SAINT JOHNS UNIV (MNJ)

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LOCAL ID CSB Clemens General Collection, TX558.S7 W67 2008

TITLE
The world of soy /

AUTHOR

VOLUME
ISSUE
ARTICLE AUTHOR
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ARTICLE TITLE
Soybeans and Soyfoods in Brazil, with notes on Argentina: Sketch of an Expanding World Commodity

DATE
PAGES 234-256
ISBN 9780252033414
ISSN

DUE DATE

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The World of Soy

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UNIVERSITY OF ILLINOIS PRESS
Urbana and Chicago

TX
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Library of Congress Cataloging-in-Publication Data
The world of soy / edited by Christine M. Du Bois,
Chee-Beng Tan and Sidney W. Mintz.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-252-03341-4 (cloth : alk. paper)
1. Soyfoods.
2. Cookery (Soybeans)
3. Food habits.
I. Du Bois, Christine M., 1962– II. Tan, Chee Beng. III. Mintz, Sidney Wilfred, 1922–
TX558.S7W67 2008
641.3'5655—dc22 2007046950

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Soybeans and Soyfoods in Brazil, with Notes on Argentina

Sketch of an Expanding World Commodity

IVAN SERGIO FREIRE DE SOUSA AND
RITA DE CÁSSIA MILAGRES TEIXEIRA VIEIRA

Introduction

In Latin America, the direct presence of soybeans in human nutrition is a recent development with uncharted growth ahead.[1] This growth, however, will probably not parallel their history in Asian cuisine. Ongoing changes in food technology alongside the creativity of local chefs will eventually bring the soybean into the Brazilian diet. Fortunately, technological advances, such as improvements in the product's taste and odor, have eliminated some of the soybean's less desirable qualities.

Thanks to its high protein content and to animal husbandry research in the United States and Europe, the soybean plays a role in Latin America today as a basic component of animal nutrition. Its insertion into the system of meat production has been clearest in Brazil and Argentina.

All kinds of interests (economic, political, social, and scientific) combine and interweave powerful global networks[2] of transformation and development where soybeans are concerned. The beans have generally been sold in three main forms: as whole soybeans, as soy meal,[3] and as soy oil. Derived from those original forms, there are now a multitude of products for humans, for animals, and for many industries (e.g., pharmaceuticals).

The soy network is tightly enmeshed with other strong networks such as those dealing with poultry, swine, cattle, and animal feed. The soybean, then, is not merely a cash crop but instead brings to Latin American agribusiness a new and powerful motor of change. In Brazil, agriculture found

in the soybean a powerful force for the dissemination of inputs, machines, silos, and processing units. The crop is always associated with the use of research-generated technologies and agricultural expansion; its presence supports whole regions of the countryside.

Soy also plays a crucial role in the internal Brazilian food supply. Derivatives such as oil and other components for processed foods have extraordinary importance in the daily diet of the population of all classes.

In the 2003–2004 harvest, Brazil and Argentina together contributed about 47 percent of total world soybean production. The combined production of these countries surpassed production in the United States, the current global leader. The three countries produce 81 percent of the world's soybeans (USDA/FAS 2004).

North America's share of soybean production has recently declined due to increasing competition from Brazil and Argentina. Brazilian soybean production grew from 1.5 million metric tons in 1970 to 51 million metric tons in 2005, with an expected 52.4 million metric tons in 2006. In Argentina soybean production may have leveled off, with 38.3 million metric tons produced in the 2004–2005 harvest (Brazil 2004; SAGPyA 2006; IBGE 2006).

Factors such as the strength of the dollar relative to South American currencies as well as North American price support programs (which indirectly raise the price of land) have been limiting somewhat the competitiveness of the North American product. The expansion of soy agriculture in South America has also been spurred by favorable conditions in external markets, adaptation and generation of varieties, other agronomic research, increases in crushing capacity, rapid growth of the poultry sector, agricultural policy incentives, and technical support for farmers.

Evolution of Soybean Production in Brazil and Argentina

Until the mid-1960s, soybeans did not figure among the main crops of Brazil and Argentina. In the late 1960s and early 1970s, however, soybean production experienced extraordinary growth, altering its relative importance on the national and international scenes (Soskin 1988; Warnken 1999).

In the early 1960s the main motive for soybean production was to obtain vegetable oil, not protein meal. In the latter part of that decade, Brazil's increasing need for foreign exchange earnings prompted the government to encourage meal export. Domestic soybean processing was greatly stimulated. At the same time, soy oil began to be a more important consumer item.

Expansion was further stimulated by President Richard Nixon's decision in 1973 to restrict soy exports from the United States. This greatly upset the Japanese, who were quite dependent on U.S. soybeans and therefore turned to Brazil for soy. This event propelled Brazilian soy production to the world stage. In 1974 with Japanese financial support, a program was launched to transform Brazilian savannahs into areas suitable for a dynamic agriculture. The program known as PRODECER (short for Japanese-Brazilian Cooperation Program for Cerrado Development) began concrete actions in 1978. The pilot project was financed by the Japan International Cooperation Agency with monetary resources managed by Japan's Long Term Credit Bank. The later expansion project was funded by Japan's Overseas Economic Cooperation Fund.

