

# **Brazil's outlook for sugarcane: facts of the last decade and perspectives for the cane agro-industry**

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## **Abstract**

Brazil is the biggest producer of sugarcane in the world. The country is reference about the amount of sugarcane harvested each year, around 600 million tons. The dominium of the technology and the relative low costs of production explain this fact. The Brazilian sugarcane industry is also sustainable due to the growing transformation of cane residues and its by-products in other cane derivatives, such as the bioenergy, and more recently, the cellulosic ethanol and bioplastics. This panorama is evident since 1990's and represents a new opportunity for this business and for Brazilian economy. This paper aims to present the data of production, the prices for sugarcane and the traditional derivatives (sugar and bioethanol) with a critical explanation concerning the features of the last decade and the perspectives to the future of this industry. For that reason, it is necessary to outline a set of public policies for sugar-energy combined to private sector (highlighting areas like research and development and technology), what can result in economic, social and environmental gains for Brazil.

**Key Words:** Bioproducts, Prices, Sugarcane, Sugar, Ethanol

## **1. Introduction**

Brazil is recognized as the largest producer of sugarcane in the world, recognized as the first producer of sugar and the second one in bioethanol. The highlight of the country is in due to the vast area of production, expressive crop productivity and lower operating costs for the process. Brazil also highlights itself by the dominium and the development of cane technology, mainly by institutes and researches centers as Agronomical Institute of Campinas (IAC), Sugarcane Technological Center (CTC), Brazilian Agricultural Research Corporation (Embrapa) and Inter-University Network for the Development of the Sugarcane Industry (Ridesa).

These are the main factors behind the market share of the country in relation to the production and exportation of sugarcane and its derivatives. In this sense, sugar-energy business influences Brazilian Gross Domestic Product (GDP). Although these positive factors, the country needs to develop updated technologies to apply to this industry. The improvement in the current process and investments in research and development (R&D) are fundamental to explore all the potentials and competences of this raw material to be less dependent of the traditional commodities (sugar and bioethanol).

The focus of this article is to present a bibliographic review of Brazilian sugarcane data of the last decade and also to analyze, critically, the data of producing and prices, discussing the panorama and conjunctures of that period, crucial to the modernization of cane industry. The last decade shows the difficulties regarding the still strong dependence of sugar and bioethanol commodities (mainly due to the prices), but showed new opportunities and possibilities of appliance technology in this sector.

## **2. Brazil's sugarcane producing: the panorama of the last decade**

The relation of sugarcane production and the area occupied by the crop<sup>1,4</sup> explains why Brazil is the biggest producer of the world. Besides of this, the politic of expansion areas adopted in the past achieved this level<sup>5,6</sup>. The relative low operating costs (comparing to the other important producers like India and China) exemplifies a second reason for that fact. These prices are also causes to explain the competitiveness of Brazilian sugarcane derivatives in the international market<sup>3,7</sup>. Despite of this, the costs in the last years are growing<sup>7</sup> and it can be explained by the almost totally shift of the manual to the mechanized harvesting<sup>7</sup> in a short term. This new condition of operating has brought significant environmental and social benefits<sup>2</sup>, but also a new standard of the raw material (with more vegetable and mineral impurities)<sup>1-7</sup>. Other reasons that explain the higher costs are: the modification of intern policies for cane industry<sup>2,3</sup> and the crisis of overproduction installed by the lack of efficient management of the mills<sup>1-7</sup>.

The Southeast region of Brazil has the major impact in sugarcane agro-industry, mainly the State of Sao Paulo. Almost 54% of sugarcane produced in Brazil is represented by the production of this State, which is responsible for almost 63% of totally sugar and 49% of ethanol produced in the country<sup>8</sup>. On the other hand, it's necessary to recognize that the productivity of this country still remains lower than it

could be<sup>8,9</sup>. The average of productivity predicted to the last five years was around of 120 metric tons *per* hectare, but it was observed just 75 metric tons *per* hectare.

