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Brazil: The Future of Modern Agriculture?

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Executive Summary

In an attempt to understand better Brazil's future role in agricultural markets, the authors of this report traveled to Brazil on a fact-finding mission in September 2003. The goal was to get a first-hand impression of Brazil's agricultural sector and especially its future potential. In this report we provide a general description of crop and livestock production, government policies, public and private cooperation, and transportation and biotechnology issues. The most striking observations made during our time in Brazil was the universal sense of optimism expressed by producers, government officials, agronomists, and market analysts about the future growth of Brazilian agricultural production. Does that mean Brazil, as one person suggested, is the future of modern agriculture? Our answer to that question depends on one's view of the future of global agriculture. Brazilian large-scale, commercially oriented, forward-looking operations are well suited to compete in commodity markets that are constantly driven to increase productivity and reduce costs. On the other hand, we observed factors within Brazil itself that have potential for creating tensions, which may ultimately force politicians to consider reforms that reduce production efficiency to achieve other social and environmental objectives.

Keywords: agricultural development, agricultural policy, biotechnology, infrastructure, Brazil, production.

BRAZIL: THE FUTURE OF MODERN AGRICULTURE?

Introduction

In the last two decades, Brazil has become an increasingly influential exporter in several agricultural markets. From 1992 to 2002, Brazilian net exports of soybeans, soybean meal, and soybean oil increased 444, 65, and 288 percent, respectively, giving Brazil a 30 to 40 percent share of world trade in these commodities. Over the same period, Brazil switched from being a net importer of corn and cotton to being a net exporter, providing 7.7 and 5.8 percent, respectively, of corn and cotton traded in 2003. Similarly, Brazil is currently the second-largest net exporter of beef and broiler meat and the third-largest exporter of pork. Brazil's growing importance in agricultural trade has drawn the attention of researchers, government officials, and farmers around the globe who are wondering how future trade flows and prices will be impacted by developments in Brazilian agriculture.

In an attempt to understand Brazil's future role in agricultural markets, the authors of this report traveled to Brazil on a fact-finding mission in September 2003 (see the Appendix for a list of institutions visited). Among the many observations made during our time in Brazil, the most striking was the universal sense of optimism expressed by producers, government officials, agronomists, and market analysts about the future growth of Brazilian agricultural production. As one producer put it, "Brazil is the future of modern agriculture!" While we may not share this farmer's bravado, his belief is not wholly unfounded. Just as important, perhaps, is the fact that the pervasive conviction that Brazil's role in international agricultural markets will continue to expand is reflected in positions taken by Brazilian officials in recent agricultural trade negotiations.

This report documents the facts and impressions gathered by the research team during our brief time in Brazil. The report is not intended to provide a complete picture of Brazilian agriculture; rather, we focus on selected areas, primarily in crop production, that are relevant for understanding Brazil's current situation and future potential. The

next section provides a general description of crop production in Brazil, including some discussion of production costs and government policies. This is followed by an explanation of public and private cooperation in investments in agricultural technology, transportation infrastructure, and biotechnology. Finally, we touch briefly on some features of livestock production before concluding with our perspective on the factors that will influence Brazil's impact on agricultural markets in the future.

Crop Production

Agronomic Conditions

Historically, crop production in Brazil was concentrated in the southeastern states of São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul (see map of Brazil, Figure 1). Soils in these states are fertile, water is abundant, and transportation to population centers and export facilities can be achieved effectively by truck. By the 1960s, however, agricultural land in these states had been fully developed and was populated by a large number of small farms. Expansion was difficult because land prices were high. Consequently, a number of farmers began purchasing large, inexpensive tracts of land in the Center-West, in Mato Grosso do Sul and Mato Grosso, to expand their operations. The region had promise because it was relatively flat and covered by grass and low trees, so it could be easily converted to cropland. However, the soils were acidic and not very fertile.

In the 1960s and 1970s, the Brazilian government facilitated the expansion of cropping activities in the Center-West through its program to increase self-sufficiency in wheat. High support prices for wheat, coupled with abundant credit to large producers, encouraged area expansion and the application of mechanized production methods. Soybeans were introduced as a second crop to follow wheat in order to increase land productivity (Schnepf, Dohlman, and Bolling 2001). Soybean production expanded dramatically in the Center-West in the early 1980s in response to three important factors: high soybean prices, the development of soil conditioning techniques that significantly enhanced the productivity of the region, and the development of soybean varieties that were suitable for the tropical climate (Embrapa staff, pers. comm.).

In cooperation with the University of Wisconsin, researchers at the University of Rio Grande do Sul developed a program of soil conditioning that dramatically increased the

productivity of Cerrádo soils. The process involves applying 3 mt of lime, 500 kg of phosphates, and 400 kg of potassium with micronutrients (predominately zinc) to each hectare of land. Before soybeans are grown, a cover crop of oats or rice is grown to build humus into the soil. Depending on the specific soil characteristics, lime and phosphorus must be added to the soil every two to five years.

