

**Escola Superior de Agricultura “Luiz de Queiroz” – ESALQ/USP  
( Luiz de Queiroz College of Agriculture)**



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- Industrial Organization
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  - Market Structure, Price formation, Market Power
  
- Agricultural Labor Market
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  - Wage Formation
  - Labor conditions
  
- Bioenergy
  - Policies, Regulation
  - Impact of Bioenergy on the Economy
  - New Products: Sustainability Challenges

# Production of Ethanol from Sugarcane in Brazil: from State Intervention to a Free Market

Natural Resource Management and Policy  
Series Editors: David Zilberman · Renan Goetz · Alberto Garrido

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## Production of Ethanol from Sugarcane in Brazil

From State Intervention to a Free Market

**FAPESP**

 Springer

Book co-authored with Prof David Zilberman  
(UC Berkeley)

- Origin of Proalcool, the role of the military government, the deep state intervention existing on the sugarcane, sugar and ethanol sectors until 1999
- The process of deregulation occurred from the late 90s, and the challenges and changes faced by the stakeholders in a free market environment
- The new rules since 2000, the international interest in alternatives to oil, the new environmental and social agendas, the financial constraints, and ultimately how we see the future of biofuels in Brazil.

## Topics

- Brazilian Ethanol Program: a brief overview
- Socioeconomic indicators

- Brazilian National Ethanol Program – Proalcool – was launched in 1975 by the military government
- Since then we produce and use sugarcane ethanol as a fuel in a large scale
  - anhydrous (mixed to gasoline)
  - hydrous (automobiles powered by hydrous ethanol and on flex fuel cars)
- **The main motivation of the Proalcool was economic**
  - At that time Brazil was heavily depended on imported oil and was badly hit by the 1973 and 1979 oil shocks, with serious effects on the country's trade balance and inflation
- Brazil adopted two strategies:
  - Increasing exploration and production of oil
  - Stimulating the production of anhydrous ethanol, to be mixture to gasoline (First Phase of Proalcool)
  - Replacing part of gasoline consumption with *hydrous ethanol* (Second Phase of Proalcool)
  - **Main driver behind Proalcool: the policy to *replace oil***

Two main conditions enabled the creation of Proalcool (1975)

1) robust production of sugarcane and sugar tightly regulated by the government

From 1930 to 1999 the government:

- established production levels for sugar and ethanol for each plant
  - fixed the prices for sugarcane, sugar, and fuel ethanol
  - controlled all sales and exports of sugar
  - regulated the relationship between sugarcane suppliers and industrial units
- **There was a very intensive control over the sectors**

2) military regime that was in place at the time

- whose decision-making and enforcement powers were quite broad, making it easier to coordinate the activities of the various stakeholders and sectors involved

- From the second half of the 80: the political system changed from military regime to a democratic one
- Federal government initiated an administrative reform aiming an economic liberalization in Brazil:
  - privatizations, deregulation of agricultural productive chains – milk, coffee, wheat, sugarcane
- Deregulation of the sugarcane, sugar and ethanol sectors:
  - Caused strong impacts on these sectors
  - Main changes:
    - on the system of pricing of sugarcane, sugar and ethanol
    - on production controls and crop plans previously issued by the government
    - on policies designed to support the production of sugarcane and ethanol
    - on the activities of the stakeholders themselves, including the government (at the federal and state level)
- Deregulation: affected the relationships among sugarcane suppliers; sugar mill owners; ethanol plant owners; fuel distributors; consumers of sugar and ethanol, government

