

The Brazilian Dilemma

We may be facing a seismic shift in the geography of world food trade as China emerges as a massive food importer and Brazil becomes a leading food exporter. While China is losing cropland rapidly, Brazil is gaining it at a record rate, setting the stage for a fast-expanding agricultural link between the two countries.

Over the last few decades, the dominant bilateral food-trade link was between the United States, the leading exporter of grain, soybeans, and meat, and Japan, the top importer of these commodities. Signs that the Brazil-China link could eclipse the U.S.-Japan link are already in evidence with soybeans. China is now the world leader, importing some 22 million tons in 2004—more than four times Japan's soy imports of 5 million tons. Meanwhile, Brazil replaced the United States as top exporter, shipping 44 million tons of soybeans, including soybean meal and oil, to other countries in 2004 compared with 33 million tons from the United States.¹

In 2004, China also displaced Japan as the world's number one wheat importer. It may soon do the same for feedgrains. If Brazil can accelerate the growth in its grain harvest to match that of soybeans over the last decade, it will have a large exportable surplus of grain to help cover

the expanding needs of importing countries such as China. However, it will be exceedingly difficult for Brazil to duplicate the soybean expansion for both economic and ecological reasons.²

There are also signs that China may move ahead of Japan as an importer of meat in the not-too-distant future. In some recent years, China has imported more poultry than Japan has. With imports of pork rising, China may overtake Japan here as well. With beef, however, Japan's imports lead the world, while China's are still negligible. On the export side, Brazil's fast-growing exports of pork, poultry, and beef are in the process of overtaking those of the United States. Barring some unexpected event, Brazil soon will be the world leader.³

The pressures to push back the agricultural frontier in Brazil will be intense in the next few decades, since this is the only country with a vast land area that potentially can be cropped. Economic forces and political pressures for Brazil to expand its cultivated area are strong and growing stronger. The world urgently needs more grain and high-quality protein. Projections indicate that nearly 3 billion people will be added to world population by 2050, some 5 billion people in developing countries want to move up the food chain, 840 million people are still chronically hungry and malnourished, and the backlog of technology to raise land productivity is shrinking. Throughout the late twentieth century, additional demand for food from population growth translated into efforts to raise land productivity, but now as that becomes more difficult, continuing population growth is generating pressure to expand the cultivated area.⁴

This pressure to clear more land means the worst fears of environmentalists may be realized. The prospect of losing so much of the earth's remaining biological diversity is scary, to say the least. In our increasingly inte-

grated world, the fate of both Brazil's Amazon basin and the *cerrado*—a savannah-like region the size of Europe on the basin's southern edge—can no longer be separated from the family planning decisions of hundreds of millions of couples outside of Brazil and the aspirations for a better diet of billions more.

Can Brazil dramatically expand its cropland area and avoid the ecological catastrophe that followed on the heels of the last major cropland expansion initiative, the Soviet Virgin Lands Project in the 1950s? Can Brazilian agriculture expand in a way that will respond to growing world food needs and at the same time protect the rich diversity of life in the Amazonian rainforest and the *cerrado*?⁵

World's Leading Source of Soybeans

For Brazil, the door into the soybean world opened in 1972 with the collapse of the massive Peruvian anchovy fishery, a leading worldwide source of protein supplements in livestock and poultry rations. Since this fishery accounted for one fifth of the world fish catch and for an even larger share of animal feed protein supplements before its demise, its abrupt collapse created a protein shortage that drove soybean prices off the chart. These steep price rises, combined with a U.S. soybean export embargo in 1973 when Washington tried to check the inflationary rise in domestic food and feed prices, set the stage for Brazil's entry into the market. The embargo, which raised concerns about the reliability of the United States as a supplier, led importing countries in Europe plus Japan to encourage soybean production in Brazil and Argentina.⁶

In a prescient move, the Brazilian government invested heavily in a comprehensive soybean research program, including the breeding of varieties adapted specifically to local soils and growing conditions throughout the coun-

try. Government leaders also started thinking seriously about how to create the infrastructure needed to link the country's vast unplowed interior to world markets. These research initiatives, along with economic incentives, boosted Brazil's soybean production from 1 million tons in 1969 to 15 million tons in 1980.⁷

