrading and improving existing waterways, and developing new transportation routes along the Amazon waterway. In the past decade, significant progress has been made towards achieving these goals and lowering transport and marketing costs. However, Brazil's internal marketing costs remain high despite substantial post-reform, private-sector investment in road, rail, and waterway infrastructure.

Table D-2—Brazil's soybean and products exports by port, Feb. 1998 to Jan. 1999

Port	Soybean	Soybean meal	Soybean oil
		1,000 metric tons	
Atlantic ports			
Paranagua	3,734	4,646	849
Rio Grande	1,641	2,184	416
Santos	1,897	1,214	4
Sao Francisco	31	1,636	124
Vitoria	489	863	0
Ilheus	431	151	0
Sao Luis	358	0	0
Others	31	165	13
Amazon River			
Itacoatiara	581	0	0
Parana-Paraguay waterway			
Caceres/Corumba	118	0	0
Total	9,313	10,859	1,406

Source: DECEX/Safras & Mercados.

Figure D-10

Several projects designed to open the Amazon waterway as a conduit for agricultural products are underway

Source: Economic Research Service, USDA.

From 1983-97, the margin between the f.o.b. Rio Grande do Sul port prices and farm prices for soybeans in Mato Grosso averaged a fairly stable $76 per metric ton. In 1998 and 1999, the margin declined to an average of about $47 per ton, implying that, even if international prices are held constant, producer incentives are improving via lower marketing costs. Similar margins for the South, based on average farm prices in Parana, were $52 per ton during 1983-97 and $31 in 1998-99 (fig. D-11).

In early 1996, the GOB initiated the privatization of publicly held railroads, setting in motion the gradual upgrade of the country's rail infrastructure. Massive sales occurred under this program, including almost the entire stock of nonurban track—about 27,000 kilometers—as well as 1,800 locomotives and 40,000 railcars.

Several projects designed to ease transportation of Brazil's agricultural output to port facilities have recently been completed or are currently in progress. For example, the *Madeira-Amazon waterway*, which became operational in 1997, is Brazil's newest river transport system and is an important transportation improvement for soybean production in western Mato Grosso. This waterway facilitates the transport of soybeans grown in Mato Grosso to international markets via the Amazon River. Soybeans are trucked from central and western Mato Grosso to Porto Velho, Rondonia, then barged north down the Madeira River to the Amazon port of Itacoatiara, located over 1,000 kilometers upriver from the mouth of the Amazon. A floating elevator at Itacoatiara offloads barges and uploads Panamax-sized oceangoing vessels. Nearly 1 million tons of soybeans were estimated to have been exported via this route in 1999/2000, about half of its estimated capacity (Burrack, 2001). Transportation costs along this route are estimated at about $84 per metric ton from central Mato Grosso to Rotterdam (Verheijden and Reca; 1998), about $24 per ton less than using overland truck routes via the port at Paranagua.

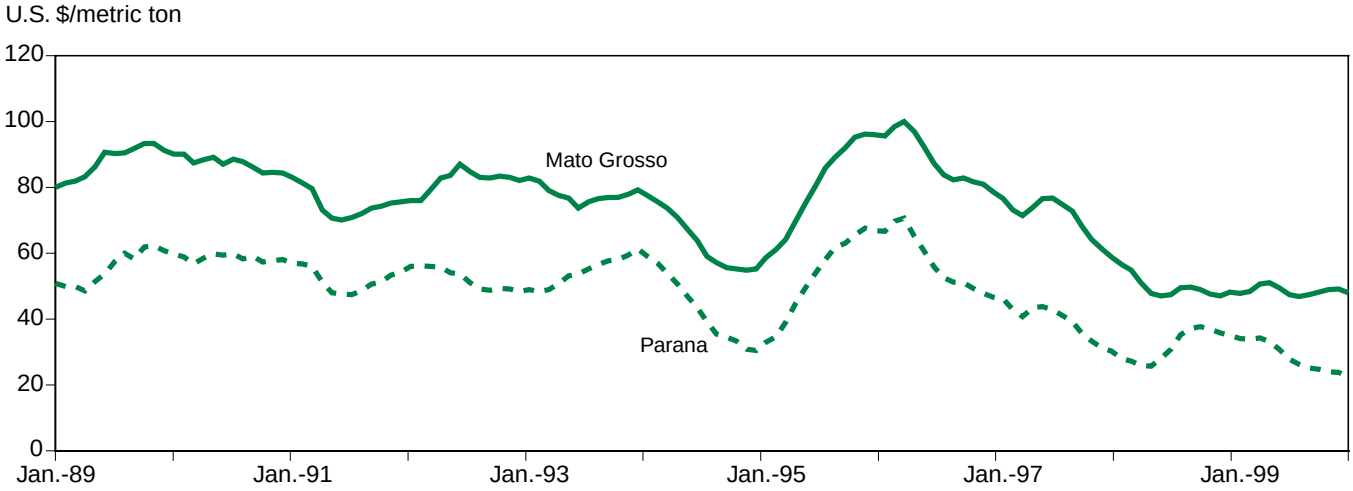
The *Tiete-Parana waterway* is also expected to reduce freight costs for soybeans grown in Mato Grosso do Sul. These soybeans travel first by highway to the Parana River, then barge upriver via the Tiete to a railway that reaches the seaport of Santos. The Tiete-Parana system is presently the most developed waterway in Brazil, including 13 dams, 10 locks, and more than 1,000 navigational buoys (Goldsby, 2000).

