Challenges and Opportunities for Conservation, Agricultural Production, and Social Inclusion in the Cerrado Biome

Technical Annex: The Agriculture Sector, Agriculture Supply Chains, and Transportation Infrastructure

August 2016

This technical annex accompanies the “Challenges and Opportunities for Conservation, Agricultural Production, and Social Inclusion in the Cerrado Biome” report, developed for the Climate and Land Use Alliance by CEA Consulting. The full report and associated materials can be found at: www.climateandlandusealliance.org/reports/cerrado/
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Agriculture in the Cerrado

**Historical background and overview**

- Beginning in the mid 1970s, agricultural production in the Cerrado expanded greatly – through a large scale national investment in agricultural research and development. Today, it is one of the most intensive and productive agricultural regions in the world.
- In the twenty years between 1991 and 2011, the value of Brazil’s agricultural exports increased ten-fold, from USD 7.9 billion to USD 81 billion. The Cerrado has been at the heart of this growth. Today, the biome accounts for about 40 percent of the total GDP from Brazil’s agricultural sector.

**Notes on this section:**

- Much of the agricultural data is provided by state rather than biome, so much of the information presented here is not perfectly aligned to the biome.
- Comprehensive information on the agricultural sector is limited by the fact that the latest Agricultural Census was published in 2006 and there are no current plans for another census. As a result, a number of the charts in this chapter only provide data through 2006.

Sources: (1) FAOSTAT, 2015. (2) MMA, 2014.
Agriculture in the Cerrado

Soy

• Soy production has grown at a rapid clip in the past few decades. Planted area has tripled since the mid 1990s and export value has quadrupled since 2006. Soy accounts for almost 40% of Brazil’s agricultural exports, by value.¹

• Of the Cerrado states, Mato Grosso has by far the most land area planted with soy, but Matopiba is growing in importance for soy production.²

Beef

• Brazil has the largest commercial cattle herd in the world and is the #2 producer and exporter of beef globally. However, the majority of Brazil’s beef is consumed domestically.³

• The processing segments of the supply chain is highly concentrated for both soy and beef.

• The beef sector is not growing as quickly as the soy sector. Slower growth and a trend towards intensification could free up land for crop expansion onto former pasture lands.

Sources: Photos by CEA, from western Bahia. (1) MDIC, Agroicone. (2) IBGE - Produção Agrícola Municipal, via Agroicone. (3) USDA, 2015.
AGRICULTURE

OVERVIEW OF AGRICULTURE IN BRAZIL
Brazil is a top global producer and exporter of agricultural commodities

- Brazil is important to world food production.
- Brazil leads world production and export of orange juice, sugar, and coffee.
- It is second for production and export of soybeans, producing 30% of the world’s soybeans and accounting for almost 40% of global soybean exports.
- Brazil is the world’s second top exporter of beef.

Source: Data from USDA.
Agriculture exports account for over 40% of Brazil’s total exports by value.

• Brazil has exported about $100 billion USD worth of agricultural commodities, on an annual basis, over the past few years, and imported about $30 billion.
• Brazil’s total exports are worth about $230 billion USD.
• The agriculture sector is important for maintaining Brazil’s trade balance.

Source: Ministério da Agricultura. Chart and text adapted from Agroicone.
Agriculture is an important, but not leading, sector for foreign investment. Brazil's agriculture sector averaged USD $350 million in foreign investment per year from 2007 to 2009, hitting almost USD $500 million in 2008. However, it lags far behind mineral and oil extraction.

Brazil’s agriculture sector averaged USD $350 million in foreign investment per year from 2007 to 2009, hitting almost USD $500 million in 2008. However, it lags far behind mineral and oil extraction.

Soy and beef are the commodities most linked to deforestation, especially in Matopiba

**Soy**
- Soy production has grown at a rapid clip in the last few decades. Planted area has tripled since the mid-1990s. Soy accounts for almost 40% of Brazil’s agricultural exports, by value.

**Beef**
- Brazil has the largest commercial cattle herd in the world and is the #2 producer and exporter of beef globally.
Pesticides, nutrient pollution, soil erosion, and genetic engineering are significant concerns for Brazilian agriculture

- **Pesticides** are a major concern in the Cerrado because of the human and ecosystem health impact. Brazil is now the world’s largest buyer of pesticides, and some pesticides that are outlawed in the United States and/or Europe are still allowed in the Cerrado, with pesticide companies and users arguing that the needs in the Cerrado’s tropical climate differ from those of more temperate regions. However, cases such as an accidental crop-dusting of a school which sent 30 children and teachers to the hospital have fueled a strong anti-pesticide movement.¹

- **Nutrient pollution** from excess nitrogen and phosphorous from crop agriculture, is a growing concern in the Cerrado. These nutrients can pollute surface and groundwater (aquifers) and causing algae blooms that strangle aquatic ecosystems. Left unchecked, nitrogen pollution of drinking water sources can lead to major health effects such as “blue baby syndrome.”²

- **Soil erosion** impacts the long-term productivity of crops and pastures. Unchecked overgrazing in particular can cause erosion, compaction, and destruction, especially in sensitive riparian areas. Soil erosion also leads to significant carbon loss in the Cerrado.

