Sugarcane and Ethanol in Brazil
A literature review

Case study for the Sugar Ethanol Campaign (SEC) of Solidaridad

Aidenvironment
Matthijs C. Schuring
August 2008
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Commissioned by Solidaridad

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Introduction

Recently, global demand for biofuels has started to grow and it is expected that this growth will increase sharply due to the combination of high fossil oil prices and stimulating policies for biofuels. Although many crops and plants seem suitable to produce biofuels, at this moment ethanol made from sugarcane is the most efficient and effective biofuel. Not only in terms of yield per hectare, energy balance and emissions of greenhouse gasses, but also in terms of costs. Sugarcane generally grows in production countries with low land prices and labour costs. The best showcase for this is Brazil, the country responsible for one third of the global sugarcane production in 2006 with a highly efficient sugarcane ethanol industry. Brazil is currently expanding ethanol production to meet domestic and international biofuel demand. Recent developments and infrastructural plans in Brazil subscribe this statement; Brazil is preparing for a sugarcane ethanol boom.

The expected expansion of sugarcane ethanol production capacity creates opportunities for rural development and renewable energy. However, sugarcane is often associated with issues related to land right conflicts, poor labour conditions, conversion of natural habitats and pollution as well. An ethanol boom thus brings both benefits and risks.

In the beginning of 2008, the Dutch NGO Solidaridad established the international Sugarcane Ethanol Campaign (SEC), a three-year programme aimed at stimulating sustainable sugarcane ethanol production. The campaign acknowledges the economic contribution of sugarcane ethanol production and aims to contribute to a more just balance between economic, social and environmental interests in the production of sugarcane. This would mean that industry and governments refrain from expansion in vulnerable areas, that plantation management improves its labour and environmental conduct and that the rights and desires of local communities are respected.

This case study is a supplement to the SEC background document on sugarcane ethanol (to be published), which describes the characteristics of global sugarcane ethanol production and trade, including the current status, impacts and policies, potential future scenarios, and sustainability opportunities. In order to describe some of the main production areas in more detail, case studies of Brazil and two other countries or regions (probably Mozambique and Colombia) are added. Presently (August 2008), only the Brazil case study is elaborated, the others will be dealt with later in 2008. The aim of this document is to inform (potential) partners of SEC on the characteristics of the sugarcane ethanol market in Brazil, and to provide leads for potential focal points for the campaign.

Note to readers:
For some topics in this document it proved to be difficult to access recent information or data (e.g. current Brazilian legislation); other parts might be far from complete (e.g. information on main Brazilian institutions and sustainability initiatives concerning sugarcane ethanol). In case you have more up-to-date information on these or other topics and if you are willing to share this information, please contact Aidenvironment.
Summary

History, current status and potential expansion of sugarcane ethanol in Brazil

In the early 1970’s the Brazilian economy was flourishing, referred to by many observers at the time as “the Brazilian economic miracle”. However, the 1973 oil embargo and price distortions unveiled some structural economic flaws in all western nations, including Brazil. In a reaction, Brazil launched its Próalcool program to reduce the need for oil imports, provide an additional market for Brazilian sugarcane and to create new jobs in the agricultural sector.

The first stage promoted production of ethanol for blending into gasoline, while the second stage entailed government agreements with major car companies to install assembly lines for 100% ethanol cars. Sugarcane and ethanol production grew rapidly, until problems arose in 1986 due to falling oil prices, scarce public funds for subsidising programmes and a continued production of ethanol-only vehicles. The combination of stagnant ethanol production and rising demand sparked a supply crisis in 1990, forcing Brazil to import ethanol and add methanol to gasoline to keep its cars running. The following decade was characterised by deregulation and privatisation of the Brazilian economy, winnowing out inefficient producers, restructuring and consolidating the industry. In 2000, flex-fuel vehicles were introduced, which soon developed into the main driving force in Brazil’s domestic ethanol demand.

From 2004, Brazilian ethanol exports grew significantly, fuelled by domestic demand and ethanol blending initiatives in the US and EU. The combined domestic and export ethanol demand surpassed the Brazilian production capacity, resulting in rising prices. In order to keep up with the growing demand, Brazil has launched several ambitious infrastructural plans, among which a 1,300 km ethanol pipeline and 2,400 km of navigable waters. Projects like these are supposed to increase the export capacity from 3 billion litres of ethanol in 2006 to 9.4 billion litres in 2012.

From the Northeast of Brazil, where sugarcane is produced for centuries, the pith of sugarcane production shifted in the 1970’s to the Southeast of Brazil. Currently, São Paulo accounts for 55% of the sugarcane production, and two other Southern states (Minas Gerais and Paraná) for 15%. As land prices in São Paulo keep rising, areas more inland, for example the Cerrado, become more attractive. Due to the high biological and ecological value of the Cerrado, expansion in this area is controversial. Nevertheless, all states which show the highest recent growth in sugarcane area (Goiás, Mato Grosso do Sul, Minas Gerais), are (partly) located in the Cerrado biome.

Sugarcane ethanol market structure

After years of government support in the 1980’s and increasing foreign investments in the last couple of years, the Brazilian sugar and ethanol market is increasingly controlled by a small number of ‘sugar families’ and multinational corporations. With foreign investors knocking on their doors, the sugar families have been consolidating their holdings and restructuring their companies in order to attract foreign investment. Backed by sufficient capital, these professional organizations are taking over smaller firms and expanding production for export. The Ometto family, which controls Cosan and São Martinho, and the Biagi family, controlling Santelisa Vale and Crystalsev, are some of the most dominant market forces, but as the market is still fragmented and foreign direct investment is high, consolidation is likely to continue.

The main issues linked to sugarcane ethanol

Although expansion of sugarcane ethanol production creates opportunities for rural development and renewable energy benefits, it is often associated with labour, social-economic and environmental issues. Some of the most important issues are:
- Conversion of natural habitats - expansion in the Pantanal and Amazon biomes in proposed to be limited by law, but the biological rich and ecological important Cerrado is expected to be strongly affected by expansion of sugarcane production. Indirect effects of expansion in the Cerrado will most likely also affect the Pantanal and Amazon regions;
- Bonded labour and poor working conditions - 52% of all slaves freed by the Brazilian Ministry of Labour in 2007 were working in the sugarcane (ethanol) sector;
- Land right issues - although detailed statistics are not available or do not lead to a clear conclusion, conflicts over land still occur;
- Unemployment - mechanisation and increasing monoculture cropping lead to declining employment opportunities;
- Water use and pollution - both sugarcane and ethanol production require large amounts of water. This can be reduced through higher water efficiency and reuse. Pollution occurs due to the use of fertilizers and pesticides, and when mills are periodically cleaned and large amounts of oxygen-tying organic matter are introduced into nature;
- Burning - when sugarcane is harvested manually, the fields are burned first to reduce the costs of harvesting and transportation, leading to pollution and emission of greenhouse gases. Although manual harvesting and the burning of cane is gradually decreasing, it is still practiced especially in the Northeast region of Brazil

Legislation exists on most of these issues, but law enforcement is a crucial problem due to weak institutional arrangements and nepotism.

Initiatives striving for sustainability in the sugarcane ethanol sector

There are several Brazilian initiatives aimed at making the sugarcane ethanol sector more sustainable. Four of the main initiatives are:
- The recent Ethanol Verde, a voluntary protocol developed by the state of São Paulo and the sugarcane sector;
- The voluntary Brazilian Programme on Biofuels Certification by Inmetro (part of the Brazilian Ministry of Development, Industry and Foreign Trade);
- The multi-sectoral Iniciativa Brasileira aiming for generic criteria for all agricultural commodities;
- The Imaflora / SAN standard developed in 2002, which despite the successful development process in terms of participation, transparency and representation, seemingly has failed due to the lack of public policies and market incentives.
1 History of sugarcane and ethanol in Brazil

The history of sugarcane and ethanol production in Brazil can be characterised by three major trends. First, the pith of the sugarcane production shifted in the 1970’s from the Northeast of Brazil, where sugarcane has been produced since the 16th-century, to the Southeast of Brazil. Second, the ethanol market that was aimed at fulfilling the government-supported domestic demand is recently becoming more and more export-oriented to meet the international demand for ethanol as biofuel. This trend is attracting an increasing amount of foreign investors (see paragraph 5.4). The third trend is the shift from manual to mechanical harvesting (see paragraph 6.3.4), in order to increase efficiency and decrease negative environmental impact and improve labour conditions.

This chapter provides a detailed overview of the early and recent history of sugarcane and ethanol production in Brazil.

1.1 15th - 16th century: introduction of sugarcane in South America

Native to Southeast Asia, sugarcane made its way to the Americas for the first time with Christopher Columbus during his 1492 voyage to the Dominican Republic, where it grew well in the tropical environment. By the mid 16th-century the Portuguese had brought some to the northern region of Brazil and, soon after, sugarcane made its way to British, Dutch and French colonies such as Barbados and Haiti. Most sugar was exported to Europe to meet the growing demand.

In 1580, Portugal and Spain were joined as a dynastic union; while Portugal remained technically independent, the Spanish inquisition was introduced in Brazil. In 1630, a Dutch fleet conquered Brazil's northeast - the sugar growing provinces. When the Dutch were expelled by the Brazilian Portuguese in 1654, they moved to the non-Spanish islands located in the Caribbean, and beginning a sugar plantation economy there. The Caribbean islands soon succeeded Brazil as the world's foremost sugar producer, the French colonies being most productive.

Soon after the introduction of sugarcane in South America the colonists realised they were lacking sufficient manpower to plant, harvest and process the crop. The first slave ships carrying the solution to this problem arrived in 1505 and continued unabated for more than 300 years. By the middle of the 19th century, more than 10 million Africans had been forcibly removed to the New World and distributed among the (sugar) plantations of Brazil and the Caribbean, of which 6 million slaves to Brazil.¹

1.2 The Proálcool programme: creating domestic demand

Only deep in the 20th century sugarcane production in Brazil increased rapidly again. Although the Brazilians have been using sugar-based ethanol to fuel cars since the 1920s, the industry really got off the ground in the 1970s when the government sought relief from a first oil price shock and established the Proálcool programme. In 1975, the federal government decided to promote the production of ethanol as a substitute for pure gasoline, in order to reduce oil imports that then were weighing heavily on the country's external trade balance. At that time the price of sugar on the international market was falling rapidly, which made it worthwhile to switch to the production of sugar for ethanol.² Since 1970, sugarcane production is shifting from Northeast to Southeast Brazil (Minas Gerais, São Paulo). The Midwest (particularly Goiás, see also Table 3.1) has recently become the new sugar frontier.³

The Brazilian ethanol program can be described in terms of the five distinct phases described below.⁴

1. 1975 to 1979: initial phase

Efforts focused on the production of anhydrous ethanol for blending with gasoline. A mandatory blend was introduced in January 1976, containing 11% ethanol. The blend was then gradually increased to 23% in May 1978. In addition to this, several other policies were implemented to support the production and consumption of ethanol, such as cheap loans and guarantees, and investment and marketing programmes.⁵ Ethanol production subsequently rose from 600 million litres a year (1975-76) to 3.4 billion litres a year (1979-1980). The first cars powered exclusively by ethanol appeared in 1978.⁶
2. **1980 to 1986: consolidation**
The second oil shock (1979-80) tripled the price of a barrel of oil, and petroleum purchases came to represent 46% of Brazilian imports in 1980. The government decided to take additional steps to implement the Proálcool programme. Agencies such as the National Alcohol Council (CNAL) and the National Executive Commission on Alcohol (CENAL) were created to move the programme forward. In 1979 the Brazilian government signed agreements with major car companies to install assembly lines for 100% ethanol cars, which were only able to run on 100% ethanol. The combination of existing government policy that kept the price of ethanol for consumer significantly lower than the cost of gasoline and ethanol vehicle availability ensured a level of demand needed for large scale investments. Between 1979 and 1986 ethanol production more than quadrupled from 3.4 to 12.3 billion litres, exceeding by 15% the initial target set by the government (10.7 billion litres). The proportion of ethanol-powered cars in the total fleet produced in the country rose from 0.46% in 1979 to 26.8% in 1980, and reached a peak of 76.1% in 1986. Ethanol accounted for approximately half of Brazil’s fuel consumption.

![Figure 1.1: Brazilian ethanol production between 1975 and 2007, in m3](image)

3. **1986 to 1995: stagnation**
Beginning in 1986, the international oil market picture changed. The price per barrel of crude oil fell from a level between US$30 and $40 to between $12 and $20. The effects began to be felt in Brazilian energy policy in 1988, and coincided with a time of scarce public funds for subsidising programmes to encourage energy alternatives, hampering ethanol production growth. The ethanol demand, however, grew steadily due to sales of ethanol-powered cars and lower taxes on these vehicles in comparison with those that ran on gasoline. This combination of stagnant ethanol production and rising demand sparked a supply crisis in 1990. During this crisis, Brazil had to import ethanol and add methanol to gasoline to keep its cars running (see Figure 1.2). Car manufacturers quickly responded by switching back to conventional gasoline cars, seemingly ending Brazil’s ethanol era.

4. **The 1990’s: deregulation and privatisation**
The 1990’s were characterised by deregulation and privatisation of the Brazilian economy, which opened Brazil’s export market to private enterprises and eliminated sugar price controls. The production of sugarcane, Brazil’s feedstock for both ethanol and sugar, increased by 40% between 1993 and 2000, from just over 218 million tonnes to just under 307 million tonnes. Because of the increased car sales combined with the maintained mandatory ethanol blend of 20% by volume, ethanol production peaked again in 1997 at 15.4 billion litres.

In 1999, fixed producer prices for sugarcane were eliminated. Prices for anhydrous and hydrous ethanol were liberalised in 1997 and 1999 respectively. As a result, ethanol prices declined as producers and distributors negotiated new arrangements. This, along with a relatively high sugar price, made sugar
production slightly more attractive\textsuperscript{a}, which in combination with dry seasons in 2000 and 2001 resulted in the dramatic drop in ethanol production in those years. During this period an increasing number of Brazilian engineers and policymakers showed interest in flex-fuel vehicles, which once again initiated talks between car manufacturers and the government about manufacturing flex-fuel vehicles for the Brazilian market.\textsuperscript{14}

In 2001, the Brazilian government agreed to treat flex-fuel vehicles as ethanol fueled vehicles. This entitled flex-fuel vehicles to a preferential sales tax of 14\%, compared to a 16\% sales tax on non-ethanol vehicles. In reaction, Ford launched the first flex-fuel prototype in 2002, with Volkswagen and other car manufacturers quickly following. Flex-fuel vehicles sales increased dramatically, from only 3.5\% of new car sales in 2003 to 88.1\% in 2007. In just 4 years, they are developing into one of the driving forces in Brazil’s domestic ethanol demand.\textsuperscript{15}

The current Brazilian blending policy sets a 20\% mandatory ethanol target. This is easily met as ethanol accounts for 48\% of transport fuel consumption.\textsuperscript{16} In recent years, Brazil has begun to focus on biodiesel production and use as well. The government has mandated the use of 2\% biodiesel by 2008, and 5\% percent by 2013.\textsuperscript{17}


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\begin{figure}[h]
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\includegraphics[width=\textwidth]{figure1_2.png}
\caption{Brazilian ethanol trade between 1982 and 2003\textsuperscript{18}}
\end{figure}

1.3 Export-driven growth
Almost simultaneously with the rise of flex-fuel vehicles, another era in the long ethanol history of Brazil has seemingly begun. With fossil oil prices at all-time high records in the beginning of 2008, and an increasing number of stimulation policies directed at biofuels throughout the world, demand for the relatively cheap Brazilian sugarcane-based ethanol is on the verge of drastic growth. This marks the shift from production primarily for domestic demands to more export-driven production (see Figure 1.2).