The *Parana-Paraguay waterway* conducts soybeans and other agricultural output from southern Mato Grosso do Sul to the Atlantic Ocean. Environmentalists have voiced concerns about the dredging of the Parana and Paraguay Rivers and its effects on the ecosystem of the Pantanal—an important natural wetlands area in southern Brazil about 2,700 kilometers from the Atlantic Ocean—due to potential water flow changes. These concerns may limit the extent of transportation improvements and subsequent cost reductions for soybeans and other commodities.

The *Ferronorte* railroad currently operates 780 95-ton railcars, with 50 locomotives, from the port of Santos through the State of Sao Paulo to Alto Araguaia in

Figure D-11

Soybean f.o.b.-to-farm price differences are declining as infrastructure develops*



*12-month moving averages.

Source: farm prices, Getulio Vargas Foundation Brazil; F.O.B. prices (Rio Grande do Sul), Oil World.

southeastern Mato Grosso. By the end of 2002, it is scheduled to reach Rondonopolis, Mato Grosso, about 170 kilometers to the west. The *Ferronorte* will eventually be extended another 180 kilometers to Cuiaba, Mato Grosso. From there it will branch west to Porto Velho on the Madeira River and north to Santarem on the Amazon.

The *Novoeste* railroad extends from Santos to Corumba, Mato Grosso do Sul, near the border with Bolivia. Improvements under privatization of this railroad are expected to greatly facilitate access to export markets for producers in both Mato Grosso do Sul and southern Mato Grosso.

Plans to pave highway *BR163* from Cuiaba north through Mato Grosso to the Amazon port-city of Santarem, in the State of Para, will enable direct loading onto Panamax-sized oceangoing vessels. Mato Grosso officials are projecting cost savings of up to $36 per ton ($1 per bushel) for soybeans traveling from central Mato Grosso (Burrack, 2001). Although the 2002 completion date is overly optimistic, significant construction of agricultural processing facilities is underway along the proposed highway. For example, ADM has recently constructed a 10,000-ton-per-day oilseed crushing plant in Sorriso. The plant includes enormous storage facilities and rail loadout access in anticipation of the *Ferronorte* railroad's arrival.

Other infrastructure improvements targeting rail, roads, and waterways are either underway or in the planning stage. If realized, these improvements would enhance Brazil's competitiveness in international markets. In addition, they will increase domestic production incentives by permitting a larger share of international prices to reach the farm level, and will boost crop productivity by backhauling fertilizer and other farm inputs to these areas.

Fuller et al. (2000) evaluated the potential cost savings from transportation improvements in Brazil, including: (1) improvements in the upper *Parana-Paraguay* waterway and the deepening of ports in the lower Parana River, (2) the development of barge transportation on the Madeira River and its link to oceangoing transportation at Itacoatiara, (3) extension of the *Ferronorte* railroad from the port of Santos into the State of Mato Grosso, (4) privatization of the *Novoeste* railroad in Mato Grosso do Sul, and (5) improvement of highways linking Mato Grosso to Porto Velho on the Madeira River and Santarem on the Amazon River. The results indicate that:

- Improvements on the upper *Parana-Paraguay* waterway are projected to lower barge rates from Corumba in Mato Grosso do Sul to lower Parana ports in Argentina and Uruguay by $8 a ton.
- Development of the barge-based Madeira-Amazon connection between western Mato Grosso and the port at Itacoatiara is projected to lower transport costs to export position by 20 percent (or $11) from the current estimate of $55 per ton by truck.
- Privatization of the *Ferronorte* and *Novoeste* railroads is projected to lower transportation costs by 40 percent (from $30 to $18/ton/1,000 kilometer) for agricultural produce out of Mato Grosso and Mato Grosso do Sul (Banco Interamericano de Desarrollo, 1996). Completion of the *Ferronorte* from the port of Santos to Rondonopolis is expected to further lower transport costs from that area.
- Improvements in these major transportation systems are expected to increase producer prices for soybeans in Mato Grosso do Sul, east Mato Grosso, and west Mato Grosso by about $10, $12, and $20 per ton, respectively.

