Introduction

The success of soybean production and utilization in Brazil actually begins with the development of the poultry sector during the 1950s in the southern United States (Kiel, 2005). Researchers in the United States sought to adapt soybeans to lower latitudes in order to provide southern poultry farmers with a local high-quality protein meal. Researchers quickly developed varieties adapted to the longer growing season and warmer climates by focusing on the role of the nighttime photoperiod in soybeans’ growth and development (Kiel, 2005).

These new varieties became the opening for the Brazilians. Researchers took the low-latitude technology and developed germ plasm that could be deployed in the Southern three states of Brazil (Rio Grande do Sul, Santa Catarina, and Parana) with a growing climate similar to the Southern United States (Schnepf et al., 2001). Brazil’s soybean industry began in the South of the country in the late 1960s, supporting both soybean processing and poultry production.

By the 1980s, the federal agricultural research institute [Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA)] had advanced the photoperiod line of research even further. EMBRAPA successfully adapted soybeans to grow in the tropics at even lower latitudes. Developing this technology opened up soybean production to the West and North regions of the country that lie between 15 degrees south latitude and 5 degrees north latitude. Of greatest potential was the Cerrado region encompassing over 200 million hectares (the equivalent of the combined land areas of the 12 Midwestern U.S. states stretching from Ohio to North Dakota) of low brush-like forest that was easy to clear and had predictable rainfall. The development of the lowest-latitude varieties begins the real story of the Brazilian soybean complex.

Compared to the South region of Brazil, Cerrado farming could take advantage of huge economies of scale. U.S. agricultural development and land privatization began before the age of mechanization. The U.S. Midwest was settled using the concept of a section, where 80 acres (32.4 ha) was sufficient to support a homesteading
family. Brazil’s Cerrado region has none of that social, political, or normative legacy as to what is an appropriate unit of production. The rapid expansion of soybean production in the 1980s arose because of the availability of large tracts of arable land, soybean technology that produced yields equal to those of the United States, mechanization that allowed operational efficiency, and the lowest operating costs per hectare in the world. Cerrado farming also has great challenges. The production, transportation, and processing infrastructure is underdeveloped; markets are distant; soils are relatively poor; and environmental concerns exist.

Brazil did not become a significant player in the world soybean scene until the mid 1970s when low-latitude varieties were commercialized, production topped 10 MMT (11 million t), and 10% of the world’s product (Fig. 22.1). In the 30 yr since, Brazil has expanded its soybean production fivefold. South America—led by Brazil, Argentina, Paraguay, and Bolivia— as a region, recently surpassed the United States’ output, and it now produces 48% of the world’s needs (Fig. 22.2).

The United States still holds the most soybean-processing capacity, followed by China and Brazil (Fig. 22.3). Following the expansion of soybean production outside the United States though, a fundamental shift occurred in soybean-processing investment, away from the United States and Europe toward China, Argentina, and Brazil (Fig. 22.4). Capital for soybean processing is increasingly invested outside the United States because of superior procurement economies, lower costs of plant operation, and close proximity to high-growth livestock industries (Goldsmith et al, 2004). Soybean meal and oil demand growth is most active outside the United States, so many times foreign crush facilities are better able to supply these new customers. For example, two of the fastest growing poultry and pork sectors are in Brazil and China, which are able to utilize their domestically produced meal (Fig. 22.5).

**Soybean Industry In Brazil**

**Production and Yield**

Brazil produced 51 MMT (56 million t) of soybeans on 23 million hectares (57 million acres) in 2005 (Fig. 22.6). Since 1990, the size of Brazil’s soybean crop increased 10.5% per year. The value of the national crop is $14B and has more than doubled over the last five years (Fig. 22.7). Yields over that period were flat, but significant expansion of soybean acreage combined with increasing prices is behind the growth in the industry.

The leading states producing soybeans are located in the Southeast and the Center West regions of the country (Fig. 22.8). Mato Grosso, in the Center–West part of the country, produces almost 16 MMT (17.6 million t), about 70% greater than the number-two state, Parana, and double the number-three state, Rio Grande Do Sul.
Soybean Production and Processing in Brazil

Fig. 23.1. World soybean production (Source: FAO, 2005; author’s calculations).

