Sustainability in Global Trade of Biofuels and Bioproducts

Medan, Indonesia, 16-17 March 2011

GREENLIGHT BIOFUELS

UNICAMP

CTBE

Biofuel Production from Sugarcane in Brazil

Session 3 – International Perspectives

UNICAMP

Arnaldo Walter – Unicamp & CTBE
Camila Ortolan F. Oliveira – CTBE
Pedro Gerber – Unicamp

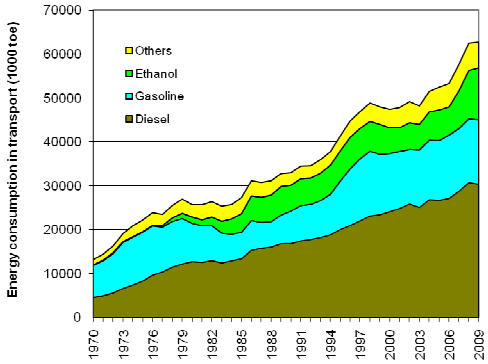
CTBE

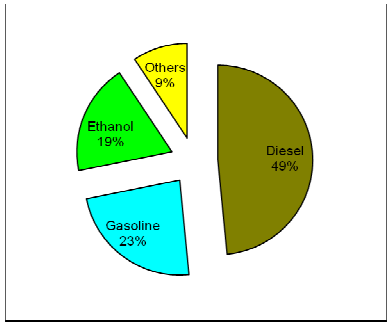
Summary

- **Energy in the transport sector in Brazil**.
- **Ethanol production in Brazil:** historical facts and perspectives.
- **Actions for production diversification.**
- **Sustainability of ethanol production in Brazil**: results and the way forward.
- **Final remarks.**

Energy in the transport sector in Brazil

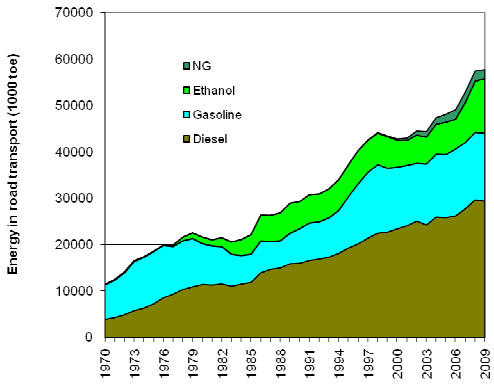
Energy in the transport sector





- Large-scale ethanol use since 1976. In 2009 the share of ethanol in the transport energy matrix was 19% of the energy consumption (42% just considering light vehicles).

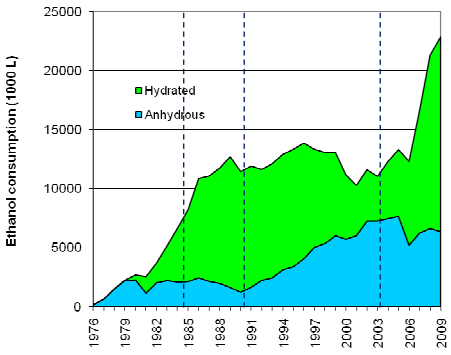
Energy in the road transport sector



- Also in 2009, just considering ethanol and gasoline, the share of ethanol was 45% (energy basis; 55% volume basis).

Ethanol production in Brazil

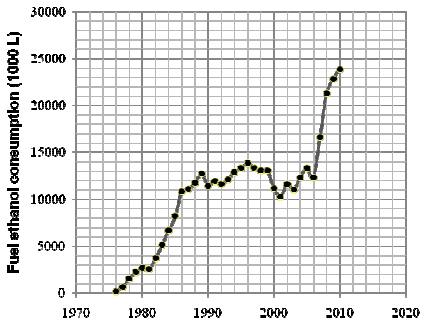
Ethanol production in Brazil



- 575 Mt of sugarcane produced in 2010-2011, being about 55% for ethanol production.