Other Agricultural Sectors Are Vital to Soybean Prospects

This section presents developments in other agricultural sectors that have been integral to the evolution of Brazil's soybean sector. These include corn, wheat, rice, and cotton, as well as the livestock sector.

Brazil's Corn Sector on the Rise

Brazil is a major corn producer, traditionally ranking third behind the United States and China in global production. Brazil's corn production has enjoyed steady growth during the past several decades. During 1999-2001, production averaged 36.2 million tons, up nearly 50 percent from average production during the 1980s. Despite such strong growth in corn output, production has barely kept pace with domestic demand. Nearly 20 percent of Brazil's corn production enters domestic food channels, with the remainder used as animal feed. During the 1990s, Brazil's huge domestic market (including rapidly growing poultry and pork industries) easily absorbed the entire crop and Brazil was a regular corn importer, mostly from Argentina. Annual imports averaged over 1 million tons during the decade, fluctuating from 0.4 million tons in 1995 to 1.8 million tons in 1997.

However, with record production of 41 million tons in 2000/01, Brazil was a net exporter (of 3.7 million tons) for the first time since 1981. Brazil's corn crop appears to be predominantly nonbiotech, which may have contributed to demand from some major corn importing countries seeking *Starlink*-free supplies. Exports have also been bolstered by the continued weakness of the "free-floating" real.

Brazil's recent corn export surge may be temporary—net exports in 2001/02 are projected to drop to 500,000 tons. Future production and export growth prospects will likely hinge on the development of commercially viable tropical corn varieties and infrastructure developments that could continue to open up the Center-West to corn production. Corn yields in Brazil's tropical zone are subject to greater production risk due to the humidity, short day length, and occasional dry spells (*veranicos*). This risk factor has prevented corn from expanding more rapidly into Brazil's interior territories despite strong domestic demand and often-favorable prices for corn relative to other major field crops (e.g., soybeans and cotton).

However, continued adaptations of domestic corn varieties to tropical conditions, along with rotational benefits, have contributed to expanded corn plantings. A corn-soybean rotation offers many of the same advantages to Center-West producers that U.S. Corn Belt growers benefit from—e.g., weed and disease control and nitrogen fixation. To date, Center-West producers have avoided significant soybean nematode and disease problems despite continuous soybean cultivation in many areas, but such diseases will likely develop with time, particularly under continuous cropping. In addition, current low nitrogen use appears to offer plenty of room for improvements in corn yields from more intensive input applications.

Brazil's net-trade status will be closely linked to the development of the pork sector and the increasingly export-oriented poultry industry (and the income growth that is driving them). If Brazil's researchers continue to improve tropical corn varieties, corn could compete with soybeans and cotton for area in the Center-West. Brazil's Government recognizes the importance of an adequate corn supply to the development of its pork and poultry sectors. Nearly 90 percent of field trials granted by the GOB on about 800 biotech projects are devoted to improving varieties of tropical corn (Taylor, 2001).

About 40-percent of corn area is in the South, with the remainder split between the Center-West and the Northeast (table D-3). However, yields are significantly higher in the Center-West where large-scale mechanization is more suitable to corn production. Average corn yields in the Northeast are suppressed by a large share of low-yielding subsistence corn cultivation.

An important phenomenon with respect to Brazil's corn production is the growth of second-crop output. Since 1989, second-crop production expanded from less than 0.5 million tons to a record 5 million tons in 1997 as producers responded to the high international corn prices.