Initially, production growth was concentrated in the traditional farming regions in the south—the states of Rio Grande do Sul, Santa Catarina, Paraná, and São Paulo—but after 1990 it began to spread rapidly into the *cerrado*. (See Figure 9–1.) *Cerrado* soils are highly acidic, saturated with aluminum, and low in phosphorus, with a



Figure 9–1. The Cerrado of Brazil

limited capacity to store water. These characteristics provided a formidable barrier to cultivation until Brazilian scientists discovered that adding 3–8 tons of lime per hectare reduced the acidity and neutralized the free aluminum in the soil. Once this was done, the deep well-drained soils of this savannah-like region could be farmed. Liming and heavy fertilization, combined with the breeding of varieties that could tolerate higher aluminum levels, set the stage for the expansion.⁸

On the downside, as Kenneth Cassman of the University of Nebraska notes, it is likely that soil organic matter will deteriorate rapidly in these tropical and subtropical soils, where temperature, humidity, and abundant rainfall all favor the decomposition of organic matter and crop residues. This contrasts with the U.S. Corn Belt, where cold winters slow down soil decomposition. The carbon sequestration on this land once it has been tilled for a few years will be far less than in the original *cerrado*, thus contributing to higher atmospheric carbon dioxide levels.⁹

Analysts estimate that the Brazilian *cerrado* includes an additional 75 million hectares (185 million acres) of potentially cultivable land, an area almost as large as the U.S. area planted to grain and soybeans. Although Brazil now produces one third of the world's soybeans, U.S. Department of Agriculture experts believe the country has the potential to easily triple its current soybean production.¹⁰

Argentina has also achieved hefty gains in soybean production, but its potential for continuing rapid expansion is limited compared with Brazil. Indeed, part of Argentina's soybean expansion has been at the expense of grain.¹¹

Brazil's soybean production has expanded at a pace rarely matched for a major crop in any country. In 1969, Brazil was producing only 1 million tons of soybeans. (See Figure 9–2.) By 1986, it produced 13 million tons

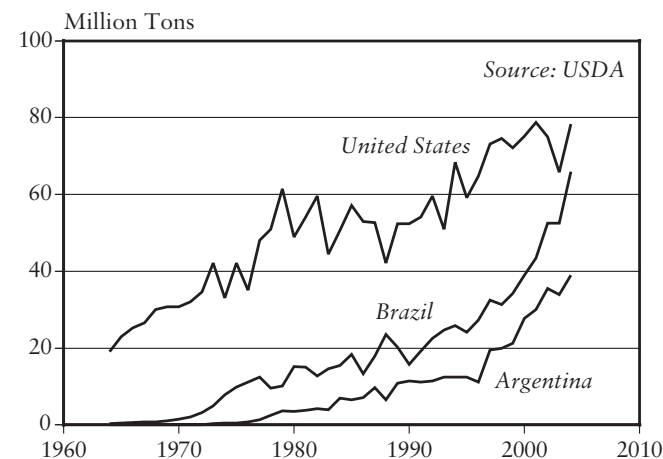


Figure 9–2. Soybean Production by Country, 1964–2004

compared with a U.S. output of 53 million tons. Since then, Brazil's production has expanded more than five-fold—jumping to 66 million tons in 2004, compared with U.S. production of 78 million tons. Within the next few years, Brazil is likely to become the world's leading soybean producer, a position held by the United States since it displaced China a half-century ago. While Brazil can expand soybean output severalfold, the U.S. potential for expansion is limited by the lack of new land to plow.¹²

On the import side of the equation, China's soybean imports, which were negligible a decade ago, are now four times those of Japan, the traditional leader. (See Figure 9–3.) For several decades the largest movement of soybeans between two countries was that between the United States and Japan. Now the largest bilateral flow is between Brazil and China.¹³

By 2004, Brazil's 24 million hectares of soybeans had exceeded not only its area of corn, wheat, and rice individually, but the area of all of them combined. The 2004