The lack of expressive investments for the technological improvement as well as the still fragile structure and tradition of R&D department in the mills<sup>6</sup> contributes to this aspect<sup>7,9</sup>. Brazil began a slow process of modernizing sugarcane agribusiness, what can be seen as a deep change in the pattern of production of cane derivatives. The regulatory Law of burning cane (Sao Paulo State Law No. 11.241 of 19 September 2002) is the first step towards this change, and the best example for this new panorama of sugar-energy sector<sup>7,11,12</sup>. Although it still needs structural change, the Brazilian sugarcane agribusiness begins to awake to the industrial modernization and to explore the capacity of sustainability enabled by that versatile raw material, what can be seen due to the production of new products, like bioplastics.

### 3. Brazilian sugarcane market: the case 2005 - 2015

Brazil showed a big expansion in the volume of sugarcane produced (Figure 1) in each harvest (that means the period of April to March, for Brazil's Center-South and North regions and September to Northeast region), in the last decade. This condition was reflected in the international market and, nowadays, Brazil is responsible for 25% of sugar exportation in the world (Figure 2). In the case of bioethanol, Brazil needed until 2011 to import the fuel to supply its demand, when started to export the surplus that was produced to regulate the intern prices<sup>11</sup> (Figure 3). The growth of grinding sugarcane in this period (about 75% more, comparing the harvest 2015/2016 to the 2005/2006) was favored, mainly, by some factors such as: Brazilian intern policies to develop this sector (mainly in the first half of the period analyzed), favorable climatic conditions for Brazilian's harvests, the failure crop of Indian and other Asiatic countries, the increase of the prices and demanding of sugar<sup>1,13,14</sup>.

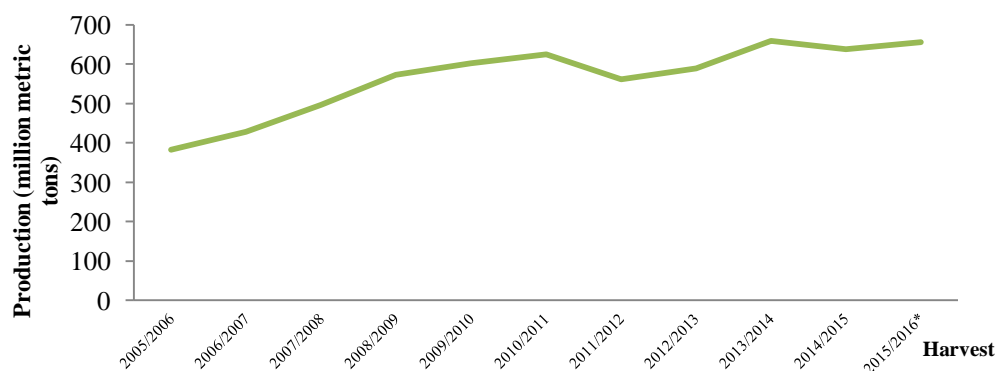


Figure 1. Historical data for Brazil's sugarcane production in the last decade *per* harvest. The signal \* represents an estimative. Source. Elaborated according to MAPA (2015)<sup>1</sup>.

<sup>1</sup> Original data of Ministério da Agricultura, Pecuária e Abastecimento (MAPA) available at: <[http://www.udop.com.br/download/estatistica/institucional\\_economia/18nov15\\_planilha\\_comparacao\\_setor\\_sucroalcooleiro.pdf](http://www.udop.com.br/download/estatistica/institucional_economia/18nov15_planilha_comparacao_setor_sucroalcooleiro.pdf)>, viewed 10 November 2015

