

RCN Conference on
Pan American Biofuels
& Bioenergy Sustainability
Golden Tulip Recife Palace,
Recife, Brazil July 22-25, 2014



PAN-AMERICAN
BIOFUELS &
BIOENERGY
SUSTAINABILITY
AN NSF RESEARCH COORDINATION NETWORK



Session: Industry-Government Perspectives on Biofuel and
Bioenergy Sustainability

The sustainability of biofuels in Brazil

Suani T. Coelho, J. Goldemberg
Recife, July 24, 2014

General overview



Concept of sustainability: evolved considerably in the 20th century (from landscape/biodiversity conservation in IC's).

Population growth and higher access to goods in former undeveloped countries:

- pressures on mineral resources,
- scarcity
- environmental problems (urban air pollution and global warming).

Sustainability concerns :

- Use of resources in a more rational fashion,
- Increased efficiency
- Shifting the resources used, and
- Use of renewable resources, particularly in the case of energy. (replacement of fossil fuels.
- Liquid biofuels, in which Brazil in the United States are the main producers.

However, liquid biofuels sustainability: still seen as a controversial issue considering environmental and social aspects.

Consensus (?) today that "bioenergy is not bad or good" but it depends on how it is produced.

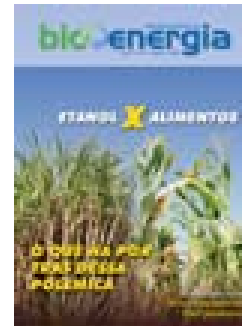
- **CENBIO – the Brazilian Reference Center on Biomass**



- Created in 1996
- Studies on Biofuels and Bioenergy



Bioenergy sustainability



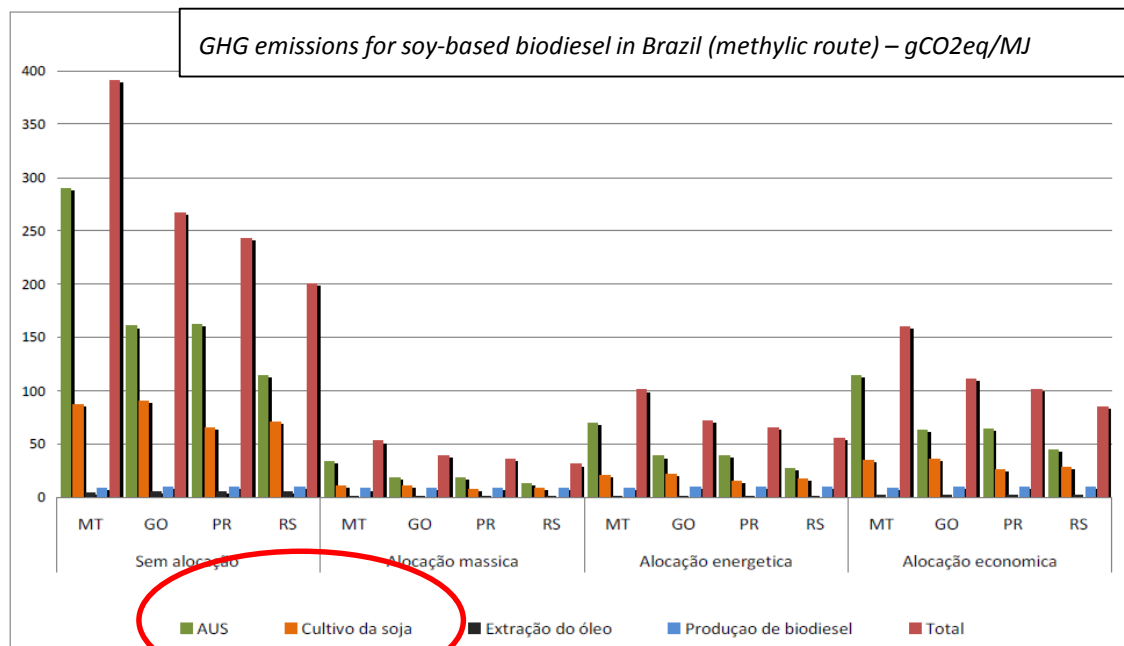
<http://cenbio.iee.usp.br>



BIOACV Project – Life Cycle

Assessment of Biodiesel from Soybean and Animal Fat through Methylic and Ethylic Routes (2013)