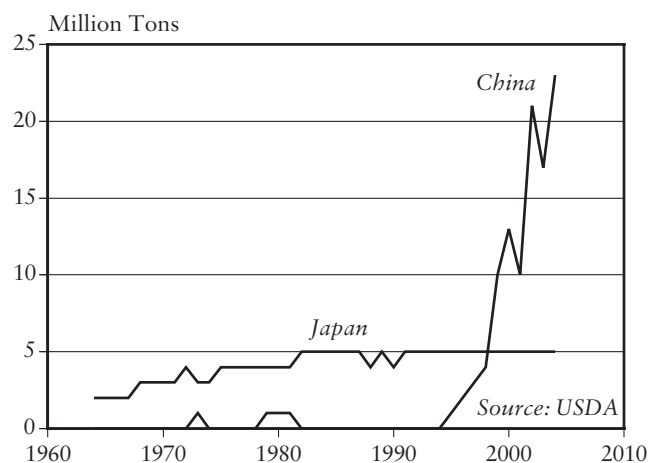


Figure 9-3. Soybean Imports into China and Japan, 1964–2004

soybean harvest of 66 million tons exceeded the grain harvest of 60 million tons (Figure 9-4), marking the first time an oilseed harvest has eclipsed that of grain in any large agricultural country. In the United States, the area in soybeans passed that in wheat in 1978 and now rivals that planted to corn. Even so, total U.S. soybean production of 78 million tons in 2004 is scarcely one fifth the size of the U.S. grain harvest of 360 million tons.¹⁴

Brazil's national agricultural research network, EMBRAPA, has worked hard and successfully to adapt temperate-zone soybean varieties to Brazil's subtropical growing conditions. Reflecting its success, the soybean yield per hectare in Brazil today has edged above that in the United States, long the world leader.¹⁵

Despite Brazil's extraordinary successes, future expansion will not always be easy. Brazil's soybean growers are faced with a debilitating Asian rust disease that is now curbing yields. Spraying crops with a fungicide to

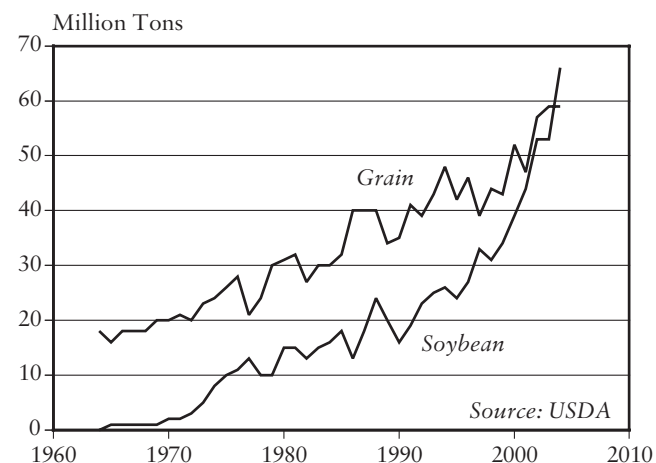


Figure 9-4. Grain and Soybean Production in Brazil, 1964–2004

control the disease, which cost \$1.2 billion in 2003 and 2004, is sometimes ineffective because frequent rains wash the treatment off the plants. In some areas, the cost of protecting the soybeans from this damaging disease may now go as high as 50¢ per bushel, which represents roughly 8 percent of the crop's value based on prices over the last decade.¹⁶

A lack of infrastructure, principally roads and electricity, also hinders Brazil's soybean expansion. Because the *cerrado* on average is some 1,600 kilometers by road from the east coast ports, getting soybeans from the interior to points of export is costly. Although Brazil's cheap land gives its soybean farmers a huge edge over their U.S. counterparts, the United States has a well-developed barge system for moving the product from the Midwest down the Mississippi River to the port of New Orleans. Beans destined for Asia also can move easily by rail from the U.S. Midwest to West Coast ports such as Seattle and Portland.¹⁷

Transportation costs loom large for Brazilian exports of soybeans and grain. First the commodities must be moved to a port either on the coast or on one of the tributaries of the Amazon. Ships loading at Amazon ports have to travel more than 1,500 kilometers, or nearly a thousand miles, merely to get to the Atlantic Ocean. If they are going to Asia, they must then either go north through the Panama Canal or south around the Cape of Good Hope. Either way, the distance is some 20,000–22,500 kilometers. Even shipping to Europe is costly. Marty McVey and his colleagues with AGRI Industries point out that shipping soybeans from Sapezal, Mato Grosso, to Europe costs \$1.59 a bushel, while from Iowa it is only 84¢, barely half as much.¹⁸