Abundant and predictable rainfall is one of the most important characteristics of the Cerrádo that make it suitable for crop production. In Mato Grosso, rainfall is frequent for six months of the year (October to March), followed by six months of drier weather. Other regions further east have less predictable rainfall, and drought can be a problem as frequently as two of every five years in Bahia. Groundwater irrigation systems are developed in some parts of Bahia and more are planned, but there is concern about falling water tables. One of the important agronomic developments in Brazilian soybean culture is the application of no-till cultivation. The Cerrádo is a gently rolling plateau with loose soils in many areas, making fields highly erodible. No-till practices preserve the topsoil and increase the soil's organic matter content (Embrapa staff, pers. comm.).

Given the relatively short agricultural history of the Cerrádo region, pest problems are much lower than in the southern states. In recent years, nematode infestations have forced some producers to begin introducing corn or other crops in rotation with soybeans to control nematode populations. Since 2001, soybean rust has been a major concern among Brazil's soybean producers, with losses in 2002 estimated as high as $1.3 billion. Ongoing research at Embrapa (Empresa Brasileira de Pesquisa Agropecuária), the Brazilian Agricultural Research Corporation, is identifying management practices that have limited success at controlling the spread of the fungus. Soybean rust can be confused with brown spot early in the growing season, and preliminary results from Embrapa research indicates that more effective protection can be achieved if fungicides are applied prior to visible evidence of infection rather than after spores have formed (Embrapa, pers. comm.).

Farm Structure

Farm size in the traditional agricultural areas of the Southeast is small, averaging 30 ha or less (Schnepf, Dohlman, and Bolling 2001). With continued expansion of production in the Cerrádo, these small farms are declining in their share of Brazil's total

crop production. The dense population and high cost of land in the Southeast hinder the growth in production scale and the utilization of mechanized technology. According to researchers at Embrapa, 100 ha is the minimum scale for a soybean producer to be competitive in Brazil, and farm sizes in the Southeast average one-third of this level. As a consequence of the small size of their operations, farmers in this region usually market their crops through a cooperative, which typically subtracts $1.00/bag ($0.45/bushel) to cover marketing costs (CEPEA staff, pers. comm.). The small farms in the Southeast are also more likely to depend on government-subsidized credit to finance their operations.

Agricultural production in the Center-West has expanded rapidly since the 1960s. Soybean production has grown from virtually nothing to 14 million tons in the last 20 years. This region differs significantly in its history and farm structure from the traditional farming areas in the South. Farms in the Center-West are much larger, with more than 65 percent of farms cultivating an excess of 1,000 ha (Schnepf, Dohlman, and Bolling 2001). Large farms are often organized in holdings owned by families (e.g., the Maggi Group). According to one Embrapa researcher, there are approximately 4.5 million ha under cultivation in Mato Grosso, but there are only 3,000 significant commercial farmers. This implies an average holding of 1,500 ha per farm.

Unlike their counterparts in the South, farm operations in the Center-West are highly capitalized, utilizing advanced mechanization and state-of-the-art technologies, such as global positioning systems (GPS) to exploit precision farming practices. Farm managers and owners are generally highly educated and see themselves at the cutting edge of agriculture. These farms are market-oriented, self-financed operations that are not dependent on government subsidies. Their size and financial strength allows them to compete on international markets, and they often deal directly with multinational grain handlers. By dealing directly with major grain handlers, the farmers in the Center-West can obtain the same price as the cooperatives in the South, reportedly increasing their average profit margin from the 16 percent realized by southern farmers to 22 percent (CEPEA, pers. comm.). In several instances, the large commercial farms in the Cerrádo have built their own research, quality management, and transportation infrastructures to compensate for the lack of funding from the central government. These projects may be undertaken by a single operation or in concert with other farmers. It is this combination

of modern technology, market-oriented management, financial viability, and independence from government subsidies that lies behind the Brazilian farmer's claim to be the future of modern agriculture.

Factors Influencing Crop Mix

In a market-driven economy, the most important factor influencing a farmer's cropping decision is expected net return. Soybean area has expanded steadily in Center-West Brazil because it is the most profitable crop for most producers to grow. The climate allows double cropping, and many farmers follow their soybean crop with wheat, corn, or forage crops. Historically, corn has been grown predominately on smaller farms in the Southeast. Wheat is a risky winter crop in the South because of frost. Moreover, recent prices have favored corn over wheat, and roughly 80 percent of the area in the South has been planted to corn during the winter crop. In the Cerrádo, there was little demand for corn until recent years because most of the non-ruminant livestock production was concentrated in the Southeast. Moreover, corn yields are unpredictable because the second crop is grown during the dry season when rainfall varies substantially. However, as swine and poultry production increasingly moves into the interior, the demand for corn in the Center-West is growing. An expanding number of soybean farmers are growing corn following soybeans because soybean yields are slightly higher following corn (Embrapa staff, pers. comm.). As the second crop's share of total corn area rises, livestock producers are concerned about the certainty of corn supplies and have increased their use of input supply contracts with corn growers (FAS 2003).

In Mato Grosso, Goiás, and Bahiá cotton is planted following soybeans with rising frequency. The dry climate during the second crop season is conducive to growing high-quality cotton, and lucrative cotton prices in the mid-1990s enticed a number of soybean growers in the Center-West to introduce cotton into their rotation. Now a "cotton culture" has developed in some regions of the Cerrádo, and highly mechanized cotton operations are expanding their output and share of total domestic production.