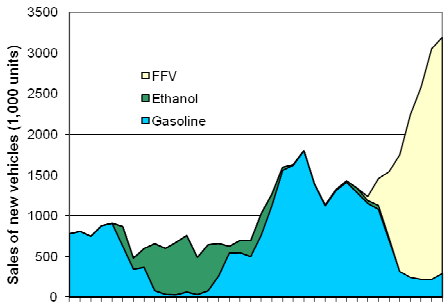
- Large-scale production since 1976.
- All production is based on sugar cane.
- Anhydrous ethanol used in E25 blends (all gasoline sold as E25).
- Hydrated ethanol used in FFVs (since 2003) (E100 vehicles before).
- The production in the harvest season 2009-2010 was 26.1 BL, while the domestic consumption reached almost 22.8 BL in 2009 (it was 16.5 BL in 2007).
- Second largest producer in the World (after US), covering about 35% of the production.

Ethanol consumption in Brazil



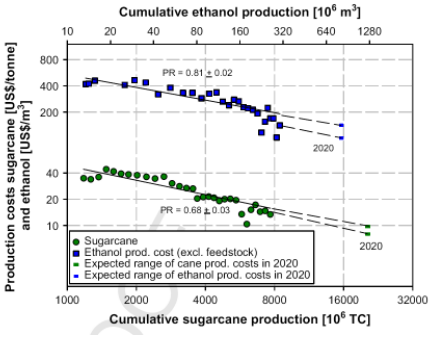
- Since 2003 fuel ethanol consumption has grown 11.7% per year (on average).
- The consumption of anhydrous ethanol is declining while the consumption of hydrated is growing fast (23.5% per year along the period 2003-2009).
- This result is due to the success of flex-fuel vehicles (FFVs) in Brazil.

FFVs in Brazil



- FFVs = 88% of the sales (2.7 million vehicles) of new light vehicles in 2009 and 86% in 2010 (2.9 million vehicles)
- FFVs have deeply impacted the domestic ethanol market since 2003.
- In Brazil, FFVs can run with any fuel mix between gasohol (E20–E25) and pure hydrated ethanol (E100).
- The relative low price of ethanol regarding gasoline and the good technology of FFVs are the main reasons why, currently, they represent about 90% of sales of new cars in Brazil.
- It is estimated that FFVs is about 35% of the fleet of light vehicles and possibly will each 65% by 2015.

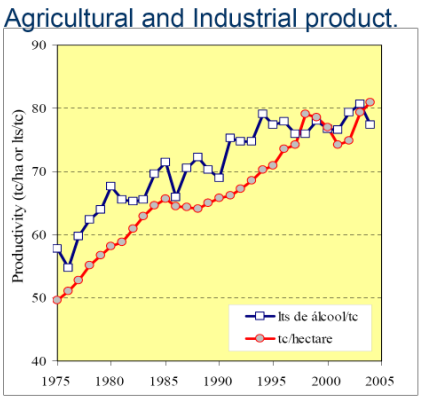
Cost reduction



Source: van den Wall Bake (2009)

- Feedstock cost reduction was mostly due to the development of new varieties of sugarcane with indirect impacts on costs of soil preparation, planting, stock maintenance and land rents.
- Industrial processing costs were reduced more due to economies of scale, with impacts on investments and on operation and maintenance costs. Furthermore, up scaling lead to vertical chain integration that indirectly allowed optimization of the production chain.

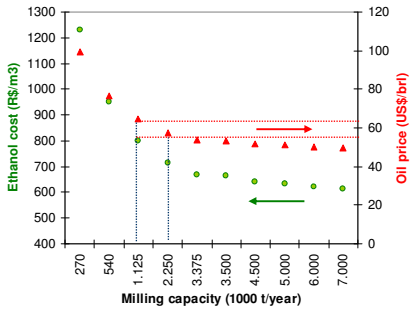
Technological development



Source: van den Wall Bake (2009)

- 60-65% of the ethanol cost is due to sugarcane.
- Since 1975 yields have grown almost 60% due to the development of new varieties and to the improvement of agricultural practices.
- Due to the technological developments achieved both on the agriculture and on industry sides, average (combined) production yields have grown from 3,000 liters/ha/year (67 GJ/ha/yr) in early 1980s to 6,500 liters/ha/year (145 GJ/ha/yr) in 2005.
- Average production yields based on conventional process can reach 8,000 liters/ha/year (178 GJ/ha/yr) before 2015, while best practices would allow more than 8,000 liters/ha/year.