Within Brazil, simply getting soybeans from the more remote parts of Mato Grosso, which straddles the *cerrado* and the Amazon basin, to port can be costly. In a world where oil prices are likely to be rising, the variation in transportation costs of moving soybeans, corn, or meat to the outside world could shape Brazil's pattern of development, pushing it toward meat exports rather than the far bulkier shipments of grain.¹⁹

Creating the agriculture transport infrastructure within Brazil will take time and, among other things, vast amounts of capital investment. Nonetheless, these barriers are not insurmountable. Soybean output will likely continue expanding until Brazil becomes the world's largest producer, most likely well before the end of this decade.

Feed Supplier for the World?

Brazil's impressive capacity to raise soybean production has raised questions about whether it could also become a leading world supplier of grain for food and feed. As of 2004, the country is a modest net importer of grain and has been for several decades. Like other tropical coun-

tries, it has difficulty producing wheat in its tropical and subtropical regions. Brazil's wheat is produced almost entirely in its southernmost states, on the border with Argentina. Given the heavy fertilizer requirements in the *cerrado*, wheat production costs in the expansion region are nearly double those of Argentina and the United States. It thus seems unlikely that Brazil will emerge as a wheat exporter unless world wheat prices climb far beyond current levels.²⁰

Wheat and rice are Brazil's two food staples. The nation consumes roughly 10 million tons of wheat per year, producing half and importing half. In contrast, it consumes roughly 8 million tons of rice a year and is essentially self-sufficient. Given the tightening rice situation in Asia, could Brazil boost its rice production enough to produce a surplus for export to Asia? Is there enough water in Brazil's rice-growing states, all in the south, to expand production of this water-intensive grain? The Amazon basin has an abundance of water, but are its soils suited to rice production?²¹

Corn, which totally dominates Brazil's grain harvest at over 40 million tons a year, is used primarily as a feed-grain. Until recently, Brazil imported corn, but it is now self-sufficient and typically exports a few million tons per year. Corn rotates well with soybeans since the latter fix nitrogen, for which corn has a ravenous appetite. Soybeans grown in rotation with corn are less vulnerable to damage from disease and insects, but corn and soybeans are not a perfect marriage in Brazil, simply because corn yields are relatively low on the *cerrado* soils. While Brazil's soybean yields match or exceed those in the United States, its corn yields run around 3.5 tons per hectare, compared with U.S. yields of 9 tons. In addition, corn grown on the nutrient-poor *cerrado* soils requires heavy doses of fertilizer, especially nitrogen. Unfortunately,

nitrogen leaches through these porous soils, leading to high nitrogen levels in both surface and underground water.²²

Beyond these agronomic and environmental issues, transport costs are formidable. Although a bushel of corn is worth less than half as much as a bushel of soybeans in the world market, the cost of transporting it from the remote interior to the coastal ports is the same. Whether Brazil could overcome the combination of heavy fertilizer requirements, low yields, and high transportation costs to become a major corn exporter remains to be seen.²³

Corn is not the only feedgrain option. Sorghum is also a possibility. Although sorghum output in Brazil is limited, the annual harvest has jumped from less than a million tons to over 2 million tons within the last three years. Since this is a drought-tolerant crop that does well during the dry season, it could find an ecological niche in the rotation systems in the drier regions of the Brazilian *cerrado*.²⁴

Brazil's annual net grain imports of 8 million tons during the 1990s have dropped to a modest 3 million tons, mostly wheat, during the current decade. Given the robust character of the country's agriculture, the net imports could be eliminated entirely and Brazil could become at least a small net exporter, largely on the strength of its corn exports. The key question is, How much would the world corn price have to rise to justify a large expansion in production for the world market?²⁵