Costs

Land values in the Cerrádo are significantly lower than in the southern states. This is the primary source of cost advantage for Brazilian soybean producers relative to the

United States. However, land values in the Center-West are rising. The extremely inexpensive land that enticed investors in the 1960s and 1970s has been purchased, and land that has been developed for crop production is valued based on its productivity. New investors are facing substantially higher land prices. Since 2001, land prices in the Mato Grosso have increased by 50 to 100 percent. Nevertheless, the price per hectare is still less than half the cost of similar land in Paraná (FNP Consultoria and AgroInformativos staff, pers. comm.). According to Embrapa sources, when the Cerrádo was first opened to crop production in the 1970s, a hectare cost about five bags of soybeans. Presently, a hectare of top-quality Cerrádo farmland sells for 150 to 200 bags of soybeans ($1,800 to $2,400 per hectare at a soybean price of $200 per metric ton).

Financing. Years of high inflation and frequent changes in government policy have created an environment of high real interest rates (in excess of 15 percent) in Brazil's commercial credit industry. The government established a commodity loan program to ease credit constraints of farmers. Under this program, producers are able to loan out up to 70 percent of the value of their projected crop, using the government's minimum price to establish crop value. Farmers are charged a nominal interest rate of 8.75 percent, which amounts to -3 percent real interest at recent inflation rates (FAS 2003). Loans are made by private banks. The total value of the loan is limited, and most producers are only able to finance production on 250-300 ha. Consequently, the government loan program has its greatest impacts in the traditional cropping regions where farm sizes are small.

Most middle- and large-sized farms in the Center-West obtain their financing from input suppliers and multinational grain handlers. Prices for inputs are often quoted in terms of bags of soybeans. The input suppliers are able to hedge the value of the credit they extend on the futures market to lock in an implicit rate of return. This mechanism also eliminates the risk of exchange rate movements because the value of inputs and soybeans are expressed in U.S. dollars. This arrangement provides producers in the Center-West with access to foreign credit at internationally competitive rates, allowing them to avoid the high-risk premiums charged by local lenders.

Taxation. The Brazilian agricultural tax system influences production and marketing decisions. Our discussions with Brazilian agricultural professionals centered around two tax issues, the interstate movement tax or ICMS (Imposto Sobre Circulação de Mercadorias

e Serviços) and property taxes. The ICMS is levied on products that are moved across state borders for domestic sale or processing. Since 1996, exports of raw material and semi-manufactured products are exempt from this tax through the "Lei Kandir." This differential treatment of exported raw materials encourages soybean processors to procure raw material from the state where the crushing facility is located. For example, soybean meal and oil from a crushing plant in Mato Grosso that is exported through a port in the South is exempt from the ICMS, as long as the crushed soybeans were procured in Mato Grosso. In contrast, soybeans grown in Mato Grosso and transported to another province for processing are subject to the ICMS, even if the meal and oil are eventually exported. Thus, it is not cost effective to process soybeans produced in the Center-West region in the southern states, because the cost of the tax paid on the movement of soybeans cannot be recovered from the exported meal and oil. Because a large portion of the Brazilian meal and oil production is exported, the tax is a substantial cost that processors seek to avoid. The continuous increase in the export share of total production may be attributed, in part, to costs associated with the ICMS (CEPEA, pers. comm.).

The ICMS also has implications for the domestic livestock industry. Soybean meal that is transported across state lines for domestic consumption is taxed, which provides some incentive for end users to locate in the same state as the crushing facilities. Thus, as more crushing facilities locate in the Center-West, the ICMS reinforces other factors, prompting livestock producers to move their production facilities inland.

The property tax on agricultural land holdings also influences development and utilization of farm land. This tax favors the utilization of property for production. In the state of Mato Grosso, agricultural land is taxed on its reported value at a maximum rate of 10 percent. However, the rate is gradually reduced to a minimum tax rate of 0.3 percent according to a set formula that depends on the utilization rate for agricultural production. Consequently, by reducing the tax burden as the share of land engaged in production increases, the tax schedule provides a de facto subsidy for agricultural production. This tax structure is intended to discourage speculative land ownership and promote agricultural development (Chris Ward, pers. comm.). One unintended consequence of the policy is that some producers allegedly misreport land values to reduce their tax burden.

Public and Private Investment Initiatives

One of the interesting dynamics driving the growth in Brazil's agricultural sector is the mixture of government and private investment. The Brazilian government has established a broad range of institutions and government programs designed to support the development and modernization of agricultural production. However, many institutions lack sufficient public funding to carry out the research and extension functions required by Brazilian farmers. Producer organizations and private companies are increasingly stepping in to fill funding gaps and to provide information and services to producers. This section discusses some of the cooperative investment and research activities encountered by the study team.

Crop Research and Technology Development

The principal government agency involved in crop research and development is Embrapa. Embrapa is organized under the Ministry of Agriculture and Food Supply, but individual research centers have substantial control over developing research priorities. Embrapa is involved in a wide range of activities related to agricultural research and technology, including plant breeding, pest management, food safety, satellite monitoring, sustainable agricultural development, and hunger relief. Soybean breeding and pest management activities are headquartered at the Embrapa facility in Londrina in the state of Paraná, but crop research activities are carried out at locations around the country to develop crops and varieties that are suited for local conditions. Embrapa research centers are organized to conduct research by crop, ecosystem, or along particular thematic lines (such as biotechnology).