Warnken (1999) has pointed out six key Brazilian policy objectives tied to soybean agriculture: saving foreign exchange, increasing foreign exchange earnings, improving the national diet, stimulating industrial development, holding down food price increases, and territorial occupation. These motivations led to such a rapid rise in production and crushing of soybeans during the 1970s that Brazil became the world's top exporter of soy meal, although the country has recently been supplanted by Argentina. While the emergence of soy production in Argentina followed Brazil's by about a decade, Argentina is now the world's largest exporter of oil and meal, with Brazil ranked second (USDA/FAS 2005c). The bulk of Brazilian soy oil is consumed internally.

In Brazil, the expansion of soybean production has occurred most notably in the southern and west-central regions. During the 1960s, soybean production was mainly located in the northern part of Rio Grande do Sul and in the state of Paraná. These southern lands lie principally within the same humid, warm semitropical latitudes as the northern portions of Argentina's agricultural region. Brazil's southern region has been for decades among the world's most productive agricultural zones.

In 1980 under a variety of government incentives, agriculture expanded into the *cerrado* (savannah) lands of Brazil's interior states. Today, the central-western region rivals the south as the main area of agricultural production within Brazil. The region lies entirely within South America's sprawling tropical zone. As a result, Brazil has had to develop crop varieties adapted to the lower variability of day length and to temperatures associated with tropical agriculture (figure 9).

By 2002, the traditional soybean-producing areas remained important, but less significant than before, as the central-western state of Mato Grosso

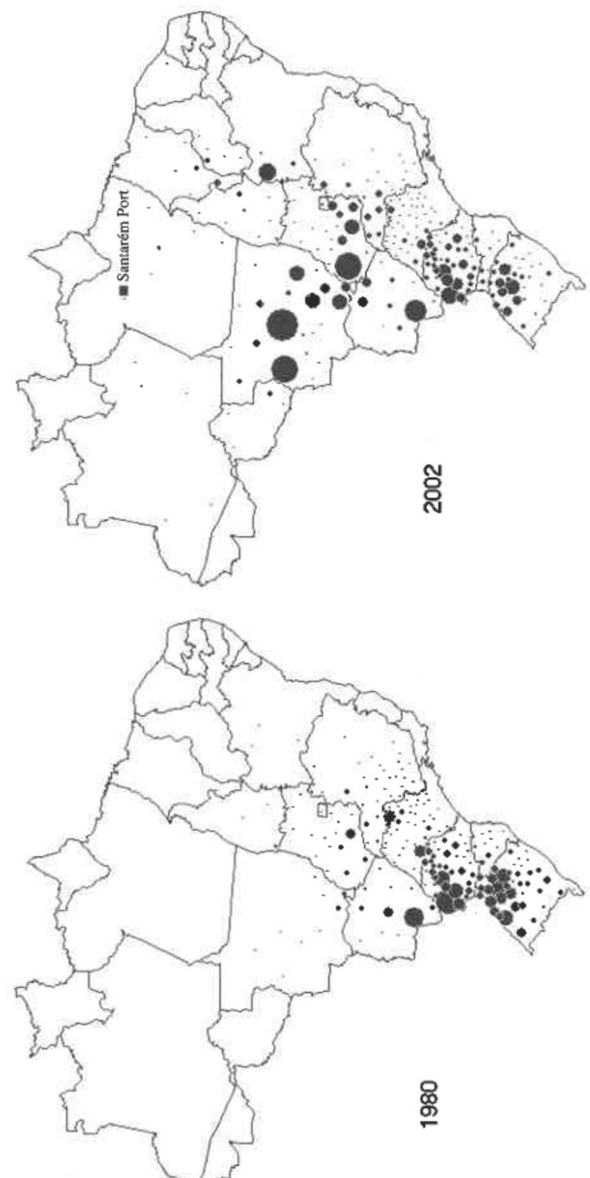

Figure 9. Geographical changes in Brazilian soybean production over time. (Data from IBGE [1980, 2002]. Figure was constructed by the authors.)

surpassed them in production. Increased production in the central-eastern states of Minas Gerais and Bahia is also noteworthy. In the 2003–2004 harvest, the central-western region contributed 49 percent to national soybean production, while the contribution of the south was 33 percent. The central-western area also presents the highest average yields in Brazil and is the area where the most spectacular growth in soy agriculture is occurring. In fact, Brazil's *cerrado* lands are the area of the globe most conducive to the expansion of soy agriculture. There are still about 66 million hectares of *cerrado* lands that could be converted to farmland, and soybeans are particularly suited to the agroecological and economic conditions of the area.

Brazil has the technical potential to increase its soybean production nearly tenfold. This will not occur without opposition, however (Ratter, Ribeiro, and Bridgewater 1997; Stedman-Edwards 1999). Some studies emphasize the environmental consequences of soybean expansion. The Brazilian savannahs are apparently the most species-diverse in the world (Fearnside 2001; Myers et al. 2000; Klink, Moreira, Solbrig 1993). Because soy is a basic export commodity with a strong economic network, its cultivation could lead to the destruction of natural habitats over wide areas.