- **Genetic engineering** is a concern for many Brazilians because of its possible effects on human health and its potential to contaminate non-GMO crops. 60% of cotton, 54% of corn, and 91.8% of soy grown in Brazil are now genetically engineered.³ ⁴

AGRICULTURE

OVERVIEW OF AGRICULTURE IN THE CERRADO
Cropland and pastureland currently account for almost half of the land cover in the Cerrado

- The southern Cerrado states of Mato Grosso do Sul, Sao Paulo, and Goiás are dominated by pasture and croplands.
- Minas Gerais and Mato Grosso are also used extensively for pasture and cropland.
- The northern part of the biome is still largely covered with natural vegetation.

Source: CEA and Greeninfo Network, using data from LAPIG Maps.

Sources:
Reference layers: http://www.naturalearthdata.com/
Cerrado: http://maps.lapig.iesa.ufg.br/lapig-maps/
Land Cover: http://www.dpi.inpe.br/tccerrado/
field work in August 2005: Successional habitat translation not final
Agricultural production in the Cerrado states nearly doubled between 2005 and 2010

- Major increases in crop production occurred in the Cerrado states between 2005 and 2010.
- Soy is one of the main growth crops in the Cerrado, and its planted area has more than tripled since 1990.
- The southern Cerrado’s planted soy area is far larger than Matopiba’s, but both are growing.
- Matopiba accounts for about 16% of planted soy area in the Cerrado.

For sugarcane and soy, planted area (rather than productivity gains) has driven yield growth in recent years.

- Soybeans have the greatest planted area in Brazil among the agricultural crops.
- Planted area for both soy and sugarcane has more than doubled since 2000, while yield has remained relatively constant.
- Corn yield have managed to grow considerably since 2000.

Data from Pesquisa Agrícola Municipal; charts adapted from AgroIcone.
AGRICULTURE

AGRICULTURE IN MATOPIBA
Farm size in the Cerrado

- Farms in Matopiba tend to be small, with the exception of Tocantins.
- Matopiba has about 50% more family farms than the southern Cerrado.
Matopiba is dominated by small family farms while larger agribusiness farms characterize the southern Cerrado

- The total farm area in Matopiba states is 66.5 Mha. About 30% (21 Mha) of this area is in family farms and about 70% (45.5 Mha) is in non-family farms.
- Family farms account for about 85% of farm units in Matopiba.
- While non-family farms cover twice the area of family farms in Matopiba, non-family farms cover almost seven times the area of family farms in the rest of the Cerrado.

Farmland is dominated by owner-farmers everywhere, though a significant share of the land area is under administrator ownership.

**Number of farms in each ownership type by state, 2006**

*Matopiba states starred*

**Area of land in each ownership type by state, 2006**

*Matopiba states starred*

Source: IBGE - Censo Agropecuário.
Average land prices in the Cerrado have increased rapidly since 2009, but land in Matopiba is still relatively inexpensive.

Source: Agriannual. Charts adapted from Agroicone.
Cheaper land prices in Matopiba make it an attractive area for agricultural expansion

**Avg. price by pasture (R$/ha)**
- 506 - 2,500
- 2,500 - 5,000
- 5,000 - 7,500
- 7,500 - 10,000
- 10,000 - 24,083

**Map of land prices in the Cerrado, 2012**

Pasture land price map made by GreenInfo Network with data from Agriannual, provided to CEA by Agroicone. The Agriannual land price database is incomplete, explaining why the map only shows select areas. Land prices map on the right-hand side is from WWF, 2013.
Currently, about 10% of the major agricultural crops and 20% of the cattle produced in the Cerrado come from Matopiba.

- Mato Grosso dominates soybean and corn production and also has the largest cattle herd.
- Sao Paulo dominates sugarcane production.
- Goiás and Mato Grosso do Sul are leaders for corn and soy.
- Maranhão is the only Matopiba state with significant sugarcane production; Matopiba also has little corn production.
- Cattle and soy dominate in Matopiba.

Soy and corn production are growing in the Cerrado

- The three “micro regions” with the highest soy and corn production in Matopiba are Gerais de Balsas (Maranhão), Alto Parnaíba Piauiense (Piauí) and Barreiras (Bahia).
- In recent years, soy production has grown most rapidly in Tocantins.
- Corn production has grown rapidly in Maranhão, Piauí, and Bahia.

Source: IBGE, via Agroicone
Grain storage capacity is a gap in the region and is concentrated in Western Bahia

Storage facilities in Matopiba

Storage capacity by area
- 0 – 60 t
- 60 – 150 t
- 150 – 300 t
- 300 – 1,000 t
- 1,000 – 3,307 t

- The Barriéras (Bahia) microregion is the most developed agricultural storage capacity, followed by Gerais de Balsas (Maranhão). Regions are shown in blue on the map.

Matopiba states receive far less agricultural credit than southern Cerrado states

• Minas Gerais and Sao Paulo receive by far the most lending of the Cerrado states, receiving about R$18 billion in 2013.
• Mato Grosso and Goiás comprise a second tier, each receiving around R$12 billion in 2013.
• Aside from Bahia, Matopiba states each received less than R$2 billion in 2013.

The Matopiba states have lower Human Development Index (HDI) scores than states in the southern Cerrado

- The Human Development Index (HDI) is a blended metric that integrates health, education, and income indicators. It was created by the United Nations Development Program, in 1990.¹
- HDI is a 0-1 scale. In 2010, the country with the highest score was Norway (0.94) and the lowest was Niger (0.32).
- Matopiba states (Maranhão, Tocantins, Piauí and Bahia), in the northern part of the biome, have lower HDI scores than southern Cerrado states.