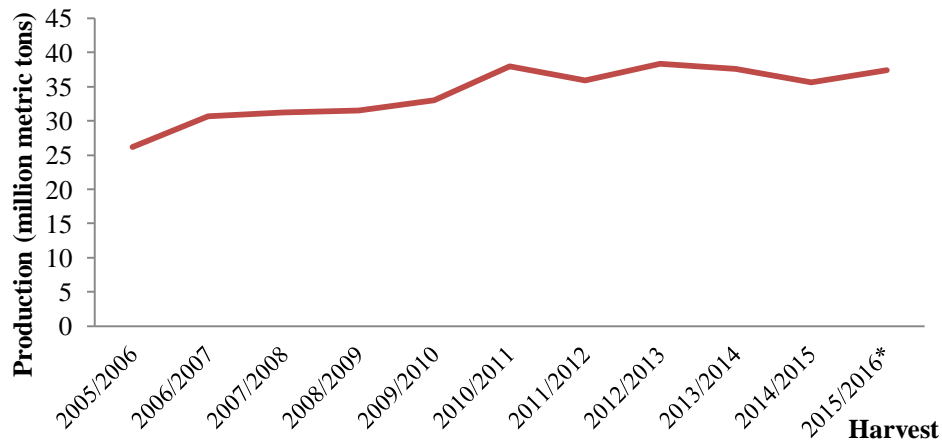


Figure 2. Historical data for Brazil's sugar production in the last decade. The signal \* represents an estimative. Source. Elaborated according to MAPA (2015)<sup>1</sup>.

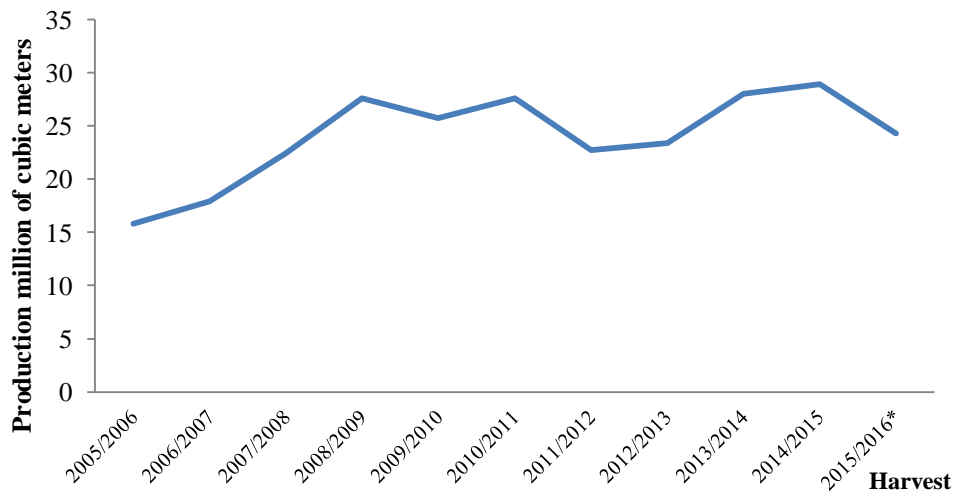


Figure 3. Historical data for Brazil's bioethanol production in the last decade. The signal \* represents an estimative. Source. Elaborated according to MAPA (2015)<sup>1</sup>.

However, since 2011 (Figure 1) it is possible to observe a period of relative stabilization on sugarcane production and grinding, contrary to the estimated panorama<sup>2,3</sup>. This stagnation can be explained due to three factors: high amounts of stocks, the fragile global economy and, of the 2 last years, by the climatic disorders<sup>15,16</sup>. Table 1 presents the accumulated intern stocks in Brazil for different types of sugar. The amount of the overproduction accumulated was sufficient to decrease the prices for this product and it also contributed to enhance the production costs<sup>3,7</sup>.

Table 1 – Accumulated stocks of sugar in Brazil in the last 3 years

Sugar	Accumulated Stocks (tons)*
Crystal	3 330 134
Demerara	10 307
Refined	286 803

\*data obtained until July, 2015. Source. Elaborated according to data of Pecege (2013) and USDA ERS (2015)<sup>2</sup>

The issue of high sugar stocks in the international market is due to favorable weather conditions in other important producing countries. This situation explains and justifies a result of supply and demand regarding the ever-lower prices for that commodity. Concerning the global economic crisis, the consequences were the fall of commodities purchasing power due the freezing in the growth of sectors that use them as inputs and raw materials<sup>11</sup>. Climate disorders, as the interchange of periods with excessive and disorderly rains, led to the decline the production of the plant and its products.