Brazil has demonstrated clearly that when the world soybean price is \$6 a bushel or above, farmers will invest in the land clearing and the government will invest in the needed infrastructure to expand soybean production and exports rapidly. It is doubtful, however, that it can produce large quantities of corn for the world market at

the \$2.50 per bushel price of recent years if the transport cost to Europe is \$1.59 a bushel, as it is for soybeans. It does not seem likely that Brazil will become a major supplier of grain to the world unless corn prices rise to \$4 or so. Brazil's weakness as a grain producer is evident when it is compared with the United States. While it is about to overtake the United States in soybean production, it produces only 60 million tons of grain compared with 360 million tons in the United States. (See Figure 9-5.)²⁶

Meat Exports Climbing

An expanding world market for meat combined with surging domestic consumption is spurring rapid growth in Brazil's beef, pork, and poultry sectors. Total meat exports have expanded from scarcely a half-million tons in 1990 to 4 million tons in 2004, enabling Brazil to challenge the United States for world leadership.²⁷

Brazil has the world's largest commercial cattle herd,

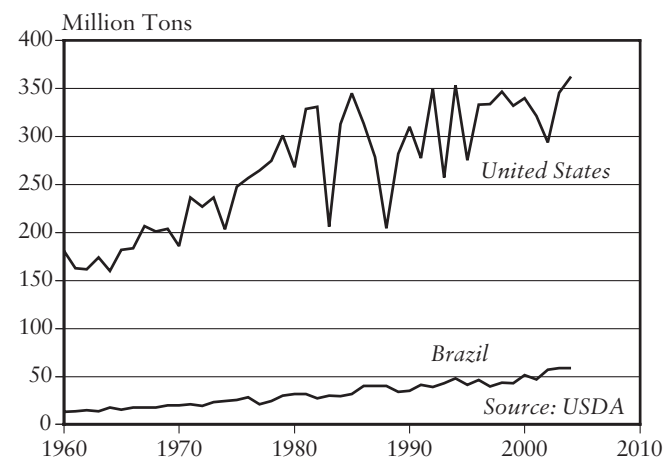


Figure 9-5. Grain Production in Brazil and the United States, 1960-2004

with 190 million cattle. (See Figure 9–6.) With the eradication of foot-and-mouth disease in the key cattle-raising states—including Mato Grosso, Rondônia, and Tocantins, which straddle the *cerrado* and the Amazon—and with eradication of this disease expected nationwide by 2005, many new markets have opened up for Brazilian beef. Interested buyers include not only industrial countries, such as those in Western Europe, but also developing countries, such as Chile, Egypt, and Saudi Arabia. In anticipation of this export growth, the annual increase in the Brazilian herd jumped from less than 2 million during the 1990s to 6 million from 2000 to 2004. Much of this growth is occurring on the edge of the Amazon.²⁸

Brazilian beef exports leapt from 200,000 tons in 1995 to 1.4 million tons in 2004, just edging out Australia and the United States, the traditional leaders in beef exports. Growth in demand for beef was driven by the expanding domestic market until the December 1998 devaluation of the Brazilian real, which made Brazilian

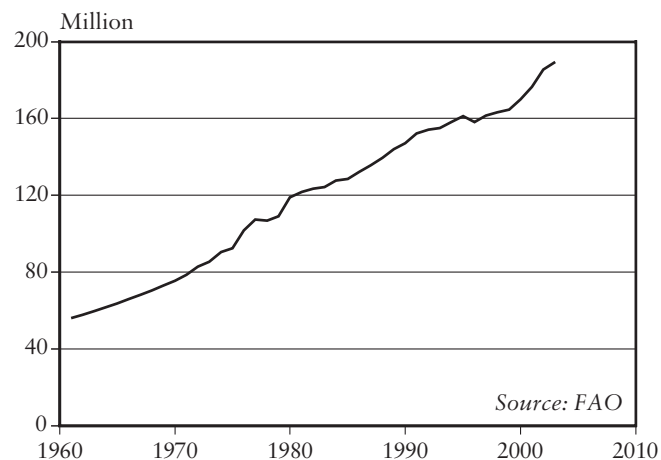


Figure 9–6. Number of Cattle in Brazil, 1961–2003

beef much more competitive in world markets. (See Figure 9–7.) The resulting expansion of exports raised the price of beef in the Amazon.²⁹