Taking into account only the EU and US biofuel policies for respectively 2020 and 2017, an additional land area of 8 Mha of sugarcane would be needed even if the entire current US corn crop would be converted to ethanol\textsuperscript{b} and if 50\% of the ethanol demand is met with sugarcane ethanol only and thus also 50\% from

\begin{footnotesize}
\textsuperscript{a} Most modern sugarcane mills can easily switch between sugar and ethanol production, depending on actual market developments.
\textsuperscript{b} America does not have nearly enough arable land to produce enough ethanol to meet its 2017 target of 132.6 billion litres of ethanol. It has been estimated that converting the entire US corn crop to ethanol would only yield energy equal to 12 percent of our gasoline consumption – 16 billion gallons or 60.6 billion litres. The U.S. Energy Information Administration estimates that the practical limit for domestic ethanol production is even lower at 10.7 billion gallons a year, a figure they do not think is realistic until 2030. Even assuming substantial improvements in corn conversion technology and the expansion of corn production to arable areas now producing other crops, ethanol production would fall far short of the 2017 goal. Furthermore, corn for ethanol and soybeans - the primary US feedstock for biodiesel - compete for the same land (source: Fact Sheet NGVAmerica: Why Ethanol and Biodiesel Alone Can Not Achieve 35 Billion Gallons of Petroleum Displacement by 2017, http://www.ngvc.org/pdfs/35BilGalWhitPaper.pdf).
\end{footnotesize}
other ethanol sources (see paragraph 5.1.3 - SEC background document on sugarcane ethanol (to be published)). This is an increase of 39% compared to the global sugarcane production area in 2006 of 20.4 Mha, and an increase of 129% compared to the Brazilian sugarcane production area in 2006 (6.2 Mha, see Table 2 - SEC background document on sugarcane ethanol (to be published)). Furthermore, it is expected that an additional sugarcane production area of 0.3 to 0.4 Mha is needed in Brazil by 2015 as a result of the sugar policy reforms of the European Union (see paragraph 4.1.1 - SEC background document on sugarcane ethanol (to be published)).

Both the Brazilian government and the private sector are currently facilitating the sugarcane ethanol boom, as is illustrated by the following list of programmes for production and use of ethanol fuel:¹⁹
- The Brazilian AgroEnergy Plan (2006-2011) has eased the nerves of investors and seeks to minimize risks and maximize efficiency in agroenergy projects;
- The government supported the Platform of Brazil, in which the countries of Latin America and the Caribbean pledged that, by 2010, at least 10% of the energy they use will be renewable;
- At the 2007 International Conference on Biofuels, Brazil announced that it will begin to issue the Environmental Certificate, which will ensure the environmental, social and technical sustainability of Brazilian biofuels;
- The North-South corridor is nearing conclusion, which will help consolidate the sugar-ethanol agroindustries in the States of Maranhão, Piauí and Tocantins;
- The creation of the Inter-American Ethanol Commission;
- Petrobras of Brazil and Mitsui of Japan announced plans to invest US$8 billion in the expansion of ethanol production capacity;
- Firms such as Infinity Bio Energy, Cosan, Tereos, Louis Dreyfus and Cargill are investing in biofuels and listing their stock on the London Exchange (see paragraph 5.4);
- Mitsubishi Corp. signed a 30-year supply contract and has acquired shares in Usina Boa Vista (see paragraph 5.4);
- Brenco (Brazil Renewable Energy Company) is building 10 industrial plants in the Central/West part of the country, with its partners investing approximately US$2.3 billion (see paragraph 5.4);
- According to UNICA (União da Indústria de Cana de Açúcar), by 2012, 87 new industrial plants will be added to the 325 in operation presently.

¹⁹ The figure of 50% of the ethanol demand from sugarcane ethanol and 50% from other sources is not based on an official prediction.
2 Export and international trade of Brazilian ethanol: status and plans

Most experts consider Brazil to be the only country capable of exporting significant quantities of ethanol in the next few years as international demand grows and foreign investments flow in to secure a steady level of supply.\textsuperscript{20}

Brazil has been exporting relatively small amounts of ethanol for many years, most of which was used for non-fuel purposes. It was not until 2004 that Brazilian ethanol exports grew significantly, fueled by ethanol blending initiatives in the US, Europe and beyond. Export grew from less than 100 million litres in 2000 to over 2 billion litres in 2004, and over 3 billion in 2006. As the Brazilian production capacity couldn’t keep up with domestic and international demand, prices rose as well. Table 2.1 shows the development of Brazilian ethanol exports and export prices over the past 12 years.\textsuperscript{22}

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<td>1,880,514.894</td>
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<td>2006</td>
<td>3,098,266.423</td>
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<td>2005</td>
<td>2,501,944.397</td>
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<td>2,196,545.137</td>
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<td>2003</td>
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<td>1997</td>
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<td>1996</td>
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<td>US$ 367.19</td>
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</table>

\textsuperscript{d} Januari – July

Table 2.1: Development of Brazilian ethanol exports\textsuperscript{d} and export prices\textsuperscript{e}, 1996 -2007\textsuperscript{23}

Most of the Brazilian ethanol exported is hydrous ethanol, shipped to the Caribbean to be dehydrated and re-exported to mainly the USA. As can be seen in Table 2.2, more than 1.7 billion litres of ethanol was imported by the USA in 2006 if exports to Caribbean countries are included. In 2007, from January through July, 32% of ethanol exports were going to the USA. If Caribbean imports are included, this would
amount to 47%. From these figures, the Netherlands is an important biofuel country (80% of EU imports), yet most ethanol that is imported is either used for industrial purposes or overhauled to other countries.24

In Asia, most ethanol is imported by Japan. Japanese blending initiatives and lack of domestic production capacity could increase Asia’s share in Brazilian exports significantly. The same holds for the European Union as many member states are introducing mandatory blending in their domestic market. As demand grows, the question is whether Brazil has the infrastructure to fulfil such demand.25

Table 2.2: Brazilian ethanol exports by country of destination (million litres)

<table>
<thead>
<tr>
<th>Country</th>
<th>Undenatured 2006</th>
<th>Denatured 2006</th>
<th>Totals 2006</th>
<th>Share '07 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>1,512.3</td>
<td>610.8</td>
<td>2,123.1</td>
<td>32%</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>332.2</td>
<td>228.3</td>
<td>560.5</td>
<td>9%</td>
</tr>
<tr>
<td>Japan</td>
<td>222.4</td>
<td>194.7</td>
<td>417.1</td>
<td>6%</td>
</tr>
<tr>
<td>El Salvador</td>
<td>181.1</td>
<td>172.4</td>
<td>353.5</td>
<td>5%</td>
</tr>
<tr>
<td>Jamaica</td>
<td>131.0</td>
<td>141.3</td>
<td>272.3</td>
<td>4%</td>
</tr>
<tr>
<td>Sweden</td>
<td>188.9</td>
<td>82.7</td>
<td>271.6</td>
<td>4%</td>
</tr>
<tr>
<td>Nigeria</td>
<td>42.7</td>
<td>72.9</td>
<td>115.6</td>
<td>2%</td>
</tr>
<tr>
<td>Mexico</td>
<td>48.4</td>
<td>31.0</td>
<td>79.4</td>
<td>1%</td>
</tr>
<tr>
<td>South-Korea</td>
<td>92.3</td>
<td>21.2</td>
<td>113.5</td>
<td>2%</td>
</tr>
<tr>
<td>Porto Rico</td>
<td>10.4</td>
<td>10.4</td>
<td>20.8</td>
<td>0%</td>
</tr>
<tr>
<td>Venezuela</td>
<td>78.9</td>
<td>0.0</td>
<td>78.9</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>257.6</td>
<td>314.8</td>
<td>572.4</td>
<td>9%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,098.2</strong></td>
<td><strong>1,880.5</strong></td>
<td><strong>4,978.7</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Based on SECEX data from Ethanol Statistics26

a2007 data reflect only the period January to July 2007

2.1 Increasing export capacity: infrastructural plans

As foreign demand is increasing rapidly, congestion, storage facilities, draught and other issues related to port and export capacity will have to be addressed to avoid any bottlenecks. Most experts believe that Brazil is able to export between 4 and 5 billion litres, before it runs into serious logistical problems. The main problems seem to be port infrastructure and capacity.27 This would mean there is limited excess export capacity left at this moment.

More than 82% of all ethanol exports in 2007 were shipped from two ports in the centre-south: Santos in São Paulo and Paranagua in Paraná. Located on the coast of Brazil’s most important ethanol producing state São Paulo, Santos was responsible for more than 68% of all ethanol exports in the first half of 2007. However, Santos could face considerable problems regarding draught and supply routes, lacking pipeline connections, and being mainly supplied by trucks and only 10% by train. Santos has ambitious plans to expand the train supply to 50% by 201028, but other ports are developing considerable competitive advantages. These advantages are mainly connected to more favourable natural conditions allowing transportation by larger product tankers with a capacity of well over 100,000 m3.29

The state-owned Brazilian company Petrobras is backing the ports of Ilha D’Agua and São Sebastiao with ambitious expansion plans. Figure 2.2 shows Petrobras’ vision of broader industry plans to construct a large network of pipelines from inland areas to Paulinia and the two latter ports. Petrobras’ most ambitious plans are the Goiás - Paulinia pipeline (1,300 km ethanol pipeline able to transport 4 billion litres of

Draught is affecting the depth of water and potentially hindering boats to navigate.
ethanol annually, with estimated construction costs at $235 million. / - and the Goiás - Paulinia waterway\(^9\) (2,400 km of navigable waters between the state of Goiás, São Paulo and Parana, expected transporting capacity approx. 4 billion litres per year.).\(^{30}\)

São Sebastião, located near Rio de Janeiro, has a very favourable position because it has the largest loading capacity of all ports, being able to supply vessels up to 300,000 tonnes. Additionally it is already connected to Petrobras’ existing network of pipelines. In combination with the two most important ports on Brazil’s North-Eastern coast, its planned export capacity amounts to 9.4 billion litres, which seems to be well enough to stay ahead of the potential international demand. However, it remains uncertain whether the considerable investments needed for Petrobras’ plans will be realised.\(^{31}\)

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\(^9\) Petrobras has signed a memorandum of understanding with Japan’s Mitsui Trading for the construction of this waterway, while Japan’s national bank has agreed to facilitate its financing. Mining company Cia. Vale do Rio Doce is also participating in the project, because of its investments in coal and hydroelectric energy. The major problem is not the financial issue as some believe, but the issue of ownership. Brazilian ethanol producers are reluctant to give state owned oil company Petrobras too much control in the project.
3 Current and potential future sugarcane production regions in Brazil

Although sugarcane is grown in 17 out of 26 Brazilian states, the production is primarily located in a few southern states (55% in São Paulo, 8% in Minas Gerais, and 7% in Paraná; see Table 3.1). Figure 3.1 clearly shows the importance of the Southeast as sugarcane production region. Table 3.1 also shows the (expected) growth of the sugarcane production area between 2006 and 2008. In three states the area is predicted to grow with more than 70%, namely Mato Grosso do Sul (70%), Minas Gerais (74%), and Goiás (109%).

São Paulo not only has the largest production area, but also the highest productivity, the most advanced technology through R&D companies like CTC (Copersucar Technology Centre), modern mills and distilleries, a good infrastructure and a harvest season from April through November. São Paulo thus dominates production, which accounts for 62% of Brazil’s sugarcane production, 66% of its sugar production and 62% of the ethanol production. Soil and climate parameters are ideal for agricultural production in the central and Southern regions, especially in the states of Paraná and São Paulo.  

Table 3.1: Sugarcane area per district (in 1,000 hectares)

<table>
<thead>
<tr>
<th>District</th>
<th>Region</th>
<th>2006</th>
<th>2007</th>
<th>2008 (est.)</th>
<th>% of total sugarcane area (2007)</th>
<th>% growth 2006 - 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>São Paulo</td>
<td>Southeast</td>
<td>3,285</td>
<td>4,328</td>
<td>4,874</td>
<td>55%</td>
<td>48%</td>
</tr>
<tr>
<td>Minas Gerais</td>
<td>Southeast</td>
<td>431</td>
<td>651</td>
<td>752</td>
<td>8%</td>
<td>74%</td>
</tr>
<tr>
<td>Paraná</td>
<td>South</td>
<td>433</td>
<td>539</td>
<td>631</td>
<td>7%</td>
<td>46%</td>
</tr>
<tr>
<td>Alagoas</td>
<td>Northeast</td>
<td>402</td>
<td>414</td>
<td>415</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Pernambuco</td>
<td>Northeast</td>
<td>337</td>
<td>400</td>
<td>401</td>
<td>5%</td>
<td>19%</td>
</tr>
<tr>
<td>Goiás</td>
<td>Centre-west</td>
<td>238</td>
<td>400</td>
<td>496</td>
<td>5%</td>
<td>109%</td>
</tr>
<tr>
<td>Mato Grosso</td>
<td>Centre-west</td>
<td>202</td>
<td>235</td>
<td>261</td>
<td>3%</td>
<td>29%</td>
</tr>
<tr>
<td>Mato Grosso do Sul</td>
<td>Centre-west</td>
<td>153</td>
<td>192</td>
<td>260</td>
<td>2%</td>
<td>70%</td>
</tr>
<tr>
<td>Paraiba</td>
<td>Northeast</td>
<td>116</td>
<td>137</td>
<td>147</td>
<td>2%</td>
<td>27%</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>Southeast</td>
<td>164</td>
<td>133</td>
<td>137</td>
<td>2%</td>
<td>-16%</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>419</td>
<td>462</td>
<td>487</td>
<td>6%</td>
<td>16%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6,179</td>
<td>7,891</td>
<td>8,861</td>
<td>100%</td>
<td>43%</td>
</tr>
</tbody>
</table>

Source: IBGE

Figure 3.1: Sugarcane production in Brazilian regions in 2007

Although its soils are fertile in Brazil’s northern region too, the region often has to cope with drought and requires irrigation to maintain productivity. Its infrastructure is poorly developed, but mills and distilleries
tend to be close to its ports. Overall however, this region is considered to be more expensive for production. Harvesting takes place from October till March, which is almost opposite to the centre-south. On average, this region is relatively more focussed on ethanol production and less on sugar production than the centre-south (50% vs. 59%).

3.1 Expansion areas for sugarcane production

According to Ethanol Statistics, the central and Southern regions still have sufficient land available for a significant expansion of Brazil’s sugarcane production. However, increasing land prices in Brazil’s main producing states (see Table 3.2) are becoming a limiting factor as they reduce the margins in sugar and ethanol. As a result, a slowly increasing number of companies is exploring and moving more inland, into states such as Goiás, Mato Grosso and Mato Grosso do Sul. By doing so, they are sometimes entering the Cerrado biome. This 1.9 million km² (0.74 million square miles) region accounts for 22% of Brazil’s area (see Figure 3.4 and paragraph 6.3.1).