Brazil's Wheat Sector on the Decline

Brazil is perennially among the world's leading importers of wheat due to limited domestic production and a large, predominantly urban population with a

Table D-3—Regional corn production in Brazil

Period averages	Brazil	South-Southeast	Center-West	North-Northeast
		Million hectares		
Harvested area				
1990-94	13.56	6.17	2.86	3.22
1995-99	12.75	5.15	2.51	3.51
		Million metric tons		
Production				
1990-94	30.94	16.92	8.18	1.87
1995-99	32.45	16.66	8.99	3.60
		Metric tons/hectare		
Yield				
1990-94	2.28	2.76	2.86	0.55
1995-99	2.55	3.24	3.58	1.03

Source: CONAB and unofficial USDA data.

strong demand for wheat products. During the 1970s and 1980s, the Brazilian Government supported wheat production over other field crops. Policies kept wheat area abnormally high and suppressed wheat imports. Brazil's wheat acreage peaked at 3.8 million hectares in 1979, but the sector continued to receive support until reforms in the early 1990s. During 1986-90, wheat area averaged about 3.5 million hectares and production about 5.8 million tons.

Under the policy reforms of the early 1990s, wheat production supports were removed and resources quickly left the sector. Since 1992, wheat harvested area has remained below 2 million hectares. In 1999-2001, Brazil's wheat area and production averaged only 1.4 million harvested hectares and 2.4 million tons. Much of the wheat area shifted into other field crops, particularly soybeans. Meanwhile, wheat imports began to flood in, growing almost 9 percent per year during the 1990s (fig. D-12). Brazil's imports were estimated at 7.2 million tons in 2000/01. This level would place Brazil as the world's leading wheat importer—a position it is projected to maintain at least through 2010 under USDA's longrun baseline projections (USDA; 2001).

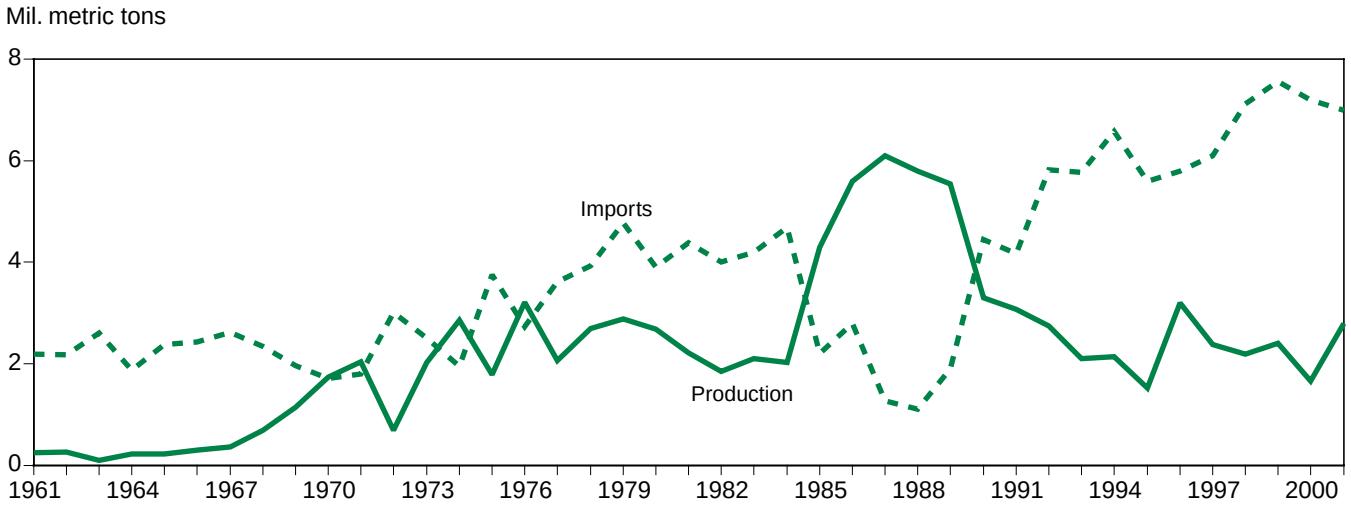
Cotton Production Poised for Breakthrough in the Center-West

Soybeans are not the only major field crop to benefit from the expansion of commercial agriculture onto Brazil's *cerrado* soils. The tropical conditions of a long growing season, high year-round solar radiation, abundant rainfall (averaging 5-8 inches per month during the growing season), and year-round temperatures averaging in excess of 27°C (81°F) combine to offer tremendous production potential for cotton, a crop Brazil has regularly imported since the late 1980s. The occurrence of temporary droughts—*veranicos*—threatens yields only slightly given the nature of the cotton plant's development. Cotton yields are generally determined by the length of the growing season, with a preference for wetter conditions during the early stages of plant development and drier conditions during the latter stages. Thus, the distinct pattern of rainy and dry seasons in Brazil's Center-West, if coordinated with plantings, appears almost ideal for optimum yields.