In relation to sugar prices (Figure 4) it was observed an increase in the second half of the analyzed period. That was due to the shortfall in the Indian sugarcane crop production and the high demand for sugar<sup>1</sup>. Because of these attractive prices, Brazil reorganized the intern priorities producing more sugar than ethanol. The data of the last two years are atypical, because of the unstable climatic conditions<sup>2-4</sup>.

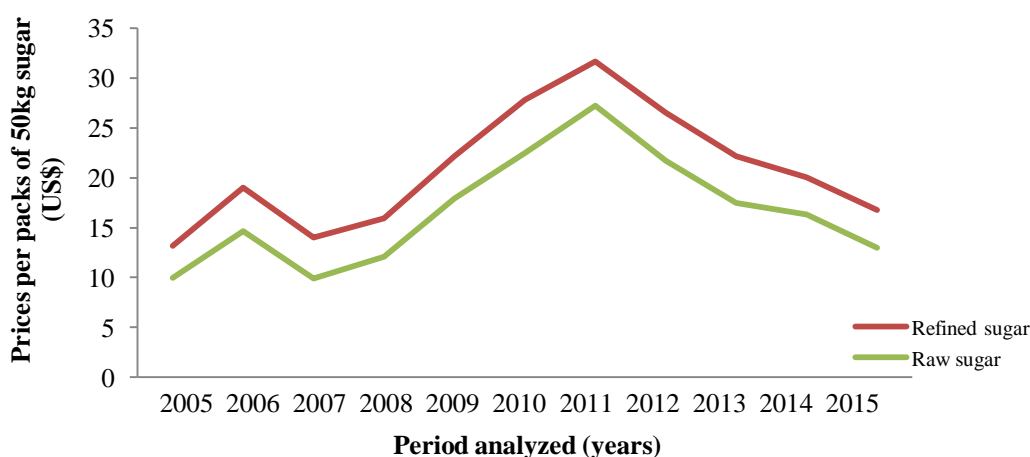


Figure 4. Historical data for sugar prices. Source. Elaborated according to USDA ERS (2015)<sup>2</sup>

On the other hand, more attractive prices to ethanol were registered in the first half of the period analyzed (Figure 5), what can be explained by the intern energy strategies adopted in Brazil, that showed themselves more favorable to the use of bioethanol instead petroleum. The high demand for fuel, the high

<sup>1</sup> Original data of Ministério da Agricultura, Pecuária e Abastecimento (MAPA) available at: <[http://www.udop.com.br/download/estatistica/institucional\\_economia/18nov15\\_planiha\\_comparacao\\_setor\\_sucroalcooleiro.pdf](http://www.udop.com.br/download/estatistica/institucional_economia/18nov15_planiha_comparacao_setor_sucroalcooleiro.pdf)>, viewed 10 November 2015

<sup>2</sup> Original data of United States Department of Agriculture available at <http://www.ers.usda.gov/media/1895316/eib144.pdf>, viewed at 10 November 2015

prices of petroleum (period of 2001-2010) in international market and the low costs for the production of bioethanol were also fundamental points to that market trend observed<sup>13,15</sup>.

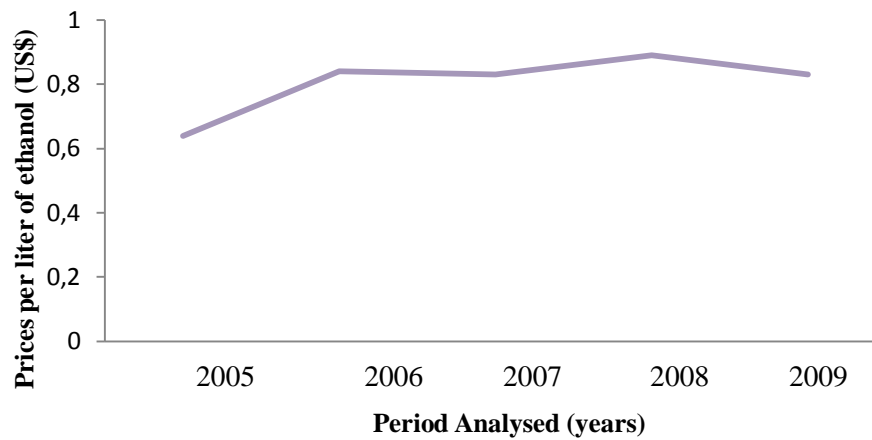


Figure 5. Data for ethanol prices. Source. Elaborated according to USDA ERS (2015)<sup>2</sup>