Even though land in São Paulo is more expensive than in other parts of the country, the tendency is that about 50% of the cane predicted to be produced in 2015 would be produced in São Paulo.

<table>
<thead>
<tr>
<th>State-County</th>
<th>R$/hectare</th>
<th>US$/hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>São Paulo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribeirão Preto</td>
<td>16,000 – 21,000</td>
<td>7,500 – 9,700</td>
</tr>
<tr>
<td>Piracicaba</td>
<td>9,700 – 13,800</td>
<td>4,500 – 6,400</td>
</tr>
<tr>
<td>Aracatuba</td>
<td>12,000</td>
<td>5,500</td>
</tr>
<tr>
<td>Paraná</td>
<td>13,500</td>
<td>6,300</td>
</tr>
<tr>
<td>Paranaíva</td>
<td>11,300</td>
<td>5,200</td>
</tr>
<tr>
<td>Minas Gerais</td>
<td>7,200</td>
<td>3,300</td>
</tr>
<tr>
<td>Uberaba</td>
<td>5,400</td>
<td>3,900</td>
</tr>
<tr>
<td>Conceição de Alagoas</td>
<td>3,750</td>
<td>1,750</td>
</tr>
<tr>
<td>Goiás Grosso</td>
<td>4,100</td>
<td>1,900</td>
</tr>
<tr>
<td>Poços de Caldas</td>
<td>1,500</td>
<td>700</td>
</tr>
</tbody>
</table>

Table 3.2: Land price for sugarcane production in October 2006

Production in the Cerrado biome will have to be supported by infrastructural and logistical developments as producers are located too far inland to deliver the product efficiently to export markets. Expansion into the Cerrado is furthermore bound to legislation by the Ministry of Environment, as it contains a large range of plant and animal biodiversity. Although the main sugarcane production areas of São Paulo and the Northern coast are located far from the Amazon biome, smaller production locations in other states are found much closer to the Amazon (e.g. in Mato Grosso) and the Pantanal (e.g. in Mato Grosso and Mato Grosso do Sul) (see Figure 3.2). Furthermore, the states where the sugarcane area is growing the fastest (Goiás (GO), Minas Gerais (MG) and Mato Grosso do Sul (MS) - see Table 3.1) are all located in the Cerrado (see Figure 3.2 and Figure 3.4).

According to a study by the Brazilian NGO ISPN, 142,000 hectares of Cerrado were converted to sugarcane for the 2006/2007 harvest, most of which in São Paulo (86,000 ha) and Minas Gerais (25,000 ha). In Goiás, Mato Grosso and Mato Grosso do Sul respectively, 13, 12 and 6 thousand hectares were converted.

A number of companies are currently involved in projects to improve the accessibility of the Cerrado area through the construction of pipeline networks and other solutions. Petrobras, as well as a cooperation of large ethanol producers, among which Copersucar, are currently undertaking major infrastructural projects (see paragraph 2 and Figure 2.2).

However, at least about 50% of the Cerrado region is not adequate or has low suitability for sugarcane plantation, as can be seen in Figure 3.3 showing land suitability for sugarcane plantation, with no irrigation, taking into account soil and weather adequacy. It can be seen in the figure that a small area in Brazil is highly suitable for sugarcane plantation (the Ribeirão Preto region) and that most of the area occupied with sugarcane in São Paulo has in fact just average conditions for this crop.

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h The Cerrado biome covers the Brazilian states of Goiás, the Federal District, most of Mato Grosso, Mato Grosso do Sul, and Tocantins, the western portions of Minas Gerais and Bahia, the southern portions of Maranhão and Piauí, small portions of São Paulo, Roraima and Paraná.
Presently, more than half of the Cerrado has been converted to pastures for cattle-breeding and to a lesser extent agricultural lands for production of mainly grains such as corn, soybeans and rice. The Brazilian Research for Agriculture Enterprise (EMBRAPA) estimates that about 80 Mha are potentially available for crop production, and 35 Mha is in use for cattle breeding. Although these 35 Mha could be converted to sugarcane, this expansion of the sugarcane area could result in a shift of land use functions to the border areas of agricultural expansion. Most likely, deforestation for agricultural development will follow the usual gradual process starting with partial deforestation, then conversion into pasture land and extensive farming, and followed by a shift to intensive farming.

In June 2008, Brazilian agricultural officials and biofuel advocates were reported lobbying hard for using already devastated parts of the Amazon rainforest to grow sugarcane for ethanol. Former Agriculture Minister Odacir Klein, who now leads a biofuel producers association, said Brazil’s plan to grow sugarcane in already cleared areas of rainforest balances the need for biofuel with environmental protection and is very responsible. Odacir Klein claimed that the government will not allow plantations to damage the environment. In response, Brazilian President Luiz Inacio Lula da Silva said that Brazil has no intention of planting sugar cane in the Amazon region. In the beginning of August 2008, Agriculture Minister Reinhold Stephanes and Environment Minister Carlos Minc expressed their support to a proposal on a law to restrict cane planting amid concern about the environmental impact of the crop’s rapid expansion. No new ethanol plants will be allowed in Pantanal’s plains under the proposal, but it will permit restricted planting in the region’s highlands. The proposal would require planters in this region, where cane has been cultivated for more than 10 years, to use direct, or no-till planting methods, eliminating the use of machinery and agrochemicals, the ministry’s statement said. No new mills would be allowed in the Amazon biome, but three plants that already had permits will be allowed to operate. The final decision concerning the proposal rests with President Luiz Inacio Lula da Silva.

1 Blue = high; green = average; yellow = low; red = inadequate
4 Relative economic importance of sugarcane

In Table 4.1, the economic importance of sugarcane production per state for 2006 is shown. The following conclusions can be drawn when analysing the data shown in this table:

- São Paulo is by far the largest state in terms of value of the sugarcane production (almost 10 billion R$ (6.4 billion US$) in 2006, 57% of the total Brazilian sugarcane production value);
- For seven other states, the sugarcane production value ranges from almost half a billion to 1.2 billion R$ (in descending order Paraná, Minas Gerais, Alagoas, Pernambuco, Goiás, Mato Grosso do Sul and Mato Grosso);
- Three states highly depend on sugarcane for the value of their agricultural activities, namely São Paulo (72%), Alagoas (90%), and Pernambuco (62%), while five states (Paraiba, Rio de Janeiro, Rio Grande do Norte, Espírito Santo and Sergipe) depend on sugarcane for 32 to 43% of their agricultural value. Sugarcane production represents 23% of the total agricultural value of Brazil (72.3 billion R$).
- In terms of the national Gross Domestic Product (GDP), agriculture accounts for 1.8%, while sugarcane accounts for 0.8%.
- When looking at the GDP per state, it can be noted that for five states agricultural activity accounts for more than 7% of the federal GDP (Paraná (8.4%), Alagoas (7.2 %), Goiás (9.5%), Mato Grosso do Sul (12.1%), and Mato Grosso (20.9%));
- Seven states depend for more than 1% on sugarcane for their GDP, namely São Paulo, Goiás and Mato Grosso (all 1.3%), Pernambuco and Paraiba (1.5%), Mato Grosso do Sul (2.3%) and Alagoas (6.5%).

As can been seen in Figure 4.1, sugarcane production occupied just over 2% of the total area in use or available for agriculture and pastures in 2006: 7.3 million hectares of the total agricultural plus cattle breeding area of 339.9 million hectares (40% of the total area of Brazil).\(^k\)

For comparison: soy production represented 26% of the total agricultural value of Brazil in 2006, occupying over 6% of the total area in use or available for agriculture and pastures (see Figure 4.1). In nine states, soy is most important in terms of agricultural value (Mato Grosso (57% of the total agricultural value), Mato Grosso do Sul (56%), Tocantins (49%), Goiás (44%), Paraná (36%), Piauí (35%), Distrito Federal (29%), Rio Grande do Sul (28%) and Maranhão (26%)). Mais is another mayor agricultural crop, representing 14% of Brazil’s agricultural value and occupying almost 4% of agricultural and pasture land in 2006. Mais is the most important crop for three states, namely Minas Gerais, Ceará and Distrito Federal (24 to 29% of the state agricultural value).\(^m\)

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\(^j\) The GDP data per state reflect the 2005 situation, while the data on the value of the agricultural and sugarcane production reflect 2006 data. Therefore, the percentage of the value of the agricultural and sugarcane production vis-à-vis the GDP as stated in the most right columns of the table should be only used for indicative purposes.

\(^k\) The figure of 7.3 million hectares of sugarcane production in Brazil in 2006 differs from source to source. According to FAO (see table 2, main Sugarcane Ethanol document) and IBGE (see Table 3.1, this document), it is 6.2 million hectares, while USDA mentions MAPA and UNICA as source for the figure of 7.3 million hectares.
### Table 4.1: Economic importance of sugarcane production per state (2006)

<table>
<thead>
<tr>
<th>State</th>
<th>Value of sugarcane production (1.000 R$)</th>
<th>Value of agricultural production</th>
<th>Gross Domestic Product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of national value</td>
<td>Total value (1.000 R$)</td>
<td>% sugarcane</td>
</tr>
<tr>
<td>São Paulo</td>
<td>9,648,330</td>
<td>13,322,748</td>
<td>72% ***</td>
</tr>
<tr>
<td>Paraná</td>
<td>1,217,003</td>
<td>10,655,095</td>
<td>11% *</td>
</tr>
<tr>
<td>Minas Gerais</td>
<td>1,161,540</td>
<td>5,752,883</td>
<td>20% *</td>
</tr>
<tr>
<td>Alagoas</td>
<td>912,799</td>
<td>1,012,100</td>
<td>90% ***</td>
</tr>
<tr>
<td>Pernambuco</td>
<td>750,159</td>
<td>1,213,836</td>
<td>62% ***</td>
</tr>
<tr>
<td>Goiás</td>
<td>658,108</td>
<td>4,780,519</td>
<td>14% *</td>
</tr>
<tr>
<td>Mato Grosso dS</td>
<td>487,690</td>
<td>2,625,611</td>
<td>19% *</td>
</tr>
<tr>
<td>Mato Grosso</td>
<td>474,144</td>
<td>7,842,518</td>
<td>6%</td>
</tr>
<tr>
<td>Bahia</td>
<td>343,484</td>
<td>3,635,956</td>
<td>9%</td>
</tr>
<tr>
<td>Paraíba</td>
<td>251,169</td>
<td>667,958</td>
<td>38% **</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>191,264</td>
<td>448,583</td>
<td>43% **</td>
</tr>
<tr>
<td>Rio Grande dN</td>
<td>180,242</td>
<td>557,265</td>
<td>32% **</td>
</tr>
<tr>
<td>Maranhão</td>
<td>118,792</td>
<td>1,183,064</td>
<td>10%</td>
</tr>
<tr>
<td>Espirito Santo</td>
<td>114,072</td>
<td>350,566</td>
<td>33% **</td>
</tr>
<tr>
<td>Sergipe</td>
<td>92,954</td>
<td>281,042</td>
<td>33% **</td>
</tr>
<tr>
<td>Other states</td>
<td>367,441</td>
<td>17,954,482</td>
<td>2%</td>
</tr>
<tr>
<td>Brazil</td>
<td>16,969,191</td>
<td>72,284,226</td>
<td>23%</td>
</tr>
</tbody>
</table>

Note: *** / ** / * indicate the importance of sugarcane production: high / medium / low

---

### Figure 4.1: Agricultural Land in Brazil in 2006

- **Soybeans**: 59%
- **Corn**: 6%
- **Sugarcane for ethanol**: 4%
- **Sugarcane (other uses)**: 23%
- **Other crops**: 6%
- **Pastures**: 1%
- **Available land**: 1%

---

1. 1.000 R$ = about 470 USD (average over 2006), http://finance.yahoo.com/currency/convert?from=BRL&to=USD&amt=1&t=5y.
2. The GDP data per state reflect the 2005 situation, while the data on the value of the agricultural and sugarcane production reflect 2006 data. Therefore, the percentage of the value of the agricultural and sugarcane production vis-à-vis the GDP as stated in the most right columns of the table should be only used for indicative purposes.
3. Ibid
4. Ibid
5 Stakeholder mapping of the Brazilian sugarcane ethanol industry

The Brazilian ethanol market structure is more complex than its counterparts in Europe and the US. After years of government support in the 1980’s and increasing foreign investments in the last couple of years, the Brazilian sugar and ethanol market is increasingly controlled by a small number of ‘sugar families’ and multinational corporations. With foreign investors knocking on their doors, the sugar families have been consolidating their holdings and restructuring their companies in order to attract foreign investment. Backed by sufficient capital, these professional organizations are taking over smaller firms and expanding production for export. Between 2000 and 2005, 39 mergers and acquisitions took place within the country’s sugar and ethanol industry. The result is a closely linked network of sugar mills, holding groups and cooperatives, in which foreign investors are starting to play an increasingly important role.