Embrapa uses a decentralized approach to variety development, locating an average of one research center in each state. The research centers cooperate with private seed producers and farm organizations on product development. The Londrina research center spends about 5 million Brazilian real (R$) each year on varietal research, with R$4.5 million of that funding obtained from the private sector. The soybean research center generates genetic material that is distributed to other research stations throughout the country. In any given year, Embrapa has up to 300,000 breeding lines in the pipeline.

Traditional breeding technology is predominately employed to develop the new varieties, but Embrapa does have an active biotechnology program. The biotechnology

center in Londrina was constructed in 1997. Currently, the biotechnology program focuses on generating gene transforms, developing markers, and identifying gene functions. Particular interest is centered on drought tolerance, herbicide resistance, disease resistance, and pest resistance. They have successfully developed round-up ready varieties adapted to local conditions using technology licensed from Monsanto. Currently, no genetically modified (GM) crops developed by Embrapa have been released for planting outside of greenhouses.

Institutions in Mato Grosso. In the state of Mato Grosso, Embrapa cooperates with Aprosmat (Associação dos Produtores de Sementes do Mato Grosso), the Mato Grosso Seed Growers Association, for dissemination of soybean varieties. Aprosmat was established in 1980 as an association of commercial seed growers with the purpose of developing technical information for producers, promoting the expansion of crop production in Mato Grosso, and developing and disseminating new seed varieties. In the early 1980s, crop production in Mato Grosso and much of the Cerrádo area was underdeveloped. The primary source for technical assistance for farmers was Famato (the Federação da Agricultura do Estado de Mato Grosso), an agency of the state government. Famato initially placed its primary emphasis on providing assistance to cattle producers and later expanded its activities to soybean producers.

Research designed to develop soybean varieties adapted to the Mato Grosso region started in earnest in 1982. In 1990, Aprosmat established a laboratory for analyzing seeds in Rondonópolis. The laboratory was expanded in 1998, and a Seed Quality System (SQS) was established. Under the SQS program, Aprosmat contracts with 11 or 12 soybean farmers in the state to grow foundation seed intended for sale throughout Mato Grosso. Genetic material is obtained from Embrapa, and farmers that purchase the foundation seed pay $0.50 per bag to Embrapa in royalties. The two organizations have cooperated on producing and disseminating soybean varieties in Mato Grosso that resist stem cankers, nematodes, and soybean rust. Aprosmat also contracts for foundation seed production for corn, rice, cotton, and forage grasses. It works with a total of 62 farmers in the state (Aprosmat 2003).

In addition to its foundation seed activities, the seed analysis lab provides seed testing for farmers anywhere in Mato Grosso. In cooperation with the Mato Grosso Foundation

(MGF) (Fundação Mato Grosso), seeds are collected from farmers in 1 kg containers for analysis. One sample is collected for every 350 bags of seed (21 mt). Each farmer has an identification number that is stamped on the sample container. Some larger producers have multiple numbers corresponding to different parcels of land. The lab analyzes about 5,000 samples each year, mostly soybean seeds. However, the lab also analyzes rice, cotton, and beans, and it plans to add corn, safrina, and forage seeds in the future.

The seed samples are initially sorted by size and checked for visible signs of disease, insects, and surface defects. Then they are tested for germination rates, plant vigor, and fungus contamination. MGF members pay R$64 per sample for the analysis, and non-members pay R$78.1 per sample. Farmers use the information to identify the high-quality seeds that should be saved for planting and those that are best for commercial uses. Less than 20 percent of the sample can fail the germination or disease and pest tests to be considered suitable for seed stock (Aprosmat, pers. comm.).

The MGF was created in 1993 to provide agro-technical support for farmers in the state and is not dependant on government funding. The MGF specializes in soybeans and cotton, and its core activities are to develop new seed varieties, develop new technologies and management practices, and disseminate new technologies to producers. Roughly 70 percent of the Foundation's funding comes directly from member producers, and additional funds are generated by royalties from seed sales. Cotton growers contribute to the Foundation through a check-off system.

The MGF has 40 experimental farms scattered around the state. These farms are a key element of the Foundation's technology development and diffusion programs. The Foundation does very little direct consulting or extension work with farmers; however, it is involved in training agronomists and technicians in the use of new technologies. It also has 30 field days during the year when farmers can visit the farms to learn about new seed varieties, agrochemicals, and pest management practices. The MGF also holds meetings with farmers and agricultural specialists at its annual Cerrádo AgroShow.

The MGF collects data on the quality of seeds used in the state in an effort to improve the utilization of more productive varieties. The MGF has designated 23 member farms for foundation seed production and works closely with Aprosmat and Embrapa to develop improved varieties. The seed stocks produced by the MGF are

certified through the Ministry of Agriculture. In 1999 the MGF created Unisoja, a commercial branch focusing on the marketing and sales of MGF foundation seed. Approximately 70 percent of the Foundation's members use seed produced by the MGF.

Introduction of Genetically Modified Crops. Brazil is one of the remaining few major soybean producers that officially bans the use of GM varieties. The often diametrically opposite views of stakeholders has made the GM soybean debate in Brazil heated and contentious. The lack of a unified and consistent government policy has only added much confusion to the matter. On the one hand, producers want to have the option of being able to plant both GM and non-GM soybean, to capture cost savings and improve productivity. One the other hand, there is serious concern that Brazil will lose access to markets in Europe and Asia if GM soybeans are approved for commercial use.