EMBRAPA's 1990 study (Warnken, 1999) projected that new land development in the *cerrado* would most likely occur as large-scale mechanized agriculture based on a rotation system of improved pasture, grains, and oilseeds with some perennial crops (mostly coffee) for enterprise diversification. At the time of the study, the Brazilian cotton industry was on the decline, with little prospect for the expansion into the Center-West that is currently underway. Brazil's total cotton harvested area had fallen from 2.4 million hectares in 1988 to 0.7 million hectares in 1996, with most of the reduction occurring in the South and Northeast. However, varietal improvements in the late 1990s and increasing mechanization appear to have opened the Center-West to economical cotton production. That region has seen its cotton harvested area climb from 557,000 hectares in 1996 to 853,000 hectares in 2000 and now accounts for 86 percent of Brazil's harvested cotton area.

Figure D-12

Brazilian wheat imports have accelerated since the late 1980s in response to declining production



Source: USDA; Aug. 10, 2001.

Production data for the 1999 and 2000 crop years bear witness to the Center-West's excellent growing conditions. Average cotton yields exceed 1 metric ton of lint cotton per hectare for Mato Grosso do Sul and Goias, while yields in Mato Grosso are estimated to surpass 1.285 tons per hectare. This compares with U.S. national average yields of about 0.7 ton per hectare. Such high yields are atypical of upland, rainfed cotton production, but instead typify irrigated production in a Mediterranean-type setting.

Cotton producer incentives in Mato Grosso received an added boost in 2000 when the State government passed a special tax break for cotton. Under the law, 75 percent of ICMS taxes for cotton are to be refunded, 60 percent to producers and 15 percent for research on cotton. Proposals for similar legislation are pending in Bahia and Maranhao.

Rice Expected To Remain an Important Food Crop

Rice has been an important crop in the Center-West since large-scale commercial agriculture first arrived, partly because it fits well into the crop cycle associated with clearing virgin scrubland. Initially, after the scrub brush has been cleared and burned, the land is planted to a cover crop and some cattle are run on it. Prior to the take off of soybean production in Brazil, the most widespread and traditional use of cleared and fertilized savanna land in the Center-West was for pasture. Rangeland still remains the primary first use of newly converted scrubland. However, as infrastructure development brings feeder roads into the area, commercial field crop activity becomes viable.

Rice is traditionally the first row crop to follow conversion from rangeland. Because rice grains sit high on their stalks at harvest, they allow mechanical harvesting above much of the stubble that remained in the field after initial clearing. After a year or two of rice cultivation, soybean production follows. As a result, total rice area on *cerrado* soils is linked to land expansion activities, although some rice may continue to be grown following the introduction of soybeans.

In general, Brazil's total rice area has been declining since the late 1970s falling from a 1979 peak of 6.5 million hectares (harvested) to only 3.3 million in 2000. Rice is likely to remain secondary to soybeans and corn, but it should remain an important food crop and a standby in crop rotations.

Livestock Populations and Meat Production Grow Rapidly in Brazil

Livestock in tropical Brazil are primarily beef and some dairy cattle, although sheep and goats also consume significant forage in this area. Enormous tracts of permanent pastureland (estimated at 185 million hectares) support Brazil's animal populations. Brazil has the world's largest commercial cattle herds. Average annual cattle inventories were estimated at 163.6 million head during 1998-2000. Unlike Argentina, Brazil's cattle population has been steadily increasing over the past three decades (table D-4). Like Argentina, most beef production is grass-fed. Brazil is also an important exporter of beef. However, foot-and-mouth disease (FMD) is endemic to most of Brazil's cattle herd (although a few States have obtained FMD-free status), so most of Brazil's beef exports are destined for lower-priced processing markets in Europe and North America.

Brazil's large dairy herds, estimated at 28.8 million head in 2000, also depend heavily on grazing and forage. However, a rapidly expanding poultry sector and a significant hog population are steadily increasing the demand for feed grains.

Table D-4—Livestock populations and meat production in Brazil

	Population				Meat production			
Period	Cattle	Pigs	Sheep	Goats	Beef & veal	Pork	Mutton & lamb	Poultry
	-------- Million head --------				*---------- 1,000 metric tons ----------*			
1968-70	73.0	30.2	17.5	5.7	1,789	734	35	334
1978-80	111.7	34.5	17.9	8.0	2,690	910	28	1,131
1988-90	143.6	32.9	20.0	11.6	4,130	1,057	76	2,189
1998-2000	163.6	27.4	18.3	12.6	6,146	1,736	88	5,560

Source: FAOSTATS, FAO.