Table 5.1: The 20 largest sugarcane mills in Brazil, based on ethanol output, 2006/07, in m3 ethanol

<table>
<thead>
<tr>
<th>Mill</th>
<th>State</th>
<th>Sugarcane Harvest (t)</th>
<th>Ethanol (million m3)</th>
<th>Sugar (Thousand t)</th>
<th>Ethanol Market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) DA BARRA</td>
<td>São Paulo</td>
<td>7,018,366</td>
<td>299,268</td>
<td>528,674</td>
<td>1.63%</td>
</tr>
<tr>
<td>(2) SÃO MARTINHO</td>
<td>São Paulo</td>
<td>6,735,073</td>
<td>286,340</td>
<td>499,729</td>
<td>1.61%</td>
</tr>
<tr>
<td>(3) SANTA ELISA</td>
<td>São Paulo</td>
<td>5,960,328</td>
<td>269,949</td>
<td>370,244</td>
<td>1.52%</td>
</tr>
<tr>
<td>(4) TAMARARIT</td>
<td>Mato Grosso</td>
<td>5,076,429</td>
<td>230,001</td>
<td>232,821</td>
<td>1.29%</td>
</tr>
<tr>
<td>(5) VALE DO ROSÁRIO</td>
<td>São Paulo</td>
<td>5,497,347</td>
<td>227,770</td>
<td>373,790</td>
<td>1.28%</td>
</tr>
<tr>
<td>(6) DA PEDRA</td>
<td>São Paulo</td>
<td>4,101,366</td>
<td>216,771</td>
<td>218,117</td>
<td>1.22%</td>
</tr>
<tr>
<td>(7) EQUIPAV</td>
<td>São Paulo</td>
<td>4,434,660</td>
<td>213,961</td>
<td>278,807</td>
<td>1.20%</td>
</tr>
<tr>
<td>(8) CATANDUVA</td>
<td>São Paulo</td>
<td>3,912,799</td>
<td>212,415</td>
<td>211,837</td>
<td>1.20%</td>
</tr>
<tr>
<td>(9) MOEMA</td>
<td>São Paulo</td>
<td>4,408,051</td>
<td>198,524</td>
<td>299,829</td>
<td>1.12%</td>
</tr>
<tr>
<td>(10) COLORADO*</td>
<td>São Paulo</td>
<td>4,482,502</td>
<td>181,254</td>
<td>356,552</td>
<td>1.02%</td>
</tr>
<tr>
<td>(11) SÃO JOSE – MACAT.</td>
<td>São Paulo</td>
<td>3,466,913</td>
<td>167,500</td>
<td>256,269</td>
<td>0.94%</td>
</tr>
<tr>
<td>(12) BARRO GRANDE</td>
<td>São Paulo</td>
<td>3,349,883</td>
<td>162,500</td>
<td>244,745</td>
<td>0.91%</td>
</tr>
<tr>
<td>(13) VALE DO VERDÃO*</td>
<td>Goiás</td>
<td>3,547,250</td>
<td>160,285</td>
<td>149,419</td>
<td>0.90%</td>
</tr>
<tr>
<td>(14) COLOMBO*</td>
<td>São Paulo</td>
<td>4,412,312</td>
<td>158,165</td>
<td>383,292</td>
<td>0.89%</td>
</tr>
<tr>
<td>(15) SANTA CRUZ – AB</td>
<td>São Paulo</td>
<td>3,277,022</td>
<td>158,039</td>
<td>224,596</td>
<td>0.89%</td>
</tr>
<tr>
<td>(16) CERRADINHO</td>
<td>São Paulo</td>
<td>3,526,695</td>
<td>156,218</td>
<td>262,058</td>
<td>0.88%</td>
</tr>
<tr>
<td>(17) BURITI</td>
<td>São Paulo</td>
<td>1,735,172</td>
<td>155,180</td>
<td>0</td>
<td>0.87%</td>
</tr>
<tr>
<td>(18) BARRÁCUAL</td>
<td>Mato Grosso</td>
<td>2,921,667</td>
<td>153,234</td>
<td>49,996</td>
<td>0.86%</td>
</tr>
<tr>
<td>(19) DESTILARIA MORENO</td>
<td>São Paulo</td>
<td>3,208,175</td>
<td>150,159</td>
<td>215,683</td>
<td>0.85%</td>
</tr>
<tr>
<td>(20) BONFIM</td>
<td>São Paulo</td>
<td>3,814,035</td>
<td>144,381</td>
<td>347,170</td>
<td>0.81%</td>
</tr>
</tbody>
</table>
| *Autonomous mills

Table 5.1: The 20 largest sugarcane mills in Brazil, based on ethanol output, 2006/07, in m3 ethanol

5.1 Sugar mills

From the sugar mill level, the Brazilian ethanol market still is relatively fragmented. In the 2006/2007 harvest 328 sugar mills actually produced one or both products, 251 in the productive centre-south and 73 in the northeast. As can be seen in Table 5.1, 17 of the largest 20 sugar mills are located in the state of São Paulo. The largest five are (1) Da Barra, which has a strong consumer brand, (2) São Martinho, which was merged into São Martinho S/A in September 2006 to launch an Initial Public Offering (IPO), (3) Santa Elisa and (4) Vale do Rosario, both part of a recent merger that resulted into the second largest group of Brazil called Santelisa Vale and (5) Itamarati, an autonomous sugar mill based in Mato Grosso. Most large sugar mills are part of a holding group. Table 5.1 shows that of the largest 20 sugar mills, only 4 are autonomous. Smaller mills still tend to be autonomous, but as the market demands more professional management and security of supply, the trend is towards further consolidation.

5.2 Sugar groups

Holding groups, owned by ‘sugar families’ and multinational corporations, are increasing their grip on the industry as it evolves. In 2006, the largest 13 groups account for 32% of Brazil’s sugarcane production, 28% of ethanol production and 35% of sugar production (see Table 5.2). More recent merger and acquisition activity ensures that the list below will have changed significantly in 2007 and 2008.
In July 2007, leading Brazilian industrial conglomerate Odebrecht acquired its first existing center-south sugar and ethanol mill for $151.8 million, with an additional $15.6 million allotted for expansion plans. The mill, Alcâdia, is located in the state of São Paulo and has a capacity of roughly 1.4 million tonnes of sugarcane. Norberto Odebrecht SA announced it would start investing $2.6 billion to get into Brazil’s booming ethanol business. “Odebrecht aims to be one of the three or four largest sugar and ethanol producers in Brazil in the coming 7-8 years,” said Eduardo Carvalho, the executive leading the venture. The project entails building 12-15 plants with combined capacity to crush at least 30 to 40 million tonnes of sugarcane and produce 1.5 billion litres of ethanol. By 2012, Odebrecht thinks it is able to expand Alcâdia’s crushing capacity to approximately 4.6 million tonnes of cane. The surrounding region of Alcâdia allows for a total of 13 to 16 million tonnes, according to the company.

In 2006, Vale do Rosário and Santa Elisa announced plans for a multi-stage merger that, when complete, would rival industry leader Cosan. In January 2007, Cosan itself placed a bid for 50.02% of Vale do Rosário’s shares to prevent such a move and to improve its position in the industry. Multinational Bunge Ltd. placed a competing offer, but it was shareholder entity and holding company B5, owned by the Biagi family, that exercised the right to outbid Cosan and raised R$ 1.35 billion from private bank Bradesco to place a bid itself. This proved to be successful, creating the second largest group in Brazil, which aimed to produce approximately 18 million tonnes of sugarcane in 2007. The merger includes Vale do Rosario, Santa Elisa, as well as three other mills, MB, Jardest and Continental. Cosan moved on to form a holding company with São Martinho and Santa Cruz, to acquire two other mills, Santa Luiza S/A and Agropecuária Aquidaban, which combined produce 3.3 million tonnes of sugarcane.

5.3 Sugar families and Cooperatives

The Ometto family

Until Vale do Rosário and Santa Elisa merged into a new company, Cosan was by far the largest sugar and ethanol group in Brazil. Although it was formally founded in the year 2000, its history leads back to 1936 when the Costa Pinto mill was established by the Ometto family in the State of São Paulo. The Ometto family is now at the centre of the Brazilian sugar and ethanol industry with several companies, most important of which is Cosan. The company is controlled by Rubens Ometto Silveira Mello, its indirect controlling shareholder, chairman and chief executive officer. Under his leadership, Cosan built port terminals, invested in genetically modified sugarcane and sought international relationships to strengthen its position. Cosan has strategic partnerships with several multinational organizations such as Tate & Lyle, Sucden and Kuok group, the latter two of which have also become major shareholders. Cosan owns 17 manufacturing units in Santos, a city in the state of São Paulo and the largest port in Latin America. During the 2006/2007 harvest, Cosan processed 36.1 million tons sugarcane, produced on 580,000 hectares, producing 1,322 million litres ethanol and 3.2 million tons sugar. However, the Ometto span of control becomes really clear when its interests besides Cosan are examined. The Ometto family also controls the São Martinho group, which until September 2006 was

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of mills</th>
<th>Sugarcane (million t)</th>
<th>Ethanol Sales (Million L)</th>
<th>Sugar Sales (Thousand t)</th>
<th>Ethanol Market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSAN</td>
<td>17</td>
<td>35.5</td>
<td>1,273</td>
<td>3,113</td>
<td>7.17%</td>
</tr>
<tr>
<td>IRMAO BIAGI</td>
<td>3</td>
<td>7.0</td>
<td>426</td>
<td>306</td>
<td>2.40%</td>
</tr>
<tr>
<td>VALE DO ROSARIO</td>
<td>3</td>
<td>9.4</td>
<td>421</td>
<td>619</td>
<td>2.37%</td>
</tr>
<tr>
<td>ZILLO</td>
<td>3</td>
<td>8.3</td>
<td>402</td>
<td>596</td>
<td>2.26%</td>
</tr>
<tr>
<td>SÃO MARTINHO</td>
<td>2 (3)</td>
<td>9.2</td>
<td>393</td>
<td>677</td>
<td>2.21%</td>
</tr>
<tr>
<td>SANTA ELIS</td>
<td>3</td>
<td>7.6</td>
<td>346</td>
<td>452</td>
<td>1.95%</td>
</tr>
<tr>
<td>LOUIS DREYFUS</td>
<td>7</td>
<td>10.8</td>
<td>305</td>
<td>620</td>
<td>1.72%</td>
</tr>
<tr>
<td>VIRGOLINO OLIVEIRA</td>
<td>3</td>
<td>6.2</td>
<td>305</td>
<td>378</td>
<td>1.72%</td>
</tr>
<tr>
<td>TÉRCIO WANDERLEY</td>
<td>4</td>
<td>8.7</td>
<td>267</td>
<td>500</td>
<td>1.50%</td>
</tr>
<tr>
<td>SANTA TEREZINHA</td>
<td>5</td>
<td>8.1</td>
<td>206</td>
<td>835</td>
<td>1.16%</td>
</tr>
<tr>
<td>OSCAR FIGUEIREDO</td>
<td>3</td>
<td>8.2</td>
<td>203</td>
<td>809</td>
<td>1.14%</td>
</tr>
<tr>
<td>CARLOS LYRA</td>
<td>5</td>
<td>9.5</td>
<td>197</td>
<td>614</td>
<td>1.11%</td>
</tr>
<tr>
<td>GUARANI</td>
<td>3</td>
<td>8.3</td>
<td>164</td>
<td>850</td>
<td>0.92%</td>
</tr>
</tbody>
</table>

| Total            | 62              | 136.8                  | 4,908                     | 10,439                   |                      |
| Total Brazil     | 425.8          | 17,750                 | 29,839                    |                          |                      |
| Market Share top 13 |    | 32.13%                 | 27.65%                    | 34.98%                   |                      |

*Partly financed by foreign capital † Fully financed by foreign capital ‡ Merged into Santelisa Vale in 2007"
known as the ‘Companhia Industrial e Agrícola Ometto’. After an Initial Public Offering (IPO), early 2007, São Martinho sold 10% of its under-construction Boa Vista mill to the Mitsubishi Corporation, simultaneously signing a 30-year agreement to sell 30% of the Boa Vista production to Mitsubishi for export to Japan. The Boa Vista mill in Goiás is expected to begin operating in the 2008/2009 harvest with an initial estimated annual sugarcane crushing capacity of 1.7 million tons and annual ethanol production capacity of 95 million litres. São Martinho currently owns two sugar and ethanol mills in the State of São Paulo, one of them being the São Martinho mill, the second biggest mill in Brazil. During the 2006/2007 harvest, São Martinho processed 9.3 million tons sugarcane, producing 394 million litres ethanol and 0.7 million tons sugar.

The Biagi family
Another strong sugar family in Brazil is the Biagi family, shareholder and controlling factor in the merger between Vale do Rosário and Santa Elisa. Owners of Irmãos Biagi, Santa Elisa and B5, and indirect shareholders in Vale do Rosário, the Biagi family made sure that hostile bids of Cosan and Bunge were rejected. Together with the Junqueira family, they have created the second largest ethanol group in Brazil. They have announced to actively seek foreign partnerships, while increasing existing ones. Santa Elisa has formed a US$ 300 million joint venture with the Carlyle Group and Global Foods holding, called CNAA, which plans to have 4 mills operational by 2009 with a combined sugarcane crushing capacity of 20 million tonnes.

Meanwhile, Cargill’s expansion in Brazil is largely taking place through the Biagi family. In June 2006, Cargill bought the Cevasa mill in São Paulo from Maurílio Biagi Filho. This is all part of a long term strategy that involves the Biagi controlled cooperative Crystalsev. The plan is to merge all 9 members of the cooperative into a completely integrated producer and trader, similar to Cosan. While Crystalsev focuses on the domestic market, it is able to enter foreign markets through its partnerships with Cargill and Global Foods. Cargill’s Cevasa plant aims to annually ship 350 million litres of ethanol through the ethanol export terminal TEAS, jointly owned by Cosan, Crystalsev, Cargill and two smaller parties, to Cargill’s and Crystalsev’s joint-venture ethanol plant in El Salvador. This gives it duty free entrance to the US.

Cooperatives
Cooperatives are generally much larger than the groups in terms of volume. Copersucar is the largest cooperative in Brazil; a private cooperative that was created in 1959 by 10 sugar mills in the State of São Paulo in order to provide shared commercial distribution for their ethanol and sugar production. Currently, Copersucar is comprised of 27 producers in the states of São Paulo, Minas Gerais and Paraná. While simultaneously competing, both Biagi family is involved in the cooperative through the Irmãos Biagi group. Copersucar’s by-laws require associated firms to make 100% of their sugar and ethanol production available to Copersucar. Revenues from these products and expenses incurred due to the Cooperative’s operations are allocated by Copersucar to each cooperative member, proportionally to the products made available. Crystalsev and Bioagencia, the two other major cooperatives have similar operations. Table 5.3 shows the three largest Brazilian cooperatives, plus Cosan. Though Cosan is not a cooperative, its size and similar activities make this comparison relevant.

The table does not include sugar and ethanol traders such as SCA trading and CPA, as the sugar mills that supply them are not shareholders in the company. In addition, the list only contains cooperatives from the centre-south of Brazil. In the northeast, Sindaçucar plays an important role in Pernambuco, while Coopertrading, João Lyra and Carlos Lyra are dominant players in Alagoas.

<table>
<thead>
<tr>
<th>Marketer</th>
<th>Sugarcane (t)</th>
<th>Ethanol (m³)</th>
<th>Sugar (t)</th>
<th># plants</th>
<th>Market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPERSUCAR</td>
<td>58,685,115</td>
<td>2,730,319</td>
<td>3,935,219</td>
<td>27</td>
<td>13.78%</td>
</tr>
<tr>
<td>COSAN*</td>
<td>35,538,478</td>
<td>1,272,562</td>
<td>3,113,118</td>
<td>17</td>
<td>8.35%</td>
</tr>
<tr>
<td>BIOAGENCIA</td>
<td>29,882,377</td>
<td>1,100,825</td>
<td>2,440,132</td>
<td>16</td>
<td>7.02%</td>
</tr>
<tr>
<td>CRYSTELSEV</td>
<td>25,550,035</td>
<td>1,148,157</td>
<td>1,686,408</td>
<td>9</td>
<td>6.00%</td>
</tr>
<tr>
<td>Subtotal</td>
<td>149,656,005</td>
<td>6,251,893</td>
<td>11,176,827</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>425,751,744</td>
<td>17,750,269</td>
<td>29,838,812</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Cosan is technically not a cooperative, but an integrated producer and trader

Table 5.3: Brazil’s largest sugar and ethanol cooperatives, ranked by production, 2006
5.4 Foreign investors

The complex structure of family owned mills, groups and cooperatives described above is slowly changing as a result of foreign investments made in the last couple of years. Maurílio Biagi Filho, member of the Biagi family and president of the AgroEnergy and Bio-Fuels Committee of the Brazilian Rural Society (SRB), expects that the participation of foreign capital in the Brazilian ethanol industry will reach 50% in 10 years or less. In 2006, foreign participation was about 3.5%, while approximately 6% was expected for 2007. The developments with the main foreign investors listed below, illustrate this trend.  

Louis Dreyfus

This French commodity group was one of the first foreign companies to enter the Brazilian sugarcane industry in 2000, when it acquired the Cresciúmal refinery, in São Paulo. Between 2000 and 2006, Louis Dreyfus acquired 2 more mills, before it announced the R$ 1 billion acquisition of the Pernambuco-based Tavares de Melo group. The acquisition includes four operating plants and one plant that is under construction. Dreyfus aims to process 11.8 million tonnes of sugarcane in the 2007/08 crop and expects to be able to increase this to 18.5 million tonnes in 2009.  