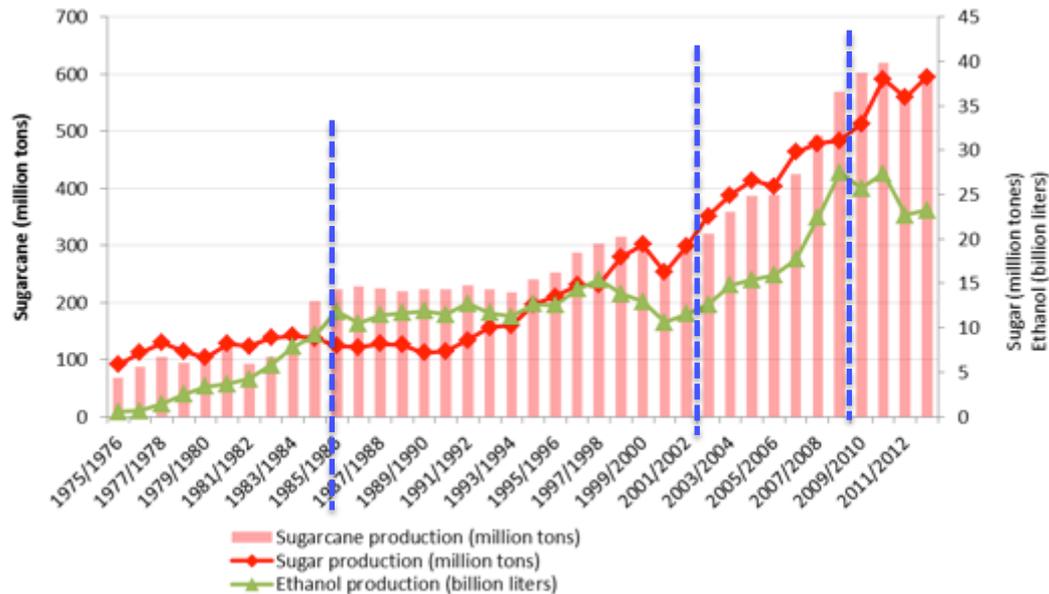
The free market: profound changes and the new agenda

- Mergers and acquisitions process;
- International capital inflow;
- Expansion of electric energy co-generation;
- Investments in new process and products from sugarcane
- New social and environmental agenda

## **Main challenges: ethanol market**

- The market for fuel ethanol, given its connection to the oil market, was more dependent on government intervention than were those for sugarcane and sugar
  
- Ethanol and gasoline are interchangeable, the demand for hydrous ethanol is greatly influenced by the price of gasoline, which is affected by the federal government (through Petrobras) at the oil refinery level
  - Petrobras (mixed public-private capital company) is able to define the price of gasoline at the refinery level, enjoying a *de facto* monopoly
  
- Consumers in Brazil are quite sensitive to the relationship between the prices of the two fuels, gasoline and hydrous ethanol (used in cars running on hydrous ethanol and flex fuel cars, introduced in 2003)

