Brazilian sugarcane sector: an economic and environmental approach

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Abstract: The Brazilian sugarcane industry constitutes a main player in the domestic economic environment and more specifically in the state of São Paulo. In this sense, engendering an economic and environmental analysis of the São Paulo sugarcane industry, and to identify possible points of conflict between the expansion of crop area and environmental conservation, constitutes the main objective of this essay. Using a combined approach with descriptive purposes, it was precede unstructured interview with technical manager of the Rural Association of Growers and Sugarcane Suppliers of Sorocaba region, primary documentary evidence obtained from the entity and secondary data from various official sources. The results showed that reduction in the number of agro-industrial units due to the strong economic crisis now facing the sector. However, the expansion of cultivation area has increased and, in parallel, the industry has been engaged in environmental conservation, especially with the increase of green areas, protection of water sources and reduced water consumption in the production process.

Keywords: sugarcane industry; economy; environment; sugarcane; environmental; Brazil.


Biographical notes: Edenis Cesar de Oliveira has a PhD in Management (2015) by the Programa de Pós-Graduação em Administração da Universidade Municipal de São Caetano do Sul (PPGA-USCS). He is an Associate Professor at the Federal University of São Carlos – UFSCar. He has an experience in administration, acting on the following topics: organisational theory, environmental management and sustainable territorial development.
1 Introduction

The global sugarcane production is about 1.91 billion tons annually and is concentrated in tropical regions, particularly in developing nations in Latin America and Asia. According to the UN Food and Agricultural Organization (FAO), there are over 100 countries producing sugarcane today (Bhatnagar et al., 2016).

Brazil currently leads world production of sugarcane crop, with a planted area estimated at over nine million hectares for the 2014/2015 harvest. Production for the same crop was 634.8 million tons, 3.7% lower than previous harvest, which represents a reduction of 24.1 million tons. Sugar production was 35.56 million tons, 6.1% lower than previous crop cycle (2013/2014), whereas ethanol production was around 29 billion litres (anhydrous and hydrated), an increase of 2.5% (703.2 million litres) compared to the previous harvest. All this potential has placed the country as the world leader in ethanol production technology (CONAB, 2015).

The sugarcane crop has importance in the Brazilian agricultural scenario because of its versatility, being used from the simplest form as animal feed, even the most noble as sugar, ethanol and energy (Schneider et al., 2012; Marin et al., 2015).

According to the National Supply Company data, productivity achieved in the current season (2014/2015 crop) was 70.5 ton ha⁻¹, which means a significant reduction of 5.7% compared to the previous harvest which obtained value of 74.8 ton ha⁻¹ there is. Please note that this reduction relates to the centre-south region. In the state of São Paulo, the reduction reached 11% level compared to the previous harvest (CONAB, 2015).

The south-central region (ES, GO, MG, MS, MT, PR, RJ and SP) is the largest producing region of the country, accounting for approximately 90% of the produced amount.

Figure 1 shows the cumulative percentage change for the centre-south region in the period 2006/2007 to 2014/2015 crop yields (estimate).

Figure 1 Cumulative percentage change – south central region (see online version for colours)

Note: Estimate in April 2015.
Source: CONAB (2015)
Brazilian sugarcane sector

The south-central region had an impact on the decrease in productivity (reduction of 7.3%) on production, which was reduced by 4.4%. However, the impact was not more pronounced due to the 3.1% increase in planted area as a result of expansion of new planted areas (CONAB, 2015).

Figure 2 shows the mapping of sugarcane in the country.

Figure 2 Sugarcane crop growth regions (see online version for colours)

Production of the centre-south region, the state of São Paulo accounts for over 60%, as can be seen in Figure 2.

Engender an economic and environmental analysis of the sugarcane industry in the state of São Paulo, and to identify possible points of conflict between the expansion of cultivation area and environmental conservation, constitutes the main objective of this essay.

The article is structured as follows: beyond this preamble, Section 2 provides a brief economic overview of the sugarcane industry. Section 3 objectively presents the methodology used at work, using secondary data, while that in Section 4 presents the data (primary and secondary) under the environmental perspective. In the last section was reserved his final remarks.

