

ETHANOL IN THE STATE OF SÃO PAULO



Development

Institute of Agricultural Economics technical team

Coordination

Valquíria Da Silva

Team

Sérgio Alves Torquato

Raquel Castellucci Caruso Sachs

Carlos Eduardo Fredo

Nilda Tereza Cardoso de Mello

ETHANOL IN THE STATE OF SÃO PAULO

INDEX

1. THE HISTORY OF SUGAR CANE IN BRAZIL

2. SOCIO-ECONOMIC IMPORTANCE OF SUGAR CANE IN THE STATE OF SÃO PAULO

3. PRODUCTIVE CYCLE OF SUGAR CANE IN THE STATE OF SÃO PAULO

- Varieties
- Reproductive cycle
- Harvest operation

4. INDUSTRIAL PROCESSING

5. ETHANOL PRODUCTION AND ENVIRONMENT

6. RESEARCH AND DEVELOPMENT

1. THE HISTORY OF SUGAR CANE IN BRAZIL

- Sugar cane was introduced in Brazil in 1532, in São Vicente, a hereditary Captaincy settled by the Portuguese, in the State of São Paulo, where the first sugar mill was founded to produce sugar for the European Market. However, it was in the Northeast Region that the sugar-mills multiplied, mostly, in the Captaincies of Pernambuco and Bahia.
- Up to 1654, Brazil maintained the world monopoly on sugar production.
- At the beginning of the 18th Century, the production growth in the Caribbean and Netherlands Antilles weakened the Brazilian leading position in the world's sugar market.
- At the beginning of the 19th Century, as Europe started producing sugar from sugar beet they became self-independent and no longer needed to import sugar.
- The Great Depression in America: The 1929 crisis had a significant impact on the production of coffee as well as the great European presence, especially Italian immigrants as they acquired lands and started producing sugar cane brandy, which all in all widen path once again for the sugar cane plantation in São Paulo. Piracicaba stands out with the expansion of the sugar cane Agribusiness along with the creation of the first factory of equipment in Brazil, in order to comply with the sugar production.
- In 1933, the Sugar and Alcohol Institute (IAA) was created in order to control the expansion of Brazilian sugar production, by regulating sugar cane grinding quotas for each refining plant. The expansion of the industry also needed prior authorization of IAA.
- Second World War: São Paulo refining plants were authorized to enlarge their sugar production to assure the supply in the southern states of Brazil. In the 50's, the volume of produced sugar in the state of São Paulo overcomes the production of northeastern states, breaking free the hegemony of more than 400 years.
- The 70's: Due to the world's sugar market crisis, Brazil established the National Alcohol Program (PROALCOOL). Both petroleum crisis along with the industrial automotive plants in the State of São Paulo, provided a major impulse to the production of ethanol and encouraged the modernization and consolidation of the sector.
- Until the end of the 80's: ethanol-fueled vehicles represented 85% of the national fleet. However, supply-chain logistics problems as well as petrol price reduction and sugar price recovery in the international market made ethanol less competitive and led to National Alcohol Program's stagnation. Furthermore, in the 90's the deregulation of state owned sugar and ethanol markets came into effect.
- From 2003 on: the launch of flexible-fuel vehicles provided new impulse to Ethanol as petrol price increased, not to mention the concern of developing countries to find solutions to mitigate global warming and carbon dioxide (CO2) emissions from vehicles.

2. SOCIO-ECONOMIC IMPORTANCE OF SUGAR CANE IN THE STATE OF SÃO PAULO

- The agriculture and cattle breeding in São Paulo show great diversification as for the soil occupation and composition of agricultural income.
- We highlight the participation of the occupied land areas, in 2007, with pastures, 43.2%; with sugar cane for the industry, 22.0%; natural vegetation coverage, 12.4%.
- For the 2008/2009 harvest, the area cultivated with sugar cane in the State of São Paulo is foreseen to be 4.9 million hectares out of the 7.5 million hectares foreseen in Brazil.
- 50 products sum up to the Value of Agriculture and cattle breeding yield in São Paulo. In 2007, sugar cane represented 36.0%, followed by the value generated by dairy cattle breeding and cattle slaughter, 15.9%.
- The average sugar cane yield in the State of São Paulo is 84 tons/ha, whereas in Brazil it is about 77 tons/ha
- The Brazilian ethanol-fuel has estimated average cost of US\$ 0.28 per liter, in comparison to US\$ 0.45/liter in North America and US\$ 0.53/liter in Europe.
- In 2007, sugar and ethanol sector represented 29.5% of São Paulo State agribusiness exports, corresponding to 23.4% of sugar export and 6.1% of ethanol export. In comparison to Brazilian exports in this sector, São Paulo sugar represented 71.0% and ethanol 62.7% of the total exports.
- The sugar cane cultivation for the industry is present in more than 70.0% of São Paulo State municipal districts.
- About 163 thousand workers were involved in the 2006/2007 sugar cane harvest.
- The average productivity of a sugarcane harvester man is about 8.74 tons/day; in some regions such average could reach 18 tons/day per harvester.
- Harvesters earned an average R\$3.27 per ton in the 2006/2007 harvest.
- 90% of sugar cane harvesters are employed according to labor laws and regulations.
- Sugar cane cultivation provided 26.7% of the formal employment in the agriculture and cattle breeding sector in 2006.
- The great number of jobs generated by sugar and ethanol activities provided the largest proportion of wages paid for the agriculture and cattle breeding sector in the State of São Paulo.