In contrast to the situation with beef, Brazil is a second-tier producer of pork, with only 2.5 million tons a year compared with 9 million tons in the United States and a staggering 46 million tons in China. Yet Brazilian exports of 400,000 tons of pork put it third among exporting countries, trailing only Canada and the United States.³⁰

With poultry, Brazil is both a leading producer and exporter. Its rapidly growing production may overtake China within the next few years, leaving it second only to the United States. Exports have climbed to 2.2 million tons in 2004, matching those of the United States.³¹

In summary, Brazil's exports of beef, pork, and poultry are expanding steadily. It is the leading exporter of beef, ranks third in pork, and is vying with the United States for the lead in poultry. With beef, Brazil is essentially exporting grass, part of it grown on land in the

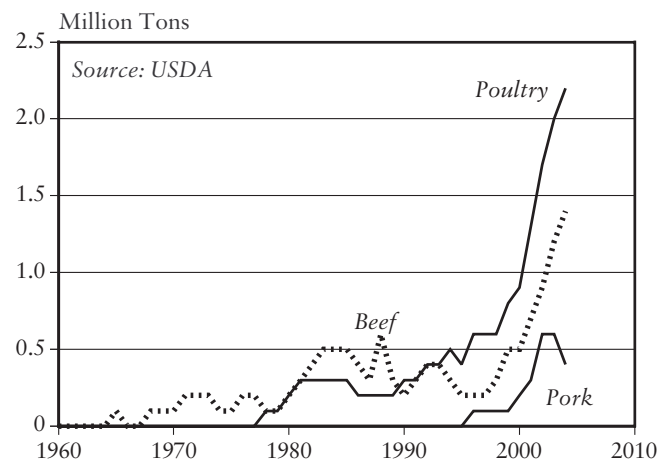


Figure 9–7. Meat Exports from Brazil, 1960–2004

Amazon basin that was until recently covered by rainforest. But when it comes to pork and poultry, it is basically grain that is being exported. While no precise data are available, Brazil appears to be exporting close to 10 million tons of grain in the form of meat. It may be that the country's future lies not so much in exporting grain per se as it does in exporting grain indirectly in the form of pork and poultry.³²

Domestic Demand Growing

Brazil's capacity to export grain will be affected by its fast-growing domestic needs, fueled by a population that is currently expanding by 2 million per year. By 2050, Brazil's population is projected to reach 233 million, four fifths of the current U.S. population of 297 million. Annual income per person is projected to go from \$2,400 today to \$26,000 in 2050. This compares with \$27,000 in Canada today and \$34,000 in the United States.³³

As incomes rise, Brazilians will move up the food chain, consuming more grain-intensive livestock products. Although meat consumption is dominated by beef, which is almost entirely grass-fed, the consumption of pork and poultry, both grain-fed, is rising. At present, two thirds of the grain used in Brazil is consumed indirectly in the form of livestock products. Of the nearly 44 million tons of animal feed used in 2003, 24 million tons were for poultry and egg production, 13 million for pork, 4 million for cattle, and 3 million for other uses. Grain used for feed is likely to continue rising in parallel with the consumption and export of grain-rich livestock products.³⁴

One way of assessing future demand for grain is to look at recent trends. Between 2000 and 2004, annual grain consumption in Brazil grew 2 million tons a year. If it continues to grow this much on average as both its population size and income levels approach those of the

United States today, total grain consumption would climb to 154 million tons by 2050. This compares with current U.S. grain consumption of roughly 240 million tons per year and would mean that Brazil's farmers would need to add roughly 100 million tons of grain production to current output just to remain self-sufficient.³⁵

Stated otherwise, Brazil would need to nearly triple its grain harvest by 2050 to satisfy the growth in domestic demand. By comparison, over the last half-century the United States has doubled its grain harvest, nearly all of it by raising land productivity. Given this large projected domestic demand for grain and the high cost of shipping corn to markets in Europe and Asia, Brazil will not easily develop a large exportable surplus of grain.³⁶