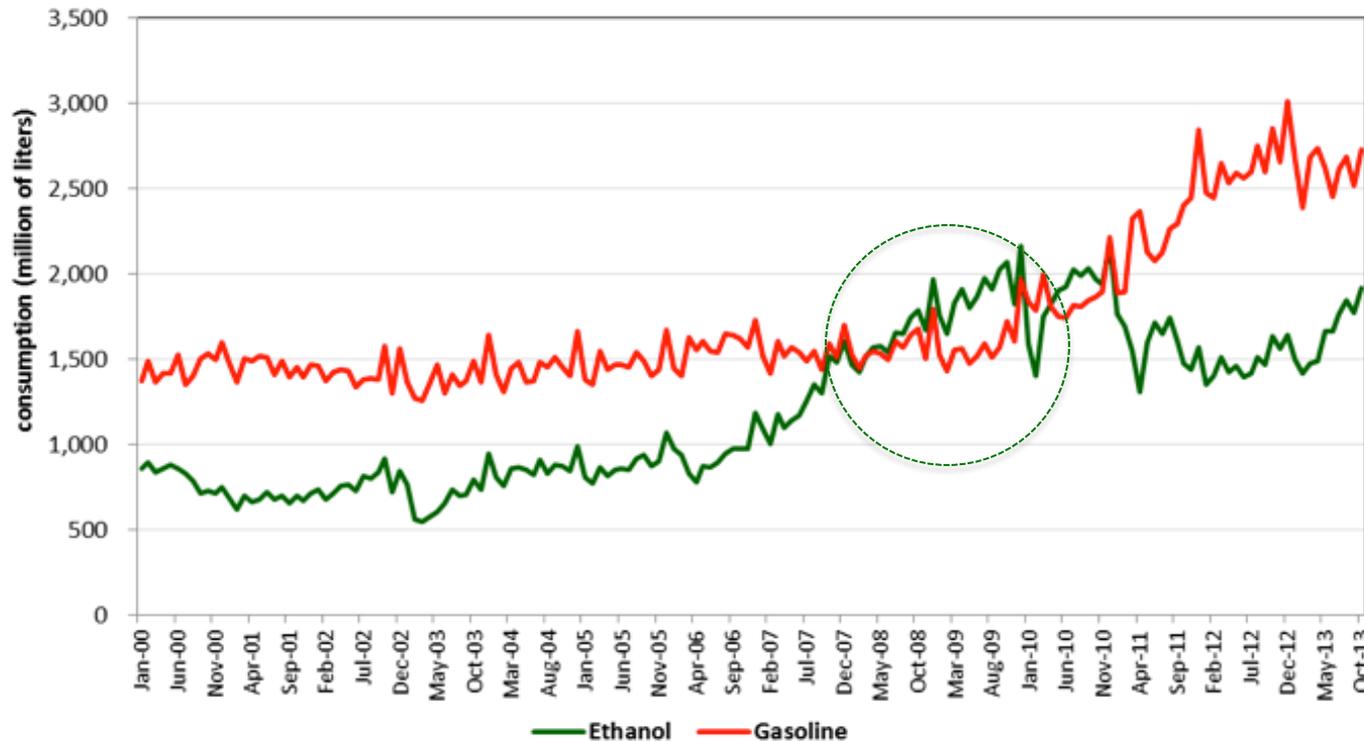
# Rebirth (2003-2010): Production Expansion



Evolution of the production of sugarcane, sugar, and ethanol between the harvests of 1975/76 to 2011/12

- There were two phases of rapid growth:
  - from **1975 to 1986**, a period of intense government intervention in which the main growth factors were stimuli from the Proalcool plan and the demand for hydrous ethanol to fuel ethanol-powered vehicles (vehicles running exclusively on ethanol).
- The second period, from **2003 to 2010**, the expansion was mainly due to:
  - Introduction of flex-fuel vehicles
  - Expectation of increased exports of anhydrous ethanol
    - Development towards a low carbon economy globally
    - Recognition of ethanol from sugarcane on reducing greenhouse gas emissions
    - Oil importers: reduction of oil dependence
  - Reduction of protectionist measures on the international sugar market also encouraged increased production of sugar and, consequently, greater production of sugarcane.

# Domestic consumption of Ethanol and Gasoline



Note: "Ethanol" refers to anhydrous and hydrous ethanol.

Source: The Brazilian National Regulatory Agency for Petroleum, Natural Gas, and Biofuels (<http://www.anp.gov.br/>).

- The expansion of the flex-fuel vehicle fleet and the introduction of flex-fuel motorcycles (2009), together with the competitiveness of ethanol in much of the market after 2003, promoted a significant increase in the domestic consumption of ethanol, which surpassed that of gasoline in April of 2008
- Flex-fuel vehicle owners base their decision regarding which fuel to use on the ratio between the pump prices of the two (on average, hydrous ethanol ceases to be economically attractive when its pump price exceeds 70% of that of gasoline)
- Fuel police: currently aims to control inflation by maintaining prices of gasoline at the refinery, regardless of fluctuations in production costs and oil prices on the international market
- Competitiveness of ethanol has been reduced

# Crisis: forces affecting ethanol industry

What factors can explain the sharp reversal in the growth of ethanol production in Brazil?

