Creating a Market for Ethanol - Challenges Faced in the Brazilian Experience

Agnes Maria de Aragão da Costa
Tiago de Barros Correia
João Paulo Resende

Ministry of Mines and Energy - Brazil
The Sugarcane Industry in Brazil

- Oldest economic activity in Brazil
- Almost all Brazilian States produce sugarcane, but São Paulo concentrates about 60% of the National production
- 320 industrial units - “usinas”

Crop Growing Characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth cycle</td>
<td>5 years</td>
</tr>
<tr>
<td>Number of cuttings</td>
<td>5 cuttings</td>
</tr>
<tr>
<td>Sugarcane productivity</td>
<td>85 ton/ha (160 -65)</td>
</tr>
<tr>
<td>Sugar yield</td>
<td>138 kg/ton</td>
</tr>
<tr>
<td>Ethanol yield</td>
<td>82 l/ton</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture, Livestock and Food Supply (2007)
Brazil was responsible for more than 30% of the sugarcane produced by the main producing countries in 2005.

**Main sugarcane producing countries - 2005**

<table>
<thead>
<tr>
<th>Country</th>
<th>Sugarcane Production (thousand ton)</th>
<th>Crop area (thousand ha)</th>
<th>Productivity (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>422,926</td>
<td>5,794</td>
<td>72.99</td>
</tr>
<tr>
<td>India</td>
<td>232,300</td>
<td>3,602</td>
<td>64.49</td>
</tr>
<tr>
<td>China</td>
<td>87,768</td>
<td>1,361</td>
<td>64.49</td>
</tr>
<tr>
<td>Pakistan</td>
<td>47,244</td>
<td>967</td>
<td>48.86</td>
</tr>
<tr>
<td>Mexico</td>
<td>45,195</td>
<td>636</td>
<td>71.06</td>
</tr>
<tr>
<td>Thailand</td>
<td>43,665</td>
<td>1,097</td>
<td>39.80</td>
</tr>
<tr>
<td>Colombia</td>
<td>39,849</td>
<td>426</td>
<td>93.54</td>
</tr>
<tr>
<td>Australia</td>
<td>37,822</td>
<td>434</td>
<td>87.15</td>
</tr>
<tr>
<td>Indonesia</td>
<td>29,505</td>
<td>435</td>
<td>67.83</td>
</tr>
<tr>
<td>USA</td>
<td>25,308</td>
<td>373</td>
<td>67.85</td>
</tr>
<tr>
<td>South Africa</td>
<td>21,265</td>
<td>428</td>
<td>49.68</td>
</tr>
<tr>
<td>Philippines</td>
<td>20,795</td>
<td>369</td>
<td>56.36</td>
</tr>
<tr>
<td>Argentina</td>
<td>19,300</td>
<td>305</td>
<td>63.28</td>
</tr>
<tr>
<td>Guatemala</td>
<td>18,500</td>
<td>190</td>
<td>97.37</td>
</tr>
<tr>
<td>Egypt</td>
<td>17,091</td>
<td>135</td>
<td>126.60</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture, Livestock and Food Supply (2007)
Sugarcane is used as input to several industries, but mainly for sugar and ethanol production.

88.67% of the 2007/2008 sugarcane production will be designated to the sugar and ethanol industry.

The remaining 11.33% (59.82 million tons) will be used for the production of “cachaça”, animal food, seeds, “rapadura”, muscovado sugar and others.

Ethanol: 80% of the ethanol produced in Brazil is for fuel use, 5% for food, perfumery and chemical industries, and 15% for exports.

- Anhydrous ethanol is used for gasoline “C” production
- Hydrated alcohol is directly used in automotive vehicles refueling
The Sugarcane Industry in Brazil

Evolution of alcohol and sugar production – by crop

51/52 CROP
- Anhydrous: 47,997 m³
- Hydrated: 122,365 m³
- Sugar: 1,595,706 t

05/06 CROP
- Anhydrous: 7,663,245 m³
- Hydrated: 8,144,939 m³
- Sugar: 26,214,391 t

Source: Ministry of Agriculture, Livestock and Food Supply (2007)
The Sugarcane Industry in Brazil

Variables to the production decision at the “usinas”:

- Long term contracts with independent sugarcane producers
- Seasonability, unpredicted effects of climate changes and possible crop ruptures due to plagues or other factors
- Flexibility of producing several products with the same input: sugar, alcohol (anhydrous and hydrated) and electricity
  - Relative price and demand of sugar (considering internal and external markets) and alcohol
  - Commodities: exogenous market instability
  - International oil prices
  - Vehicle fleet
  - Mix of anhydrous ethanol to gasoline
The Sugarcane Industry in Brazil