HDI in Cerrado municipalities (2010)³

- 0.44 – 0.58
- 0.58 – 0.64
- 0.64 – 0.69
- 0.69 – 0.74
- 0.74 – 0.85

Sources: (1) UNDP, 2013. (2) World Bank 2015. (3) CEPF 2015
Soybean production is concentrated in southern Cerrado, Mato Grosso, and western Bahia; high yield areas are dispersed.

Source: Produção Agrícola Municipal via Agroicone
Soy prices have skyrocketed

- Growth in soy prices has far outpaced sugarcane and corn, leading it to be the fastest expanding crop in the Cerrado.
- Sugarcane prices have hardly increased since 1995
- Corn prices have fluctuated since 2009, with modest overall growth.

Source: data from Pesquisa Agrícola Municipal; chart adapted from Agroicone.
Soy production of Tocantins and Maranhão have comparable yields to the rest of the Cerrado; Bahia and Piauí lag behind.

**Soy yield by state in the Cerrado, 2013 (kg/ha)**

- Goiás
- São Paulo
- Mato Grosso
- Minas Gerais
- Mato Grosso do Sul
- Tocantins
- Maranhão
- Bahia
- Piauí

Source: IBGE - Produção Agrícola Municipal, via Agroicone
Soy supply chain

**Inputs**
- Seeds
- Fertilizers
- Pesticides
- Machinery
- Other

**Production 81.7 m ton**
- West Central 46.8%
- South 37.1%
- Southeast 6.4%
- Northeast 6.4%
- North 3.3%

**Originators**
- Warehouse
- Agricultural cooperatives
- Trading companies

**Soybean crushers**
- Private companies
- Cooperatives

**Industrial oil derivatives**
- Salad
- Dressing
- Margarine
- Mayonnaise
- Other

**Distribution**
- Wholesale
- Retail
- Institutional Market
- Domestic Market

**Crushing industry:** Process whole soybeans into meal and oil. Soybean meal in the domestic market goes to the feed industry. Other processed products can also be sold to the food, chemical and pharmaceutical industries.

**Industrial soy oil derivatives:** The refined oil can be further processed into margarines, mayonnaise, and vegetable fats, which are intended primarily for the domestic market through wholesale distributors and retailers.

**Distributors:** Link the crushing and soy derivatives industries to the final consumers.

**Originators:** Transact with producers / cooperatives in order to acquire soybeans and sell to the foreign market and to the crushing industry. This step can be skipped.

**Note:** Values, when mentioned, for 2013. Source: Ministério da Agricultura; IBGE - Produção Agrícola Municipal.
Brazilian soy supply chain by the numbers

Production: 82 million tons
Crushing: 36 million tons
Meal: 28 million tons
Oil: 7 million tons
Export: 12 million tons
Domestic market: 16 million tons

Source: ABIOVE & MDIC-Secex, via Agroicone.
Bunge, Cargill, ADM, and Louis Dreyfus dominate Brazilian soy trading

Active crushing units in Cerrado by company, 2014

<table>
<thead>
<tr>
<th>Company</th>
<th>Units</th>
<th>Location</th>
<th>Company</th>
<th>Units</th>
<th>Location</th>
<th>Company</th>
<th>Units</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunge</td>
<td>6</td>
<td>BA, GO, MS, MT, PI</td>
<td>Agrex</td>
<td>1</td>
<td>GO</td>
<td>Oleoplan</td>
<td>1</td>
<td>BA</td>
</tr>
<tr>
<td>Cargill</td>
<td>5</td>
<td>BA, GO, MG, MS, MT</td>
<td>Amaggi</td>
<td>1</td>
<td>MT</td>
<td>Olvebasca</td>
<td>1</td>
<td>BA</td>
</tr>
<tr>
<td>ADM</td>
<td>4</td>
<td>GO, MG, MS, MT</td>
<td>Araguassu</td>
<td>1</td>
<td>MT</td>
<td>Olvego</td>
<td>1</td>
<td>GO</td>
</tr>
<tr>
<td>Caramuru</td>
<td>3</td>
<td>GO, MT</td>
<td>Cereal</td>
<td>1</td>
<td>GO</td>
<td>Producampo</td>
<td>1</td>
<td>MT</td>
</tr>
<tr>
<td>Granol</td>
<td>3</td>
<td>GO, SP</td>
<td>Clarion</td>
<td>1</td>
<td>MT</td>
<td>Selecta</td>
<td>1</td>
<td>MG</td>
</tr>
<tr>
<td>Algar Agro</td>
<td>2</td>
<td>MA, MG</td>
<td>Correcta</td>
<td>1</td>
<td>MS</td>
<td>Sodru</td>
<td>1</td>
<td>SP</td>
</tr>
<tr>
<td>Brejeiro</td>
<td>2</td>
<td>GO, SP</td>
<td>Dureino</td>
<td>1</td>
<td>PI</td>
<td>Sperafico</td>
<td>1</td>
<td>MT</td>
</tr>
<tr>
<td>Comigo</td>
<td>2</td>
<td>GO</td>
<td>Grupal</td>
<td>1</td>
<td>MT</td>
<td>Taua</td>
<td>1</td>
<td>MT</td>
</tr>
<tr>
<td>Louis Dreyfus</td>
<td>2</td>
<td>GO, MT</td>
<td>Lasa</td>
<td>1</td>
<td>GO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sina</td>
<td>2</td>
<td>SP</td>
<td>Noble</td>
<td>1</td>
<td>MT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- There are around 30 companies or cooperatives trading soy in the Cerrado region, with 42 soybean crushing units between them, including 10 inactive units.
- The top 10 companies with the largest installed crushing capacity represent 55% of the total industry capacity in Brazil.
- In 2014, Bunge, Cargill, ADM, and Louis Dreyfus exported USD$ 17 billion (Bunge - $6 billion; Cargill - $4 billion; Louis Dreyfus - $3.5 billion; ADM - $3.3 billion). These four companies exported 55% (USD$ 17.2 billion) of the total soy complex exported by Brazil in 2014 (USD$ 31.4 billion).
- In recent years, the Brazilian soybean crush industry has become more concentrated due to mergers and acquisitions in the late 1990s, when international companies bought small and medium national industries.