- 2008 global financial crisis and lack of credit for investments in ethanol plants
- Hydraulic-fracturing in the US (reduced the need for ethanol in the United States)
- Climate conditions: heavy rains and drought severely damaged harvests
- Indebtedness of productive units (and, consequently, the postponement of investment for renovation of sugarcane plantations)
- Increased costs of production (higher wages, land prices and interest rates)
- Discovery in Brazil of a huge oil deposits offshore, called Pre-Salt (four miles deep and under a cap of salt )
  - since the discovery of the pre-salt oil reserves, Brazil realized its potential to become a big player in the international oil business, and decided to make a US\$250 billion investment in pre-salt oil rather than make investments in biofuel production
- **Loss of competitiveness of hydrous ethanol compared to gasoline**
  - Political decisions regarding the price of gasoline and regulatory taxes levied on this fuel had a significantly influence on the demand for fuel ethanol in Brazil

- Certain issues need to be addressed over time, including:
  - the degree of government intervention and regulation
  - the role of ethanol in the Brazilian energy matrix
  - the need for clear rules regarding the pricing of gasoline
  - the importance of recognizing the positive externalities of ethanol
  - the need for efficiency gains in the ethanol production sector

# Sugarcane Production Chain: Main Agents

## Sugar Cane Fields

70,000 sugarcane growers



25% harvest manually and 75% mechanically

**439,922 employees**



## Industrial Sugar and Ethanol Production



**400 Sugar Mills/Ethanol Distilleries**

**600,000 employees**

### **Sugar cane field**

- ✓ The sector comprises 70k independent producers, accounting for 40% of national sugarcane production
- ✓ 60% of sugarcane comes from self supply of vertically integrated mills
- (mills have sugarcane fields plus processing plants)

Sugarcane processing plants in Brazil can produce sugar and/or ethanol

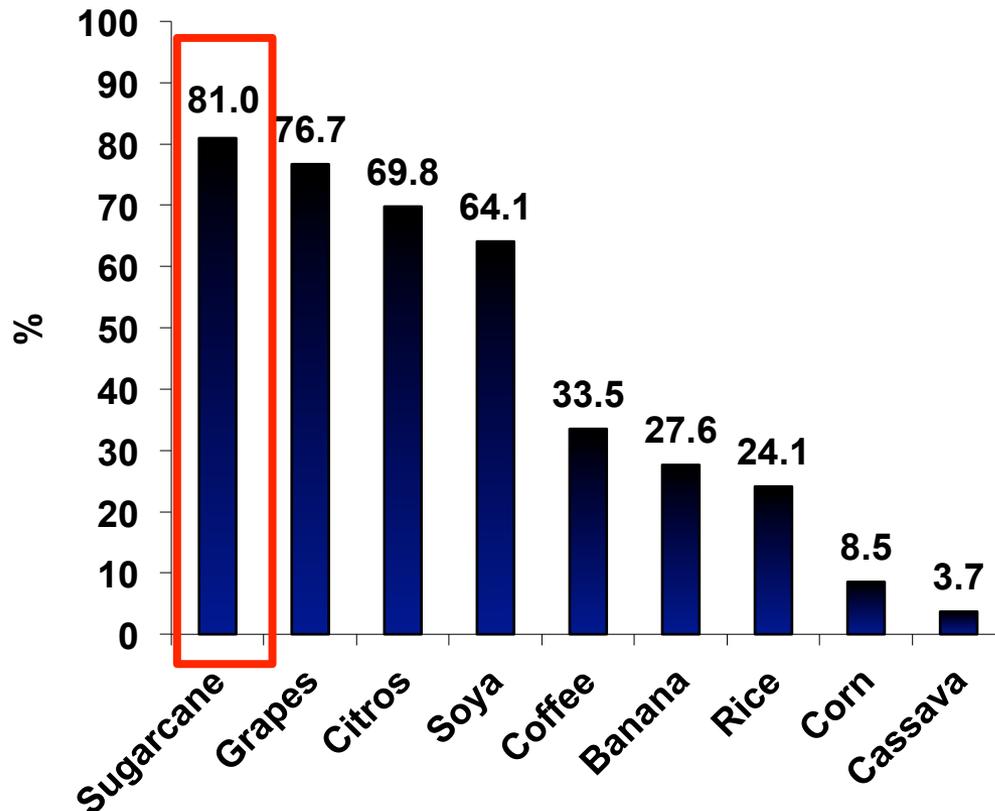
By products:

- Vinasse: used as biofertilizer
- Bagasse: electrical power generation
  - all plants are self sufficient in electric power
  - most efficient sell the energy surplus to the market

# Number of formal workers by producing regions and sector 2012

|                                   | Region                  | 2012             |
|-----------------------------------|-------------------------|------------------|
| Sugarcane                         | NNE                     | 74,484           |
|                                   | CS                      | 256,226          |
|                                   | <b>Total for Brazil</b> | <b>330,710</b>   |
| Sugar                             | NNE                     | 230,443          |
|                                   | CS                      | 322,431          |
|                                   | <b>Total for Brazil</b> | <b>552,874</b>   |
| Ethanol                           | NNE                     | 45,232           |
|                                   | CS                      | 162,759          |
|                                   | <b>Total for Brazil</b> | <b>207,991</b>   |
| <b>Total for Brazil 3 sectors</b> |                         | <b>1,091,575</b> |

**2,258,276 agricultural workers in Brazil**



✓ The proportion of workers who are formally employed in the Brazilian agriculture is very low: 40%

✓ Sugarcane shows the best indicator:

✓ about 81% of the employees are formally hired

✓ The state of SP has a very impressive proportion of formally hired workers: 92%

✓ These employees have all labor rights established in the legislation:

✓ access to retirement, Social Security, elimination of child labor, protection or insurance against unemployment, among others, improving quality employment

## Socioeconomic aspects of the Brazilian production

- Solid institutional apparatus that regulates the labor market
- Large number of jobs created in the three sectors (sugarcane crops, sugar and ethanol): surpass one million formal jobs
- Positive impacts on development of rural areas , spillover effects
- There have been an improvement of the indicators of the sugarcane:
  - Better observance to labor and environmental legislation
  - Better working conditions
  - Greater number of formal jobs in sugarcane sector
  - Reduction in underaged workers
  - Investment in training and qualification
  - Social and environmental certification programs adopted by companies

## Ethanol Expansion: main challenges

- Viability of the fuel ethanol market is dependent on the federal fuel pricing policy
  - which currently aims to control inflation by maintaining prices of gasoline at the refinery, regardless of fluctuations in production costs and oil prices on the international market
  - this policy reduces ethanol competitiveness with gasoline, in terms of the relative pump prices
- The government must set a nationwide energy policy and establish an energy matrix, making it clear to society what is the role of each fuel from a long-term perspective.

## Ethanol Expansion: main challenges

- Defining the roles of different fuels in the energy mix would allow planning ethanol production
  - which becomes particularly important when one considers that ethanol is made from agricultural raw materials, making its production subject to adverse weather conditions as well as to the seasonal nature of sugarcane cultivation
  
- The lesson to be learned from the Brazilian experience is that, in a free market environment, without clear rules, the sugarcane ethanol industry cannot garner the level of investment needed in order to meet the potential demand for biofuels

➤ Labor policies in Brazil

(Moraes, M.A.F.D.; Oliveira, F.C.R.; Kretzmann, C.K. In: Baer, W. **The Regional Impact of National Policies. The case of Brazil**. Edward Elgar: Cheltenham, UK. Northampton, MA, USA. 2012 . ISBN 978 0 85793 669 1)

➤ Socio-economic Indicators and Determinants of the Income of Workers in Sugar Cane Plantations and in the Sugar and Ethanol Industries in the North, North-East and Centre-South Regions of Brazil.