The Brazilian government waffled in its position on GM soybeans. Commercial planting of Round-up Ready soybeans was initially authorized by Brazil's National Technical Commission on Biosafety in 1998. After intense lobbying by international nongovernmental organizations and consumer groups, who argued in favor of a ban on GM crops because of their concerns about potential long-run impacts of GM organisms, the Brazilian courts issued an injunction against planting GM soybeans. Recently, the Brazilian government published a provisional decree allowing farmers to plant GM soybeans for the February/March harvest in 2004 (Agra Europe, various). This appears to be a stop-gap measure until a more definitive ruling has been reached, because the decree only allows farmers who currently hold GM seeds to plant them.

In addition to the vacillation in federal policy, there are some inconsistencies between statements at the federal and state levels. For example, despite recent declarations by the Brazilian federal government that the planting and sale of GM soybeans is legal for the current marketing year, individual states have openly declared themselves GM-free zones. This is the case, for example, in Paraná, Brazil's second-largest soybean producing state. With changing policy positions at the federal level and inconsistencies between federal- and state-level policies, enforcement of GM policies in general have been weak. The confusion has also created an opportunistic attitude among some producers regarding compliance with GM bans. It is common knowledge that soybean producers in Brazil's southern area have ignored the country's ban on planting

Round-up Ready soybeans for some time. It is estimated that 60 to 80 percent of the soybeans harvested recently in the southern state of Rio Grande do Sul were genetically modified, and over 80 percent of the stocks ready for export from Brazil's main port in Paranágua are GM soybeans (Agra Europe, various).

The lack of a clear policy direction has been detrimental to Brazilian agriculture in a number of other respects. After a court challenge that resulted in the ban on GM plantings, Monsanto eliminated its GM test plots in Brazil. With most of its GM seeds secured illegally from Argentina, farmers lack training in proper handling of GM seeds. Moreover, there is no accountability for unforeseen impacts, if any, that may result from GM plantings. Illegal GM seeds also hurt the profitability of certified seed producers because farmers can secure GM seeds without paying any royalties to the seed companies. On the export side, haphazard marketing of GM soybeans increases the potential that international buyers may refuse deliveries of Brazilian soybeans if GM contamination is found or if Brazilian exporters cannot certify that their shipments are GM-free.

To date, GM soybeans have not spread into the Center-West region, largely because existing varieties are not well adapted to the tropical climate in the region (Embrapa staff, pers. comm.). However, once the government adopts a more certain position on GM crops, large producers in this region may be in a position to quickly shift to GM varieties if they believe they will be accepted by end-users. Large producers are better able to meet end user preferences because the vertically and horizontally integrated structure of many of these farms enables them to segregate varieties at the farm level and preserve the crop's identity until it reaches the grain handler. In addition, their superior quality-control structures would facilitate establishing efficient certification processes with little additional cost. Both farmers and researchers in the region believe producers in the Cerrádo are well positioned to handle an environment with both GM and non-GM soybean varieties (farm manager at Carolina Sementes Seed Farm, pers. comm.).

Infrastructure

The development of transportation and storage infrastructure in Brazil's Center-West has lagged behind the crop production explosion. Roads, railroad lines, and port facilities suitable for grain transportation were concentrated in the traditional agricultural regions of the Southeast in the 1980s. Consequently, as the Cerrádo opened up to crop

production, grain usually was transported by truck to the southern states for processing and export. Over the last two decades, processing facilities have started to move inland, and several public and private investment projects to develop transportation infrastructure have been initiated. Nevertheless, 62 percent of all agricultural products (70 percent of soybeans) shipped out of Mato Grosso are transported by truck. Railways handle 19.9 percent of Mato Grosso's agricultural exports (25 percent of soybean exports), and water transportation accounts for 12.8 percent (5 percent of soybeans). In terms of relative transportation cost, rail transportation is three times more expensive than barge transport, and trucking is nine times more costly (Famato staff, pers. comm.).

A number of investment projects are currently underway to develop rail and water transportation routes for crops grown in the Cerrádo region. One route developed by private investors uses trucks to transport grain up to 1,000 km west from Mato Grosso to Porto Velho, where the grain is loaded onto barges and transported north on the Madeira River. A private port has been built at Itacoatiara near the confluence of the Madeira and Amazon rivers, and the grain is transferred at this point from the barges to ocean-going vessels. The cost of transporting along this route is still high because grain must still be trucked long distances before it is loaded onto boats. Although the road from Cuiabá to Porto Vehlo is paved, it is very congested and in poor condition. One estimate of the transportation cost along this route is $25/mt to move soybeans from Cuiabá to Porto Vehlo by truck and an additional $8-$10/mt to ship the beans up the Madeira River to Itacoatiara. It is estimated that the port facilities on this route have an annual capacity of 750 tmt (Embrapa staff, pers. comm.).