Fig. 23.2. Global soybean market shares (Source: FAO, 2005; author’s calculations).
Fig. 23.3. World soybean crushing capacity shares in 2005 (Source: FAO, 2007; author’s calculations).

Fig. 23.4. Leading soybean meal producers (Source: FAO, 2005; author’s calculations).
Fig. 23.5. Pork and poultry production in China and Brazil (Source: FAO, 2005; author’s calculations).

Fig. 23.6. Brazil soybean production and acres harvested (1990–2005) (Source: FAO, 2007; author’s calculations).
Fig. 23.7. Brazil soybean yield and value of the national crop (1998–2005).

Fig. 23.8. Brazilian soybean production by state (1990–2006) (Source: IBGE, 2007).
Prices

The prices received by farmers in Brazil vary considerably across the country. Prices nationally averaged $5.39/bu over the 2003–2006 period, $1.10 or 20% less than the Chicago Cash price for the same period. The price in Ponta Grossa, Parana, located in a major soybean region in Southeastern Brazil had an average price of $6.14/bu, only $3.4/bu (5%) less than the average Chicago Cash price (Fig. 22.9). On the other hand, Sorriso, Mato Grosso, in Central Mato Grosso had an average price of $4.76/bu, $1.72/bu (27%) less than the Chicago Cash price.

Late in the year, Eastern Brazil shows a positive or neutral basis compared to the Chicago Cash price. These months correspond to the harvest period in the Northern Hemisphere, thus driving U.S. prices down combined with binding storage constraints that create late-season shortages in Brazil (Fig. 22.10).

Soybean prices are seasonal. The highest average daily prices (e.g., Parana) occur in November at $6.33/bu, as new crop supplies of soybeans are exhausted six months after harvest. The lowest average monthly prices ($5.71/bu) are seen in January as U.S. selling drives down world prices at the beginning of the tax year.

Prices fall, moving from the East to the West in Brazil. The difference between the Center–West with the coastal regions widened over the period to over $2.00/bu (32%) by late 2006. The interior price in central Mato Grosso was on average about 23% or $1.38/bu lower than in the coastal state of Parana (Fig. 22.11).

The price disparities are due to two factors: the decreasing quality of the infrastructure and a lack of local agro–industrial activity as one moves west. The agro–industrial complex is much larger in the historically more highly populated and developed Eastern states of Brazil. For example, 64% of all the soybeans produced in the state of Mato Grosso are exported internationally (51%) or domestically (13%) as whole grain (Goldsmith et al., 2007). Of the remaining soybeans, 34% are converted into meal and oil, of which 95% is sold outside of the state. So, in summary, 96% of the soybeans are not converted in-state to higher valued goods, such as meat, food, or energy, but are exported.

The soybean cluster in Mato Grosso was estimated in 2004 to be about $8 billion (Goldsmith et al., 2008). For example, Illinois, a U.S. state with a similar size soybean crop, has a soybean cluster over three times as large, at $25 billion. Soybean production comprises about 11% of the Illinois cluster that incorporates processing and meat production, while soybean production in Mato Grosso comprises close to 60%.

Cost Of Production

Soybean costs of production are about 38% lower in the high-growth regions of the Center-West of Brazil compared to the Midwest United States (Hirsch, 2004). Fixed costs per acre in the Center-West are about one-fifth the costs in the Midwest in the
Fig. 23.9. Selected regional average soybean prices in Brazil (2003–2006) (Source: IBGE, 2007).

Fig. 23.10. Monthly average prices in Chicago, Mato Grosso, and Parana (2003–2006) (Source: Barchart.com, 2007; IBGE, 2007; author’s calculations).
United States due to differences in land prices (Fig. 22.12). Operating costs and ocean freight (FOB Rotterdam) are quite comparable. Internal freight costs to the port are almost three times greater from the Center-West, though the distances are comparable. Transport from the interior of Brazil involves significant usage of trucks over a very poor highway system. The United States relies much more heavily on rail and water transport, which are much less expensive per kilometer per MT.