3. PRODUCTIVE CYCLE OF SUGAR CANE IN THE STATE OF SÃO PAULO

- Currently, there are about 200 varieties of sugar cane available in Brazil and the main 20 varieties occupy 80% of crop area.
- The most cultivated varieties are SP81-3250 and RB72454, which occupy 20% of sugar cane crop area in Brazil. In the State of São Paulo, RB867515 is also applied in order to reduce the risk of agricultural losses. Small or mid-scale plants utilize about 15 varieties and large-scale plants use between 15 and 20 varieties.
- Some varieties of sugar cane for ethanol and sugar yield are better suited for mechanical harvest.
- There are two distinct planting and harvest periods in Brazil. One of them is in the Northeast and other in the Center-south. The latter covers the State of São Paulo and presents three different periods for planting:
 - Year and half cane: planting period runs between February and May;
 - Winter cane: planting period runs between the end of May to September;
- Year cane: planting period runs between September and November.
- In São Paulo State, the harvest period is done between April and November, which can be extended up to two months. On average, 5 cane cuttings are done. In some cases, however, up to 7 cuttings could be accomplished.
- Sugar cane can be harvested either manually, which includes first the burning of dry straw in order to facilitate the cutting, or by mechanical harvesters. Data show that for the first half of 2008, about 45% of the sugar cane was harvested mechanically in São Paulo State.

4. INDUSTRIAL PROCESSING

- The sugar and ethanol sector presents different types of industrial plants: Sugar refinery plants with annexed distillery; autonomous distillery plants; plants which produce ethanol, sugar and other sub-products. Currently, the latter is the most predominant to guarantee larger autonomy regarding ethanol production or sugar (mix) according to market dynamics.
- New industrial units already adopt high-pressure boilers that reduce emissions of gas and particules, as well as, increase the energy efficiency of the plant by enabling larger volumes of energy cogeneration and the concomitant environmental benefits. The production of such boilers takes place, mostly, in Sertãozinho and Piracicaba.
- Production ratings in the sugar & ethanol processing units according to their business scale: small-scale, sugar cane grinding capacity of about 600 thousand tons/year; medium-scale, grinding capacity of 2 million tons/year; large-scale, above 3 million tons/year up to 7 million tons/year. The largest concentration is medium-scale plants.
- In the Center-south region the sugar cane grinding period mostly runs between April and November.
- In the 2007/2008 harvest, 11 billion liters of ethanol were produced in São Paulo State, out of 21 billion liters produced in Brazil.
- The inputs and outputs of water regarding sugar cane processing have been rationalized over the last two decades. The outcome is currently an average consumption slightly above 5.0 m³ of water per ton of cane in the process instead of 21.0 m³ of water per ton of cane utilized in the past.

5. ETHANOL PRODUCTION AND ENVIRONMENT

- Ethanol is a renewable source of energy and undoubtedly a viable fuel to mitigate the greenhouse effect as well as an important alternative for air pollution prevention and control.
- The reduction of greenhouse liquid gas emissions in Brazil, based on the use of ethanol in transportation and the substitution of fossil fuel for the residual cane-waste (bagasse), is about 12.7 million tons/year of carbon or 46.6 million tons/year of CO₂.
- Sugar cane bagasse for power generation, which makes the industrial units self-sufficient in terms of electric power consumption and able to send the surplus power to other sectors through cogeneration.
- Better water management based on increasing internal water reuse in the industrial process as well as ferti-irrigation as good practices to mitigate environmental impacts.
- Federal Government Law no. 4771/65, last altered by Law no. 7.803/89 and Temporary Measure Law 2166-67 published in 2001 demands Legal Reserve Area maintenance, equivalent to 20% of the owned land.
- CONAMA Resolution Act no. 01/86, of the Environmental Council (Conselho Nacional de Meio Ambiente) as of January 23rd, 1986, of the Federal Government, requires both Environmental Impact Study (EIA) and Environmental Impact Report (RIMA) to be provided by ethanol distilleries prior to environmental licensing.
- Environmental State Secretariat (Secretaria de Estado do Meio Ambiente) pursuant to SMA Resolution Act No. 42/94, or Environmental Impact Report (EIA) which formally outlined the need of Preliminary Environmental Report presentation (RAP) as an essential precondition to the Environmental Licensing of refinery plants installation activities for sugar cane grinding up to 1.5 million tons per year.
- The Sao Paulo State Law 11.241 as of September 19, 2002, regulated by the Decree Law 47.700 as of March 11, 2003, establishes the gradual phasing out of sugar cane burnings during the harvest process, in areas above 150 hectares. For terrains where the slope gradient is equivalent or lower than 12% by 2021 and slope gradient greater than 12% by 2031.
- Cooperation Protocol between São Paulo State Government and the sugar and ethanol Sector, voluntarily signed on the 4th of June 2007, establishes parameters for issuing Agriculture-environment certificate of compliance:
 - Sugar cane burning total phase-out for terrains where the slope gradient is equivalent or lower than 12% by 2014 and slope gradient higher than 12% by 2017.
 - Sugarcane burning prohibition from 2008 onwards into the expansion areas of sugar cane cultivation fields;
 - Implementation of technical programs for soil preservation and water resources; Protection of ciliary forest areas and natural vegetation recovery around spring water shed; Adoption of good agricultural practices;