2 Theoretical framework

2.1 Brief economic outlook of the sugarcane industry

The sugarcane production is one of the main economic activities of the agriculture sector in several places around the world (Martinez-Guido et al., 2016). In Brazil, the scenario is no different.
The gross domestic product (GDP) of the sugarcane industry, for the 2013/2014 crop cycle was estimated in US$ 43.36 billion, equivalent to 2% of 2013 GDP, resulting in an increase of 44% when compared with 2008/2009. Taxes on total revenues amounted, for that period, about US$ 10.9 billion, of which US$ 2.38 billion (approximately 22%) were generated only by the sale of agricultural and industrial inputs (Neves and Trombin, 2014).

Estimates suggest that global consumption of liquid fuels is expected to grow at a rate of 0.9% per year between 2007 and 2035, while the growth rate of renewable fuels must submit an increase of 2.6% per year. According to projections from the Energy Information Administration (EIA), this rate should increase the share of 11.5% of renewable fuels in total liquid fuels in the world in 2007 to around 45% in 2035. The Brazilian production ethanol is expected to jump from 0.3 million barrels per day to 1.6 million barrels per day (EIA, 2010).

The estimated revenue generated from the sale of sugarcane to agro-industries was US$ 17.99 billion (Table 1), 61% from own production and 39% of sugarcane growers and partners integrated in the production system (Neves and Trombin, 2014).

The industry in question has been the stanchion of the Brazilian economy, especially by contributing to energy production by providing inputs for bioelectricity. Together, ethanol and sugarcane bagasse account for about 15% of the Brazilian energy matrix, and supports significant levels of employment and substantial tax revenues across its supply chain (Neves et al., 2010).

In addition, the sector is seen as a great opportunity for economic development, social, environmental and industrial in many countries producing sugarcane. Important changes have arisen in the sector in recent decades, transforming the sugar mills, just before producing food in a diverse production plant.

The state of São Paulo has a significant representation in sugarcane production scenario in the country. It is by far the largest producing state of the raw material, sugar and ethanol. For the 2013/2014 crop, the area cultivated with sugarcane in the state of São Paulo accounted for approximately 65%. Table 1 shows the total area cultivated with sugarcane in the state of São Paulo in the 2013/2014 crop.

### Table 1 Total area cultivated with sugarcane in São Paulo

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total cultivated area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South-central region</td>
</tr>
<tr>
<td>2013/2014</td>
<td>9.480.577</td>
</tr>
</tbody>
</table>

*Source: INPE/Canasat (2015)*

Based on the 2013/2014 crop cycle, with regard to sugarcane, the state of São Paulo holds 62.49% of total production. More than 40% of the sugar produced was the responsibility of the state of São Paulo for the same crop. In terms of total ethanol (anhydrous + hydrated) the state of São Paulo stopped 83.41% of total production, with reference to the same crop.

Table 2 shows the grinding and production of sugarcane to the states of the south-central region.
### Table 2: Milling and production of state of the south-central region

<table>
<thead>
<tr>
<th>State</th>
<th>Sugarcane crop production</th>
<th>Sugar</th>
<th>Total Ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES</td>
<td>3,519,207</td>
<td>3,769,980</td>
<td>98,762</td>
</tr>
<tr>
<td>GO</td>
<td>52,726,898</td>
<td>62,017,736</td>
<td>1,875,260</td>
</tr>
<tr>
<td>MT</td>
<td>16,318,765</td>
<td>16,989,204</td>
<td>491,919</td>
</tr>
<tr>
<td>MS</td>
<td>37,330,449</td>
<td>41,496,041</td>
<td>1,741,908</td>
</tr>
<tr>
<td>MG</td>
<td>51,759,457</td>
<td>61,042,002</td>
<td>3,418,321</td>
</tr>
<tr>
<td>PR</td>
<td>39,725,948</td>
<td>42,215,787</td>
<td>3,086,138</td>
</tr>
<tr>
<td>RJ</td>
<td>1,421,948</td>
<td>2,007,610</td>
<td>95,342</td>
</tr>
<tr>
<td>RS</td>
<td>32,852</td>
<td>73,236</td>
<td>0</td>
</tr>
<tr>
<td>SP</td>
<td>329,922,736</td>
<td>367,449,592</td>
<td>23,289,350</td>
</tr>
<tr>
<td>TOTAL</td>
<td>532,758,260</td>
<td>597,061,188</td>
<td>34,097,000</td>
</tr>
</tbody>
</table>

Notes: ¹Tons. ²Million litres.