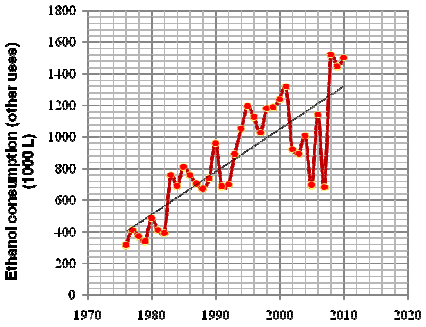
Economic feasibility

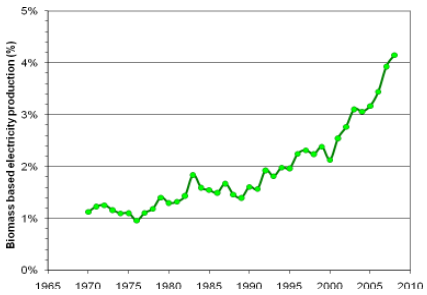


- Figure shows ethanol total costs (2009) as function of the milling capacity, considering sugarcane costs and O&M costs constant (in a new plant, i = 15% per year, n = 25 years, equity = 100%).
- The oil break-even price is shown in the right side.
- Typical ethanol cost in a existing mill would be R$ 620/m^3 (240-280 Euro/m^3) (oil break-even price 50 US$/brl), being about 65% of the cost due to sugarcane (including land costs).

Production diversification

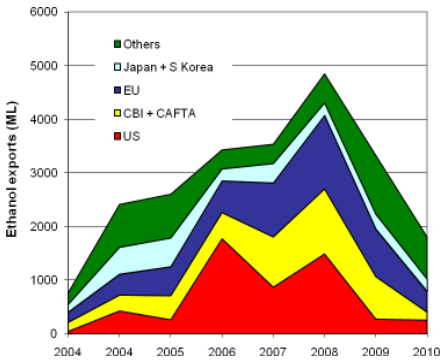
Production diversification





- Other uses of ethanol are increasing, but still represents only 6% of the total production. However, some new mills aim at the production (exclusively) of plastics and chemicals.
- Electricity production from sugarcane residues is about 4% of the total electricity production. Surplus electricity is equivalent to self-consumption, but could be much larger (3-4 times).

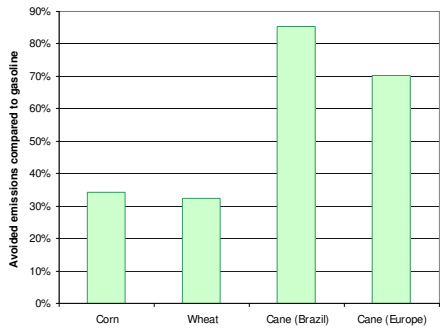
Ethanol exports



- By far the most important is the domestic market, that represents 85-90% of the total production.
- Despite a reduction of about 30% of the volume exported from 2008 to 2009, Brazil has kept the leading position as ethanol exporter (42%).
- In 2010, the US became a net exporter of fuel ethanol and a reasonable share was traded with Europe. Brazil was impacted twice, losing a large share of the US market, and also losing its market share in Europe.
- Trade barriers and unfair trade practices have impacted biofuel (and fuel ethanol) trade.