There are alternative routes to northern ports using trucks, but these do not provide significant cost advantages. For example, crops grown in Maranhão, Tocantins, Piaui, Bahia, and Goiás can be trucked on paved roads to the port of São Luis on the northern coast of Brazil. Likewise, the Brazilia-Belém Highway can be used to transport grain from Goiás and Tocantins. A new highway from Cuiába to Santarém on the Amazon is under construction, but only 200 km are currently paved (Embrapa staff, pers. comm.). Depending on the actual origin of the crops, grain may move a shorter distance if it is transported to the southern port of Santos or the eastern ports of Ilheus and Vitória.

Recognizing the high cost of truck transportation, alternative water routes are also under consideration. The Araguaina River flows out of Mato Grosso and forms the western border of Goiás and Tocatins. This river could be used to ship grain to the port of Belém, and there are some government efforts under way to condition this water way for barge traffic. However, the large number of cataracts and environmental concerns are slowing the development of this route. There is also some potential for using the Paraguay River that flows south out of Mato Grosso into Paraguay and Argentina to export grain out of Buenos Aires. There are concerns about the environmental impacts on the Pantanál wetlands region as a consequence of developing this southern route, which currently limits its potential (Embrapa staff, pers. comm.).

Livestock Production

Beef Cattle

Before crop production took hold in the Cerrádo, cattle production was the dominant agricultural activity in the region. Roughly 35.5 percent of Brazil's 161 million cattle are located in the Center-West region. More than 75 percent of Brazil's cattle are traditional breeds, with the remaining 25 percent improved cross-breeds. Pasture-based production systems are most common in Brazil. However, unimproved pasture land in the Center-West has poor fertility and a low carrying capacity for cattle. On average, it takes five years for cattle to reach slaughter weight in a pasture-based system. Confinement or feedlot systems can reduce the production cycle to two to two and one-half years. Confinement systems are being used increasingly by producers who want to expand their operations but who are unable to purchase additional pasture land.

In an effort to improve the productivity of their pasture, some cattle ranchers are leasing this degraded pasture land to soybean producers. The rancher and the farmer often agree on a share-cropping arrangement, in which some of the soybeans produced on the pasture are returned to the rancher as rent for the land. A typical reconditioning program begins by first spraying a broad-spectrum herbicide on the pasture to kill the existing vegetation. Then lime is worked into the soil and the ground is sown to oats. The rancher's cattle may be grazed on the oats for a period of time and then removed. The oats may be harvested as forage, and then soybeans are planted on the pasture. Depending

on the agreement reached between the two parties, the land may remain in crop production for three to five years before it is returned to cattle pasture (Embrapa staff, pers. comm.). Producers we interviewed claim that there are no price premiums based on meat quality. Feeder cattle are valued by visual inspection only, while finished animals are purchased based on carcass weight after slaughter.

Brazil has the largest cattle herd in the world, and it recently exceeded Australia as the largest exporter of beef. The future of this sector is promising. Cattle growers in Brazil tend to be independent and do not rely heavily on debt financing. Nevertheless, the Brazilian government has a number of programs available to beef producers to reduce the cost of pasture improvement, constructing silos and warehouses, and purchasing machinery. The budget for 2003-04 is U.S.$0.9 billion. This figure excludes separate programs sponsored by commercial lending institutions, such as competitive export credit lines. The government has active breeding programs to improve cattle herds (cattle farm manager in Rondonopolis, pers. comm.). Brazil has been successful in controlling outbreaks of foot-and-mouth disease (FMD). Reports estimate that 85 percent of the country's cattle herd is contained in 15 of its states declared FMD-free with vaccination. The aim of Brazil's program is for the entire country to be FMD-free by 2005. Efforts to penetrate new markets and expand traditional markets are now common strategy among meat exporters and are well coordinated. Brazil has established a cattle traceability program, anticipating that international buyers will demand such information about its products in the near future. Also, Brazil recently signed a sanitary agreement with China that may open the door for increased exports in the future.

Swine and Poultry

In contrast to the cattle sector, swine and poultry production is predominantly organized through contractual arrangements between growers and integrators. This is especially true for meat produced for export markets. There are still a large number of independent swine producers who market their animals for domestic consumption (CEPEA, pers. comm.). The rapid growth in the poultry sector over the last two decades has been partially driven by the increased availability of soybean meal.

With corn and soybean production traditionally based in Southeast Brazil, nonruminant livestock production was based in that part of the country. As soybean and, more

recently, corn production have moved inland, swine and poultry production have followed. Not only abundant feed but also cheaper land costs are driving the migration of the industry. Slaughter facilities are also migrating toward the Center-West to be closer to production locations. As the number of slaughterhouses in the southern states decline, the small independent producers have fewer options for marketing their animals (CEPEA, pers. comm.). As in the cattle sector, the Brazilian government does provide some investment assistance to the swine and poultry sector through the National Bank of Economic and Social Development. Funds are available for upgrading processing facilities and for financing meat exports.

Dairy

Similar to other agricultural activities, Brazilian milk production was historically concentrated in the southeastern states, particularly in Minas Gerais and São Paulo. In recent years, production has expanded north and west, and Goiás is now the second-largest milk producing state. The increased availability of feed grains in the Center-West and the rapid adoption of ultra high temperature milk by Brazilian consumers has facilitated the shift in production away from the primary milk consuming areas. Investments by large dairy processors are expanding the base of milk production in the Center-West, where land, feed, and labor costs are lower than in traditional milk producing regions. The state of Goiás also provides some tax exemptions for investment in the dairy sector (FAS 2002).