Sources: Table - ABIOVE. Chart - MDIC-Secex. Both graphics and slide text adapted from AgroIcone.
Soybean crushing capacity is concentrated in the southern Cerrado and the far Southern region of Brazil

- In the past 10 years crushing capacity has increased by 37% in Brazil, from 132 to 180 thousand tons/day.
- In the same period, crushing capacity in the Cerrado increased by 48%, from 104 to 109 thousand tons/day.
- MT/MS/GO comprise 41% of Brazilian soybean crushing capacity, while states in the far South comprise 38%.
- Matopiba’s crushing capacity is currently very limited.
- Since 2004, crushing capacity has increased about 96% in MT, 50% in RS, 37% in GO, and 45% in MS.

Source: ABIOVE. Charts adapted from Agroicone, slide test partially adapted from Agroicone.
Whole soybean exports are growing while soybean meal and oil exports are declining

- In the 1990’s, soybean meal was the main soy product exported by Brazil.
- Starting in 2000, China began to invest it its own crushing capacity and started to import more grain than meal.
- Domestic consumption of soybean meal has increased significantly in the last decade, mainly due to expansion and concentration of Brazilian meat production.
- Since 2005 an increasingly greater proportion of Brazilian soybeans have been exported, while the amount consumed domestically fluctuates considerably year over year.

Sources: (1) Data source: MDIC, chart adapted from AgroIcone. (2) Data source: Pesquisa Agrícola Municipal / MDIC-Secex, chart adapted from AgroIcone. This graph is for soybeans, in particular – does not include soybean meal or soy oil. Some slide text adapted from AgroIcone.
Domestic consumption of soybean meal has increased, while major international buyers have gained a preference for whole soybeans.

- China imports the vast majority of Brazilian soybeans (71% in 2014).
- India and China each import about one third of Brazil’s soybean oil exports.
- As of 2014, the main Brazilian soybean meal importers are the Netherlands, France, Germany and Thailand.
- China used to buy more soybean meal from Brazil, but it has invested in its own crushing capacity and now imports the lower-value whole soybeans.

**Whole soybean export destinations, 2014**

<table>
<thead>
<tr>
<th>Destination</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>71%</td>
</tr>
<tr>
<td>Spain</td>
<td>5%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>4%</td>
</tr>
<tr>
<td>Thailand</td>
<td>3%</td>
</tr>
<tr>
<td>United States</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>15%</td>
</tr>
</tbody>
</table>

**Soy oil export destinations, 2014**

<table>
<thead>
<tr>
<th>Destination</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>33%</td>
</tr>
<tr>
<td>China</td>
<td>15%</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>8%</td>
</tr>
<tr>
<td>Algeria</td>
<td>7%</td>
</tr>
<tr>
<td>Cuba</td>
<td>7%</td>
</tr>
<tr>
<td>Other</td>
<td>30%</td>
</tr>
</tbody>
</table>

**Brazilian soybean meal export destinations in 1998**

<table>
<thead>
<tr>
<th>Destination</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>23%</td>
</tr>
<tr>
<td>France</td>
<td>19%</td>
</tr>
<tr>
<td>Thailand</td>
<td>12%</td>
</tr>
<tr>
<td>China</td>
<td>7%</td>
</tr>
<tr>
<td>Other</td>
<td>37%</td>
</tr>
</tbody>
</table>

**Brazilian soybean meal export destinations in 2014**

<table>
<thead>
<tr>
<th>Destination</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>39%</td>
</tr>
<tr>
<td>France</td>
<td>14%</td>
</tr>
<tr>
<td>Thailand</td>
<td>9%</td>
</tr>
<tr>
<td>China</td>
<td>11%</td>
</tr>
<tr>
<td>Other</td>
<td>26%</td>
</tr>
</tbody>
</table>

Source: MDIC-Secex, via Agroicone.
Globally, the United States and Brazil dominate soybean exports and China now accounts for nearly 65% of soybean imports.

- US (49 million tons) and Brazil (46 million tons) are the largest exporters of soybeans, globally, followed by Argentina (8 million tons) and Paraguay (5 million tons) as of 2014/15.

- Brazil soybean exports increased by 128% in last decade, followed by Paraguay (67%) and US (63%). Argentinian exports decreased by 16%.

- In the last decade China’s soybean imports have increased by 187%, while imports by Japan and the EU have decreased by 32% and 13%, respectively.

Source: chart data from USDA, charts adapted from AgroIcone. Slide text adapted from AgroIcone.
Growth in soybean production is expected to continue at a fast pace

- From 2014 to 2024, the Brazilian government predicts an increase in soybean production of 37%, reaching 118 million tons by the 2023/24 growing season.