Funding Agency:



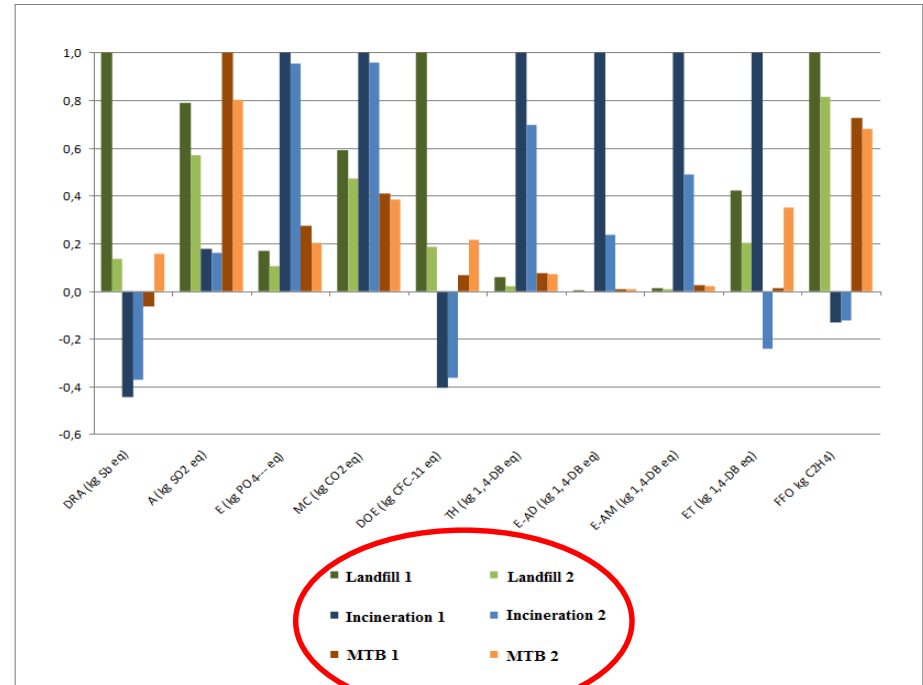
- Environmental sustainability of biodiesel in Brazil. [Érica Castanheira](#), [Renata Grisoli](#), [Fausto Freire](#), [Vanessa Pecora](#), [Suani Coelho](#). *Energy Policy*, v. 65, 2014, p.680-691
- **Energy for Sustainability Conference 2013** Sustainable Cities: Designing for People and the Planet Coimbra, 8 - 10 September 2013
- Emissões de Gases de Efeito de Estufa no Ciclo de Vida do Biodiesel de Soja Produzido no Brasil. R., Grisoli, A. Nogueira, É. G. Castanheira, F. Freire, G. A. Silva, S. Coelho. **III Congresso Brasileiro em Gestão do Ciclo de Vida de Produtos e Serviços**. 03 a 06 de setembro de 2012. Maringá – PR - Brasil

COMPARISON OF MUNICIPAL SOLID WASTE TECHNOLOGIES THROUGH LCA METHODOLOGY AS A TOOL FOR ADEQUATE POLICIES

Suani T. Coelho, Gil Anderi da Silva,
Cristiane L. Cortez, Vanessa Pecora,
Manuel Moreno, Alex Nogueira,
Carlos Alberto da Silva,
J.Goldemberg

R&D Project CENBIO/IEE/USP/EMAE
nº 0393-00611, 2011 – 2013,
developed under the ANEEL (Brazilian
Regulatory Agency of Electric Energy)
regulation

Funded by EMAE



GBEP – The Global Bioenergy Partnership



The Global Bioenergy Partnership (co-chaired by Brazil and Italy) - FAO (Food and Agriculture Organization) - UNEP (United Nations Environmental Program)

- 24 bioenergy sustainability indicators (environmental, social and economic), accepted by all its member countries.
- Several countries already implementing this methodology (Europe, Africa and Latin America) for different types of bioenergy.

Brazil - a new study is starting to be developed for sugarcane ethanol mills in São Paulo State by the University of São Paulo, funded by the Government of Italy/Forum of the Americas with the support of the Brazilian Federal Government and the Secretariat for Environment of São Paulo.