#### 4. Relevance of sugar-energy industry for Brazilian economy

Sugarcane is a product of historical importance for Brazilian economy and it constituted the first economic cycle of Brazilian colonial period<sup>1,16</sup>. The second defining moment for cane was the project to expand and renew the industry, executed by the Emperor D. Pedro II<sup>16</sup>. The dependency ratio of the Brazilian economy with sugarcane industry was built<sup>1-3</sup>. So, the country stands out in this area, because it has the technological dominium of the transformation sugarcane, including all the agricultural and industrial activities related to the production of sugar, bioethanol and bioelectricity derived from sugarcane<sup>17</sup>.

The importance of this sector for Brazilian economy should be considered beyond the traditional concept of the sugar-alcohol activities. The movement of great quantities of jobs, resources and taxes, the reduction of Greenhouse Effect Gases (GEEs) and production areas that combines uses of raw material, by-products and cane derivatives, like the case of molasses being transformed to bioethanol and the cases of liquid sugar<sup>14-20</sup>, are some examples of how deep sugarcane impacts socially, financial and environmentally Brazilian economy.

The current technological support turned enabled the production of bioenergy, bioplastic and biohydrocarbons, besides the traditional commodities. This new panorama shows the evidence that there is a great need for the development of new technologies to be invested in other products obtained from sugarcane, considering the diversity of all possible one that the sector is capable to produce<sup>12</sup>. Thus, the sugar-energy concept comes to substitute the sugar-alcohol one, once it covers a variety of products and technologies.

Currently, the sector's GDP has approximately US\$ 48 billion dollars<sup>14</sup>. The gross value moved in the harvest 2013/2014 has exceeded US\$100 billion dollars, with an approximately of US\$ 43.36 billion

dollars as the GNP of sugar-energy sector. This represents almost 2% of total Brazilian GNP for 2013 and about 1.3% for Brazil jobs in the same year<sup>17</sup>. The impact of sugar-energy GNP in Brazilian GNP showed an increase about 44% between the period of 2008/2009 harvest to 2013/2014<sup>3,17</sup>.

Despite the sector GDP have been increased in the period 2013/2014 compared to 2008/2009, agro-industries face an unprecedented crisis<sup>3</sup>. Since 2009 it was closed, approximately, 50 agro-industries in the Center-South region of Brazil<sup>3,7</sup>. It is known that more industries will be closed in the following years<sup>3,16</sup>. Although exacerbated by drought, this circumstance was not a determinant factor for such recessionary conditions in the sector. The changes in Brazilian strategic policies (especially regarding energy, being more favorable to petroleum than ethanol after 2010) as well as the consequences of the latest global economic recession were responsible for the crisis in this sector<sup>3,15-19</sup>. So, the study of new technologies besides the economic gains from quality improvement in this sector may be the keys for the maintenance of production facilities and processing of sugarcane.

## **5. An analysis of Brazilian sugarcane industry: trends and perspectives for the future**

The development of technologies is essential to aggregate value to by-products derived from sugar refining. The uses of by-products come from the 1990's, when the market had presented a financial frailty. In that decade, some agro-industries were looking to diversity bringing up the second transformation products, like cellulosic ethanol, liquid sugar and bioplastics<sup>21</sup>. In the last decade, we have also had emphasis to the reuse of vinasse and yeast, by-products already studied since the beginning of the century. The investments on the sector's R&D reached, in 2013, US\$ 115 million dollars.