- In the same period, domestic consumption and exports are expected to increase by about 26% and 44% respectively.

- The increase in domestic consumption will be caused by higher demand from the feed industry and for biodiesel production.

- The planted soybean area is expected to increase by 10 million hectares over the next 10 years, reaching 40 million hectares in 2024.
  - The planted area is expected to increase, mainly in the Matopiba states.
  - In Mato Grosso, soybean area is expected to expand, primarily over degraded pasture areas.

Source: Chart data from Ministério da Agricultura, chart adapted from Agroicone. Slide text partially adapted from Agroicone.
Soybean meal and oil production are projected to grow more slowly; oil will likely remain mostly domestically consumed.

**Soybean Meal**
- Between 2013/14 and 2023/24, soybean meal production is expected to increase by about 25%, reaching 35 million tons in 2023/24.
- Growth is expected to be primarily driven by domestic consumption.
- The Brazilian government estimates that in 2023/24, about 54% of soybean meal production will be consumed domestically, and 45% will be exported.

**Soybean Oil**
- Between 2013/14 and 2023/24, the Brazilian government estimates an increase of about 26% in soybean oil production, reaching 9 million tons in 2023/24.
- Domestic consumption and exports are expected to increase by about 23% and 18%, respectively.

Source: Chart data from Ministério da Agricultura, chart adapted from Agroicone. Slide text partially adapted from Agroicone.
The cattle herd is dispersed throughout Brazil, with significant stocks in the Cerrado and Amazon.

Cattle herd in Brazil, beef and dairy, 2013

- Cattle for beef and milk are major agricultural products in Brazil for both domestic consumption and export.
- Cattle, especially beef cattle, is present in the frontier areas, and pasture is often the first productive use of lands converted from natural vegetation.
- Soy and other crops are more profitable uses of land, so often recently deforested land spends a few years as pastureland before being converted to cropland.

Legend

- 90 to 54,175 head
- 54,176 to 118,456 head
- 118,457 to 222,810 head
- 222,811 to 547,022 head
- 547,023 to 3,766,176 head
- No data

Source: IBGE - Pesquisa Pecuária Municipal.
Beef cattle are dispersed around the country, while dairy cattle are concentrated in southeastern Brazil

- While cattle for beef in Brazil are spread throughout the Cerrado (especially south & west) and the Amazon, cattle for dairy are concentrated in the southeast part of Brazil.
- Consequently, dairy cattle are likely a less direct driver of deforestation; the soy used in their feed is likely the main driver of deforestation from the dairy industry.

Source: IBGE – Censo Agropecuário & IBGE – Pesquisa Pecuária Municipal
Beef production is expected to grow 20% by 2040; milk production is projected to grow 30% in that timeframe.

**Beef projections**
- Roughly 2% growth per year is expected in beef production through 2024.
- Between 2014 and 2024 Brazilian beef consumption is expected to increase by 16%, from 7.7 million to 9 million tons.
- In the same period, a growth of about 40% in exports is expected, from 2.1 million to 2.9 million tons. This represents, on average annual growth rate of 3.4%.

**Milk projections**
- Between 2013/14 and 2023/24, projections show an increase of about 30% in milk production, from 36 million to 46 million tons.
- Brazilian milk consumption is expected to increase by about 27% in the next 10 years, from 38 million to 48 million tons.
- Exports will increase by about 34% in the same period, reaching 191 thousand tons.
- Import projections show a decrease by about 9% in the period, from 1.1 million to 991 thousand tons.

Source: Ministério da Agricultura. Charts and some text adapted from AgroIcone.
Brazil has one of the largest commercial cattle herd in the world

- 5 countries share 79% of the world’s cattle: India (367 million head), Brazil (258 million), China (151 million), USA (125 million) and the EU (117 million).
- Brazil has the largest commercial herd in the world (much of India’s herd is outside of the market).
- Between 2000 and 2013 the Brazilian cattle herd increased by nearly 40%, while India’s expanded by only 9%. During that same time the other major cattle-producing countries declined:
  - China, -7%
  - USA -10%
  - EU -10%
- The total world cattle herd decreased by 3% between 2000 to 2014 from 1.32 billion head to 1.28 billion head.

Source: data from USDA, chart adapted from Agroicone. Slide text a partially adapted from Agroicone.
The US, Brazil, EU, and China lead in beef consumption

**Production**
- Brazil ranks second in global beef production.
- In 2014 Brazilian production represented 16% of world production, 32% higher that its share in 2000 (12%).
- From 2000 to 2014, US and EU production decreased by around 10%, while production in Brazil, China and India increased by 49%, 34% and 170% respectively. These five countries accounted for two-thirds of global beef production in 2014.

**Consumption**
- World beef consumption increased by 9%, from 2000 to 2014, reaching 58 million tons.
- In the last decade, Brazilian beef consumption increased by 29% and Chinese beef consumption increased by 48%. On the other hand, the US, and EU Argentina consumption decreased by about 10%, 8% and 2%, respectively.
- In 2014, Brazil, China, US, EU, and Argentina together consumed 63% of the total world beef.

Source: data from USDA, chart adapted from Agroicone. Slide text a partially adapted from Agroicone.
Since 2000, Brazil’s beef exports have increased five-fold, while China emerged as a major importer.

**Exporters**

- The main beef exporters in 2014 were India (2.1m tons), Brazil (1.91m), Australia (1.85m), USA (1.17m) and New Zealand (0.6m).
- According to the USDA, from 2000 to 2014, beef exports increased considerably in India and Brazil, by about 505% and 291%, respectively.