In July 2008, the Brazilian unit of Louis Dreyfus Commodities agreed with the Swedish ethanol trading company SEKAB to supply certified sustainable hydrous and anhydrous ethanol in August until April 2009. The companies didn't disclose the amount of ethanol to be exported to Sweden and northern Europe.  

Guarani and Tereos

French sugar group Tereos followed soon after Louis Dreyfus through the acquisition of Açúcar Guarani and by investing in Cosan. Tereos held a 6.3% equity stake in industry leader Cosan, before selling it in June 2007 when it acquired a 68% majority share in its sixth ethanol plant through Guarani. In the 2006/07 season, Guarani crushed roughly 8.3 million tonnes of cane and is forecasted to produce 9.6 million tonnes, not including the new mill. The new Andrade mill produced 2.9 million tonnes of sugarcane in the 2006/07 season, 215,000 tonnes of sugar and 144,300 m³ of ethanol. The purchase comes right after Açucar Guarani filed documents with Brazil’s securities regulator, CVM, to launch an initial public offering on the São Paulo Stock Exchange.  

Companhia Nacional de Açúcar e Álcool (CNAFA)

CNAFA is a joint venture between founding shareholders Santa Elisa and Global Foods Holding. It has closed a US $240 million private equity placement with an investor consortium led by the Carlyle / Riverstone Renewable Energy Infrastructure Fund. The company plans to build and operate four high-efficiency sugar and ethanol production facilities and to develop 120,000 hectares of sugarcane plantations in Minas Gerais and Goiás. The mills will have a total planned capacity of 20 million tonnes of crushed cane by the year 2009 and will generate enough electricity to be energy self-sufficient and sell excess electricity to the local grid.  

Infinity Bio-Energy

Infinity Bio-Energy Ltd. was founded in March 2006. It has since made a number of acquisitions of Brazilian ethanol sugarcane mills, and is developing ethanol production facilities. In the beginning of 2008, the company owned four production facilities consisting of about 13 mills located in the states of Minas Gerais and Espírito Santo. The combined sugarcane crushing capacity of these mills will be around 5.9 million tons per year. Furthermore, Infinity Bio-Energy bought a 51% share in Montasa, a mill located in Espírito Santo. It is expected to be completed in 2009 with initial crushing capacity of 1.5 million tons, fully dedicated to the production of ethanol. In 2006/2007 the company produced 153 million litres of ethanol. In 2007/2008 the company expects to produce 207 million litres of ethanol.  

Infinity's strategy is to produce in regions not having a tradition in sugarcane. Infinity focuses on the south of Mato Grosso do Sul and the north of Espírito Santo, near the borders with Minas Gerais and Bahia.  

Brazilian Renewable Energy Company (Brenco)

Brenco is a new Brazil-focused ethanol company that has raised $200 million in a private placement of its common shares. High profile investors such as Sun Microsystems Inc. founder Vinod Khosla, supermarket magnate Ron Burkle and the co-founder of AOL Steve Case are participating in the company. The new company is headed by Philippe Reichstul, the ex-president of Brazil’s state-owned oil company Petrobras. Brenco plans to invest $2.2 billion in building 10 sugar and ethanol mills in the country. The 10 mills will
have a joint sugar cane crushing capacity of 44 million tonnes a year, from which it will produce 3.7 billion litres of ethanol; sugar will not be produced by Brenco. Brenco has already begun planting sugarcane for four ethanol distilleries, and claims that the mills (crushing capacity 17 million tonnes) are likely to start operating in 2009.\textsuperscript{81}

**Clean Energy Brazil (CEB)**

Clean Energy Brazil is a British investment fund, investing in integrated sugar and ethanol production units in Brazil. It is being managed by Temple Capital Partners, a partnership between Czarnikow Sugar (UK), Agrop (Brazil) and the investment bank Numis Securities (UK, part of Numis Corporation). The company’s aim is to participate in the development of sugarcane businesses with an ideal critical mass in excess of 30 million tonnes of annual cane crushing capacity with a view to becoming a leading low cost participant within the sector.\textsuperscript{82}

Clean Energy Brazil has investments in four crushing plants (three in Paraná, one in Mato Grosso do Sul), which will have have a crushing capacity of 2.3 million tons of sugarcane each. The crushing capacity of the Usaciga crushing mill will be expanded to 9 million tonnes in five years time. Investments are considered in two distilleries (one in Goiás, one in Mato Grosso do Sul), which will have a combined crushing capacity of 3.1 million tons of sugarcane and will produce 272 million liters of ethanol.\textsuperscript{83}

**Bunge**

In September 2007, Bunge acquired Agroindustrial Santa Juliana, a sugarcane mill and ethanol production facility located in the state of Minas Gerais, Brazil. Bunge plans to expand the processing capacity from the present 1.6 million tons of sugar cane to 4.0 million tons of per year.\textsuperscript{84}

**Cargill**

In 2006, Cargill acquired a 63 percent shareholding in Cevasa (Central Energética Vale do Sapucaí Ltda.), in Patrocínio Paulista (state of São Paulo). Cevasa has an annual processing capacity of 1.4 million tons of sugarcane, generating 125 million litres of ethanol, but aims to increase this significantly to 350 million litres. Cargill also acquired a 43.75 percent share in Itapagipe mill (Usina Itapagipe Açúcar e Álcool Ltda.), in the state of Minas Gerais, and has a share in TEAS, the ethanol export terminal in Santos, state of São Paulo\textsuperscript{85} (see also paragraph 5.3, alinea about the Biagi family).

### 5.5 Petrobras

Despite the market power of sugar families and foreign investors, the government is still a very dominant factor in Brazil’s fuel supply chain through Petroleo Brasileiro S/A, or Petrobras, founded in 1953. It was initially active in the exploration and production of petroleum, but today, like most oil companies, it has diversified into other energy segments such as petroleum derivates, natural gas and renewable energy. Before it was partly privatized in 1995, the company was 100% state-owned. Today, 44% of its shares are traded publicly on the São Paulo Stock Exchange. Petrobras’ oil production amounts to more than two million barrels a day, making Brazil self-sufficient in its oil demand. Through Petrobras, the Brazilian government has created a monopoly in its oil exploration market. Because of Petrobras’ firm position in the downstream side of the fuel market, it plays an important role in Brazil’s ethanol market. Petrobras is also the main player in some major infrastructural expansions planned for 2012 (see chapter 2 & Figure 2.2).\textsuperscript{86}

### 5.6 Main institutions involved in sugarcane ethanol

UNICA (União da Indústria de Cana de Açúcar - Sugarcane Industry Union) - http://www.unica.com.br/

UNICA, the São Paulo Sugar Cane Agroindustry Union, represents the sugarcane, sugar and alcohol business areas in the State of São Paulo. UNICA had three categories of associate industrial units, namely the sugar and alcohol producers, those that only produce alcohol, and those that concentrate on sugar production.\textsuperscript{87}

As the successor to several sectorial organisations in São Paulo, UNICA, created in 1997, enabled the combination of institutional work into a single entity, strengthening the dialogue with the government and society. Recognized as a national reference center, UNICA safeguards the statistical memory of Brazilian sugarcane, sugar and alcohol production. It keeps abreast of the progress achieved in the sector’s
technological area and fights to open foreign markets for sugar and alcohol. As the agency responsible for more than 60% of Brazilian production, it has a natural leadership position in the country that qualifies it to act as an intermediary with entities in the other producer States. More than 100 production units are UNICA associates, including traditional sugar exporting groups.\textsuperscript{88}

UNICA’s Objectives are:\textsuperscript{89}
- To break protectionist barriers, aiming at expanding the free market of sugar and alcohol;
- To universalize the production and use of fuel ethanol (alcohol), transforming it into a commodity with an environmental value, opening markets for it as a gasoline oxygenator or as the main fuel for advanced technology vehicles;
- To support policies to expand the use of biomass in the energy consumption matrix in Brazil;
- To diversify the operations of sugar producing countries, adding ethanol and cogeneration of energy to their production programs;
- To promote sugar and fuel alcohol for their qualities to improve public health and the environment;
- To develop policies to give competitiveness to biomass, as a clean and renewable energy source;
- To characterize energy from biomass as a concrete alternative to fossil sources, considering its environmental, social and economic properties: it reduces local pollution (improving the atmosphere in the large urban centers) and global pollution (the greenhouse effect), it creates jobs and income in a decentralized fashion, helping to reduce social inequality, it generates and saves foreign exchange, besides lowering the dependence on petroleum, that it produced in politically unstable regions.

CTC (Centro de Tecnologia Canavieira - Sugarcane Technology Centre) - http://www.ctc.com.br/
The objective of CTC is to promote the technological development of the associated sugar mills through research, development or acquisition, and transfer of technology. CTC offers strategic and economic considerations and special training programs; its budget is 100% covered by from associate’s fees. Formerly known as Copersucar Technology Center, CTC is one of the world’s most advanced research and development centers for sugarcane agriculture and industry. It has four experiment stations in Brazil (in Piracicaba, Jaú, Miracatú and Camamú), and several laboratories and pilot plants for analysis and quality control and research on industrial development, plant pathology, entomology, and biotechnology.\textsuperscript{90}

The main working fields of CTC are:\textsuperscript{91}
- Technology transfer to the national sugar and alcohol industry;
- Genome project to identify the 50,000 cane genes;
- Production of biodegradable plastic;
- Creation of VVHP-type sugar that requires less processing effort;
- Technology for using cane processing residues in electricity cogeneration.

Empresa Brasileña de Investigación Agropecuaria (EMBRAPA) - http://www.embrapa.br/english
The Brazilian Agricultural Research Corporation's mission is to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer. Networking through 38 Research Centers, 3 Service Centers and 13 Central Divisions, EMBRAPA is present in almost all the states of the Union, each with its own ecological conditions. There are 8,155 employees in EMBRAPA, of which 2,097 are researchers, 25% with master's degrees and 66% with doctoral degrees. EMBRAPA coordinates the National Agricultural Research System, which includes most public and private entities involved in agricultural research in the country. EMBRAPA is also involved in a programme aiming to monitor the sugarcane production by satellite.\textsuperscript{92}

The main working fields of EMBRAPA are:\textsuperscript{93}
- Alternative feedstocks for ethanol production;
- International market;
- Agroenergy farming cooperatives;
- National Agroenergy Plan;
- Technologies for using agricultural wastes.
6 Issues in the Brazilian sugarcane sector and linked legislation

This chapter describes the main issues related to labour, socio-economic aspects and the environment in the Brazilian sugarcane sector. For each issue, relevant Brazilian legislation is described as far as available. Most legislation data is based on a research by Smeets et al., published in August 2006. This research mainly discusses national legislation, while in some cases legislation divers between states or even municipals.

Although legislation exists on most issues, law enforcement is a crucial problem due to insufficient resources for adequate inspection and monitoring, and abuse of power positions by decision-makers and large land owners.

6.1 Labour issues and legislation

6.1.1 Bonded labour - Modern slavery

Living conditions on monoculture plantations are often reported to be degrading. The Brazilian Ministry of Labour estimates that 25,000 - 40,000 sugarcane workers lived under slave-like conditions on sugarcane plantations in Brazil in 2007. They are mostly poor immigrants in the South coming from the Northeast. Their have been numerous reports that they have to share a small cabin with too many co-workers, that sanitary conditions and medical provisions are far below basic standards and that they depend on the plantation store for their supplies. The long distance to nearby settlements enables plantation owners to demand monopoly prices. There are also reports of sugarcane cutters that are not paid in cash, but who receive a written note telling them how much they have earned and with which they can pay in the plantation store. In effect, sugarcane cutters often get underpaid and having no cash, they do not have the possibility of leaving the plantation.

Although the Brazilian government is making an effort to improve the situation – by carrying out freedom operations – the problem remains and numbers are still alarming. The trend is rising; at the end of the 90s, the annual amount of reported cases was between 500 and 2,500 - since 2002, the number has risen to more than 5,000. The Brazilian NGO Repórter Brasil states that although sugarcane producers represent only 1% of the number of producers on the ‘dirty list’ produced by the Brazilian Ministry of Labour - containing all producers known to make use of slaves - sugarcane is the third worst sector when it comes to the number of slaves (see also paragraph 7.2). According to the Brazilian NGO Comissão Pastoral da Terra (CPT), 52% of all slaves freed by the Ministry of Labour in 2007 were working in the sugarcane (ethanol) sector: 3,131 of 5,974 freed slaves in total. Almost 50% of the sugarcane slaves were freed in Mato Grosso do Sul, a third in Pará, and the remainder in Mato Grosso and Goiás.

Legislation

There is legislation on the issue of worker rights in Brazil that should prevent forced labour and allows workers to join unions. For example, the law provides that violators of forced or compulsory labour laws may be sentenced up to eight years in prison. The law also provides penalties for various crimes related to forced labour, such as recruiting or transporting workers or obliging them to incur debt as part of a forced labour scheme. The abolition of forced labour was hindered by:

- Failure to impose effective penalties;
- The impunity of those responsible;
- Delays in judicial procedure;
- The absence of coordination between the various government bodies.

The law also allows the government, after compensating the landowner, to seize lands on which forced labour has been found and to distribute the property in the government’s land reform program. There has been few criminal prosecutions relating to forced labour because of:

- The lack of a clear legal definition;
- Local political pressure;
- Weak coordination among the police, the judiciary, and prosecutors;
- The remoteness of areas in which forced labour was practiced;
- Witnesses' fear of retaliation;
- Police failure to conduct criminal investigations when accompanying labour inspectors on raids.