Alcohol and sugar production system

Planting → Harvest → Transport → Agriculture

Bagasse → Milling → Distillation

Electricity

Anhydrous Alcohol → Hydrated Alcohol

Sugar → Domestic Consumption

Exports

Source: JBIC (2006)
The Sugarcane Industry in Brazil

- Products and byproducts of the sugarcane industry are playing a more important role as sources of energy in Brazil.
- Production system has a big advantage in saving fossil energy.
- In 2006, ethanol accounted for 40% of the fuel burnt in automotive engines (Otto cycle) in Brazil.
- The Brazilian sugarcane industry generated as much as 11,3 TWh of electric and mechanic energy, mainly for self-consumption.
- The sugarcane industry has a strong potential of energy supply growth, especially through the generation of electric energy.
The Sugarcane Industry in Brazil

- Electricity generated by the sugarcane industry covers the consumption of its industrial processes and has also been sold to the grid.

- Electricity generation by the sugarcane industry is limited to the crop season – which means for the Center-South region of Brazil the months from May to December - the period of lower storage capacity at the Southeast / Center-West submarket.
The Sugarcane Industry in Brazil

Storage Curve at the Southeast / Center-West Submarket (%) x Crushed Sugarcane in the Center-South Region (thousand tones, monthly average, 2001)

Source: Souza (2002)
The Sugarcane Industry in Brazil

- Incentives to invest in electricity generation
  - PROINFA: 3,300 MW of installed capacity of small hydro plants, biomass-fired thermal plants and wind turbines by 2008 – benefit: long term PPAs
  - Restructuring of the contracting framework set in place by the 2004 reform of the ESI:
    - Self-producer
    - Independent power producer (PIE): electricity may be partially or totally commercialized
    - Commercialization in the regulated bi-lateral market (ACR) or in the free-bilateral market (ACL)
Incentives to invest in electricity generation

Distributed generation:

- distribution companies are allowed to contract energy from distributed generation plants
- public bidding directly promoted by the DISCO
- may not exceed 10% of the DISCO’s load
The Sugarcane Industry in Brazil

- The importance of the sugarcane industry to the Brazilian power system is expected to grow in the next year.

Electricity Supply – by source

2005: 425 TWh
2030: 1,196 TWh

Source: Ministry of Mines and Energy – Brazil
The PRÓALCOOL Experience

- Strong interventionist policies since the thirties
- PRÓALCOOL (1975): response to the oil crisis
  - Phase 1: increase of installed production and storage facilities
  - Phase 2: production expansion due to hydrated alcohol
    - Lower prices for ethanol were guaranteed
    - New technology: 100% ethanol-fired vehicles
- Results:
  - Vertiginous growth in ethanol production
  - Productivity gains in agriculture and in the handling of sugarcane
  - Sensitive reduction of ethanol production costs
  - 90% of the new vehicles commercialized in Brazil from 1983 to 1988 were ethanol fueled
Light Cars Sales - Fueled with Alcohol and with Gasoline

Source: Morceli (2006)
Recent Ethanol Market Development in Brazil

- Liberalizing structural changes:
  - End of Sugar and Alcohol Institute (IAA) in May 1990
  - Creation of Inter-ministerial Sugar and Alcohol Council (CIMA) in 1997
  - Regulation by National Agency for Oil, Natural Gas and Biofuels (ANP)
  - End of the Annual Crop Planning
  - Deregulation of prices
  - Exports liberalization

- Some consequences:
  - Capital concentration/centralization
  - Constitution of producers’ cooperatives or associations
  - CONSECANA: system to share revenues among sugarcane, sugar and ethanol producers
Recent Ethanol Market Development in Brazil

- Development of a world concept of car with an engine fired by any type of gasoline C – the flex fuel vehicle (FFV)
  - Eliminated consumers’ exposure to fuel shortage risks
  - 2003: 2.9% of the total light vehicles sold were FFV
  - 2006: 56.3% of the total light vehicles sold were FFV
  - 6 automobile companies installed in the country, which offer nowadays more than 52 FFV car models
  - FFV fleet (May / 2007): 3.3 million units
Final Considerations

Perhaps the most important role to be played by Brazil is disseminating the technologies developed related to sugarcane production (varieties, plague control, efficiency gains).

<table>
<thead>
<tr>
<th>Ethanol Production Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>US$/l</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Brazil 0.20</td>
</tr>
<tr>
<td>USA 0.40</td>
</tr>
<tr>
<td>EU 0.60</td>
</tr>
</tbody>
</table>

Evolution of Brazilian alcohol exports (million liters)

Source: Ministry of Agriculture, Livestock and Food Supply (2007)