Soybean cultivation could also entail significant social costs. Even in regions where soybeans generate visible economic benefits, factors conducive to inequality should be noted. In some places big firms dominate the soybean business, transferring inputs to producers and receiving the product back during harvest. Profits are concentrated in a relatively small number of hands. There is also excessive vertical integration of production, that is, a multiplicity of economic functions relating to soybeans (growing, transporting, processing, exporting) all controlled by the same firm.

In Argentina, nearly all field crop production occurs in the central and northern divisions of the eastern third of the country. This rich agricultural zone is centered on the fertile pampas—an area of slightly more than fifty million hectares—but extends into Argentina's northern tier of warm, semitropical provinces. The central provinces of Buenos Aires, Cordoba, Santa Fe, and western Entre Rios, located in the heart of the pampas, dominate row-crop production. More than 90 percent of Argentina's soybean farming takes place in these provinces.

Underlying Technical and Economic Reasons for the Expansion

Both Argentina and Brazil have made the most of cultivars produced and adapted in the United States. Because the soybean originated in East Asian regions situated between 40° and 50° latitude, the plant had to be modified by selective breeding in order to succeed as a crop in the United States (Sousa and Busch 1998; Warnken 1999, 46–52). Scientists of both the public and private sectors in the United States effected the needed modification. Much of their technology later set the pattern of development for scientific institutions and soybean farms in Argentina and Brazil.

Further technological advances were a more important challenge for Brazil than for Argentina. Unlike Argentina, most of Brazil's lands lie in the tropics, yet the major American cultivars imported into Brazil were bred for latitudes between 30° and 35°. The traditional or prototypic soybean plant inherently required long days to flourish properly, a function of its photoperiodism. The short days of tropical regions would induce precocious flowering, leading to low yields. But from 1980 on, Brazilian researchers developed soybean cultivars that were less and less dependent on latitude (Hartwig and Kiihl 1979; Kiihl and Garcia 1988), making soybean production possible across Brazil and in other low-latitude regions.

However, other limiting factors existed in Brazil. In addition to constraints stemming from their high photoperiodic sensitivity, soybeans were limited by aluminum toxicity in *cerrado* soils, low soil fertility in certain new lands, and the low capacity of some soils for retaining water (Souza and Goedert 1987). Technical solutions were found for each of these difficulties (Hartwig and Kiihl 1979; Kiihl and Garcia 1988; Döbereiner 1992; Souza and Goedert 1987).

The new agriculture in the *cerrado* is thus a product of modern mechanical, chemical, and biological technologies: the mechanical opens up the land, the chemical allows for correction of the soil, and the biological produces specific genetic material for local agroecological conditions. Production was also enhanced because the farmers came from parts of Brazil, such as Rio Grande do Sul, that already knew modern capitalist agriculture. Other factors including the availability of natural resources, conservationist practices such as no-till farming, and the existence of efficient financing, processing, and trading entrepreneurs were also important for soybean expansion in Brazil. The increase of installed processing capacity and the development of new export corridors through intermodal transport systems also played a role in the shifting of production areas.

New factors stimulating production include the reaction of European consumers to the risks of Bovine Spongiform Encephalopathy (BSE, or Mad Cow Disease), which forced greater use of plants in the composition of animal feed. At the same time, increasing consumer incomes within

Brazil have stimulated production. The income elasticity of demand for meat is high. That is, as consumer incomes increase so does the demand for meat, and those animals are frequently raised on soybeans. The market is also expanding due to economic growth in Asia, which has led Asians to increase their direct importing of both meal and meats.

Like Brazil, Argentina showed spectacular performance in agricultural production during the 1990s. During that decade, the production of major field crops nearly doubled. This performance was due to large-scale structural changes in Argentina's economy as well as in sectoral policies. Agriculture experienced the reduction of state interventionism, which in turn led to a friendly environment for private investments, targeted to increase the sector's competitiveness. Major changes have included removal of taxes on exports in 1991, reduction of tariffs and removal of import quotas for agricultural inputs, the breaking of the government's monopoly on commodity exports, privatization of the storage and transportation systems, enlargement and modernization of the industrial sector, the use of easy-to-farm genetically modified organisms (GMOs), and overall stabilization of the economy (Pessoa 2002).

But the great agricultural transformations in South America cannot be explained solely within national contexts. Soybeans demonstrate the internationalism of the process. In the first place, the soybean seed itself came from abroad, as did much of the initial technology surrounding it. In addition, there are Brazilian farmers producing soybeans in Paraguay (the *brasiguaios*), Brazilian-bred seeds being used in Bolivia, and North American farmers growing soybeans in places as unexpected as Barreiras and Luis Eduardo Magalhães in Bahia (in 2004, there were approximately 350 North American farmers producing soybeans in Brazil). The major soybean processors are multinational conglomerates, and the bulk of soybean demand comes from abroad.

Classification and Standardization

Soybeans provide a clear example of local production for the global consumer market. But soybeans differ from other Latin American export crops such as sugar and coffee. Unlike these far older agricultural products, soybeans arrived in Latin America as an already-modern crop. Built into the soy seeds came the necessity for more specific technological packages and standardization of production to satisfy both producer and consumer

demands. Soybeans thus helped to fortify Brazilian and Argentine agribusiness and facilitated the integration of rural and urban interests.