Expansion: The Risks and Costs

Brazil has embarked on a massive expansion of its cropland area. Unlike the land planted to grain, which has changed little over the last three decades, staying at around 20 million hectares a year, the area in soybeans exploded from 1 million hectares in 1970 to 24 million hectares in 2004. Half of this growth came after 1996, most of it in the *cerrado*, with the remainder in the Amazon basin.³⁷

But is this expansion sustainable? As noted earlier, the last massive cropland expansion anywhere in the world was the Soviet Union's Virgin Lands Project during 1954–60. Within a matter of years, the Soviets had plowed an area of grassland for wheat production that was larger than the wheatlands of Canada and Australia combined. Although it boosted production initially, this plan soon turned into an ecological disaster.³⁸

Not long after the expansion, which was centered in Kazakhstan, a huge dust bowl began to form. Not only has half the land now been abandoned, but the wheat

yield on the remaining land is scarcely 1 ton per hectare—one sixth the yield in Western Europe.³⁹

Many ecologists are concerned about soil erosion in the *cerrado* if this region is cleared of vegetation on the scale that now seems likely. In the state of Mato Grosso there is already evidence of damaging wind erosion. To the west, across the border in Bolivia, soil erosion is undermining land productivity in an area near Santa Cruz that pioneered growing soybeans beginning in 1970.⁴⁰

One advantage that the *cerrado* has over the land cleared in the Soviet Union is that rainfall is much heavier, typically 39–75 inches a year. This helps explain why the yield per hectare of Brazil's soybeans, grown largely in the *cerrado*, has eclipsed that of the United States, the traditional leader.⁴¹

While the clearing of the *cerrado* is largely soybean-driven, that of the Amazon is much more cattle-driven. Nevertheless, it is the vast worldwide market for soybeans that is financing the transport infrastructure in Brazil's interior, both within the *cerrado* and into the neighboring Amazon. This is what makes the Amazon accessible to small farmers, commercial farmers, and cattle ranchers. Phillip Fearnside, a leading authority on environmental issues in Brazil says, "Soybeans are much more damaging than other crops, because they justify massive transportation infrastructure projects that unleash a chain of events leading to the destruction of natural habitats over wide areas in addition to what is directly cultivated for soybeans."⁴²

Beyond this, the commercial strength of soybean production also enables growers to buy land that already has been cleared by cattle ranchers and by small farmers located either near or in the Amazon, which drives the sellers further into the Amazon in their quest for cheaper

land. Thus while the soybean is an unrivaled source of protein in a protein-hungry world, it is also a powerful new threat to the biological diversity of Brazil.⁴³

Unfortunately, the Brazilian government itself is working to open the Amazon to development. The principal umbrella for this, a program known as *Avanço Brasil* (Advance Brazil), is intended to open up areas to industrial, agricultural, logging, and mining activities in a way that will accelerate development of the Brazilian economy. A recent article in *Science* reports, "Investment totaling about \$40 billion over the years 2000–2007 will be used for new highways, railroads, gas lines, hydroelectric projects, power lines, and river channelization projects. The Amazonian road network is being greatly expanded and upgraded, with many unpaved sections being converted to paved, all weather highways."⁴⁴

The devaluation of the real and the progressive eradication of foot-and-mouth disease together have raised the price of beef and the profitability of cattle ranching in the Amazon. It is accelerating expansion "of the region's road and electricity network and large investments in modern slaughterhouses and meat-packing and dairy plants," according to the Center for International Forestry Research. The center further notes, "Very low land prices in the Amazon also help to make ranching profitable. These prices remain very low in part because farmers find it easy to illegally occupy government land without being prosecuted, and to deforest areas much larger than the 20 percent of each landholding currently permitted by law."⁴⁵

As roads are cut through the Amazon, pulling settlers, loggers, and ranchers further into the region, the forest is becoming increasingly fragmented. Once the rainforest canopy is disrupted, the incoming sunlight dries out the land, leaving the understory vegetation vul-

nerable to fire. As a result, fires that are intentionally set to clear land sometimes burn out of control, making the forest more vulnerable to fires caused by lightning. A healthy rainforest does not burn simply because it is too wet, but once the forest is fragmented, it dries out and loses this natural defense.