Soybean operating costs of production in the Center-West region of Brazil rose 17% per year between 2000 and 2006 while gross revenue rose only 4%/yr (Table 22.1). Soybean operating costs averaged $141/acre over the 2000–2006 period. Operating cost variability was exceptionally high as costs have ranged from a low of $89/acre in 2000 to a high of $202/acre in 2004. Much of the cost increase was attributed to rising fertilizer (+$38), fungicide (+$24), and insecticide (+$19) costs per acre. In 2005 and 2006, gross margins approached zero as costs of production outpaced soybean price increases, and yields faltered due to soybean rust. Fertilizer costs average 34% of the costs of production and are the single largest cost item (Fig. 22.13). Fungicide costs quintupled as farmers were forced to combat the devastating disease Asian Rust. For example in 2004, fungicide costs per acre increased $20/acre over the previous year while gross margins were only $13/acre. During the same period, insecticides costs increased 475%. The increase in costs caused tremendous financial stress in the region. Debt repayment became difficult for highly leveraged producers who had little cash flow to use toward principal and interest payments.

Fig. 23.11. Local soybean price differences ($) with Ponta Grossa and Parana (2003–2006) (Source: IBGE, 2007; author’s calculations).
Asian Soybean Rust became an economic threat to the Brazilian soybean crop in 2002. Fungicide applications rose from less than $5.00/acre (<1% of operating costs in 2001) to over $40/acre (>15% of operating costs) by 2005 (Fig. 22.14). Costs rose for three reasons: (i) the disease spread and affected more regions; (ii) the Real strengthened and as a result increased the cost of the base products; and (iii) the intensity of the disease increased, causing farmers to spray multiple times (Fig. 22.15).

Since 2005, costs per acre have fallen as producers learned to manage rust more effectively, and a ban was imposed on second-crop soybeans. Eliminating the second crop or a mid-year crop for seed significantly reduced the quantity of host material for the fungus to reside. This, in part, broke the cycle of infection and re-infection. Starting in crop year 2009–2010, rust-resistant soybean varieties will be commercially available (Hirimoto, 2007). This will give farmers another tool to treat this devastating disease.

Costs of Transportation

The most limiting factor affecting agro–industrial development in the Center-West region of Brazil is the lack of transportation infrastructure (Hirsch, 2004). For example, the state of Mato Grosso comprises a land area almost 30% larger than the U.S. state of Texas and is ~1,600 km (1,000 miles) from an ocean port. It is Brazil’s leading agricultural (soybean) state, but it has no expressways, no commercial waterways, and…
### Table 23.1. Costs of Production for Central-West Brazil (2000–2006)*

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>Average</th>
<th>Annual Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange Rate</td>
<td>2.38</td>
<td>2.97</td>
<td>3.12</td>
<td>2.93</td>
<td>2.43</td>
<td>2.18</td>
<td>1.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer</td>
<td>$34.51</td>
<td>$50.40</td>
<td>$36.98</td>
<td>$56.34</td>
<td>$72.20</td>
<td>$64.31</td>
<td>$67.50</td>
<td>$54.60</td>
<td>15.94%</td>
</tr>
<tr>
<td>Fungicides</td>
<td>$3.12</td>
<td>$2.83</td>
<td>$3.23</td>
<td>$4.69</td>
<td>$26.70</td>
<td>$26.02</td>
<td>$19.42</td>
<td>$12.29</td>
<td>86.99%</td>
</tr>
<tr>
<td>Herbicides</td>
<td>$21.20</td>
<td>$13.58</td>
<td>$20.22</td>
<td>$23.58</td>
<td>$30.35</td>
<td>$28.16</td>
<td>$21.41</td>
<td>$22.64</td>
<td>0.17%</td>
</tr>
<tr>
<td>Insecticides</td>
<td>$2.94</td>
<td>$2.82</td>
<td>$3.27</td>
<td>$4.76</td>
<td>$22.27</td>
<td>$19.74</td>
<td>$16.95</td>
<td>$10.39</td>
<td>79.25%</td>
</tr>
<tr>
<td>Other Costs</td>
<td>$22.44</td>
<td>$19.39</td>
<td>$23.26</td>
<td>$31.47</td>
<td>$31.49</td>
<td>$35.54</td>
<td>$45.69</td>
<td>$29.90</td>
<td>17.27%</td>
</tr>
<tr>
<td>Effective Operational Costs</td>
<td>$89.17</td>
<td>$94.13</td>
<td>$94.25</td>
<td>$134.14</td>
<td>$201.72</td>
<td>$190.64</td>
<td>$180.24</td>
<td>$140.61</td>
<td>17.02%</td>
</tr>
<tr>
<td>Assumed Yield *</td>
<td>47.64</td>
<td>47.64</td>
<td>43.31</td>
<td>43.31</td>
<td>39.84</td>
<td>45.04</td>
<td>44.46</td>
<td>1.09%</td>
<td></td>
</tr>
<tr>
<td>Sale Price**</td>
<td>$3.25</td>
<td>$2.86</td>
<td>$4.81</td>
<td>$7.11</td>
<td>$5.40</td>
<td>$4.11</td>
<td>4.59</td>
<td>5.34%</td>
<td></td>
</tr>
<tr>
<td>Gross Revenue</td>
<td>$154.67</td>
<td>$136.48</td>
<td>$208.33</td>
<td>$307.84</td>
<td>$215.16</td>
<td>$185.28</td>
<td>201.29</td>
<td>3.96%</td>
<td></td>
</tr>
<tr>
<td>Return over Variable Costs</td>
<td>$65.50</td>
<td>$42.35</td>
<td>$114.08</td>
<td>$173.70</td>
<td>$13.44</td>
<td>-$5.36</td>
<td>67.28</td>
<td>-21.64%</td>
<td></td>
</tr>
</tbody>
</table>