Virtually all industrialized food contains soybean-derived components: oil, protein, stabilizers, and so on. In part for this reason, both governmental and private organizations strongly regulate soy production in the fields as well as the industrial processing of the beans and the further use of soy protein for feed and food. Two important instruments that make production in the field compatible with industrial processing are classification and standardization. Categories are created (for instance, soybean meal type 1, soybean meal type 2, and so on) based on standards.

Standards shape and define both physical objects and social structures, reflecting the outcomes of political processes of negotiation, persuasion, and coercion. Standards thereby embody fundamental ethical decisions and worldviews (Busch 2000; Bowker and Star 2000). The standardization of things moreover implies the standardization of persons. What is considered a good soybean plantation, following the rules and standards, similarly defines a good soybean farmer. Good soy meal is linked to good whole soybeans, to a good processing unit, and to a good processor. Such value judgments facilitate network formation and in capitalist countries the power of capital to establish and expand itself. Yet standardization can also serve consumer interests. Food safety crises (see, for instance, Juska, Gouveia, and Koneck 2000) have increased popular awareness of food risks, leading to an increased strategic use of agrifood standards.

Historically, the central issue in standardization has been the tension between the state and the market in the determination of classifications and standards; soybeans brought added complexity. This state-market dichotomy has gradually been superseded by the entry of other agents, for the expansion of Brazilian soybean production coincided with the rising influence of other organizations. The most important of these new agents are the standards organizations. In addition to the governmental standards organizations, private ones emerged nationally as well. Internationally, other standards organizations were formed, including the International Organization for Standardization, the World Trade Organization, the Codex Alimentarius Commission, and entities such as Mercosul (the South American common market).

Brazil did not develop a comprehensive legal instrument for the standardization, classification, and commercialization of soybeans until 1983 (Regulation 262 of the Ministry of Agriculture). But this laggardness did not hold back Brazil's export of soybeans. Norms and international patterns guided this trade from the first and determined the shape of domestic production. State standardization was always a step behind what was common practice in the international domain. Thus, Regulation 262 simply provided a domestic legal footing for inspections based on the presence or absence of undesirable qualities: excess humidity, broken beans, impurities or foreign materials, damaged beans, and unripe beans.

Regulations have also established an operational sequence to be followed in order to determine the classification of an analyzed sample (for a history of these regulations, see Sousa 2001). This happens at the time the soybean enters the processing unit. Further official norms—of identity, quality, packaging, labeling, and presentation of oil and meal—came into existence in 1993.

Modern standardization is not only present in the functioning of markets and the wording of contracts (see Krislov 1997); it also invades the private space of individuals. For this reason, among others, it does not occur without the resistance of traditional standardization. Traditional standards of taste and seasoning, for example, are historically and informally constructed and can serve as a locus of resistance to modernizing processes.

Factors connected to resistance against technological standardization are numerous: physical, chemical, economic, social, cultural, climatic, and others. Note that among those factors are elements of the so-called natural world (see Latour 1993). Soil and climate, for instance, can influence the appearance, smell, and taste of a specific agricultural product. When technology intervenes in this process (e.g., by altering soils and plant varieties), it can change not only the appearance but also the taste and odor of that product. In such a context, the previous appearance, odor, and taste can be called a traditional standard. Concealed within traditional standards are the sensory attributes of identity, important indices of belonging to some particular culture and society. Such standards are mediated by sociality, and they are not easily changed.

Manioc, corn, rice, and common beans are examples of crops with strong ties to the fundamentals of Brazilian culture and history (Ferreira, Sousa, and del Villar 2004). Largely because of such ties, Brazilians have often resisted change in how these crops are produced, sold, and consumed with regard to taste, color, smell, texture, and so on. By contrast, soybean standards in Latin America are more linked to new technologies than to tradition. Soybeans arrived in Latin America already standardized, mediated not by sociality but by money.[4] Moreover, in Brazil and Argentina the soybean commodity system mostly has its origins in the global capitalist system, which is heavily supported by science and technology. In other words, until recently the soybean was merely pasted onto Brazilian culture, taste, attachments, nutrition, and history.

By contrast with soybeans, the commercialization process of other products such as rice does not happen with the same intensity or ease, even though rice is consumed worldwide. The appearance and flavor of rice, especially after cooking, vary as functions of the physical and chemical traits of the grain, which in turn depend on the variety. These peculiarities do not turn up in soybeans with this intensity; when they do, they are less commercially important than is the case with rice (since most soy is fed to animals). Hence, soybeans have more easily become a standardized, global commodity.

Soybean Competitiveness in Brazil and Argentina

Both Brazil and Argentina show great competitiveness in soybean production. In particular, Brazil's west-central region has low production costs, partly due to the cheapness of land there. Yet Brazil does struggle to maintain soy competitiveness. The main difficulties arise from the lack of an efficient infrastructure (enough highways, railroads, ports, and warehouses). In Brazil, the average distance from the soy-processing units to the closest port is between 900 and 1,000 kilometers, while in Argentina the processing region is closer to the shipment zones, in a 250- to 300-kilometer radius. The transport costs are a burden to Brazilian exports. Each transported ton of Brazilian soybean registers a US$12 disadvantage compared to U.S. soybeans and a US$4 disadvantage when compared to Argentine soy (Espírito Santo 2001). These expenses reduce the competitive advantage that low production costs provide to Brazil.