**Importers**

- Main beef importers in 2014 were the US (1.34 m tons), Russia (920 thousand tons), Japan (740 thousand tons), Hong Kong (650 thousand tons) and China (417 thousand tons).
- Between 2000 and 2014, China had the largest increase in beef imports, about 2,506%, albeit off of a small base.

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Source: data from USDA, chart adapted from AgroIcone. Slide text a partially adapted from AgroIcone.
Most Brazilian beef is consumed domestically; Russia and Hong Kong* account for nearly half of Brazilian beef imports

- About 80% of Brazilian beef production is consumed domestically, and 20% is exported, although exports have been growing slightly faster than domestic consumption.
- Beef production increased about 50% from 2000 to 2014, reaching nearly 10 million tons.
- The main beef exporting states in 2014 were SP (439 thousand tons), MT (279 thousand tons), GO (228 thousand tons), MS (165 thousand tons) and RO (134 thousand tons).
- Key end buyers in 2014 were Hong Kong (25%), Russia (20%), Venezuela (11%) and Egypt (11%).

*It isn’t clear from the data what the final destination is for exports to Hong Kong. It may serve as an intake port for beef consumption in mainland China, or may be part of a processing and re-export hub.
Brazil’s cattle herd has been fairly stable over the last 10 years

- States with at least part of their area in the Cerrado are home to about 60% of Brazil’s cattle herd. *(Note that this graph shows Cerrado states, not the Cerrado Biome.)*
- In 2013 Mato Grosso had over 28 million head, Minas Gerais 24 million, Goiás and Mato Grosso do Sul about 21 million, and São Paulo and Bahia each had about 10 million head.
- Tocantins and Maranhão had about 8 million head in 2013, while Piauí had less than 2 million.

Source: IBGE - Pesquisa Pecuária Municipal, via Agroicone.
**Beef cattle supply chain**

**Suppliers:** Activities related to animal health, nutrition, and genetics.

**Primary producers:** Companies or farmers that breed and fatten the animals. Often there are multiple steps in this part of the chain.

**Industrialization:** Primary processing - Slaughter and initial break-down of animals.

**Marketing:**
- **Wholesalers & exporters**: These actors often also provide storage & delivery.
- **Retailers**: Sell beef directly to consumer. Retailers include grocery stores, restaurants, and food services providers.

**Consumption**

**Input Suppliers**

**Agricultural companies**

**Farmers**

**Primary processing industrialization**

**Secondary processing industrialization**

**Wholesaler or Exporter**

**Retailer**

**Collective / institutional food companies**

**Final customer**

Source: Ministério da Agricultura, via Agroicone.
The top three beef cattle companies in Brazil – JBS, Marfrig, and Minerva – control 36% of slaughter capacity

<table>
<thead>
<tr>
<th>Company</th>
<th>% of beef cattle slaughter capacity¹</th>
<th>Number and location of slaughterhouses²</th>
</tr>
</thead>
<tbody>
<tr>
<td>JBS</td>
<td>22%</td>
<td>• Total: ~50 total units in Brazil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cerrado: ~20 units in or near the Cerrado</td>
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<tr>
<td></td>
<td></td>
<td>• Matopiba: 1 unit in Maranhão; 4 units in Pará near the Cerrado (Tocantins), 1 unit near Belém</td>
</tr>
<tr>
<td>Marfrig Group</td>
<td>9%</td>
<td>• Total: ~20 total units in Brazil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cerrado: ~10 units in or near the Cerrado</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Matopiba: No identified units in Matopiba states</td>
</tr>
<tr>
<td>Minerva Foods</td>
<td>5%</td>
<td>• Total: ~8 units in Brazil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cerrado: ~5 units in or near the Cerrado</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Matopiba: 1 unit in Tocantins</td>
</tr>
</tbody>
</table>

Slaughterhouses are concentrated in southern Cerrado states, although Rondonia and Para have significant slaughter capacity.

- Slaughterhouses have settled near the producing regions, mostly in the southern Cerrado states.
- There are 260 slaughterhouses registered in the SIF (Federal Inspection Service). In MT there are 37; in MS - 35; SP - 30; MG - 29; GO - 26; RO - 18.

Sources: Map via Agrolcone. Some text adapted from Agrolcone. Chart data from Ministério da Agricultura via Agrolcone.
Brazil’s dairy sector (production value USD$37 m) is almost as important economically as its beef sector (production value USD$50 m)

- Fresh or chilled cattle meat in 2012 was valued at $34 million USD. Frozen cattle meat was valued at $12 million USD. Together they account for over 90% of the value of beef cattle production, and 53% of overall cattle production (including dairy).

Source: IBGE – Pesquisa Industrial Anual – Produto, via Agroicone.
The dairy industry is less concentrated than the cattle industry

In recent years, the dairy industry has become more concentrated, with some companies gaining market share in both the purchase of milk and in end markets.

Main international companies in this sector are DPA/Nestlé and Danone; they represented 28% of the total milk bought by the top 10 companies of this sector in 2014.

BRF is the second largest company in milk purchased and the largest Brazilian national company in the sector.

Most dairy processing is located in the largest milk producing states of MG, GO, PR and RS.