Since violators of forced labour laws enjoyed virtual impunity from criminal prosecution, the government used fines and other disincentives to penalize violators. The government withholds credit to farms using forced labour. No further information is available on other legislation or its effectiveness.\(^\text{103}\)

An important instrument to improve social conditions in sugarcane and/or ethanol companies is the National Agreement To Eradicate Slave Labour In Brazil. The Brazilian NGOs Repórter Brasil and Instituto Ethos and the International Labour Organization (ILO) have developed a facilitated research system based on the "dirty list". Using this feature, companies that have signed the National Agreement To Eradicate Slave Labour in Brazil can search if a certain estate figures on this list. Many fuel companies, such as Petrobras, Ipiranga, Texaco, Exxon, and Shell, have signed the Agreement and they are assumed to suspend ethanol companies that used slave labour from their supplier group.\(^\text{104}\)

### 6.1.2 Poor working conditions

The manual harvesting of sugarcane is often associated with the poorest working conditions. The sugarcane cutters work long hours (13-14 hours) under very tough physical conditions (heat, dust). Sugarcane workers are paid per ton. The mechanized cutting of sugarcane has become a reference for the quantity cut by the workers. As a result the workload per worker increased from 6 t/d in the 80's, to 10 t/d in the 90's. Today, workers need to cut between 12-15 t/d in regions where machines are a reference for productivity. Not meeting the target sometimes results in non-payment. Middlemen are said to claim ten percent of their harvest so in effect they have to bring even more to fulfil their targets.\(^\text{105}\) Increased mechanisation creates new demands such as cutting sugarcane close to the ground (in order to take greater advantage of the concentration of sucrose) and a better trimmed sugarcane stalk. This increases the time required for cane cutting. Further, with the increasing mechanisation of the harvesting, workers are increasingly being used in areas where conditions are not suitable for mechanized harvesting, such as areas where the terrain is not flat, the crops are planted irregularly, and the cane is of poorer quality.\(^\text{106}\) Because of targets for cane cutting, only a small number of women work in sugarcane cutting. Some sugar mills also demanded that the women should be sterilized, so they cannot have children.\(^\text{107}\)

#### Legislation

In general, there is extensive legislation regarding working conditions, working hours and safety regulations, which is broadly in line with internationally recognized standards. However, a bottleneck is the inspection and enforcement of this legislation, as further discussed in detail below.\(^\text{108}\)

The Ministry of Labour sets occupational, health, and safety standards that are consistent with internationally recognized norms. Nevertheless, the government devoted insufficient resources for adequate inspection and enforcement of these standards. Unsafe working conditions were prevalent throughout the all industries: during 2004 workplace accidents increased to 458,956 (from 390,180 in 2003), and deaths from accidents increased to 2,801 (from 2,582 in 2003). Employees or their unions may file claims related to worker safety with regional labour courts, although this was frequently a protracted process.\(^\text{109}\) Unfortunately, no data are available to analyse whether this trend was also visible specifically for the sugarcane and ethanol production sectors.\(^\text{110}\)

The law requires employers to establish internal committees for accident prevention in workplaces. It also protects employee members of these committees from being fired for their committee activities. Such firings did occur, however, and legal recourse usually require years for a resolution. The Public Ministry of Labor (MPT) - an independent agency responsible for prosecuting labour infractions - reported that numerous firms used computerized records to compile blacklists, identifying workers who had filed claims in labour courts. Individual workers did not have the legal right to remove themselves from the workplace when faced with hazardous working conditions, but workers could express such concerns to a company committee for an immediate investigation.\(^\text{111, 112}\)
The law limits the workweek to 44 hours and specifies a weekly rest period of 24 consecutive hours, preferably on Sundays. The law also prohibits excessive compulsory overtime and stipulates that hours worked above the weekly limit must be compensated at time and a half; these provisions generally were enforced in the formal sector.\textsuperscript{113}

The minimum wage increased from R$ 240 per month at the beginning of 2004 to 300 R$ per month at the beginning of 2006, while the “net required minimum wage” is calculated at 1500 R$ for a family of four.\textsuperscript{114} Wages in sugar cane and ethanol production are generally well above the minimum wage. This may however be insufficient to prevent poverty. Because of wide regional variations in salaries and in the cost of living, the government has no formal official poverty line.\textsuperscript{115}

### 6.1.3 Child labour

There has been a history of child labour being used on plantations. Exact numbers are unknown, but it is clear that child labour is being used in sugarcane production. However, it seems that child labor within the sugarcane sectors in São Paulo is lower compared to other parts of the country.\textsuperscript{116} In 2001,\textsuperscript{117} 2.4 million people younger than 17 years old were working in the agriculture sector, of which 22,876 people in the sugarcane branch (0.95%). For comparison, in 2002, the total number of workers active in the sugarcane, sugar and ethanol production was 764,593 compared to about 28.9 million people in the total agricultural sector in 2003.\textsuperscript{118} Thus the percentage of people under 17 working in the sugar and ethanol sector was 3.0%, compared to an average of 8.3% in the entire agricultural sector. Both official statistics and experts state that child labour in general still exists but has been declining over the last 20-25 years.\textsuperscript{119}

The hidden and informal nature of child labour makes children especially vulnerable to workplace accidents. For instance, children who produced charcoal, sisal, sugarcane, and footwear suffered from dismemberment, gastrointestinal disease, lacerations, blindness, and burns caused by applying pesticides with inadequate protection. In Brazil, an expressive portion of child labour at the agriculture sector is concentrated in the poorest regions of the country (mainly Northeast), but also in the South (this is the region with the highest Human Development Index in the country) due to the tradition of familiar agriculture.\textsuperscript{120}

#### Legislation

The (official) minimum working age is 16 years, and apprenticeships may begin at age 14. The law bans all minors under age 18 from work that constitutes a physical strain or from employment in nocturnal, unhealthy, dangerous, or morally harmful conditions, this clearly also includes sugarcane harvesting. However, the authorities rarely enforced additional legal restrictions intended to protect working minors under age 18. The law requires parental permission for minors to work as apprentices, and apprentices must attend school through the primary grades. The national law is broadly in line with (inter)national standards, but law enforcement is a crucial bottleneck in Brazil. The Ministry of Labour and Employment (MLE) is responsible for inspecting worksites to enforce child labour laws; its regional offices has special groups to enforce child labour laws, principally by gathering data and developing plans for child labour inspection. Nonetheless, most inspections of children in the workplace were driven by complaints brought by workers, teachers, unions, NGOs, and the media. Labour inspectors continued to prioritize inspections in the informal sector, but they remained unable to enter private homes and farms, where much of the nation’s child labour was found. In most cases, inspectors attempted to reach agreements and to have employers desist from labour law violations before levying fines of US$143 (400 R$) per violation. As a result, few employers were fined for employing children.\textsuperscript{121}

To prevent child labour and promote education, the government also continued to promote its family stipend program called “Bolsa Familia”, which provides approximately US$6 to US$40 (15 to 95 R$) monthly to low-income rural and urban families for each child (up to a total of three children per family) between the ages of 6 and 15 whose school attendance rate is at least 85%. Municipal governments have primary responsibility for day-to-day management of the program. In 2005, stipends were provided to over 8.7 million families in more than 5,560 municipalities. In addition to the federal program, an estimated 100 municipal governments operated stipend programs. The Pro-Child Institute, in São Paulo State, coordinated a labelling program to reduce instances of child labour in the footwear industry.\textsuperscript{122}
6.2 Social economic issues and legislation

6.2.1 Land rights

Sugarcane plantations are often established on land already in use (legally or not) by small (cattle) farmers. These small farmers are forced to move, without proper compensation for their land. Also the ability of small sugarcane farmers (smallholders) to compete in sugar processing has declined due to increasing market standards of refined sugar processing. According to Friends of the Earth Europe, many smallholders have already been replaced by more and more large sugarcane monocultures. In 2007, 70% of land under sugarcane cultivation was owned by 340 industrial-scale mills, with average holdings of 30,000 ha; the remaining 30% is owned by 60,000 smaller scale landowners, with average holdings of 27.5 ha.

Landless people regularly occupy land, resulting in violent conflicts with the legal owner, who is often supported by the police. The rate of conflicts is said to have gone up as a result of the increased sugarcane production, but recent data contradict this (see below).

The great majority of indigenous peoples in Brazil only have customary land rights, with the result that many live with high uncertainty about their living situation. They are dependent on the land for their livelihoods, to plant food crops and access water resources. Also, the spiritual value of the land for indigenous people is important, as their ancestors are buried in specific parts of the land. When they cannot live on their ancestral land, their spiritual life is heavily disturbed. Furthermore, without access to land, affected indigenous peoples lack access to basic goods and services, such as medicines, health services, transportation and school materials. In the most recent version of the Brazilian Constitution 1988, article 231, states: “Indians shall have their social organization, customs, languages, creeds, and traditions recognized, as well as their native rights to the lands they traditionally occupy, it being incumbent upon the republic to demarcate them and protect and ensure respect for all their property”. The process of getting land officially recognized as indigenous land is very lengthy and often difficult, but the government does not provide services to indigenous people not living in an officially recognized indigenous area.

Conflicts over land are often associated with violence. In order to take actual possession of the newly acquired land, the current inhabitants who often hold the legal title to it, are violently forced out. The Brazilian NGO Comissão Pastoral da Terra (CPT) registers violent incidents such as murder, attempt to murder and death threats, physical torture, aggression, other physical harm and imprisonment. CPT defines violence as “the moral and physical constraints exerted to workers and its allies”.

In Brazil, the total number of land conflicts has increased 17% between 1997 and 2007, while the number of families involved in land conflicts remained almost stable. The total land area related to the conflicts, however, increased significantly with 177% to 8.4 million hectares. These numbers reflect the whole agricultural and cattle breeding sectors. The statistics show a clear increase in land conflicts between 2003 and 2005; since then the numbers are declining. In the states with the largest sugarcane area (São Paulo (55% of the total Brazilian area), Minas Gerais (8%) and Paraná (7%), see Table 3.1), and in the states where the sugarcane area has recently expanded most (Goiás, Minas Gerais en Mato Grosso do Sul), however, the land area related to conflicts declined in the period 1997 - 2007 (except in Minas Gerais), just like the number of involved families (except in São Paulo). In contradistinction, the state that depends most in sugarcane production for the value of its agricultural production (Alagoas, see Table 4.1), showed a 229% increase in the number of land conflicts, a 142% increase in the number of involved families, and a 104% increase in the area related to the conflicts in the same period. Based on these statistics, a clear conclusion on the impact of sugarcane production on the occurrence of land conflicts can not be drawn.

However, cases of illegal procurement of land are still reported, such as in Maranhão where 200,000 hectares of public land was reported in April 2008 to be taken by sugarcane plantations.
Legislation
For land tenure and property rights there is legislation in Brazil, but this was not analysed in detail in the Smeets et al. (2006) study\textsuperscript{130}, because of the complexity of the issue and because various studies indicated that law enforcement is a crucial problem due to corruption and abuse of the power position of large land owners.

Land ownership is registered both in real estate notary offices and Government (municipal, federal and state) agrarian agencies. The lack of control between these four registers, the inefficient fiscal system and the fact that no single Land Register exists in Brazil are an underlying cause of many conflicts over land rights.\textsuperscript{131}

6.2.2 Unemployment vs. employment and migration

Mechanisation leads to a lower demand for plantation workers in the sugarcane industry. Much of the early expansion of Brazil’s sugarcane area, especially in the northeast, occurred as large plantation owners took over smaller-scale farms. This was a sometimes violent social disruption that led to an increase in unemployment and landlessness in the region. More recently, total employment in Brazil’s sugarcane industry declined from 670,000 in 1992 to 450,000 in 2003, largely because of the trend towards mechanical harvesting.\textsuperscript{132} This results in high unemployment and migration to the new frontier areas. In the latter the influx of migrants is said to lead to destabilisation of communities. Slums are growing around cities. There are reports of kidnapping women and children to boost prostitution, high alcohol and crack use. The demand for public services (health, schooling, etc.) increase dramatically, while supply cannot keep up or even remains the same.\textsuperscript{133} There is a growing global trend of using smallholders and contract farmers to supply sugarcane to mills.\textsuperscript{134, 135}

Employment problems exist particularly for migrant and temporary workers. Cane cutters risk their job when they fail to reach the goal of 12-15 t/d and the impossibility of returning home with nothing for the family, has made many workers ‘escape’ or ‘disappear’, migrating once again or searching for temporary work on the peripheries of urban centres. In São Paulo for example, a survey held among 50 sugar and ethanol companies showed that 75% of the workers were born in São Paulo State, thus the remaining 25% came from other states. Armed guards sometimes were used to retain escaped labourers, but the remoteness of the location, confiscation of documents, and threats of legal action or physical harm usually were sufficient to prevent labourers from fleeing.\textsuperscript{136}

The increasing use of mechanical harvesting systems has encountered opposition from labour unions, because of the expected loss of jobs. With the arrival of migration workers looking for jobs, there is even less employment for the local rural people.\textsuperscript{137} A situation of full mechanical harvesting in São Paulo and 50% mechanical harvesting the rest of the country, 165,000 jobs would be lost compared to a fully manual harvesting system.\textsuperscript{138} Another prediction states that in São Paulo, 189,600 jobs will be lost due to mechanisation by 2020 versus only 75,300 new jobs, leaving 114,000 people unemployed.\textsuperscript{139}

In Brazil, the production of sugarcane/ethanol is an important source of employment, both directly (employment in the sugarcane and ethanol production) and indirectly (employment in the industries that produce intermediate deliveries to the sugarcane and ethanol production sector).\textsuperscript{140} Brazil’s ethanol industry alone employs about half a million workers.

The use of trash for energy generation may create some 12,000 jobs in agriculture in case balers are being used to collect the biomass for energy generation. Alternatively, the cane can also be harvested including leaves and tops so that the residues are separated from the cane at the mill. The employment effect of the latter option is unknown, but probably limited.\textsuperscript{141}

Legislation
There is no specific legislation about employment levels. Yet, employment is a key priority in Brazil. However, in much legislation employment is indirectly included. An example is the legislation on cane burning and the situation in the North East of Brazil, where the government specifically aims at reducing the rate of mechanization to avoid unemployment and consequently poverty.\textsuperscript{142}
6.2.3 Food security

Despite the abundance of suitable soils and favourable climate for agriculture, the subsidies and other incentives given for sugar production and for fuel ethanol in the 70’s and 80’s caused a shift in land use patterns from food crops to sugar cane production. For example, the 362,000 ha of cane added in São Paulo between 1974 and 1979 occurred largely at the expense of food crops. The greatest impact was on maize and rice, of which the planted area declined by 35%. According to ESMAP/Saìnt, the result was higher food prices that affected especially the poor, though it is unclear how this relationship was measured. The net value of sugarcane and ethanol production is thus reduced by the loss of value added on the crop being substituted, but no further information is available on the overall impact on the economy. However, positive indirect impacts through the generation of additional income have been not been taken into account and also no data were available about the magnitude of these indirect impacts.

While food prices have been rising in the last two years, some commentators have laid part of the blame on biofuel production. However, the increase in biofuel production amounts to only a small percentage of total demand which is not likely to produce such large price shifts. Other things affecting agricultural markets worldwide are: severe weather events in several countries; changes to Westernised diets in China, India, and elsewhere; and the enormous increase in oil prices, with flow-on effects to the price of diesel and agricultural petrochemicals. The exact impact of increased biofuel production on food prices is a current topic of research worldwide, but initial results suggest that it has a small effect relative to the observed increases in food prices.

In addition to the competition for land and other production factors between sugar cane production and food production, there is a direct link between ethanol production and sugar production, since many mills produce both sugar and ethanol. The ratio sugar to ethanol that is being produced is mainly dependant on the relative price of ethanol and sugar. However, since sugar accounts for only a small fraction of food consumption, this impact is expected to be low.

Legislation
There is no legislation on this issue.

6.2.4 Genetic modification (GM)

Genetically modified sugarcane has not been commercialised yet, but research and field testing of several varieties is taking place and some are very close to commercialisation. Varieties focus on herbicide resistance, insect resistance, suppressing of flowering and sucrose enhancement. Once varieties are commercialised, they can be expected to be allowed in Brazil, as the country already has the third place in terms of GM-crops acreage under cultivation. Furthermore, the public resistance to GM mostly concerns the use of GM in food products, and is less when concerning non-food applications such as ethanol for biofuel. There is an ongoing controversy over the sustainability of GM. Proponents claim that it can increase yields, reduce production costs, improve sugar quality and reduce the environmental impact of sugarcane cultivation. Opponents claim that the production benefits are not that high, that long-term environmental benefits are unclear and that GM improves the position of the seed manufactures at the cost of the (small) farmer. Also GM is associated with a higher use of pesticides, proven by the fact that the use of genetically modified soy in Brazil has led to an 80% increase in the use of the herbicide glyphosate.