In the United States, the distances are similar to those of Brazil. However, about 60 percent of North American soybeans are transported on waterways, which are much cheaper to operate than road transportation. By contrast, as late as 2001 about 67 percent of the Brazilian soy was transported via the highway system and only 5 percent via waterways (Espírito Santo 2001).

But the logistics of Brazil's agricultural transportation are changing, albeit slowly (Caixeta-Filho and Gameiro 2001). A series of government and private initiatives is beginning to reduce transport costs. According to Espírito Santo (2001), railroad transportation volumes increased 144 percent from 1997 to 2001 versus only a 77 percent increase over the highway system. In addition, in 2003 soybean transport through the Amazon and Madeira rivers took 1 million tons of soybeans away from the highway system. Another 1.5 million tons that would otherwise have occupied fifty-five thousand trucks were transported from Mato Grosso to the Atlantic port of Santos through the Ferronorte railroad. Moreover, in that same year the Tietê-Parapanema waterway transported 1.5 million tons of soybeans from the southwest of Goiás and the Triângulo Mineiro area to São Paulo (Loureiro and Cade 2003). Recently, a port was constructed in Santarém, a town on the Amazon River in the state of Pará, to deal exclusively with field crops. The port was built by Cargill, a private transnational enterprise, and is expected to handle around 800,000 tons of soybean exports this year:

> It has been reported that the governments of Mato Grosso and Rondônia are actively seeking federal funds to improve the main highway (BR-364) linking the soybean production regions of western Mato Grosso and southern Rondônia to the barge facility at Porto Velho on the Madeira River. Barge facilities are maintained by both Grupo Maggi [now Amaggi] and Cargill here, with roughly 1.7 million tons of soybeans transshipped to their respective floating ports at Itacoatiara and Santarém in 2002/03. With the completion of paving the other primary Amazonian artery, BR-163, in the next [few] years, Cargill estimates 2–3 million tons of soybeans will be transported to its port facility at Santarém from Mato Grosso (Shean 2004).

The costs of transportation through Santarém are approximately US$30 cheaper per metric ton of soybeans than the costs through southerly Atlantic ports such as Santos and Paranaguá. The lower costs are due primarily to geography, as the port in Santarém is closer to soybean-producing areas in the northern states as well as to ports in Europe and, because of the Panama Canal, even to ports in Asia.

The competitive advantages that this transportation system will offer should be taken into account, but so too should the system's potential for environmental harm. Improving roads almost inevitably leads to habitat destruction, and intensive use of waterways can lead to pollution and the destruction of wildlife.

Society must also try to ensure that the existence of the port at Santarém does not encourage large-scale soybean production in the Amazon. It is estimated that within a radius of two hundred kilometers from the port, approximately one million hectares of land can be used for agricultural purposes. According to Shean (2004), "This land is primarily pasture or small-scale permanent agricultural fields. With appropriate fertility, technology, and management the soybean crop yield potential in this region is estimated to be 3.6 tons per hectare, while the production capacity could reach between 5–7 million tons." Although the government is not providing direct financial incentives for soy expansion in this region, private investors are interested in its potential profitability.

But modernization of agriculture in the Amazon could cause environmental and social problems. Soybeans are different from the livestock already in the area in their capacity to stimulate the local economies. In livestock areas demand for services and products is low, whereas in soybean areas demand is high for cooperatives, mechanical services, banks, medical services, and so on. Changes in the economy and population of the region—an area with little previous contact with the modern world—could be abrupt. They could, for example, change local eating habits that are currently based on regional products. Local diets could become less nutritious. Hence, despite the port's huge economic potential, caution is needed in developing it further.

In addition, vigilance is needed to protect virgin Amazonian jungle. Unfortunately, not only Amazonian pasture lands and small farms may be affected by the soybean boom: there are already reports that virgin forest south of Santarém is being cleared for soy production (Hall 2004a) and that the rate of deforestation for crop land correlates with the yearly average price of soybeans (Harder 2006). In late 2004, Brazil enacted a law to protect a small portion of the jungle from illegal squatters who were forcibly evicting residents for the purpose of growing soy (Hall 2004a, 2004b). Also helpful was the August 2006 pledge by all of the major soy processors in Brazil—Cargill, Archer Daniels Midland (ADM), Bunge, Dreyfus, and Amaggi—to refuse to buy soybeans from newly deforested lands (Muello 2006). The effectiveness of the 2004 law and the 2006 corporate pledge depends on government actions and resources, however, and is questionable. More extensive studies of this complex issue are necessary to grasp all the environmental, political, economic, and social variables within a global context of conflicting interests.

By contrast with Brazil, in Argentina soy industries invested in new processing units—at the level of about US$1 billion from 1997 to 2001 (Espírito Santo 2001)—rather than so heavily in transportation. In consequence, Argentina's modern units have twice the crushing capacity and earn US$3 per ton more than Brazil's units. This Argentine advantage should change as investments in Brazilian processing grow, however. The same international agricultural companies that operate in Argentina also operate in Brazil and can transfer useful insights and business models from country to country as conditions warrant. In addition, dynamic companies such as El Tejar in Argentina and Amaggi in Brazil have shown the importance of large grower and grower-processor soy companies that are privately owned by a country's own citizens.