*All prices in U.S. Dollars. All land units in acres. All quantities in bushels. Source: EMBRAPA and author’s calculations.
Fig. 23.13. Soybean operating costs in the Center-West Brazil in 2006 (Source: EMPRAPA and author's calculations).

Fig. 23.14. Costs associated with Asian Soybean Rust in Brazil (2000–2006) in Mato Grosso, Brazil (Source: Ma, 2007).
As a result, transportation costs in Mato Grosso are equal to 71% of the price paid to local farmers, and 41% of the landed price in Europe (Table 22.2). Freights costs add $1.58/bu in the more traditional eastern areas of soybean production as compared to $3.36/bu for soybeans sourced from the Center-West region.

The cost of the weak transportation system is borne by the producers in the prices they receive. Most of the difference between the prices received by farmers in the East compared to the farmers in the Center-West is attributed to the high freight costs. The higher costs are not just a function of distance. Goias, a state to the east of Mato Grosso, has superior infrastructure with access to both rail and water transport. Its cost per km is 22% lower than in Mato Grosso because more expensive truck transport is not as prevalent.

About 55% of Brazil’s soybeans move out from two ports in the Southeast, Parana and Santos (SECEX, 2007). Both ports receive truck shipments, but Santos is connected directly by rail to Southeast Mato Grosso. The next most active area is in the Northeast, from the ports of Vitoria (13%), Sao Francisco (12%), and Sao Luiz.
Table 23.2. Cost of Transportation in Brazil (Source: IBGE, 2007; USDA, 2006)