Source: UNICA (2014)

Preliminary data of the State Department of the Environment for the 2014/2015 record crop, for the state of Sao Paulo, producing 343 million tons of cane harvested 13.93 billion litres of ethanol produced, representing 49% of national production and approximately 16.4% of world production, 22.24 million tons of sugar, representing 61% of Brazilian production and somewhere around 12.6% of global production (SMA, 2014).

Currently, sugarcane has become multipurpose plants which produce food, energy, non-energy ethanol to other industries and biofuels. The main factor of this change is the use of sugarcane waste as raw material for energy co-generation and biofuels production (Pippo and Luengo, 2013).

There are expectations that with the trend of replacing fossil fuels with other less degrading, especially from biomass, Brazilian ethanol assumes a unique responsibility in the composition of energy sources, both nationally and internationally.

Bioethanol is an oxygenated fuel that contains 35% oxygen, which can reduce particulate matter and NOx emissions caused by combustion of the fuel. Therefore, bioethanol-gasoline blends can significantly reduce petroleum use and GHG emission. In addition, utilisation of lignocellulosic materials in bioethanol production is the most viable pathway from an environmental point of view (Sebayang et al., 2016).

Brazilian ethanol is emerging as a major alternative clean biofuel great quality and economic viability, due to its high efficiency, both in the production process and in natural energy balance. The amount of renewable energy obtained with ethanol from sugarcane in Brazil, can reach more than eight times the energy used, fossil, in all links of the supply chain (Camargo and Oliveira, 2011), or is, planting and harvesting (agricultural) to the production process (manufacturing of the raw material).

Despite the description of this scenario appears promising, the industry has been going through an unprecedented economic crisis. The financial difficulties faced by sugar and ethanol, driven by the crisis in the global economy, should result in at least ten units closed in the 2015/2016 season in United’s centre-south of the country (Toledo, 2015).
Table 3 shows, in numbers, the scene of the centre-south region of the 2007/2008 crop to the current forecast, with the new units and those definitely closed or paralysed its activities.

Table 3  Number of new and closed units for their crops

<table>
<thead>
<tr>
<th>Crops</th>
<th>Number of new units</th>
<th>Number of units closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/2008</td>
<td>22</td>
<td>2</td>
</tr>
<tr>
<td>2008/2009</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td>2009/2010</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>2010/2011</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2011/2012</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>2012/2013</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>2013/2014</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>2014/2015</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2015/2016</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>90</strong></td>
<td><strong>70</strong></td>
</tr>
</tbody>
</table>

Source: UNICA (2014), Toledo (2015) and research data

Although the forecast for the 2015/2016 crop is ten units cease to operate, less than the previous harvest, the picture, nevertheless, is bad enough. The sugarcane chain lost in recent years, more than 300,000 jobs. For a sector that had been growing on average 6.7% per year, 0% growth today is an intense negative impact.

A study in 2014 by the consulting firm MBF Agribusiness in Sertâozinho (SP) showed that the debt of the plants that went into bankruptcy protection amounts to US$ 50.7 billion. Of the 67 who entered this condition in six years, 40 are not grinding cane-though not all are officially closed (Toledo, 2015).

Undoubtedly, efforts need to be added, both by the government, to prepare sectoral public policies that allow visibility of medium and long term for the sector, with investments in research, development and innovation (RD&I), as by the industry to invest also improving operational efficiency in agriculture, trying hard to reach the level of the ‘three digits’, i.e., up to 100 tons of cane harvested per hectare. In the industrial area, it is crucial to increase efficiency in the processing and especially investing in the production of 2nd generation ethanol (lignocellulosic).

It is also for the players, especially the government give greater attention to the sector in power generation aspect from biomass, creating security conditions for private investment.

3 Methodology

The research assumes combined approach (Martins, 2012). Qualitative approach to the research process involves issues and procedures that emerge from primary and secondary data sources, with interpretation prepared by the researcher about the meaning of the data. Thus, the final report can have a more flexible structure (van Maanen, 1979; Creswell and Clark, 2006). Quantitative considering that underlies on secondary data,
where numbers are used directly to represent the properties of something. How are recorded directly with numbers, the data is in such a form that can be used for statistical analysis (Amaratunga et al., 2002; Hair et al., 2005).