Several certifications schemes already in place, but:

- GBEP indicators methodology seems to be a consensus among the governments members of GBEP and
- Good experience for comparing bioenergy among the countries.



THE GLOBAL BIOENERGY PARTNERSHIP SUSTAINABILITY INDICATORS FOR BIOENERGY

FIRST EDITION



| PILLARS | | |
|---|--|---|
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| INDICATORS | | |
| 1. Lifecycle GHG emissions | 9. Allocation and tenure of land for new bioenergy production | 17. Productivity |
| 2. Soil quality | 10. Price and supply of a national food basket | 18. Net energy balance |
| 3. Harvest levels of wood resources | 11. Change in income | 19. Gross value added |
| 4. Emissions of non-GHG air pollutants, including air toxics | 12. Jobs in the bioenergy sector | 20. Change in consumption of fossil fuels and traditional use of biomass |
| 5. Water use and efficiency | 13. Change in unpaid time spent by women and children collecting biomass | 21. Training and requalification of the workforce |
| 6. Water quality | 14. Bioenergy used to expand access to modern energy services | 22. Energy diversity |
| 7. Biological diversity in the landscape | 15. Change in mortality and burden of disease attributable to indoor smoke | 23. Infrastructure and logistics for distribution of bioenergy |
| 8. Land use and land-use change related to bioenergy feedstock production | 16. Incidence of occupational injury, illness and fatalities | 24. Capacity and flexibility of use of bioenergy |



- Countries already evaluating the indicators for biofuels:
 - Germany,
 - The Netherlands,
 - Colombia,
 - Indonesia,
 - Ghana and
 - Jamaica.
- **Brazil/São Paulo – starting 2014**

Biofuels Certification Initiatives



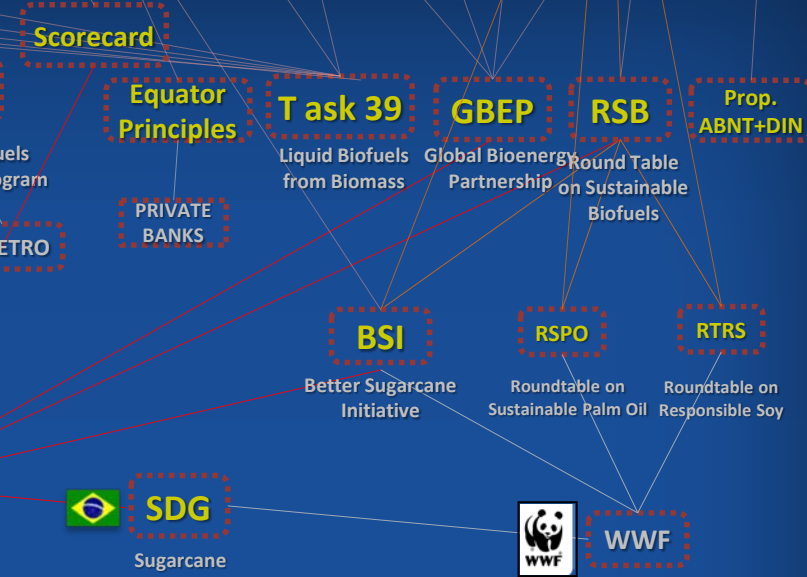
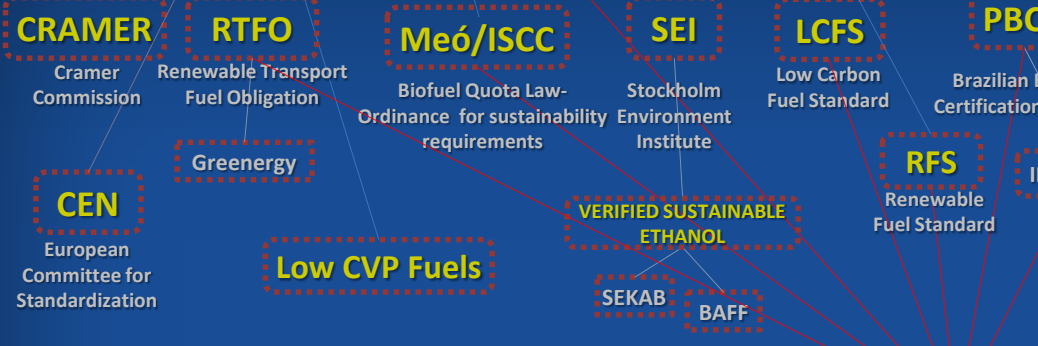
SUSTAINABLE BIOFUELS