<table>
<thead>
<tr>
<th>Soybean Source (Distance to the Port)</th>
<th>Domestic Freight</th>
<th>Ocean Freight</th>
<th>Total Freight</th>
<th>% of Landed Price</th>
<th>% of Soybean Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parana (204 km)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Freight</td>
<td>$0.53</td>
<td>$1.05</td>
<td>$1.58</td>
<td>7% (9%)</td>
<td>8% (10%)</td>
</tr>
<tr>
<td>Ocean Freight</td>
<td></td>
<td></td>
<td></td>
<td>14% (17%)</td>
<td>15% (19%)</td>
</tr>
<tr>
<td>Total Freight</td>
<td></td>
<td></td>
<td></td>
<td>20% (26%)</td>
<td>23% (29%)</td>
</tr>
<tr>
<td>Landed Price**</td>
<td>$7.72</td>
<td>$6.97</td>
<td>$14.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Goias (726 km)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Freight</td>
<td>$1.16</td>
<td>$1.08</td>
<td>$2.24</td>
<td>14% (19%)</td>
<td>15% (21%)</td>
</tr>
<tr>
<td>Ocean Freight</td>
<td></td>
<td></td>
<td></td>
<td>13% (18%)</td>
<td>14% (20%)</td>
</tr>
<tr>
<td>Total Freight</td>
<td></td>
<td></td>
<td></td>
<td>27% (36%)</td>
<td>29% (41%)</td>
</tr>
<tr>
<td>Landed Price**</td>
<td>$8.38</td>
<td>$7.63</td>
<td>$15.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mato Grosso (1190 km)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Freight</td>
<td>$2.31</td>
<td>$1.05</td>
<td>$3.36</td>
<td>26% (43%)</td>
<td>28% (49%)</td>
</tr>
<tr>
<td>Ocean Freight</td>
<td></td>
<td></td>
<td></td>
<td>12% (19%)</td>
<td>13% (22%)</td>
</tr>
<tr>
<td>Total Freight</td>
<td></td>
<td></td>
<td></td>
<td>38% (62%)</td>
<td>41% (71%)</td>
</tr>
<tr>
<td>Landed Price**</td>
<td>$8.75</td>
<td>$8.12</td>
<td>$16.87</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $U.S./bushel
** in Hamburg, Germany

(8%). The Amazon port of Manaus mostly depends on barge service via the river Madeira and accounts for 7% of soybean exports grown primarily in the State of Rondonia and western Mato Grosso.

**Soybean Processing**

Soybean processing or “crush” involves purchasing and processing raw soybeans into the principal products of soybean meal, used for animal feed, and soybean oil, used for human consumption or biodiesel. The crush margin is the difference between the cost of the soybeans and the value of the meal and oil. So, much of the value derived from the processing of soybeans is in the form of high-protein soybean meal, making soybeans principally a protein crop, not an oil crop. A “rule of thumb” holds that 78–80% of the soybean results in meal, 18–20% in oil, and the rest in the form of a low-value high-fiber mill feed.

Recently, the price of oil began to rise because of a strong demand for food oil in Asia and biodiesel feedstocks around the world (Fig. 22.16). Simultaneously, soybean meal faces increasing competition in the United States from dried distillers grains and solubles: a medium protein coproduct from the corn ethanol industry.

The average monthly ratio of the price of soybean oil to soybean meal in Brazil began to rise from a low of 1.5:1 in 2000 (Fig. 22.17). The ratio has averaged about 2.5:1 since 1998. If the ratio were to move above four, because oil was becoming more valuable and soy protein less, then the value of the oil from soybean processing would...
surpass that of the meal. The shift in soybean’s value from protein to oil, though, is unlikely in the long run because if oil were to become valuable, processors would seek out higher oil-yielding feedstocks, and farmers, in turn, would begin to switch to higher oil-yielding crops, such as canola and sunflower.

Month-to-month variability in prices and the level of correlation among prices are primary sources of uncertainty for processors. Soybean oil prices are 60% more variable from month to month than soybean meal, and 20% more variable than soybeans. Oil, though, impacts crush margin less than meal or soybeans because it is a small component of processing output.

**Brazil’s Soybean Crushing Plants**

Brazil produces 17% of the world’s soybean meal and oil (FAO, 2007). Currently, 96 plants operate in the country, representing 47 firms (Hinrichsen, 2006). The plants have the capacity to produce 141,000 MT/day (155,000 t/day) or 42 MMT/yr (46 million t/yr). The annual capacity based on 300 days of operation is about double the 22 MMT (24 million t) of meal produced in 2006 (ABIOVE, 2007). Thus, it appears that Brazil is over capacity.

The state of Parana has 21 crushing plants, representing 15 companies. It is the leading processing state in Brazil with a capacity to produce 28,700 MT/day (31,600 t/day) of soybean meal or 20% of the nation’s output (Fig. 22.18). Mato Grosso is a
close second with 11 plants, representing 9 companies, 28,300 MT/day (31,200 t/day) of capacity, and also 20% of the nation's output.