One of the principal manifestations of this vulnerability is the growing number of forest fires now systematically recorded by satellites. The fire season in the Amazon, now an annual occurrence, has become an identifiable phenomenon only in the last few decades.⁴⁶

In addition to the soil erosion and degradation associated with the loss of forest cover, there is a risk that the forest clearing could jeopardize the recycling of rainfall inland. The traditional agricultural region in the Brazilian south, not to mention in neighboring Bolivia, Paraguay, Uruguay, and northern Argentina, is watered by moisture-laden air masses from the Atlantic that move westward across the Amazon and then flow south as they approach the Andes.⁴⁷

As land is cleared of vegetation for either farming or cattle ranching, its capacity to recycle rainfall inland is reduced. Some 20 years ago, Brazilian scientists Eneas Salati and Peter Vose published a landmark article in *Science* analyzing the effect of deforestation on rainfall recycling in the Amazon. They noted that when rain from the moisture-laden air masses that originated over the Atlantic fell on healthy rainforest, about one fourth ran off, returning to the Atlantic Ocean, and three fourths evaporated into the atmosphere either directly or through transpiration and was then carried further inland to again come down as rainfall. This explains how rainforests get their name. It also explains why rainfall is heavy throughout the Amazon basin and south of it, in the *cerrado*, as well.⁴⁸

By contrast, Salati and Vose showed that when rain falls on land that is cleared for grazing or cropping, the runoff/evaporation ratio is reversed as roughly three fourths of it runs off, returning to the sea, leaving only one fourth to evaporate and be carried further inland. Thus the loss of at least 2 million hectares of Amazonian forest a year is slowly weakening the water recycling mechanism that brings water to the agricultural regions of south-central Brazil.⁴⁹

Another cost, not only for Brazil but for the world, of clearing vast areas of the Amazon rainforest and the *cerrado* to produce corn and soybeans and to graze cattle is the loss of plant and animal species. The Amazonian rainforest is one of the most biologically rich regions in the world. Although there are mechanisms in place that are designed to protect this diversity, such as the requirement that landowners clear no more than one fifth of their land, the government lacks the capacity to enforce this.⁵⁰

The *cerrado* is also biologically rich, with thousands of endemic plant and animal species. It contains many large mammals, including the maned wolf, giant armadillo, giant anteater, deer, and several large cats—jaguar, puma, ocelot, and jaguarundi. The *cerrado* contains 837 species of birds, including the rhea, a cousin of the ostrich, which grows six feet tall. More than 1,000 species of butterflies have been identified. Conservation International reports that the *cerrado* also contains some 10,000 plant species—at least 4,400 of which are not found anywhere else.⁵¹

On March 15, 2004, President Lula da Silva announced an “action plan to prevent and control deforestation in the Legal Amazon.” This plan allocates \$135 million to a range of activities, including land use planning and greater enforcement of laws concerning both the illegal occupation of government lands and their deforestation. It also commits resources to monitor

deforestation using satellite images. Notwithstanding this and other similar initiatives in the past, the forces that are driving the growing world demand for soybeans and beef, which in turn are driving the deforestation, continue to gain momentum.⁵²

According to Brazil's National Institute of Space Research, just over 2.5 million hectares of the forest in the Amazon disappeared in 2002. If anything, that number is likely to increase when the data for 2003 become available. From 1990 to 2000, cumulative deforestation in the Brazilian Amazon increased from 42 million hectares to 59 million, an average of 1.7 million hectares per year. The area of Amazonian forest lost over the decade was equal to two Portugals.⁵³

A recent article in *Science* summed up the situation: "Conserving Amazonian forests will not be easy. If the world expects Brazil to follow a development path that differs from its current one, and from a path that most developed nations have followed in the past, then substantial costs will be involved. The investment, however, would surely be worth it. At stake is the fate of the greatest tropical rainforest on earth."⁵⁴

If there is no coordinated effort for developing Brazil's interior, including both the *cerrado* and the Amazon, that integrates economic and environmental goals, many species will be threatened and countless numbers of them will likely disappear. This could lead to the greatest single loss of plant and animal species in history, biologically impoverishing not only Brazil but the planet on a scale that we cannot easily imagine.

Data for figures and additional information can be found at www.earth-policy.org/Books/Out/index.htm.