Despite new investments, more than 30 percent of Brazil's milk production is still produced on small farms and marketed fresh through local markets and stores. The government of Brazil is taking steps to eliminate this "informal" sector of the milk market and to improve the overall quality of milk production. In 2002, the government introduced the National Program to Increase Milk Quality (Programa Nacional de Qualidade de Leite), which requires all producers to acquire on-farm cooling and storage that meets international standards by 2005. In addition, type "C" milk, the quality marketed through informal channels, will be abolished starting in 2005 (FAS 2002). Currently, 60-65 percent of producers can meet the refrigeration standard, and although milk is not priced on a quality basis, premiums are paid in some markets for cold milk (CEPEA, pers. comm.). Financing for cooled storage tanks is available for small

producers and cooperatives through the government's "Pro-Leite" program, predominately in the Center-West. The refrigeration requirement is expected to reduce the number of dairy farms in the coming years and increase the scale of production and rate of technology adoption in the dairy sector (Farina 2000). However, milk production is not expected to decline.

Perspective on the Future

The dramatic growth in Brazilian agricultural area over the last two decades has occurred in the Center-West region of the country. Area in the traditional agricultural region has been fully developed for decades, and little potential for increases in cropping area exists in these states. Of the approximately 200 mha in the Cerrádo, 137 mha has potential to be developed for agricultural production. Roughly 50 mha is currently in production. According to government policy, for every 10 hectares of new land brought under cultivation in the Cerrádo, 3 hectares must be set aside as natural vegetation. In the pre–Amazon region in northern Mato Grosso, the set-aside increases to 80 percent, and the set-aside in the Amazon is 90 percent. If these regulations are observed, an additional 60 mha could potentially come into production. It is estimated that about 50 mha of that area are good, flat tracts of land on the plateaus.

With such vast potential, the Brazilians we spoke with were uniformly convinced that crop area in the Center-West will expand. The only question is how quickly it will be cleared and prepared for production. Such expectations of fast growth and high profitability have resulted in the emergence of a well-developed network of investment facilitators that actively recruit foreign investors for the agricultural sector. Corporations and individuals investors are brought into the country to operate farms and modernize the processing sector. The Brazilian agriculture professionals we encountered expect international demand for soybeans to continue to grow, particularly in China. Barring extreme circumstances, they did not envision any realistic scenarios (such as macroeconomic conditions, price drops) under which area expansion in the Cerrádo would stop growing. The rate of growth may be affected, but growth will occur.

Despite the apparent alignment of economic incentives and financial and productive resources, there may be clouds gathering on the horizon that could have significant

impacts on further development of the Cerrádo in the years to come. Three factors are currently casting a shadow over efforts to expand agricultural area in the Center-West: the agrarian reform movement, calls to expand the Indian reserve, and environmental pressures to preserve the natural forest.

With increasing frequency, factions in favor of agrarian reform (often the landless poor) are seizing plots of land from large farmers in the Cerrádo. Once they have established occupancy, the "squatters" often have to be removed by force (Famato staff, pers. comm.). Though this problem does not seem to be creating widespread demand for land reform, the prevalence of large landowners in the Center-West and the high cost of land in the traditional agricultural regions generate conditions potentially conducive to social unrest.

Similar tensions are rising between farmers and groups that support an expansion of the National Indian Reserves. Indian reservations account for about 15 percent of the total area in Brazil. Approximately 300,000 Indians (0.2 percent of the total population) live in these reserves. Some constituents in Brazil are seeking to expand the Indian reserves to include land that is currently under private ownership. In some cases the land has already been developed for agricultural purposes. Consequently, farmers near existing reservations in Mato Grosso and other states in the Center-West are worried that they may lose some of their land if the expansion is approved. The agricultural community is also concerned that once the land is turned over to the Indian Reserve, foreign companies may be able to persuade the Indians to sell or lease the land to them for agricultural production.

Finally, international organizations continue to apply pressure on the Brazilian government and on corporations to limit deforestation in Brazil, despite the fact that the Cerrádo is not a rainforest region. Although natural forest set-asides are legislated, compliance and enforcement have fallen far short of the 30 percent goal, and estimates of actual set-aside are closer to 10 to 15 percent. Given these concerns, researchers at Embrapa and staff at the MGF both suggested that the near-term expansion in soybean area would be part of an effort to improve degraded cattle pasture. In particular, there are presently sizable tracts of pasture with low productivity, particularly in Goiás along the Brazilia-Belém highway.

Other issues are starting to surface that may eventually erode the profitability of crop production in the Center-West and dampen enthusiasm for rapid expansion. Until recently, producers in the Cerrádo have had few problems with insects or plant diseases, largely as a result of the short history of cultivation in the region. Both insects and soybean rust have appeared in the Center-West in recent years and have had a substantial impact on harvests. Introduction of new crop rotations and additional chemical applications will change the structure of costs and revenues, potentially dampening the profitability of soybean cultivation. Similarly, low land costs are one of the sources for comparative advantage in the Cerrádo. However, as land prices continue to rise, the cost of expanding production through purchase or lease of new land will increase.