Plant size increased in size as the industry moved from the Southeast to the Center-West. The two largest plants in the country are located in Mato Grosso and have a capacity of 6,500 MT/day (7,200 t/day) and 5,000 MT/day (5,500 t/day), respectively. The average plant size in the new growth states of the Center-West is about 1.5 times the size of the plants in the Southeast. Center-West plants average about 1,900 MT/day (2,100 t/day) of capacity, while the older plants in the Southeast average about 1,200 MY/day (1,300 t/day). The industry remains relatively unconcentrated: 20% of the crush plants produce 40% of the nation's soybean meal (Fig. 22.19), multiple firms operate any single state, and the average two-firm concentration level for the six leading processing states is 48%.

**Crush Margin**

Processors actively use risk-management tools to help manage the volatility of prices, and to hedge against shortages and unfavorable pricing as local supplies become scarce. Additionally, crush does not uniformly take place year-round because local production is seasonal, and, as a result, prices of soybeans, soybean meal, and oil are seasonal as well. Globally, two harvest seasons occur, one in the Northern Hemisphere and one in the Southern Hemisphere. The seasonality and the relative movement among the three products determine the decision whether or not to crush. Leveraging the two harvest seasons is a powerful incentive behind the globalization of soybean processing.
Brazilian Soybean Crushing Capacity (% of National Total):

- Rio Grande do Sul, 14%
- Pernambuco, 0%
- Piauí, 1%
- Rondônia, 0%
- São Paulo, 9%
- Amazonas, 1%
- Bahia, 4%
- Goiás, 14%
- Mato Grosso do Sul, 7%
- Mato Grosso, 20%
- Parana, 20%
- Minas Gerais, 5%
- Santa Catarina, 3%
- Amazonas, 1%
- Bahia, 4%
- Goiás, 14%
- Mato Grosso, 20%
- Parana, 20%
- Minas Gerais, 5%
- Santa Catarina, 3%
- Amazonas, 1%
- Bahia, 4%
- Goiás, 14%
- Mato Grosso, 20%
- Parana, 20%
- Minas Gerais, 5%
- Santa Catarina, 3%
- Amazonas, 1%
- Bahia, 4%
- Goiás, 14%
- Mato Grosso, 20%
- Parana, 20%
- Minas Gerais, 5%
- Santa Catarina, 3%
- Amazonas, 1%
- Bahia, 4%
- Goiás, 14%
- Mato Grosso, 20%
- Parana, 20%
- Minas Gerais, 5%
- Santa Catarina, 3%
- Amazonas, 1%
- Bahia, 4%
- Goiás, 14%
- Mato Grosso, 20%
- Parana, 20%
- Minas Gerais, 5%

Blue = Southeast Region
Orange = Center-West Region

Fig. 23.18. Brazilian soybean crushing capacity (% of national total) in 2006 (Source: Hinrichsen, 2006).

Fig. 23.19. Overview of Brazilian crushing plants in 2006 (N = 96) (Source: Hinrichsen, 2006).
plant investment. Strategically locating allows a processor’s operating season to more closely match harvest, when raw material prices are at their lowest. Storing soybeans for processing later in the season can reduce the competitiveness of a plant. The cost of storage reduces already low margins and places the processor in an unfavorable competitive position with competition in the other hemisphere. For example, China, as the leading global importer of whole beans, switches its source of supply with the season to take advantage of hemispheric price differences.

The average monthly crush margin at the port of Paranagua, Brazil, was $31.55/MT or 14.55% (Fig. 22.20). The margin during the Southern harvest season of March–August was 42% higher (17% compared to 12%) than during the Northern harvest season. In 2001, margins averaged close to $38/MT (19%) as the ratio of the soybean meal price to soybean price exceeded 1.10 (Fig. 22.21). While, in 1999, the ratio of meal to soybeans sank to 0.89, reducing margins to $25/MT.