Nevertheless, despite the positive future outlook for soy industries in Brazil, the fiscal difficulties present there should be emphasized. The industries are burdened by a 12 percent interstate transport tax (ICMS, or Services and Commodity Circulation Tax). Fortunately, since September 1996 the Kandir Law has exempted from the tax whole and semiprocessed soybeans destined for export. This law has, of course, spurred Brazil's soy exports. Unfortunately, at the same time the cost of whole soybeans to Brazil's internal processing industry increased as the international price rose.

We have seen that Brazil's soybean industries benefit from cheap and plentiful land but suffer from internal transportation problems and, for internally consumed soy, from significant taxation. Argentina's soy industries enjoy a modern processing system and less arduous internal transportation, but they suffer from Argentina's distance from ultimate ports of destination. Each of these countries has thus benefited from certain aspects of competitive advantage.

Soyfoods in Brazil

The crushing of soybeans yields 70 percent protein meal and 20 percent edible oil. No other oilseed has such a valuable performance when oil and meal are jointly analyzed. The soybean represents more than 60 percent and 30 percent, respectively, of world production of protein meal and vegetable oil (Bonato, Bertagnolli, Lange, and Rubin 1999).

In contemporary Brazil, about 90 percent of consumed oil comes from soybeans. First, during the 1950s and early 1960s, vegetable oils—mostly cotton and peanut—began replacing animal fat in the Brazilian diet. Later, soy oil not only replaced the cotton and peanut oils but also eliminated the use of animal fat almost entirely. Whereas in 1960 soy oil represented only 14 percent of the vegetable oil market, by 1974 it had captured 80 percent.

The 1980s were marked by serious economic challenges, and although soy oil consumption was still rising, the rate of increase had dropped. It was only in 1994 that economic conditions started to improve. Since 2000, soy oil consumption has seen an average annual growth of 2.23 percent (USDA/FAS 2005b).

The substitution of soy oil for animal fat was encouraged by competitive pricing and by increased consumer attention to nutrition. Before the soybean era, no vegetable oil had really been able to overcome the supremacy of animal fat in the Brazilian kitchen. Yet now about three-fourths of the soy oil that Brazil consumes is used as cooking oil in the kitchen; the remaining fourth is used mostly in margarine, mayonnaise, and other foods.

Beyond this crop's oil, the other nutritional values are unquestionable. Soy flour contains approximately 47 percent protein, wheat flour is only around 13 percent protein, and corn meal about 8 percent protein (Miyasaka and Medina 1981). However, soy protein has mostly been used for animal feed. In other words, humans eat soy protein indirectly by eating animal protein. Thus, although soy meal is not largely used for human food in Brazil, it is a vital intermediate product for animal protein in the human alimentary chain.

In the last three decades, the expansion of soy meal sales made fast growth of the poultry industry possible. About 65 percent of the soy-based feed in Brazil is consumed by the poultry industry, 10 percent by the dairy products industry, and 20 percent by the swine industry. The production of inexpensive soy thus had a direct and positive impact on the national diet by containing the prices for meat, especially chicken.

Until recently, poultry was of secondary importance as a source of animal protein in the Brazilian diet. Due to its considerably higher unitary price relative to the bovine and swine meats, poultry was consumed as a Sunday delicacy, mainly by higher-income families (see Camara Cascudo 2004). In Brazil, beef has always been the most important source of animal protein; however, because of its relatively high unitary cost, only a small part of the population consumes it regularly. The meat consumption of the poor varies with the region and the price of meat. Since the 1990s, however, chicken has nationally become much less expensive than it had been. Between 1970 and 2002, Brazilian per capita consumption of poultry grew more than 1,400 percent (from 2.3 kg to 33.8 kg a year) (USDA/FAS 2005a). Undoubtedly, the advent of soy agriculture made meat in the form of chicken accessible to the urban poor on a regular basis. It is not without reason that in Brazil chicken has been called soybeans with wings.

From 1991 to 2001, Brazilian poultry production increased 130 percent while exports quadrupled. Now Brazil is the world's second-largest producer and exporter (Pessoa and Jank 2002). The production of pork doubled during the same period, and pork exports had a magnificent performance with a 1,576 percent increase, making the country the fourth-largest pork exporter. These trends were intensified with the devaluation of the Brazilian real and the European meat-production crises (e.g., BSE and foot-and-mouth disease). This excellent performance of meat production in Brazil has further positively impacted the domestic demand for feedstuffs (Pessoa and Jank 2002).

Soybean processors are increasingly determining the geography of the poultry industry. New poultry operations are being developed in the vicinity of the new agricultural borders, close to the soybean processors. Beyond the benefit of proximity with new and dynamic soybean production areas, there has been an environmental benefit to this shift. Because of the topography and farming practices of the new agricultural areas, the serious pollution problems found, for instance, with the production of swine in the state of Santa Catarina have not occurred in Brazil's central-western region (Goiás and Mato Grosso) (see Santos Filho et al. 1999).