Finally, there is evidence of concern about the influence and role of foreign investors, multinational corporations, and international special interest groups. Actions by some corporations and groups have raised suspicions about the long-run objectives of foreigners. For example, international mining companies have circumvented mining restrictions by negotiating directly with the Indians to secure rights to explore and exploit resources on land placed in the National Indian Reserve. One government official suggested that the mining companies conspire with special interest groups to lobby for expanding the reservations because that would give the companies easier access to the resources. It was suggested that similar ties exist between foreign investors in agriculture and international organizations supporting the expansion of the National Indian Reserve. It is also conjectured that international groups lobby for the preservation of natural forests to prevent Brazilian farmers from expanding production. Organizations such as Focus on Sabbatical are perceived as an overt attempt by American farm lobbies to prevent Brazilian farmers from expanding production in order to protect the American farmer. As farfetched as some of these ideas may sound, they resonate to some extent with those who feel Brazil's agricultural potential is being thwarted by farm subsidies in the United States and international trade agreements that favor the developed nations.

Conclusions

Is Brazil the future of modern agriculture? The answer to that question depends on your view of the future trends in international trade negotiations. Brazilian farmers in the

Center-West have achieved a remarkable degree of efficiency in recent years. Their large-scale, commercially oriented, forward-looking operations are well suited to compete in commodity markets that are constantly driven to increase productivity and reduce costs. There is no question that Brazilian agricultural production and exports will continue to expand in the future, regardless of the future envisioned. In an environment of continued trade liberalization and elimination of domestic farm support around the globe, the Brazilian model certainly has promise. What is not certain, however, is that international markets in the future will be characterized by ever-increasing liberalization.

Countries with a long history of support for the farming sector are finding it increasingly difficult to reduce domestic support for farmers. While the trend toward less-trade-distorting policies continues, the fact remains that greater numbers of politicians and farm groups are starting to embrace the idea that small farms provide social benefits that extend beyond the commodities they produce. The Common Agricultural Policy in Europe, agricultural policies in Japan, and the U.S. farm bill are all designed, in part, to slow or prevent the continued decline in the number of farms in these countries. By retaining small, family-owned farms, rural economies are strengthened and certain environmental goals achieved. Thus, by supporting higher-cost, multifunctional production practices, these policies slow the growth in farm sizes and hinder the adoption of the large-scale, low-cost model observed in the Cerrádo.

Even within Brazil itself, there is potential for tension developing between large and small producers. The small farms in southeastern Brazil will have increasing difficulties competing with their larger neighbors to the northwest. It is entirely possible that Brazil's subsidies for the small farmers may increase rather than decrease in the coming years. Throughout history, the concentration of land in a few hands has been the cause of social unrest in countries around the world. The divisions between the rich and poor in Brazil are severe, and it may become necessary at some point in the future to consider reforms that reduce production efficiency to achieve other social objectives.

FIGURE 1. Map of Brazil

Appendix

Dates and Locations Visited

September 15, 2003: Embrapa, the National Soybean Research Center, Londrina (Empresa Brasileira de Pesquisa Agropecuária Centro Nacional de Pesquisa de Soja). The research center is a government-funded facility responsible for soybean variety development, disease and pest research, and biotechnology research.

September 16, 2003: ICONE, the Brazilian Institute of International Trade Negotiations, Saõ Paulo. The institute was founded in January 2003 and currently has a staff of six researchers. The institute is a non-profit organization supported by the agribusiness sector, especially trading companies. The institute's objective is to support the government in trade negotiations on behalf of private industry.

September 16, 2003: FNP Consultoria & AgroInformativos, Saõ Paulo. FNP is a private consulting firm that collects and disseminates agricultural data for Brazil. It publishes a statistical yearbook annually. It also provides consulting and market analysis services to the agribusiness industry.

September 17, 2003: Cepea, the Center for Advanced Studies on Applied Economics (Centro de Estudos Avançados em Economia Aplicada), University of Saõ Paulo, Piracicaba. Cepea collects prices for many commodities. The center has agreements with various industry groups and is largely privately funded. The information collected by Cepea is sent to the board of exchange and the Bloomberg organization. These prices are used for to settle futures contracts for cattle, sugarcane, and coffee. The center also collects data on the costs of production for various agricultural products and transportation costs.

September 18, 2003: Aprosmat, the Mato Grosso Seed Growers Association (Associação dos Produtores de Sementes do Mato Grosso), Rondonópolis. The association was established by commercial seed growers in 1980 to develop technical information for producers, promote the expansion of crop production in Mato Grosso, and develop and disseminate new seed varieties.

September 18, 2003: MGF, the Mato Grosso Foundation (Fundação Mato Grosso), Rondonópolis. Created in 1993, the foundation provides agro-technical support for farmers in the state of Mato Grosso. The foundation specializes in soybeans and cotton, and its core activities are associated with the development and dissemination of new production technologies and management practices.

September 19, 2003: Cattle farm near Rondonópolis. The farm is family-owned and has a herd of about 600 head raised in a feed lot.

September 19, 2003: Carolina Sementes Seed Farm, Rondonópolis. The farm has roughly 15,000 hectares and produces soybeans for seed and commercial sales.

September 19, 2003: Famato, the Agricultural Federation of the State of Mato Grosso (Federação da Agricultura do Estado de Mato Grosso), Cuiabá. Famato is a state government agency that currently represents the interests of farmers in legal matters. In the past, Famato played a larger role in providing technical assistance to producers in Mato Grosso.

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