Since 1997 the Sugarcane Technology Centre (CTC) has been developing transgenic sugarcane varieties, including experimental planting. CTC has been involved in molecular biology research since 1990 when it headed the International Sugarcane Biotechnology Consortium (ICSB in Portuguese) in which 17 institutions and 12 sugarcane producing countries are united. The CTC has received a bio-safety quality certificate from the Ministry of Science and Technology that allows it to undertake field experiments. In addition, Brazil has recently completed the Cane Genome project, in which some 40 thousand genes have been sequenced that are involved in plant development, in the production and the amount of sugar in the plant, in the resistance to disease and so on.
No specific information is available on the impact of GM sugarcane on the ecosystem. The potential impact of GM-plants is subject of extensive research and debates, but the uncertainties are high and consequently there is no consensus. In general, the (potential) impact of GM-plants varies dependant on the exact genes that are altered or introduced.\textsuperscript{153}

**Legislation**

The use of GM crops has only recently been allowed in Brazil. Genetically modified organisms (GMOs) have been banned in Brazil for a long time, but illegal planting of GMOs has occurred on a wide scale: 8-22% of the soybean area is planted with genetically modified seeds illegally imported from Argentina. As a result, the Brazilian government has now legalized the use of GM soybeans. It is expected that regulations regarding GMOs will be streamlined and that more GMOs will be approved in the future.\textsuperscript{154} Three ministries are responsible for the approval of planting experiments. Each of these has their own protocols and requirements, but analysis of the details has not been found. Specifically regarding GMOs and sugarcane, according to the Brazilian law, the Technical Commission on Bio-Security – CTNBio – regulates the activities on GM and is responsible for the required authorization for experiments and plantations on GM. The CTNBio has given permission for the experiments at laboratory (for instance, there are thousands of plants at the CTC labs) but in 2006 it had not given authorization for experiments in the field. In 2000, the CTC was able to start experiments at the field with GM sugarcane, but CTNBio has stopped these activities due to a broad discussion in Brazil about GM.\textsuperscript{155} According to Smeets \textit{et al.} (2006),\textsuperscript{156} no GM sugarcane species has been completely tested. After an eventual permission from CTNBio, another three years of field test will be required order to prove the plants effectiveness.\textsuperscript{157} Commercial results may arise over the next five years.\textsuperscript{158}

### 6.3 Environmental issues and legislation

#### 6.3.1 Conversion of natural habitats

Sugar has probably had an impact on the environment greater than any other agricultural commodity. Most of the environmental damage was loss of biodiversity due to conversion of tropical ecosystems to develop the current 20 million hectares of sugarcane production areas. Conversion mainly took place in tropical forests, islands, fragile coastal areas and wetlands.\textsuperscript{159} In Brazil, sugarcane contributed greatly to the decimation of the Atlantic Forest in the Northeast of Brazil in the past centuries. Since 1970, sugarcane production is shifting from Northeast to Southeast Brazil, while the Midwest (particularly Goiás, see also Table 3.1) has recently become the new sugar frontier. The Brazilian area that is under cultivation of sugarcane is expected to grow from 6.2 million hectares in 2005/6 to 9 million hectares in 2011/12.\textsuperscript{160}

The natural habitat that is currently most affected by this growth is the Cerrado, which is currently losing 3 million hectares per year to agricultural expansion. The Cerrado is the planet’s most diverse savannah estimated to host 160,000 plant and animal species, many threatened with extinction. Sugarcane is often being planted on land previously used by cattle farmers, who after displacement convert forest, savannas and other areas of natural vegetation into new grazing areas - a typical example of ousting causing the agricultural frontier to move. It is unknown where these rangers resettle exactly; a part of them remains in the Cerrado, while others may go to the Amazon region.\textsuperscript{161} That way, sugarcane production indirectly leads to deforestation and the conversion of natural habitats. It is difficult to find precise numbers or percentages, especially since the distinction between sugar, soy and other crops is not always made and because it is unknown how many displaced farmers will open up new land and how many will start a new life in the city.\textsuperscript{162}

**Legislation**

There are various forest protection laws that directly affect the availability of land for sugarcane production. Riverside woods are specifically protected by both state and federal law, such as the Forest Code of 1965 (and its precursor of 1934), the Environmental Crime Law, rules on permits and licenses and recovery projects, tax legislation on rural properties.\textsuperscript{163} Expansion into the Cerrado is furthermore bound to legislation by the Ministry of Environment, as it contains a large range of plant and animal biodiversity.\textsuperscript{164} However, only 1.5% of the Cerrado area lies in protected federal reserves, compared to
In addition to specific legislation, the legislation on Preservation Units is also relevant. The most important law is the Forest Code of 1965 that requires each landowner to maintain a proportion of each property under natural vegetation as a legal forest reserve. Effective legal reserve requirements for rural properties are 80% in the Amazon region, 35% in the Cerrado (savannas) and 20% in all other regions. That is in accordance to the proposal approved by the National Environment Council (Conama), which has the representation of all concerned sectors of society. Many properties are out of compliance with the legal reserve obligation. Consequently, increased enforcement of the law has led to interest in policies that would permit trade of legal reserve obligations. Provisional regulation 2166-67 of 2001 allows landholders to satisfy the requirement for one property through legal forest reserve located on another. In some cases, the off-site legal reserve may be owned by another party, opening the way to a market in legal reserve rights.

In addition, the Forest Code designated permanent preservation areas (APP), which are:

1. Areas along rivers or water streams. The size of the area depends on the size of the water stream, e.g. 30 m for <10 m wide water streams, up to 500 m for >600 m wide water streams.
2. Areas around lagoons, lakes, or natural or artificial water reservoirs.
3. Areas at springs, yet intermittent, and at ‘water holes’, whatever the topographic situation, within a radius of at least 50 m.

These regulations exclude urban areas. It should be noted that the existing legislation requires protection, but restoration is mandatory, except for springs. Furthermore, there is also no definition of an acceptable use, and uses as public utility and/or social interest are often mentioned for suppression of vegetation. São Paulo state legislation (Law 9,989 of 1998) requires that riverside woods are recovered by owners of rural properties, but this law was not regulated further. A survey held in São Paulo revealed that areas classified as APPS occupy 0.6% of the sugar cane area, equal to 0.02 Mha. Although this figure is probably different in other states, it is thus unclear whether implementation of the APP legislation will seriously affect the existing area under cane production.

In the state of Goiás the local government in the town of Rio Verde have imposed a limit on sugarcane expansion to 10% of the municipality’s farmland i.e. 50,000 ha or 8 times current planting area. Sugarcane can not be planted within 50m of water sources, and the chaff not burnt within 20km of urban areas, environmentally protected areas, or near power lines or highways. The limit was demanded by agribusiness leaders and unanimously approved by the municipal Council.

In the beginning of August 2008, Agriculture Minister Reinhold Stephanes and Environment Minister Carlos Minc expressed their support to a proposal on a law to restrict cane planting. No new ethanol plants will be allowed in Pantanal's plains under the proposal, but it will permit restricted planting in the region's highlands. The proposal would require planters in this region, where cane has been cultivated for more than 10 years, to use direct, or no-till planting methods, eliminating the use of machinery and agrochemicals. No new mills would be allowed in the Amazon biome, but three plants that already had permits will be allowed to operate. The final decision concerning the proposal rests with President Luiz Inacio Lula da Silva (see also paragraph 3.1).

6.3.2 Soil degradation

Soil degradation during the production of sugarcane is caused by erosion, pollution, and removal of nutrients. Pollution of water (also affecting the soil conditions) is discussed in paragraph 6.3.3.

Soil erosion in sugarcane is generally limited compared to conventional agricultural crops such as corn and soybeans, although the exact difference is dependant on local conditions. Sugarcane generally requires tillage every four years. This is better than annual crops, but still leads to considerable erosion of between 15 and 505 MT/ha/year. Erosion leads to a loss of soil health (microbiological life) and soil chemical proporties, resulting in an increased need for fertilizers. The level of erosion increases with increased slope gradients (e.g. Northeast Brazil), but erosion is still prevalent in the plains of the Midwest and Southeast. Pre-harvest burning reduces soil organic matter and hence soil health, leading to higher soil input requirements. These inputs may in turn lead to soil acidification and thus to further deterioration of microbiological soil life.
The use of fertilizers in cane production in Brazil is modest compared to other countries and to other crops, but the overall use is obviously significant considering the size of cane production, particularly in São Paulo. Figure 6.1 (below) shows the recommended fertilizer application rates. During the production of sugar cane and ethanol various inorganic substances are used that are potentially harmful for the environment. Agrochemicals include among others, herbicides, insecticides, fungicides, adhesive spreading agents and defoliants. Of these, insecticides were most widespread used in Brazil in 2003 (0.12 kg active ingredient/ha/y).

Another factor of soil degradation is the fact that all cane is removed from the land and none of the nutrients contained in the bagasse (milling residue ~ 80% of mill’s output) is returned to the soil. This will lead to soil depletion in the long term (see Figure 6.1 (above)). In mechanized harvesting more material is left on the fields after harvesting, reducing the removal of nutrients.

A good practice that is prevalent in Brazil is returning the filter mud from the mills back to the land as a fertilizer.

**Legislation**

Erosion is described in several articles of the Law of Environmental Crimes. Summarising them, two main classifications are possible:

1. **Direct impact:** any soil degradation or contamination is considered such as a "Crime of Pollution". Law 9605/98, Article 54, defines in general terms if a given polluter caused the degradation intentionally or not, and also if the affected site (soil or subsoil) became temporarily or indefinitely unsuitable for human use.
2. **Indirect impact:** pollution of water bodies, flora or fauna caused by erosion in or stemming from the affected site; Deforestation, or any other human activity stemming from the affected site causing indirectly erosion is also embraced by this law.

There is also legislation that indirectly affects soil erosion, particularly the legislation regulating sugarcane burning and legislation on permanent preservation areas as discussion in paragraph 6.3.4 and 6.3.1, respectively. The most important one is the legislation on mechanical harvesting, which allows the use of cane residues to protect the soil and reduce soil erosion and this could reduce soil erosion rates substantially.

No legislation was found on the use of fertilizers, but there is detailed legislation in Brazil on the application, storage and processing of vinasse.

### 6.3.3 Water use and pollution

Sugarcane requires large amounts of water and sugarcane plantations are highly dependent upon irrigation in areas where rainfall is not sufficient or unreliable. The growing and processing of one kilo of vinasse is a black liquid residue of ethanol production formed during the distillation process. Vinasse is produced in large volumes and has a high organic load and a pH of 4-5. Vinasse is hot and therefore requires cooling. Sometimes vinasse is dumped in rivers, also leading to massive fish kills due to lack of oxygen.
Sugar requires 1,500 to 3,000 litres of water. Sugarcane requires at least 1,650 mm of rainfall per annum, distributed throughout the year. Otherwise, the plant requires considerable irrigation. The Brazilian Cerrado receives between 600 and 2000 mm rain a year; it is unclear to what extent sugar growing takes place in the naturally suitable areas. In any case, the Cerrado needs irrigation because it has a dry season between April and September. This can have a negative impact on groundwater levels.

Sugar cleaning and processing at the sugar mill also requires large amounts of water (10 cubic meters of water per cubic meter of cane). This water mostly comes from rivers, but groundwater is also used. Many sugar mills lack systems to measure water input. There is little incentive to reduce water use, because water is free. Experts claim a high potential for water savings; this is supported by the range of litres needed for the production of one kilo of sugar.

Large quantities of water are also used during the conversion of cane to ethanol. The total water use is calculated to be 21 m³/t cane (equal to 300 litres water per litre ethanol), of which 87% is used in four processes: cane washing, condenser in evaporation and vacuum, fermentation cooling and alcohol condenser cooling. Another study mentioned that in recent years mills and distilleries have improved water efficiency, with reuse and recirculation of water within the plant, resulting in a water use of 21 litres per litre of ethanol in 2005.

As a result of legislation and technological progress, the amount of water collected for ethanol production has decreased considerably during the previous years. It seems possible to reach a 1 m³/t cane water collection (14.3 litre per litre ethanol) and (close to) zero effluent release rates by further optimizing and reuse of water use and recycling.

Conventional sugarcane cultivation requires high nutrient inputs. This is supplied in the form of nitrogen-based fertilizers. Due to leaching and run-off this enters the aquatic system, thereby reducing the oxygen level (eutrophication) and hence biological living conditions of aquatic life. Leaching and aerial spraying of pesticides and herbicides also leads to water pollution. Pesticides are used in sugarcane plantations in quantities that do not exceed those of other agricultural crops (see also paragraph 6.3.2).

However, the most important polluting impacts occur when sugar mills are periodically cleaned: the organic matter is then flushed in great quantities and ties up all oxygen so that massive fish kills can be the result. Sugarcane mills require flushing one or two times a year.

Legislation
There is an extensive legal framework related to water use in Brazil and São Paulo. The framework has been expended in 2006 and legislation has been implemented, of which the billing of water use and discharge is an important element, but no hard targets have been included that are directly related to the quality of the water in an area. However, information on these issues is scarce.

Legislation implemented in Brazil to promote a more efficient use of water is based upon the “user-payer” and “pollutant-payer” principle: the user and polluter pay dependent on the amount and quality of the water collected and released. This principle is applied in all economic sectors in Brazil. In 2006, there was no legislation yet for waters within São Paulo, such as underground water, and rivers that die within the boundaries of the state. Legislation discussed here is relevant for both water use and water pollution. The main legal mechanisms for water billing are:

- São Paulo Constitution (1988). It provides that the use of water resources shall be billed and, the proceeds shall be used to maintain the quality and quantity of water;
- State Law Number 7,663 (1991). This law established the rules and regulations of the Water Resources Policy and of the Integrated of Water Resources Management System (SIGRH);
- Committee for Integration of the Paraíba do Sul River Basin (CEIVAP) Decision 8 (2001). The CEIVAP provides guidance for the implementation of billing for the use of water resources from basins. The billing considers collection, consumption, effluents treated to total effluents ratio and the biochemical oxygen demand (BOD) reduction level;
- São Paulo Bill 676 (2000) regulates the billing for the use of water in São Paulo State. The bill states that charges may vary according with the water source (superficial or underground); type, location and effective volume of use; conditions of water quality, availability and regularization in the basin; seasonal effects; and conservation measures.
Legislation related to water pollution can be summarized as follows. Next to the legislation on water use described above, the most important legislation relevant to water pollution deals with waste water emissions standards and agro-chemicals, i.e., which agro-chemicals are allowed. Further, there is legislation that is indirectly related to water pollution, such as legislation on vinasse application and legislation on nature protection. A general problem is the weak law enforcement in Brazil and thus additional monitoring and control mechanisms may be required.