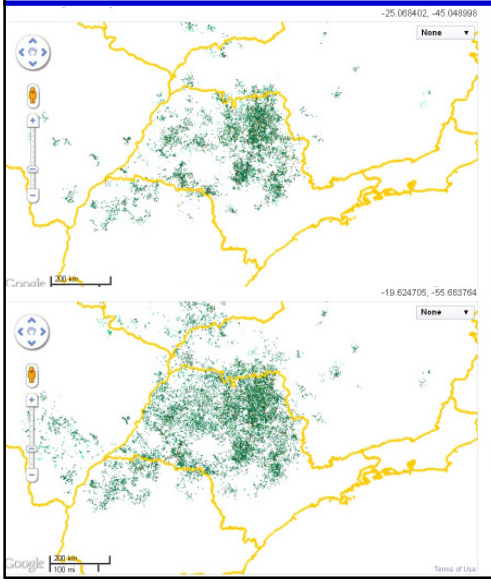
Sustainability

GHG emissions



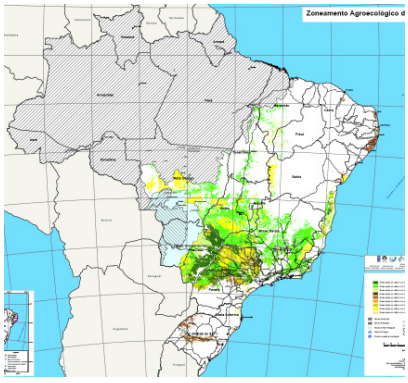
- Aspects considered: GHG emissions, LUC (indirect and direct impacts), socio-economic impacts.
- Avoided GHG emissions compared to gasoline are about 85% considering production in traditional areas and how ethanol is used in Brazil.
- This figure is 71% for ethanol use in Europe (without LUC) (recognised by RTFO-UK) and 61% considering LUC and ILUC effects (recognised by EPA-US).

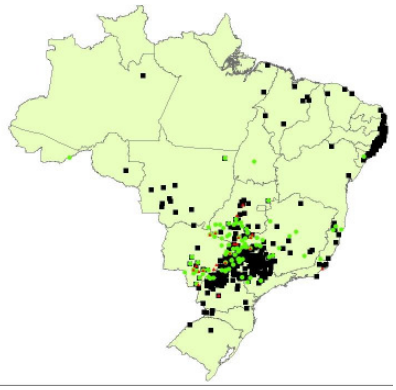
Land Use Change



- Maps based on satellite images from 2005 and 2010 (~ 80% of the production).
- In this region, 4.2 Mha in 2005 and 7.6 Mha in 2005.
- Only in state of São Paulo: 3.0 Mha in 2005 and 5.0 Mha in 2010.
- In this region, sugarcane has mainly displaced pasturelands (52%) and other crops (47%).

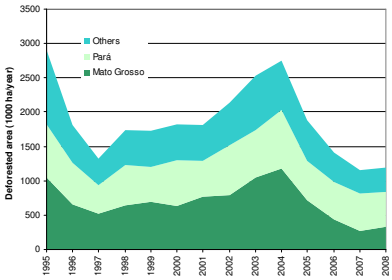
Sugarcane cropping

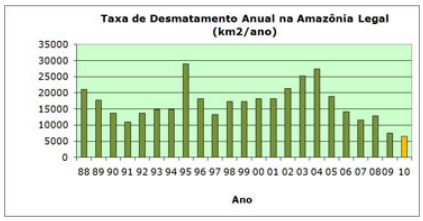


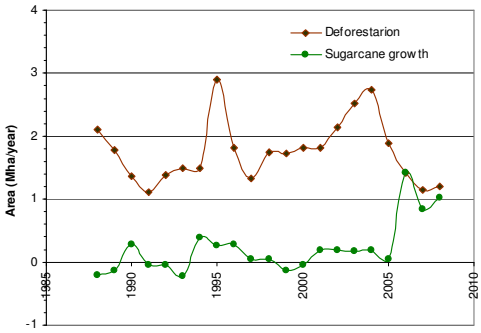


- Left side: results of the Agro-Ecologic Zoning - 65 Mha (total) are adequate for sugarcane cropping, being 37 Mha currently occupied with pasturelands.
- Right side: location of sugarcane mills; about 9 Mha are currently cropped.

Deforestation x sugarcane







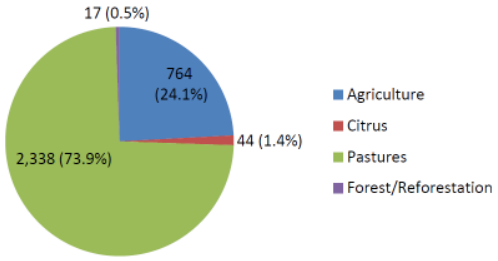
- Correlation between deforested area and growth of sugarcane area: 1988-2008 = -25,3%; 2000-2008 = -69,2%.