(Moraes, M.A.F.D.. In: Edmund Amann; Werner Baer; Don Coes. (Org.). **Energy, Bio Fuels And Development: Comparing Brazil And the United States**. : Routledg. Taylor and Francis Group, 2011, 334p.

➤ Number and quality of jobs in the sugar cane agribusiness.

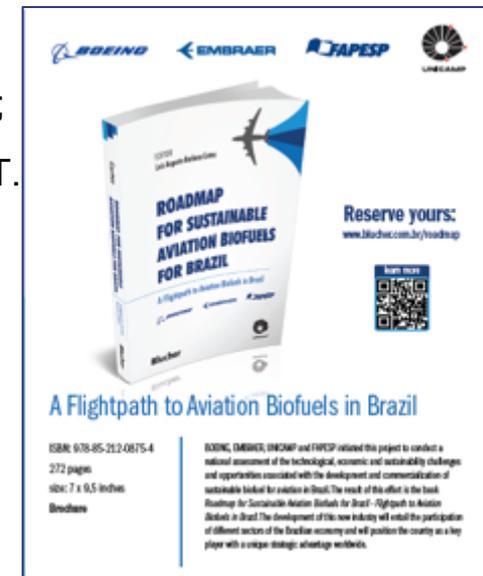
(Moraes,, M.A.F.D.; Oliveira, F.C.R. In: Sugar cane´s energy. **Twelve studies on Brazilian sugar cane agribusiness and its sustainability**)

➤ Social externalities of fuels.

(Moraes, M.A.F.D. de; Costa, C.C. da; Guilhoto, J.J.M.; Souza, L.G.A. de; Oliveira, F.C.R. de. In: SOUZA, E.L.L. de; MACEDO, I. de C. Ethanol and bioelectricity: sugarcane in the future of the energy matrix. São Paulo: UNICA, 2011. cap. 2, p. 44-75. Available at: <http://www.unica.com.br/multimedia/publica>)

- **Lessons from Brazil**  
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- **Jet Biofuels in Brazil: Sustainability Challenges**  
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BRITO, C.S.; MORAES, M.A.F.D.; MOLIN, J.P.
- **Roadmap for Sustainable Aviation Biofuels for Brazil**  
CORTEZ, L. A. B. ; NIGRO, F. E. B. ; NASSAR, A. M. ; CANTARELLA, H. ;  
NOGUEIRA, L. A. H. ; MORAES, M. A. F. D. ; LEAL, R. L. V. ; FRANCO, T.

National assessment of technological, economic and sustainability challenges and opportunities associated with the development and economic commercialization of sustainable biofuel for aviation in Brazil



- **Socio-economic impacts of Brazilian bioenergy industry**
  - An assessment of social impacts of the Brazilian Sugarcane Ethanol Program, using an analysis on intergenerational transmission of education and working conditions from parents to offspring
- **Effects of sugarcane sector expansion on municipal per capita income in Center-South Brazil (2000-2008)**
  - Dynamic spatial panel model (GMM-SYS) defined from the breakdown of per capita income into its main determinants
  - Control variables:
    - Proportion of adults in the municipal population
    - Rate of labor force utilization (total and in farming)
    - Average labor income (total and in farming)
  - Variables representing sugarcane sector expansion:
    - Share of agriculture in municipal area
    - Share of temporary crops within agriculture area; Share of sugarcane within temporary crops area
    - Districts and towns with an operational plant (dummy: 1 = yes; 0 = no)
  - Main Findings: Both Direct effect (on the cities where the expansion takes place) and the Indirect effect (on the neighboring cities) are positive
- **“On the State of the Bioeconomy Around the World”**

To provide an overview of the evolution of biofuel in Brazil and discuss some of the new findings about jet fuels and other new biofuel-related developments in Brazil



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Thanks for your attention

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