- Adoption of Good Agricultural Practices in the Industrial Processes to mitigate Environmental impacts and optimize recycling and reuse of residues generated by sugar and ethanol production.
- ORPLANA Cooperation Protocol between São Paulo State Government and Sugar Cane Growers Organization of the Center South Region of Brazil, voluntarily signed on the 10th of March 2008, establishes the following parameters prior to the issue of Agriculture-environment Certificate of compliance:
 - Anticipate sugar cane burning phase-out from 2021 to 2014, in terrains where the slope gradient is up to 12% and greater than 150hectares as well as areas in which mechanical sugar cane harvesters can be applied;
 - Anticipate sugarcane burning phase-out from 2031 to 2017, in terrains where the slope (gradient) is above 12% and greater than 150hectares as well as other areas in which mechanical sugar cane harvesters cannot be applied.
 - Anticipate sugar cane burning phase-out from 2031 to 2017, in terrains up to 150hectares and other areas in which mechanical sugar cane harvesters cannot be applied
 - In 2014, the terms established in the items above will be evaluated, based on the advances in technology for mechanical fresh sugar cane harvesting as well as machinery and equipment available for that purpose;
 - Burning prohibition from 2009 onwards, in the expansion area of sugarcane fields.
- Resolution SMA-SAA as of September 4th 2008, is aimed at improving environmental licensing procedures as for sugar and ethanol business engagement in farming areas and stimulate ethanol sustainable production towards controlling pollution and an efficient use of natural resources based on socio-environmental responsibility as well as compliance with environmental licensing processes by defining Agri-environmental Zoning policies for the sugar and ethanol sector in São Paulo State. Essential criteria have been created to determine suitable areas for sugar cane cultivation in São Paulo State: current soil occupation; edapho-climate characteristics, mechanical harvest restrictions with respect to terrain slope gradients based on established technology standards; availability of surface water and vulnerability of subterranean water; Conservation units for integral preservation, either existing or recommended by the BIOTA project, which is financed by FAPESP Foundation for Scientific Research of Sao Paulo State; priority for biodiversity increase (connectivity – BIOTA project); and air quality in the aerial basins.

6. RESEARCH AND DEVELOPMENT

- The São Paulo State Government, through its Research Institutes within the Agency for Agribusiness Technology of São Paulo (APTA) of the Technological Research Institute (IPT) and Universities, play a very important role in the development and consolidation of the sugar and ethanol sector in Brazil.
- The Agricultural Economics Institute (IEA) carries out socio-economic studies, proposes and analyzes public policies, generates and officially disseminates the State's agricultural statistics through a database which assist the economical planning and operationalizing of the sector.
- The Agronomic Institute of Campinas (IAC) is responsible for research and development of new varieties. The sugar cane center is in charge of genetic enhancement, physiology, climatology, phyto-technical, etc. IAC has about 35 varieties in production, achieving high productivity levels. We highlight IAC86-2480, IAC 87- 3396, IACSP 93-6006, IAC 91-5155 varieties which show pest resistance as well as drought tolerance and are highly recommended for ethanol production, among others. In 2004, four new varieties were launched: IACSP 93-3046, IACSP 94- 2094, IACSP 94-2101 and IACSP 94-4004.
- The Biological Institute (IB) develops research relating to pests and diseases. The Central Experimental Center is able to provide assistance and issue certificates of compliance to the refineries with respect to pest control and diseases, biofactories installation, besides offering specific courses related to the sector.
- As for Public Universities in São Paulo State, we highlight the research work currently coordinated by the Faculty of Agricultural Engineering (FEAGRI) at Campinas University (UNICAMP) aimed at the development of auxiliary harvesting machinery. It is called mobile auxiliary harvest unit (UNIMAC) and will partially substitute human labor as well as provide high level of safety and comfort to the remaining harvest workers.
- Technical consulting by the Technological Research Institute for the development of technologies aimed at bio-ethanol production via enzymatic hydrolysis of sugar cane bagasse and straw, which is well known as second generation fuel.
- Among private institutions in São Paulo State, we highlight the Cane Technology Center (CTC - Centro de Tecnologia Canavieira) and Canavialis / Allelys.
- Mechanical harvesters to be attached to the body of the harvest worker are still under study and development by the Federal Rural University of Pernambuco (UFRPE). As for upcoming benefits, we highlight the fact that the new tool will avoid the labor displacement of harvest workers, generally caused by mechanical harvesters currently being utilized to farming, as well as harvest facilitation in hilly areas, better hand-harvest quality and lower soil compaction.