Source: INPE (2009) and MAPA (2009)

Land Use Change – some data

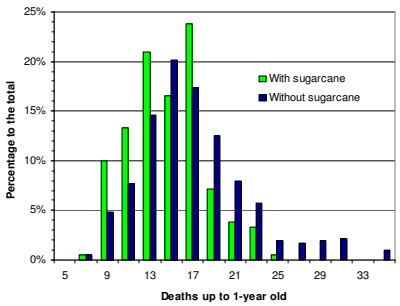
- The expansion of sugarcane cropping in areas with dense natural vegetation has been monitored. Since 2008, the estimates is that it corresponds to 0.15% of the new sugarcane area (CANASAT-INPE).

Figure 6-2: Types of Land Use Converted to Sugarcane from 2000 to 2009, thousand ha (and %)

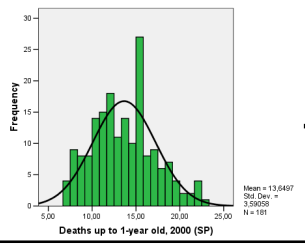


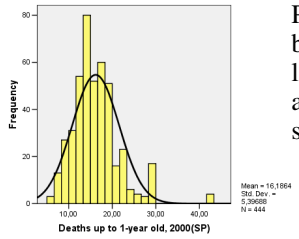
Source: personal communication with Bernardo Rudorff from CANASAT Project/INPE.

Socio-economic impacts – 1



- Some results regarding socioeconomic impacts of large scale sugarcane production are presented in the following slides.
- Assessment done for five states (~85% of the production), from 1970 to 2000.

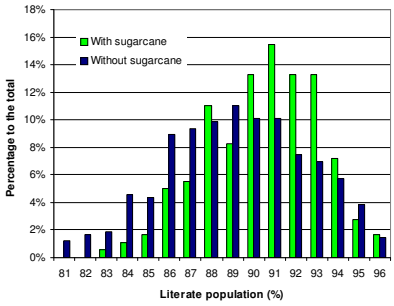




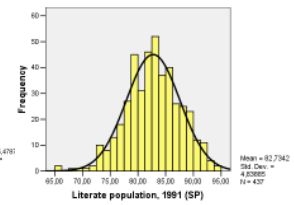
- **Deaths up to 1-year old** (São Paulo, in 2000): comparison between municipalities with large sugarcane production and municipalities without sugarcane production.

Source: Oliveira (2011)

Socio-economic impacts – 2



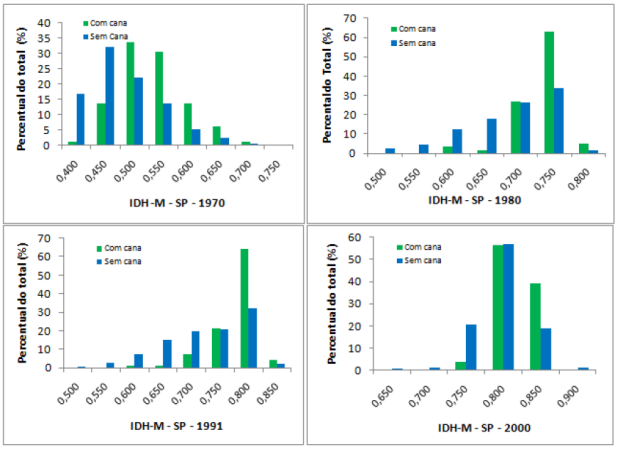
- Eight indicators were analysed.
- Municipalities with large sugarcane production do not have worst indicators regarding similar municipalities without sugarcane production.



- **Literate population** (São Paulo, in 1991): comparison between municipalities with large sugarcane production and municipalities without sugarcane production.

Source: Oliveira (2011)

Socio-economic impacts – 3

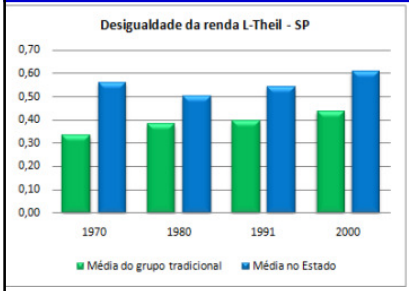


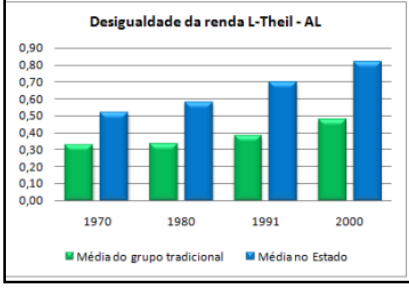
- In state of São Paulo (~ 60% of the production), the municipalities with production of sugarcane in large scale have the best (all) indicators (on average) in all analysed years.