As for purposes can be classified as descriptive as it aims to describe the characteristics of a particular phenomenon, and to establish relationships between variables, adopting to this end, standardised techniques for data collection (Gil, 2010; Vergara, 2010).

Proceeded literature review with the aim of creating a theoretical and conceptual support as subsidy to the study. Primary data were collected from the technical assets of the Rural Association of Suppliers and Sugar Cane Growers of the Sorocaba region (ASSOCANA) when it held a technical visit (Creswell, 2014), at which time held unstructured interview (Hair et al., 2005) with the technical manager. The side were extracted from the database provided by the National Institute for Space Research (INPE), through the Monitoring System Cane Sugar Satellite Images (Canasat), and EU information from Sugarcane Producers Association (UNICA), National Supply Company (CONAB), Center for Advanced Studies in Applied Economics (CEPEA/ESALQ/USP) and the Environmental São Paulo State Agency (SMA/Green Ethanol/Environmental Protocol).

4 Presentation of data: an environmental approach

The sugar-energy sector stands out for presenting great economic potential, resulting from the products commercialisation and by-products from the processing of sugarcane, such as sugar, ethanol and bioenergy.

The image of degrading sector environment was gradually been changing from the adoption of more sustainable techniques, using new technologies, worrying to meet the regulatory standards and, thus, incorporating a new environmental consciousness.

Figure 3  Harvest evolution in the state of São Paulo (see online version for colours)

Source: Prepared by the author based on SMA (2014)
Data from the Green Ethanol Project/Environmental Protocol (SMA, 2014) show an industry commitment to reduce field burning before harvest. Although the total sugarcane growth area has increased by approximately 61%, from 2006/2007 cycle to 2014/2015. Mechanical harvest with unburned sugarcane area increased by 334.23% for the same period, whereas trash burning areas decreased by 73.71%. Figure 3 illustrates these data.

In calculating these percentages are only understood the signatory agribusinesses the Environmental Protocol, representing over 90% of the São Paulo sugarcane industrial park, accounting for 93.5% of the São Paulo sugarcane production and 45.5% of national production of ethanol (anhydrous and hydrated).

Figure 4 graphically represents the amount of area (ha) could have been burned in accordance with the Law No. 11,241/02, to effectively burned area and, finally, the area left to be burned.

Figure 4 Harvested areas (ha) to slash and burn the cane (see online version for colours)

If we add the area that went from being burned over the period, we will have 9,304 hectares, which represents the non-issuance of approximately 5.7 million tons of greenhouse gases (GHG) emissions. In terms of overall pollutants (carbon monoxide, hydrocarbons and particulate matter) is allowed to emit into the atmosphere somewhere around 34.7 million tons of pollutants harmful to the environment.

Of the total cultivable area of São Paulo, 22.6%, corresponding to 4,636,738 hectares, are committed to good agri-environmental practices (via compliance with the directive techniques of the Agro-Environmental Protocol) by the signatory (SMA, 2014).

Another important fact, which shows the industry’s commitment to the environment, refers to the preservation of riparian forests. Data from the Environmental São Paulo State Agency shows that there are 267,822 hectares of riparian areas and about 8,100 springs being preserved, protected and recovered by the sugarcane industry in the state of São Paulo (SMA, 2014). In the words of technical manager of the association “[...] while the protocol does not oblige us to plant trees, we have observed many agribusinesses investing in own nurseries or in the acquisition of third-party seedlings to reforestation”. 

Source: SMA (2014)
One of the visited agribusinesses had even hired a mapping work flora and fauna through the ESALQ/USP. According to the witness, “[...] it will bring more predictability and successes in reforestation. We acquire and plant the native species, altering the ecosystem as little as possible. Also, the fauna mapping, which turn it into a catalogue for all drivers and field workers may have a copy, will help in the identification of native animal species … we have partnered with a non-governmental organisation that will help us in this work”.