In Brazil, among the several factors slowing down the direct use of soybeans as food is the widespread consumption of another crop, the common bean (*Phaseolus vulgaris* L.). Common beans contain roughly 22 percent protein and are an important source of this essential nutrient. Unlike soybeans, common beans are embedded in Brazilian culture and history; indeed, Brazil is the largest per capita consumer of common beans in the world (see Yokoyama and Stone 2000). This bean along with rice (*Oriza sativa* L.)—also a traditional crop—is a basic staple for Brazilians. The combination of the two is quite powerful even from a nutritional perspective, as the proteins from beans are rich in lysine, offsetting the poor profile of rice for that amino acid. The joining of rice and beans has been characterized as traditional food wisdom (Castro and Peliano 1985), or what Ishige (2006) calls the meal pattern specific to a society.

The taste and odor of soybeans were the initial major obstacles to their widespread acceptance as food (see Carrão-Panizzi 1998). During the 1940s and 1950s several attempts were made to incorporate soybeans in the Brazilian diet, including an effort by the famous sociologist and constitutional representative Gilberto Freyre. The stimulus for these efforts was twofold: the suffering of many undernourished people, mainly in rural areas, and the knowledge of soy's nutritional content (in addition to the protein and oil, soybeans contain vitamins and minerals). Unfortunately, however, soy

became known as a legume "for the pigs and the poor" (see Hasse and Bueno 1996, 249).

Pigs are much more inclined to ingest nutritious preparations recommended by food science than are poor people, however. In addition to showing strong preferences for certain tastes, textures, and smells, in eating a person reveals himself or herself, identifying the self with a group that the person not only accepts but also wants to be accepted by. Humans thereby give the acts of cooking and eating a whole range of social and cultural meanings. The label "food for the poor and animals" caused soyfoods to encounter great resistance in Brazil during the 1970s and 1980s. Even the favorable nutrition to price ratio for soybeans did not convince the poor to eat them. As Castro and Peliano (1985) point out, the poor eat with neither optimal nutrition nor optimal expense. Not only do sensory preferences play a role in food choices, so also do the many social meanings at stake.

Soy-oil margarine, for instance, was always cheaper than butter. But for many years, poor people preferred to buy expensive butter rather than margarine. Only when margarine began to be associated with good health and became a product for all (middle and upper classes included) did its consumption among the poor exceed their consumption of butter.

As milk, soy had a troubled but ultimately successful journey in Brazil. In the early 1970s Brazil's Food Technology Institute (ITAL) began soymilk extraction in Campinas, São Paulo. The extraction machine was developed there and was known as the mechanical cow. A 1979 model of the machine could process two hundred liters of soymilk per hour. According to Hasse and Bueno (1996, 251), "Its main components were a sink used for heating the soy; a basket from a *Brastemp* washing machine for centrifugation; and at the end of the line, devices to pasteurize the soymilk, add flavors, and pack the milk into plastic bags. One kilogram of soy yielded eight liters of milk."

In 1975 soymilk was introduced to five hundred schoolchildren (aged six to fourteen years). For this first test, the soymilk had seven different flavors: chocolate, vanilla, banana, raspberry, strawberry, coconut, and pineapple. At the end of the trial period, 72 percent of the children approved of the soymilk (Hasse and Bueno 1996). In fact, after flavoring the use of soymilk in public schools has enjoyed ample acceptance. The major problem has been with the adult population and its traditional attachment to cow's milk. Problems with the taste of soymilk have taken time to overcome.

During the second half of the 1970s, experiments in marketing soymilk to the general public were numerous but with no great success. The basic buyer was always the government. Schoolchildren and, during a certain period, pregnant women under the care of the State of São Paulo Department of Health were the principal consumers. As Hasse and Bueno (1996) note, the Coca-Cola Company also tried to develop a nourishing soy drink during that decade, but the beverage did not win public acceptance.

During the 1980s, use of the mechanical cow spread to more Brazilian states. In one of several official ceremonies introducing the machine, an unexpected setback occurred: after tasting the soymilk, Brazil's president João Batista Figueiredo (1980–85) qualified it as "disgusting." The remark cannot be totally explained by Figueiredo's bluntness. As Hasse and Bueno (1996, 251) explain, "The 'cow' had been assembled in a hurry at a meeting place of the Brazilian Legion of Assistance (LBA). Two hours before the ceremony, it was put in operation, but the engine was working backwards. The people from LBA had no operational training. Soy industrialists suspected that this turn of events had been planned by the dairy industry to blemish the image of its supposed opponent." Fortunately, today the complexity and size of soymilk extractors permit large skilled food companies to sell a variety of soymilks, even in regular supermarkets.

The use of soymilk and other soyfoods in schools remains more significant, however, than grocery sales. In the 1970s texturized soy protein was prepared by untrained school chefs and usually ended up in soups that children would not eagerly eat. Today, after more than thirty years, food science has vastly improved the palatability of soyfoods. Soyfoods have been used in the schools of several Brazilian states with the aim of improving the children's nutrition. Soy products do not tend to replace other foods but are instead being added to various recipes (cookies, cakes, banana pie, bread, sweets, milk, and others). More than thirty-seven million students are affected, making Brazil's National School Food Program one of the biggest in the world.

Fortunately, during the 1990s the barriers against the larger public's direct soybean consumption began to be knocked down. Several institutions and companies have contributed to make soyfoods attractive to Brazilian tastes, eyes, and odor preferences. Among those institutions are the Federal University of Viçosa, the ITAL, and the government's Brazilian Agricultural Research Corporation (EMBRAPA).