Sources: (1) Associação Brasileira dos Produtores de Leite via AgroIcone. (2) G100 Associação Brasileira de Pequenas e Médias Cooperativas e Empresas de Laticínios. (3) Slide text adapted from AgroIcone.
Brazil’s dairies lag behind other major milk producers in terms of yield

- World milk yield increased by 21% from 2000 to 2014, reaching over 4 tons/cow.
- From 2000 to 2014 the milk yield growth was most significant in Ukraine (94%), Argentina (43%), EU (34%), and USA (22%). In Brazil the yield improved 17% during this period.
- Brazil’s dairy productivity is lower than other major milk producing countries.

Data source: BGE - Pesquisa Pecuária Municipal; charts and text adapted from AgroIcone.
AGRICULTURE
PASTURE INTENSIFICATION
Pasture intensification can spare land, provide room for expansion of crops, and improve cattle productivity

- Pasture intensification increases productivity from a given unit of land through improved forage quality, instead of expanding production by expanding the land footprint.
- Pastures intensification can: 1) reduce the land footprint needed to produce cattle, thus reducing pressure on forests, 2) free up land that soy and other crops can expand onto, thus reducing pressure on forests, and 3) reduce the enteric fermentation emissions associated with the cattle herd by improving their diets.
- In general, Brazil has relatively low density of cattle per hectare (less than one head of cattle per hectare) spread out over ~160 Mha\(^1\) (roughly 20% of Brazil’s total area). There is considerable room for intensification and efforts are already being made on the part of the government, trade associations, and NGOs, to intensify through restoration of degraded pastures.

Sources: (1) IBGE, Agricultural Census, 2006. (2) Tollefson 2010.
The land sparing effects of pasture intensification could be very significant

In theory, intensification has a high GHG mitigation potential because it helps avoid cattle-driven deforestation. Increasing the productivity of pastures might save 250-450 Mt CO₂e per year by 2030.

- Strassburg et al. 2013 modeled intensification on Brazil’s 115 Mha of cultivated pasturelands and found that intensification might prevent land use change emissions of ~400 Mt CO₂e per year (assuming continuation of current deforestation trends), while reductions in enteric fermentation could mitigate ~50 Mt CO₂e per year in 2030.¹

- Cohn et al. 2014 did a similar analysis, investigating the effects of a government subsidy for intensive cattle production or a tax on extensive cattle production.²
  - Both a tax and subsidy yield ~400 Mt CO₂e per year by 2030 from decreases in deforestation in Brazil. (middle graph)
  - Intensification driven by subsidies would presumably increase the herd size and thus enteric fermentation emissions, while intensification driven by taxes would presumably decrease herd size and thus enteric fermentation – both effects would be marginal (<40 Mt CO₂e per year by 2030). (top graph)

Sources: (1) Strassburg et al. 2013. (2) Cohn et al. 2014.
Cattle intensification and use of mixed systems can meet the demand for land from expanded crop production in Brazil

- According to one modeling effort, future crops will demand an area of 33.5 Mha across all of Brazil. (By way of comparison, the area of the entire Cerrado is 200 Mha). If these crops were distributed across mixed agropastoral (crop-livestock) and silvopastoral (crop-planted forest) systems, then the area might be significantly larger (~60 Mha).
- This need could be accommodated using the existing footprint of agriculture by intensifying agriculture and then expanding onto newly freed-up lands.
  - According to this modeling effort, Brazilian cultivated pasturelands are only at 32-34% of their potential productivity currently.
  - Increasing productivity to 49-52% of its potential would allow for agricultural production without expanding the overall footprint of agriculture.
  - This would save 14.3 Gt CO$_2$e, almost all in avoided deforestation.

Source: Strassburg et al., 2014.
The Cerrado has significant pastureland that is suitable for crop production.

Source: Soares-Filho, et al, 2014. *Without considering climatic or land-use zoning restrictions, per biome (colors) and state (horizontal axis).
In theory, no additional vegetation needs to be cleared

- Assuming very modest levels of cattle intensification and use of mixed crop-livestock and crop-forestry systems, demand for agricultural products in 2040 can be met without expanding the overall footprint of agriculture (see right).
- An alternative scenario where cattle production is concentrated in high productivity areas would potentially even free up additional land to be reforested.
- The challenge is that, while such an allocation may make sense at the national level, it may not reflect the needs of individual landowners, each of whom are likely to seek to maximize their own economic gain from the land that they control. This may involve expanding production into areas of native vegetation.

Source: Strassburg et al., 2014.

Possible land use scenario in 2040 that avoids further conversion of natural vegetation

- Sugarcane
- Reforestation
- Agropastoral (AU/ha)
  - 0.00-1.00
  - 1.01-2.00
  - 2.01-5.35
- Silvipastoral (AU/ha)
  - 0.00-1.00
  - 1.01-2.00
  - 2.01-5.35
- Traditional Cattle Ranching (AU/ha)
  - 0.00-1.00
  - 1.01-2.00
  - 2.01-5.35
The Roundtable for Responsible Soy (RTRS) certification has the backing of global soy traders, but has had limited impact to date

RTRS was established in 2006 and is a multi-stakeholder initiative of the mainstream soy industry, including retailers, producers, the feed industry, NGOs, and banks.\(^1\)