Rudorff et al. (2010) showed that in places where land use was intended for sugarcane crop, the forest areas increased, which proves the fact that the expansion of the cultivation area is not directly related to deforestation. On the other hand, agribusinesses have complied with the legislation, not deforesting the reserve areas, as well as invest in permanent preservation areas (PPAs) reforestation, riparian forests, ensuring the custody of the springs, the source of its main natural ingredient: water.

No less important is the reduction of water consumption in the production process. In the 1990s, the agricultural industry uses about 5 m³ of water per ton of processed sugarcane. Currently, this value is close than 1 m³/ton of cane processed. This is due to investments in closed-loop system for water reuse in the process; improvement of industrial processes with greater efficiency and reduction of funding; advancement of raw harvest and advancement of dry cane cleaning.

Energy production through bagasse cogeneration is utmost and efficacious energy ventures. The technology can generate one fourth of the current power demand of world's mains sugarcane cultivating nations (Arshad and Ahmed, 2016).

In Brazil, for the production of electricity from biomass, it is known that the agricultural industries have high waste recovery rate, today called by-products, in terms of its potential for reuse. However, it is estimated that the installed capacity of cogeneration in the plants reached 10,000 megawatts, accounting for 7% of the Brazilian energy matrix, second only to hydroelectric and natural gas. In 2014, using this source of energy avoided the emission of over 8 million tons of CO₂. Thus, the growth rate has been decreasing, and in 2015 must be installed only 36% of what was invested in 2010 (Neves, 2015).

The 2014-2015 harvest data indicate that the signatory of the environmental protocol agribusiness, processed 321 million tons of sugarcane, which bagasse (by-product), biomass used in burning, generated 17,691 Giga-watt hours, corresponding to 3,600,000 Megajoules. Of this total, 9,801 GWh of electricity was exported, equivalent to 25.3% of the São Paulo residential consumption in the year (SMA, 2014).

Renewable energy sources are often called alternative energy sources that do not use fossil natural resources, with the potential to produce energy with virtually zero air pollutants and greenhouse gases. Renewable resources are more evenly distributed compared to fossil and nuclear resources (Demirbas and Demirbas, 2010).

Another important point concerns the process of vinasse concentration, a major wastewater from the production process, resulting about 16/1 rate (vinasse/ethanol). Investments in research and innovation, has provided advances to reduce its volume, making it concentrated. This process stillage concentration brings financial advantages, since there is a significant reduction in transportation costs of the crop residue (Gurgel, 2012).
The sector has undergone incremental changes of significant importance, particularly when walking to consolidate the possibility of reconciling growth/expansion/increase production capacity to environmental preservation.

5 Discussion and conclusions

This study aimed to engender an economic and environmental analysis of the sugarcane industry in the state of São Paulo, and to identify possible points of conflict between the expansion of cultivation area and environmental conservation.

At first analysis, it is observed that the sector is suffering the deleterious effects of a crisis that has been going on for some time. Even with the growth in recent years, the flex-fuel vehicle fleet, coupled with the increased percentage of ethanol blending in gasoline, the consequence of which is a direct increase in the sale of ethanol, the industry has not been able to overcome.

Economically, there are many factors affecting the dynamics of this sector. Internally, we have a blurring of sectoral policy, the Contribution for Intervention in the Economic Domain (CIDE), which for a long time left to focus on gasoline, making ethanol less competitive; the lack of Gasoline price alignment with the external market (political intervention), and the high taxation, among others.

On the external front, there is the USA investing heavily in RD&I, taking Brazil’s position of first in the production of renewable fuel. Government subsidies for sugar production in India and Thailand proves to be unfair competition, which could have cost the country over $1.2 billion (Moreira, 2014; Porto and Gomes, 2015), to be alone in these examples.

However, the environmental aspect of the sector has been highlighted. In the foreground, in compliance with regulatory standards (legislation) without which, of course, is not possible even to renew its operating license. However, it is observed that the sector has endeavoured to go beyond legal requirements, especially by committing more proactive actions in favour of the environment.

This does not mean too much kindness in the industry, far from it. However, there must be recognition of the merits, especially in the form of establishment of public policies that, in return, is conducive to the sector minimum conditions to be competitive, as well as predictability for increased investment in RD&I, particularly in the second-generation ethanol in generation energy for sugarcane biomass, in addition to the consolidation of ethanol as a clean fuel, with conditions of prospecting and consolidate the competitive global market.

References