Soybean crush margin is principally driven by soybean prices with a correlation coefficient between the two of –.47 (Table 22.3). The relationship between meal and oil prices and crush margin is not statistically significant. So, operating a plant when meal and oil prices are high does not guarantee satisfactory margins, if soybean prices are not sufficiently low. Therefore, processors are most profitable when intensifying their operations close to harvest when soybean prices are at their lowest. As a result, Brazilian crushers produce the most meal, 10% their annual total, in May as local grain prices remain low, yet meal and oil prices rise as the Northern Hemisphere pro-

![Fig. 23.20. Average crush margins in Brazil (1998–2006) (Source: ABIOVE, 2007; author’s calculations).](image-url)
Crush margin variability is greatest in the months leading up to the soybean harvest with several monthly periods having negative margins (Fig. 22.23). The preharvest months in Brazil have crush margin coefficients of variation over one with a range in prices more than double the average price (Fig. 22.24). Oftentimes, crushers choose to shut down during the preharvest period because of the variable of prices and competition from overseas (Ciappa et al., 2005).

**Trade**

Brazil is the second-leading soybean, meal, and oil exporter in the world by providing 35% of the world’s trade in soybeans, 26% of the meal, and 26% of the oil (Fig. 22.25). Argentina is the leader in the export of meal and oil, while the United States is the number-one exporter of raw soybeans. The crushing sectors in Brazil and Argentina are still decidedly export-oriented because of a very small domestic agro–industrial capacity. The United States is the opposite with a domestic-oriented crushing sector that serves a large domestic agro–industrial complex involving livestock and food production.

China is the leading importer of soybeans and soybean oil, with 43 and 18% of world trade, respectively (FAO, 2007). Brazil provides 25% of China’s soybean needs and 100% of the needs of The Netherlands, the world’s second-largest importer (Table 22.4). Brazil also provides The Netherlands, the world’s leading meal importer,
### Table 23.3. Statistical Relationships* Between Soybeans, Meal, Oil, and Crush Margin in Brazil** (1998–2006)

<table>
<thead>
<tr>
<th></th>
<th>Correlation Coefficient</th>
<th>Regression t-Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soybeans</td>
<td>Meal</td>
</tr>
<tr>
<td>Soybeans</td>
<td>.68</td>
<td>.71</td>
</tr>
<tr>
<td>Meal</td>
<td></td>
<td>.31</td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td>-.04</td>
</tr>
<tr>
<td>Crush Margin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Monthly averages  
** Location (interior Pananagua soybean prices, port F.O.B. meal and oil prices)  
*** Significant at the .01 level.

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**Fig. 23.22.** Average monthly plant utilization in Brazil (2000–2006) (Source: ABIOVE, 2007).
Soybean Production and Processing in Brazil

**Fig. 23.23.** Average monthly crush margin range (1998–2006) (Source: IBGE, 2007).

**Fig. 23.24.** Seasonal variability in Brazil crush margins (1998–2006) (Source: IBGE, 2007).
### The World's Leading Soybean Exporters: 2005

<table>
<thead>
<tr>
<th>Country</th>
<th>% Exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States of America</td>
<td>35%</td>
</tr>
<tr>
<td>Brazil</td>
<td>15%</td>
</tr>
<tr>
<td>Argentina</td>
<td>40%</td>
</tr>
</tbody>
</table>

### The World's Leading Soybean Oil Exporters: 2005

<table>
<thead>
<tr>
<th>Country</th>
<th>% Exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>26%</td>
</tr>
<tr>
<td>Brazil</td>
<td>5%</td>
</tr>
<tr>
<td>United States of America</td>
<td>46%</td>
</tr>
</tbody>
</table>

### The World's Leading Soybean Meal Exporters: 2005

<table>
<thead>
<tr>
<th>Country</th>
<th>% Exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>37%</td>
</tr>
<tr>
<td>Brazil</td>
<td>9%</td>
</tr>
<tr>
<td>United States of America</td>
<td>26%</td>
</tr>
</tbody>
</table>

Fig. 23.25. The world's leading soybean, oil, and meal exporters in 2005 (Source: FAO, 2007).
Soybean Production and Processing in Brazil

with 71% of its imports, and France, the number-two importer, with 70%. Brazil provides 100% of Iran's imported soybean oil needs, its number-one export customer. India and China are the number-two and number-three soybean oil customers for Brazil.

Since the mid-1990s, China has dedicated itself to increasing its processing capacity. It shifted domestic policy to favor soybean meal for livestock feed, and soybean oil for human consumption. This policy causes China to import large quantities of soybeans, mostly from Brazil and the United States to fuel its growing processing industry. China's demand combined with Brazil's relatively small animal industry results in Brazil exporting 73% of the soybeans it produces (production + a small amount of imports), 48% in the form of meal and 52% as raw soybeans.