- RTRS has over 150 members from more than 120 countries. Its RTRS-certified soy program was launched in 2011.
- RTRS has a goal of reaching 10 million tonnes of certified responsible soy worldwide by 2017.\(^2\) Brazil’s total soy production in 2014 was 90 million tones. In 2014, 1.5 million tonnes of RTRS-certified soy were produced, accounting for less than 1% of global soy trading.\(^3\)
- RTRS soy cannot be produced on land deforested after 2009. RTRS also promotes increasing productivity and other best agricultural practices.\(^4\)
- The price premium for RTRS soy is very low, and little public pressure has been exerted on this segment of the supply chain (traders), which reduces the incentive for buyers to buy RTRS-certified soy.
- RTRS recently completed a map to guide future expansion of soy in Brazil and Paraguay. These maps identify High Conservation Value (HCV) areas with a vision towards incorporating them into sourcing standards; discussions of how to use this map are ongoing.
- Amaggi is a leader in RTRS certifications; as of 2014, 42% of RTRS certified soy came from Amaggi and its suppliers.\(^5\)

RTRS’ mapping effort for responsible soy expansion is very detailed

Guide for responsible soy expansion

RTRS members must embed in procurement and investment strategies

RTRS criteria for soy expansion

- Not permitted
- Areas have value; depends on HCVA assessment
- Law adequate
- No native vegetation, law adequate
In addition to RTRS there are several other initiatives and certifications that have emerged for soy in Brazil

Aliança da Terra is a Brazilian NGO focused on sustainable farming

• Aliança da Terra (ADT) maintains a Registry of Social-Environmental Responsibility (RSR). The main goal of the RSR is to help guide landowners through the key criterion of the RTRS certification.²
• In 2008, ADT began working with ADM on the “Doing it Right” program, which is focused on entering ADM’s suppliers into the RSR. Today it has registered over 500 properties.²
• ADM and Aliança da Terra have also joined the SojaPlus program (see below).³

SojaPlus is the Brazilian soy industry’s main soy sustainability initiative⁴

• Launched in 2011, the Soja Plus program is the result of a partnership between ABIOVE (the Brazilian Vegetable Oil Industry Association) and APROSOJA (the Mato Grosso State Soybean and Corn Producers Association). The initiative was started in Mato Grosso but aims to eventually expand to Minas Gerais, Mato Grosso do Sul, and Paraná.⁵
• SojaPlus is a comprehensive sustainability and best practices program. It is not centered around a certification program, but nonetheless offers certification to participating farms through a third party audit.⁵
• The main activities of SojaPlus involved farm trainings and rural assistance with technology and best agricultural practices.⁶
Brazil is making significant investments in transportation infrastructure in the Cerrado

Lack of transportation infrastructure has been a limiting factor for agriculture in the Cerrado

• It is generally cheap to produce agricultural crops in the Cerrado, but relatively expensive to bring them to market. As transportation infrastructure improves, it has the potential to improve the economics of production and speed the expansion of agricultural development near transportation corridors.

Brazil’s Logistics Investment Program (LIP), first announced by President Rousseff in 2012, will lead to significant investment in road and rail transport in the Cerrado and elsewhere in Brazil.¹

• R$ 66b will be spent on roads; R$ 86b on railways, R$ 37 on ports, and R$ 8.5 on airports.

The third phase of Brazil’s Growth Acceleration Program (PAC-3) focuses on expanding investment in infrastructure to stimulate the productive sectors, including:²

• a host of new hydropower plants
• the completion of the North-South railway
• support for a East-West railway (to connect Brazil to the Pacific Ocean)
• expansion of the highway system

Brazilian roads are currently the backbone of agricultural transport in the Cerrado

There are 213,000 km of paved roads in Brazil; another 21,00 km are under currently construction.

Roads help make land accessible and usable at a lower cost, driving deforestation in the surrounding areas.

Share of total road length among Cerrado states

Sources: Ministério dos Transportes, via Agroicone. Pie chart data source: DNIT. Chart adapted from Agroicone.
PAC plans for highway expansion include:

1. the construction and paving of BR-235 in Piauí
2. the paving of BR-163 in Mato Grosso
3. the construction of the BR-158 and BR-242 in Mato Grosso
4. the duplication of the BR-080 in Goiás
5. construction of the BR-350 in Mato Grosso do Sul
6. the construction of the BR-080 passages in Mato Grosso and Goiás.
Cerrado railways: existing, planned, and under construction

• Ambitious railways schemes, including a north-south trunk link being constructed through Tocantins and Goiás, would link Cerrado breadbaskets to demand centers and ports on both the East and West coasts of the continent.

There are plans to greatly increase rail capacity in the Cerrado in support of agricultural transport

**Railroad infrastructure is slated to expand throughout the Cerrado, including through two high-profile projects.**

**The North-South railway**
- The partially-complete North-South railway will be a major route for grain export from the Cerrado.
- Between 2011 and 2014 over 900km of railway was constructed.

**Twin Ocean Railroad**
- China recently proposed a 5,300km, USD$10 billion railway that would cut across the Minas Gerais, Goiás, Mato Grosso, the Southern Amazon, and Peru. Feasibility studies are underway.
- The railway would slash the cost of shipping agricultural products to Asia.
- Critics worry that it would threaten uncontacted Amazon tribes and the rainforest.

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Port of Itaqui in Maranhão is the most important port in Matopiba

- Connected to the Transnordestina railroad and the Carajás railroad.
- By volume, the largest commodities to pass through the port in 2014 were soy (~3 million tonnes) and fertilizers (~1.5 million tonnes). Total volume was nearly 9 million tonnes.
- The port accounts for 54% of all agribusiness exports from the Matopiba region, including nearly 100% of Maranhão exports, 77% of Tocantins exports, and 89% of Piauí exports.

Source: AgroIcone