The endeavors focus not only on the use of soy derivatives in various recipes but also, since the 1952 pioneering work of Murilio Moreira, on the creation of new so-called flavorless soybean varieties. These are whole soybeans without the off-tastes produced by the oxidation of linolenic acid. In 2000 EMBRAPA announced that it had developed two new varieties, BRS 213 and BRS 216, specific for human consumption. BRS 213 has a mild taste and requires no special treatment to make it palatable. It also provides good yields in the fields (Carrão-Panizzi et al. 2002a). BRS 216, by contrast, has a higher-than-usual protein content of 43 percent, but it still requires industrial treatment to improve the taste (Carrão-Panizzi 2000; Carrão-Panizzi et al. 2002b; Carrão-Panizzi and Erhan 2002).

Extensive bibliographies in Portuguese have been dedicated to soybeans in human food. Two useful examples are Mandarino and Carrão-Panizzi (1999) and Bordignon, Carrão-Panizzi, and Mandarino (2000). In addition to providing recipes, these publications argue that soy tastes good when the balance of ingredients in a recipe is correct. For this reason, in fact, defatted soy flour and soymilk are finding a growing acceptance among those interested in a healthy diet.

Tofu is another source of soy protein available in Brazil. Popular among Japanese and Chinese immigrants and their descendants, it has also attracted other Brazilians wanting to eat healthy food. It is widely marketed in large supermarkets or in Japanese and Chinese delicatessens. In Asian-style cuisine in Brazil, soybeans and soy derivatives are found in sauces as well as in pasta and stew dishes. Asian cuisine has become popular among the general population although mainly in big urban centers.

The use of soy in Brazilian cuisine still has a long way to go. As a secondary ingredient, however, soybeans have already been integrated firmly within Brazilian cuisine. Soy products (defatted flour, isolated and concentrated protein, texturized protein, and soymilk) appear—although often in small quantities—in industrial baked products, hamburgers, soups, sausages, canned foods, sweets and snacks, cereals, chocolate powders, sauces, mayonnaise, cake toppings and fillings, yogurt, and frozen foods.

Conclusion

Soybeans have contributed decisively to Brazil's modernization process of the 1970s; to the development of wide economic and social networks in Brazil and Argentina, involving people, objects, and animals; to the opening and occupation of new agricultural frontiers in Brazil; and to the integration of Brazilian territory. Occupation of the *cerrado* is the most visible aspect of this process, which began some thirty-five years ago.

This *cerrado* occupation has had characteristics that are striking (although by no means unique), such as the development of technologies that allowed for agricultural exploration of the ecosystem and the strong presence of government as well as its offers of incentives in all stages of the process. Unfortunately, there has been a lack of planning regarding the conservation of biodiversity and proper socioeconomic development for all populations involved. The economic difficulties that small farmers have faced were made very public during protests in the spring of 2006. Squeezed by "rising production costs and a strong Brazilian *real* that affect[ed] profitability, [for several weeks] Brazilian farmers . . . block[ed] key roads and railway routes along which grains are shipped to port" (Heller 2006). In consequence, multinational companies such as Bunge reported financial losses in Brazil during that period.

The soybean expansion has contributed to dietary change as well. By the end of the 1960s, the majority of Brazil's population lived in urban areas. In big cities such as São Paulo, Rio de Janeiro, Belo Horizonte, and Recife, the urban mode of life brought great shifts in food habits, notably the introduction of prepared food. The expansion of Brazil's soybean network coincided with this urbanization, making the supremacy of soy oil in Brazilian cooking and the presence of soy protein as a minor yet important functional ingredient in processed foods both economical and logical. Some have rightly called soybeans used in this manner "an invisible friend"; their presence in a large variety of foods goes unnoticed by most people. Except for soymilk in schools and occasional tofu consumption among typical urban dwellers when they enjoy Asian cuisine, foods that are rich in soy protein have not yet had a significant impact on the Brazilian diet.

Argentina has gone through similar changes and a dramatic economic liberalization. These circumstances have promoted the flourishing of Argentina's soybean industries. Argentina has thus made choices parallel to those of Brazil in embracing the soybean, this ancient and yet most modern of crops.

Notes

1. We thank Edward G. Singer, William H. Fisher, Carlos Magri Ferreira, Mercedes C. Carrão-Panizzi, and Christine Du Bois for their critical comments and suggestions on an early draft of this essay.

2. "The word network indicates that resources are concentrated in a few places—the knots and the nodes [whose] . . . connections transform the scattered resources into a net that may seem to extend everywhere" (Latour 1987, 180).

3. Soy meal is the product left after the oil has been removed from the beans. It is high in protein.

4. In his *Philosophie des Geldes* (*The Philosophy of Money*), published for the first time in 1900, Simmel (2001) identifies as the cultural tragedy of modernity the separation between subjective and objective cultures. The cultural productions created by humans to serve them assume (with their objectification) a logic independent from the original intentions of their creation. To Simmel, the most important structural factor of modernity is the rise of the monetary economy. Money has a central role in the constitution of both modern liberty and modern tragedy.

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