Currently, Brazil is the world leader in the dominium of the technology needed for the production of sugar and ethanol, due to public and private investments applied to researches, being capable of continuing and to develop new technologies. Institutes such as IAC, CTC, Ridesa and Embrapa are responsible for great innovations on the sugar-energy area, searching not only for new raw material production systems, but also working on the genetic improvement of plants and the modernization of production plants. Due to these researches, we have the creation of more than 25 new promising varieties, bringing improvements on growth, productivity, and the production's sustainability<sup>22</sup>.

About innovation, we can cite one of the emerging technologies of the sector: the Green Plastic. It can be obtained entirely from sugarcane emerging as a renewable resource, with low environmental impacts, contributing to sustainability<sup>23</sup>. In this same segment, we have the PlantBottle packing, a patented technology used by Coca Cola Company launched in 2009, when 30% of the plastic was derived from plants. Nowadays, 100% of plastic packages are derived from sugarcane with distribution in about 40 countries<sup>24</sup>.

The cellulosic ethanol, also known by second generation ethanol (2G), is obtained from sugarcane's bagasse and/or straw. Undoubtedly, it is the latest technology to be applied in the sector. Although it has been generated on the 1990's, only in the last decade it has taken bigger proportions and appliance. This kind of technology demands management changes of the production plants, as well as improvement of the technological tools. So, many preliminary steps are required to sugar fermentation, for the lysis and removal of lignin and the enzymatic hydrolysis phase in order to the lysis of cellulose and hemicellulose on fermentable sugars of 5 or 6 carbon molecules<sup>25</sup>.

Nutrient recycling is also an example of technology applied to sugar-energy sector. Chemical elements like nitrogen, phosphor, potassium, calcium, magnesium, sulphur and other micronutrients are obtained by sugarcane from the soil and they can be returned to it through vinasse. This practice allows lower use of industrialized fertilizers contributing to the reduction of GEEs<sup>17</sup>. In 2005, the distribution of vinasse had alterations following the CETESB P4.231 Technical Norm, and it was established new criteria for the application of such residue on agricultural soils<sup>26</sup>. Ongoing studies research improvement of technologies to better destination of vinasse are presenting satisfying results, such as: production of yeast, appliance in civil construction, in livestock feed production and fermentation recycle<sup>27</sup>.

Besides all these technologies, we can also cite the personalized yeasts which try to reduce costs and improve industrial efficiency<sup>28</sup> and the use of yeasts for animal feed and diesel oil. For human feed, there is production of RNA (Ribonucleic Acidic Sodium Salt) that can be used as a raw material in food and pharmaceutical industries and also as a flavor enhancer.

The traditional products demand the implementation of modern equipment. So, for the production of sugar, ethanol and for other by-products, it's necessary to optimize all processes thinking about agro-industrial environment. Thus, technological advances in the process are welcome as well as research development agencies, what have thinned encouraged works in this area<sup>29</sup>.

Today the development of equipment with competitive advantages in relation to the conventional methodologies are growing and arriving to the mills and distilleries. These methodologies enable better performances of the processes in a short-easy understandable fashion. The use of chromatography becomes a good option due to its extensive applicability and efficiency, low error margin and price accessibility. In spite of the technical and economic barriers to its appliance in the industrial laboratories, the support to R&D projects is fomenting resources to cooperative projects with universities and research institutes<sup>30</sup>, condition that has the prospect to increase in a near future.



## **6. Considerations**

The data analysis from the last decade of sugarcane industry shows the impact that the production of the crop and derivatives has on the economy and the development of Brazil. In addition, the potential for exploitation of the resources of this agro-industry is critical to the sustainable development of the country. The modernization of the industry and the new products derived from sugarcane are fundamental to enhance the gains of this industry and to become it less dependent of traditional products (sugar and alcohol) and their fluctuant prices. This new panorama is fundamental to the sector competitiveness. Therefore, the sugar-energy sector should be prioritized by public policies of economic strategies of the country, also receiving investments from the private sector concerning to R&D and use of technological tools. The improvement of productivity and market diversification can result in economic, social and environmental gains for Brazil.

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