- **Evolution of the HDI** (São Paulo, from 1970 to 2000): comparison between municipalities with large sugarcane production and municipalities without sugarcane production.

Source: Oliveira (2011)

Socio-economic impacts – 4



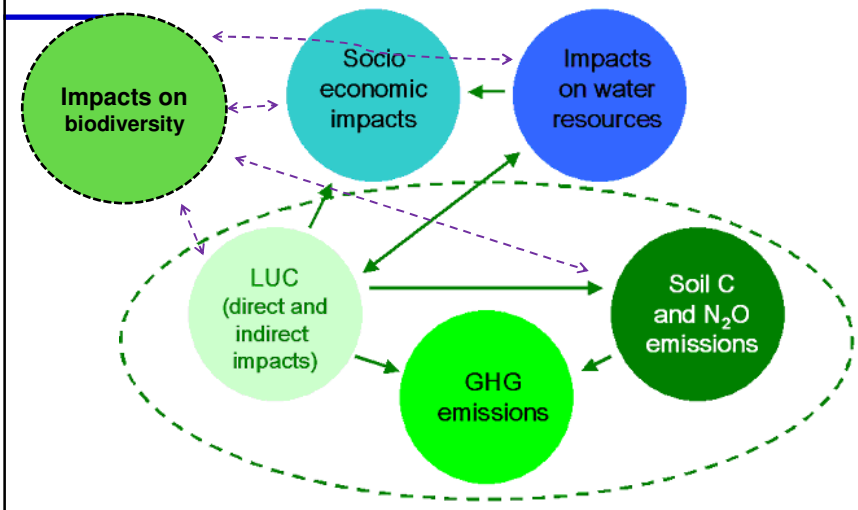


- Hypothesis: the better results are due to the impacts of the economic activity. Diversification of the economic activity seems to have also a positive impact.

- Evolution of the L-Theil index, that reflects **inequalities in wealth distribution**: (São Paulo and Alagoas, from 1970 to 2000) comparison between municipalities with large sugarcane production and average index in each state.

Source: Oliveira (2011)

Research on sustainability



The way forward ... – 1

- The necessity of understanding the **synergies between water use and social aspects**, (and also **LUC, due to biodiversity change**, etc.).
- Regarding GHG emissions, **the lack of proper information** about: (a) **carbon stocks on soil**, considering different soils, different agricultural practices, different land use changes, …; (b) The **impact of new agricultural practices**, including mechanical harvesting and trash disposal in the soil.
- Regarding LUC impacts: **the lack of proper data/information and the necessity of improving the models**.

The way forward ... – 2

- Regarding **water resources**, it is still unknown (for instance): (a) **the real impact of sugarcane cropping (in traditional areas) on water resources, considering availability and quality**; (b) it is unknown **the impacts of new agricultural practices and of new industrial technologies on water resources**.
- Questions regarding **biodiversity** (for instance): (a) **What are the actual impacts of extensive monoculture of sugarcane**?; (b) What are **the synergies between water use in large-scale and biodiversity (and LUC and biodiversity**, ….)?

Final remarks

Concluding remarks – 1

- Large scale ethanol production is Brazil is successful, but the economic feasibility and the market consolidation were only recently achieved.
- From economic and strategic points of view, the challenges are (1) diversification of the production and (2) market enlargement.
- Brazil (and other developing countries with potential and expertise on biofuels) has (have) an important role fostering the production in other countries.

Concluding remarks – 2

- A reasonable share of ethanol production in Brazil can be considered sustainable (i.e., the production fulfills the criteria presented by different initiatives).
- Obviously that there is still a lot to do: lack of proper data, inadequacy of the existing models, the scientific knowledge so far available, …
- Sustainability is a key issue, and all initiatives are welcome. But, … Do we want to foster trade or the aim is to raise trade barriers? Do we want to promote (sustainable) renewable sources of energy or just protect fossil fuels? What help do developing countries need to produce biofuels sustainably?

- Thanks!
- Questions?
- awalter@fem.unicamp.br
- arnaldo.walter@bioetanol.org.br