6.3.4 Sugarcane burning and air pollution

Cane burning is the burning of the leaves and cane stalk tops of cane standing in the field. This is necessary for manual harvesting. The goal is to reduce the costs of manual harvesting and the costs of transportation, as well as improving workers’ safety. The burning of cane has gradually decreased in São Paulo, from 82% of the harvested area in 1997 to 63% of the harvested area in 2004. Mechanical harvesting in São Paulo has increased steadily from ca. 18% of the harvested area in 1997 to 37% in 2004. For comparison: in the Northeast region about 10% of the crop area is harvested mechanically. The fraction of raw (unburned) sugarcane in mechanical harvesting increased from 22% in 1997 to 65% in 2004. The shift from cane burning (and manual harvesting) to no cane burning (and mechanical harvesting) has both negative and positive impacts. The most important negative impact is the reduced employment. The most important positive impacts are the reduction of emissions that are potentially harmful for human health, the reduction of damage to infrastructure and forests, the reduction of soil erosion rates, and the reduction of greenhouse gas emissions from cane burning.

Many studies have been carried out during the 80’s and ’90’s that focus on the impact of emissions from cane burning on human health. Some studies did not find a direct relationship between cane burning and damage to health. On the other hand, a number of studies were performed in Brazil by the Experimental Atmospheric Pollution Laboratory (LPAE) of the Pathological Department from the University of São Paulo Medical School (FMUSP). Essentially, their main conclusions are: ‘air pollution from biomass burning causes damage to the respiratory system, leading to an increase in respiratory hospital admissions. This effect is higher for children and the elderly, and it is similar to that observed in urban areas due to exposure to industrial and vehicle-emitted air pollutants’ and ‘The health effect is determined not just by acute exposures to high pollution levels but also, and more importantly, by the length of time that people spend breathing polluted air chronically (...). However, the magnitude of chronic effects is not known’. Most studies focus on the immediate respiratory diseases only; there are no exact data on long-term health effects, but these include increased occurrence of long cancer and chronic obstructive pulmonary disease.

Legislation

Legislation is implemented in São Paulo in which a sugar cane burning phasing out schedule is included, including detailed prescriptions how, where and when cane burning is allowed. Also a reporting requirement for cane produces is included in which cane producers are required to specify a cane burning reduction schedule. Cane burning is projected to be completely phased out in 2031. The legislation specifically takes into account the practical socio-economic consequences, i.e. the high capital costs associated with mechanical harvesting as well as employment effects. More information is given below. The main norms pertaining to the issue of sugar cane harvesting burning practices set by federal and state requirements in the State of São Paulo are:

- State Law Number 6,171 (July 04, 1988), about the use, conservation and preservation of agriculture soil;
- State Law Number 8,241 (November 23, 1993) amending the State Law Number 6,171, about the use, conservation and preservation of agriculture soil;
- State Decree Number 42,056 (August 6, 1997), about burning sugar cane husk in harvesting. This decree establishes a series of places and circumstances where burning practices are totally forbidden;
- Joint Resolution Number 01/98 by the State Secretariats for Agriculture and for the Environment (June 04, 1998), which regulates the gradual elimination of burning sugar cane husk, and establishes deadlines;
Federal Decree Number 2,661 (July, 8, 1998) and State Law Number 11,241 (September 19, 2002) both ask for a burning elimination schedule and specify prohibition areas as protection ranges near urban areas, highways, railways, airports, forest reserves and preservation units. In São Paulo the burning reduction schedule shown in Figure 6.2 is in force.

<table>
<thead>
<tr>
<th>Year</th>
<th>Area where mechanical harvesting is possible (Soil tilt &lt;12%)</th>
<th>Area where mechanical harvesting is not possible (Soil tilt &gt;12%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>20%</td>
<td>-</td>
</tr>
<tr>
<td>2006</td>
<td>30%</td>
<td>-</td>
</tr>
<tr>
<td>2011</td>
<td>50%</td>
<td>10%</td>
</tr>
<tr>
<td>2016</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>2021</td>
<td>100%</td>
<td>30%</td>
</tr>
<tr>
<td>2026</td>
<td>-</td>
<td>50%</td>
</tr>
<tr>
<td>2031</td>
<td>-</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 6.2: Burning reduction schedule that is in place in São Paulo
7 Examples of cases concerning abuses related to sugarcane

In the previous chapter, the main issues related to sugarcane production including the related legislation are described in general terms. In this chapter, some examples of specific cases concerning abuses related to sugarcane are described. Although, these cases probably reflect excess examples, it is important to realise that cases like this happen in the sugarcane ethanol industry in Brazil.

7.1 Deaths due to poor working conditions

Between 2004 and 2006, the Pastoral of Migrants (a church-based NGO) registered 17 deaths from excessive work in Sao Paulo State and in 2005 the state’s Regional Delegation of Labour registered 416 deaths of workers in sugar-based ethanol production. The latter include cutters that were subjected to unsafe working conditions (protection measures, etc.).\(^{206}\)

Besides the deaths occurring in the cane fields, there are those that go unregistered, and that happen across a certain amount of time. Illnesses like cancer, provoked by the use of poisons, sugarcane soot, as well as respiratory illnesses, allergies, spinal column illnesses, linked to the impossibility of being treated due lack of income to purchase medicine. Further, the repetitive movements of cane cutting cause tendinitis and spinal column problems, loosening of the digits and spasms, provoked by the excessive loss of potassium. Frequent spasms followed by dizziness, headache and vomiting are called “birola”. Many workers use medicines and drugs to alleviate the pain and stimulate their performance.\(^{206}\)

7.2 The ‘Lista Suja’ (Dirty List) - companies practicing modern slavery

The Brazilian NGO Repórter Brasil states that although sugarcane producers represent only 1% of the number of producers on the ‘dirty list’ - a list of all producers known to make use of slaves, produced by the Brazilian Ministry of Labour - sugarcane is the third worst sector when it comes to the amount of slaves. This is due to the fact that sugarcane estates are very large, and often use large groups of slaves (Repórter Brasil mentions three estates on which 626, 1064 and 318 slaves had been found), whereas in other sectors that may use slaves, like animal husbandry and coffee, estates would generally have less than 10 slaves.\(^{207}\)

Table 7.1 shows the sugarcane plantations that are currently on the Dirty List.

<table>
<thead>
<tr>
<th>No.</th>
<th>Owner</th>
<th>Name of property</th>
<th>Municipal</th>
<th>State</th>
<th>Number of freed slaves</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Agrisul Agrícola Ltda.</td>
<td>Fazenda e Usina Debrasa</td>
<td>Brasilândia</td>
<td>Mato Grosso do Sul (MS)</td>
<td>1011</td>
<td>Production of sugarcane and ethanol</td>
</tr>
<tr>
<td>10</td>
<td>Agrocana JFS Ltda</td>
<td>Agrocana JFS</td>
<td>Ceres</td>
<td>Goiás (GO)</td>
<td>36</td>
<td>Production of sugarcane and ethanol</td>
</tr>
<tr>
<td>16</td>
<td>Alcooapan Alcool do Pantanal Ltda</td>
<td>Fazenda Olho D’Água</td>
<td>Poconé</td>
<td>Mato Grosso (MT)</td>
<td>318</td>
<td>Production of sugarcane and ethanol</td>
</tr>
<tr>
<td>97</td>
<td>Ipê Agro-Milho Industrial Ltda</td>
<td>Ipê Agro-Milho Industrial</td>
<td>Inhumas</td>
<td>Goiás (GO)</td>
<td>14</td>
<td>Production of sugarcane and ethanol</td>
</tr>
<tr>
<td>161</td>
<td>Nelson Donadel</td>
<td>Fazenda Cachoeirinha - DCOIL</td>
<td>Iguatemi</td>
<td>Mato Grosso do Sul (MS)</td>
<td>498</td>
<td>Production of sugarcane and ethanol</td>
</tr>
<tr>
<td>169</td>
<td>Raimundo Everardo Mendes Vasconcelos</td>
<td>Fazenda Soever</td>
<td>Beberibe</td>
<td>Ceará (CE)</td>
<td>40</td>
<td>Production of sugarcane</td>
</tr>
<tr>
<td>191</td>
<td>Silvio Zulli</td>
<td>Fazenda Olho D’Água</td>
<td>Poconé</td>
<td>Mato Grosso (MT)</td>
<td>318</td>
<td>Production of sugarcane</td>
</tr>
<tr>
<td>192</td>
<td>Silvio Zulli</td>
<td>Fazenda Olho D’Água</td>
<td>Poconé</td>
<td>Mato Grosso (MT)</td>
<td>22</td>
<td>Production of sugarcane</td>
</tr>
</tbody>
</table>

Brazilian Ministry of Labour / Repórter Brazil\(^{208}\)

7.3 List of mills with notorious bad reputation

In July 2008, the Brazilian Ministry of Environment published a list of sugarcane plants operating without proper environmental permissions in Pernambuco. The plants have been fined a total of R$ 120 million (R$ 5 million each - 3.1 million US$) and the responsible owners will face civil and criminal prosecution.
The public prosecution service will ask the Justice Department to determine how much of the environmental damages (an estimated area of 85,000 hectares) caused by the plants should be recovered.\textsuperscript{209}

This is the list of fined factories in Pernambuco:\textsuperscript{210}

1. Usina Bom Jesus S/A  
2. Cia Usina Bulhões  
3. Companhia Industrial do Nordeste Brasileiro  
4. Usina Central Nossa Sra. de Lourdes S/A  
5. Usina Central Olho D'Água S/A  
6. Usina Cruangi S/A  
7. Zihuatanengo do Brasil Açúcar e Álcool S/A  
8. Interiorana Serviços e Construções Ltda  
9. Usina Ipojuca S/A  
10. J.B. Ltda  
11. Usivale Indústria e Comércio Ltda  
12. Cachool Comércio e Indústria S/A  
13. Destilaria PAL Ltda  
14. Usina Petribú S/A  
15. Usina Pumanty S/A  
16. Usina Salgado S/A  
17. Cia Agro Industrial de Goiana  
18. Usina São José S/A  
19. Usina Trapiche S/A  
20. Uma Açúcar e Energia Ltda  
21. Una Álcool Export Ltda  
22. Usina União e Indústria S/A  
23. Vale Verde Empreendimentos Agrícolas Ltda  
24. Vitória Agroindustrial Ltda
8 Brazilian initiatives for improvement of its sugarcane ethanol industry

There are several Brazilian initiatives aimed at making the sugarcane ethanol sector more sustainable. In this chapter, four of the main initiatives are shortly described: the recent voluntary Ethanol Verde and Inmetro initiatives, the multi-sectoral Iniciativa Brasileira and the Imaflora / SAN standard developed in 2002.

8.1 Ethanol Verde

The State of São Paulo has recently established a voluntary scheme, the Agro-environmental Protocol with the sugarcane sector, to promote best practices beyond business-as-usual. Signed by the State Governor, the Secretaries of Environment and Agriculture and the President of the Sugarcane Producers Union (UNICA) the text has a set of ambitious measures to be followed and foresees issuing an official Certificate of Conformity.

Sugarcane Sector Protocol contains the following Environmental Directives:

- a. Anticipate, in the lands with declivity lower than 12%, the final period for the elimination of sugar cane harvest burning, from 2021 to 2014. Anticipate the percentage of not burned sugarcane in 2010, from 30% to 70%;
- b. Anticipate, in the lands with declivity higher than 12%, the final period for the elimination of sugar cane harvest burning, from 2031 to 2017. Anticipate the percentage of not burned sugar cane in 2010, from 10% to 30%;
- c. Do not burn any sugar cane harvest in expansion areas;
- d. Do not burn any sub-product of sugar cane without a control system;
- e. Protect the Riparian Forest of the sugar cane farms due to its relevance for the environment and biodiversity protection;
- f. Protect the water springs of rural areas of sugar cane farms, recovering its vegetation;
- g. Implement a Technical Plan of Soil Conservation, including the erosion control and the contention of water runoffs on intern roads;
- h. Implement a Technical Plan of Water Resources Conservation, respecting the hydrological cycle, including a Water Quality Program and Water Reuse Program;
- i. Adopt good practices for agrochemicals packaging waste, promoting the triple washing practices and storing it accordingly. Train the operators correctly and certificate the use of individual workforce protections equipment;
- j. Adopt good practices to minimize air pollution from industrial process and optimize the recycling and reuse of industrial process solid waste.

SMA, the Environment Secretariat, is paying close attention to the expansion of the sugarcane culture in São Paulo. Sugarcane area grew 4.8% in the period 2000-2006 on average and 9.4% only in 2006. Adequate management and strong law enforcement are needed to increase sustainability in São Paulo’s fast growing sugarcane production area.

8.2 Iniciativa Brasileira

Iniciativa Brasileira, the Brazilian Initiative for Verification of Agricultural Activities, in operation since July 2006, seeks to lay the groundwork for a transparent system of voluntary verification, including independent certification. Its Executive Secretariat is operated by Friends of the Earth-Brazilian Amazon. It aims for generic criteria for all agricultural commodities, as many of these are interchangeable and/or produced in sequence or rotation (soy, sugarcane, cotton, cattle). Thus, the initiative aims to establish minimum criteria for all crops to prevent farmers to switch from ‘regulated’ crops to unregulated ones. The Initiative is currently in the process of developing the principles and criteria of the certification system.
8.3 Imaflora

In 2002, the Brazilian NGO Imaflora developed a standard under the Sustainable Agricultural Network (SAN) managed by the Rainforest Alliance, following a multi-stakeholder process. Despite the successful process in terms of participation, transparency and representation, the lack of public policies and market incentives seemingly caused the initiative to fail. Furthermore, in practice it was hard to find mills that could have their own products certified and traded isolated from other sources. Imaflora expected incentives from the policy side, but did not receive support from national or state government. In the opinion of Luis Fernando Guedes Pinto, director of Imaflora, certification would work if there were very concrete markets for certified ethanol, or other incentives or pressure to do this. The standard was based on nine principles related to ecosystem, water resources, and soil conservation, wildlife protection, fair and correct treatment of workers, community affairs, integrated pests and diseases handling, integrated waste management, and management and monitoring.

8.4 Inmetro

The National Institute of Metrology, Standardization and Industrial Quality (Inmetro) was created by law in December 1973, to support Brazilian enterprises, to increase their productivity and the quality of goods and services. Inmetro is part of the Brazilian Ministry of Development, Industry and Foreign Trade.

Activities related to Metrology, Standardization, Industrial Quality and Conformity Assessment are carried out by the National Metrology, Standardization and Industrial Quality System –SINMETRO. Inmetro is the executive secretariat for the National Council for Metrology, Standardization and Industrial Quality –CONMETRO, the legislative body of SINMETRO. Inmetro’s main responsibilities are:

- Coordination of the selection of standards or the establishment of technical regulations;
- Coordination of the establishment of conformity assessment procedures;
- Accreditation of the conformity assessment bodies;
- Registration of products, in mandatory cases -on implementation;
- Implementation of market surveillance actions.

Inmetro is involved in the development of a voluntary initiative called the Brazilian Programme on Biofuels Certification. Four sets of requirements are used as basis for the certificate:

- Conformity Assessment Procedure on Ethanol;
- Physical-Chemical requirements - based on technical regulations of the Brazilian Petroleum, Gas and Biofuels Agency;
- Social requirements - based on Brazilian technical regulations of the Ministry of Labour;
- Environmental requirements - based on Brazilian Acts and Resolutions of the Ministry of Environment;
- Additional requirements to fulfil global demands.

The current status of this programme and the connection with Ethanol Verde (see paragraph 8.1), if any, is unknown.
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