Argentina also is a major exporter with superior logistics due to geography. The main soybean-growing region lies within 480 km (300 miles) of the deep water port at Rosario. Argentina also maintains tax policies favoring processing over direct grain exportation. Like Brazil, Argentina exports most of its soybeans (97%), but, in contrast, 74% is in the form of meal and only 26% are raw soybeans.

Alternatively, the United States is primarily a domestic user of its soybeans and soybean meal, producing six times the soybean meal it exports (Fig. 22.26). This, in part, is due to its large domestic agro–industrial complex that increasingly focuses on domestic demand, not exports. Correspondingly, Argentina and Brazil export most of what they produce due to a much smaller local agro–industrial/livestock complex.

Conclusion

The development of low-latitude soybean germ plasm by EMBRAPA, Brazil’s national research agency, is one of the most important technological innovations in agriculture since the green revolution. The doubling of production in the last 10 yr is attributable to the development of soybean technology and practices adapted to the Cerrado region in the Center-West region of the country. The Cerrado is a low growth savannah that, prior to the 1970s, was not considered suitable for broad acre crop production.

Most of the world’s reserves of arable land reside in the low-latitude region. Important as well, most of the world’s malnutrition occurs in low-latitude regions. Low-latitude technologies like those developed by public and private researchers in Brazil will play an increasing role addressing the world’s fast-growing food and bioenergy demand. The shift to the low latitudes is already well underway as 68% of the crops and 53% of the livestock products come from developing countries, an increase of 14% in the last 10 yr. (FAO, 2007).

Soybean farmers in the Center-West currently have a comparative advantage in soybean production compared with producers in the United States because of their low opportunity costs. U.S. farmers have increasingly chosen to grow corn, while farmers in the Center-West presently have few better alternatives than soybeans. As
### Table 23.4: Brazil's Leading Soybean Trading Partners in 2007 (Source: SECEX, 2007)

<table>
<thead>
<tr>
<th></th>
<th>Soybeans</th>
<th>Meal</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading Trading Partner</td>
<td>% of Brazilian Exports</td>
<td>% of Country Imports</td>
<td>% of Brazilian Exports</td>
</tr>
<tr>
<td>(1) China</td>
<td>33%</td>
<td>25%</td>
<td>100%</td>
</tr>
<tr>
<td>(2) Netherlands</td>
<td>24%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>(3) Iran</td>
<td>28%</td>
<td>71%</td>
<td></td>
</tr>
<tr>
<td>(2) France</td>
<td>23%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>(3) Thailand</td>
<td>8%</td>
<td>81%</td>
<td></td>
</tr>
<tr>
<td>(3) Spain</td>
<td>10%</td>
<td>8%</td>
<td></td>
</tr>
</tbody>
</table>

Contrasting Soybean Production and Processing between the US and Brazil indent 802 2/20/2008 1:44:13 PM
result, the tendency will be for the United States’ role in the global soy complex to decline, while Brazil’s will increase.

Poor infrastructure will continue to limit the industry’s growth even though new low-latitude soybean technologies and global protein demand growth portend a bright future for the Brazilian soybean complex. Poor infrastructure indirectly affects soybean producers as the pace of agro–industrial investment is reduced, which, in turn, limits market opportunities in the region.

Balancing environmental stewardship, while meeting the world’s increasing demand for soybeans, is probably the greatest challenge facing the industry. The state of Mato Grosso borders some of the most ecologically important rain forests in the world. One quarter of the land in Mato Grosso is classified as rain forest, yet most of the land is Cerrado or dry land forest, both of which are suitable for soybean production. A main north-south highway, the BR163 that connects Mato Grosso to the northern port city of Santarem, is highly controversial because it passes through major rain-forest regions and has the potential to contribute to ecosystem degradation. The road is critical for the economic development of the land-locked state of Mato Grosso. At the same time, demand for soybeans has never been greater. So while the market is signaling for Brazilians to expand soybean production in the Cerrado region, some policymakers and NGOs are concerned about the environmental impact.

**References**


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