NATIONAL INITIATIVES

INTERNATIONAL BODIES

GLOBAL MULTISTAKEHOLDER INITIATIVES

EU Directives



Bonsucro certification in Brazil



- Feb 2013 – 28 mills



- Feb 2014 – 36 mills

| Year | Production | Organization | Group Name | City | State |
|------|--------------|----------------------|--------------------------|---------------|-------|
| 2014 | Sug. & Ethan | Unidade Serra | Raízen Energia S/A | Ibate | SP |
| 2013 | Ethanol | U. Morro Vermelho | Odebrecht Agroindustrial | Mineiros | GO |
| 2013 | Sugarcane | Industrial Severínia | Guarani | Severínia | SP |
| 2013 | Sugarcane | Unid. Ind.Cruz Alta | Guarani | Olimpia | SP |
| 2013 | Sug. & Ethan | Unidade Junqueira | Raízen Energia S/A | Igarapava | SP |
| 2013 | Sugarcane | Santa Cruz S/A | Santa Cruz S/A | Américo Brás. | SP |
| 2013 | Sug. & Ethan | Unid. Dois Córregos | Raízen Energia S/A | Dois Córregos | SP |
| 2013 | Sug. & Ethan | Unidade Junqueira | Alto Alegre | Colorado | PR |
| 2013 | Sug. & Ethan | Usina São Luiz S/A | Copersucar | Ourinhos | SP |
| 2013 | Sug. & Ethan | Unidade Univalem | Raízen Energia S/A | Valparaíso | SP |
| 2013 | Sug. & Ethan | Usina Monte Alegre | Adecoagro | Monte Belo | MG |
| 2013 | Ethanol | Usina Rio Claro | Odebrecht Agroindustrial | Caçu | GO |
| 2012 | Sug. & Ethan | Gasa | Raízen Energia S/A | Andradina | SP |
| 2012 | Sug. & Ethan | Tropical BioEnergia | BP Biocombustíveis | Edeia | GO |
| 2012 | Sug. & Ethan | Unidade Bonfim | Raízen Energia S/A | Guariba | SP |
| 2012 | Sug. & Ethan | Usina Iracema | Grupo São Martinho | Iracemópolis | SP |
| 2012 | Sug. & Ethan | Unidade Sta Elisa | LDC SEV Bioenergia S/A | Sertãozinho | SP |
| 2012 | Sug. & Ethan | Usina Alta Mogiana | Usina Alta Mogiana S.A | São Joaquim | SP |
| 2012 | Sugarcane | Usina Guariroba | Bunge | Pont. Gestal | SP |
| 2012 | Sugarcane | Adecoagro Ivinhema | Adecoagro | Angélica | MS |
| 2012 | Sug. & Ethan | Destilaria Alcídia | Odebrecht Agroindustrial | T. Sampaio | SP |
| 2012 | Sugarcane | Usina Itapagipe | Bunge | Itapagipe | MS |
| 2012 | Sug. & Ethan | USJ S.A. | USJ | Araras | SP |
| 2012 | Ethanol | Unidade Jatai | Raízen Energia S/A | Jatai | GO |
| 2011 | Sugarcane | Usina Bom Retiro | Raízen Energia S/A | Capivari | SP |
| 2011 | Sugarcane | Usina Costa Pinto | Raízen Energia S/A | Piracicaba | SP |
| 2011 | Sugarcane | Conquista do Pontal | Odebrecht Agroindustrial | Paranapanema | SP |
| 2011 | Sug. & Ethan | Usina Moema. | Bunge | Orindiuva | SP |
| 2011 | Sug. & Ethan | Usina Frutal | Bunge | Frutal | MS |
| 2011 | Sug. & Ethan | Usina Quatá | Copersucar (Zilor) | Quatá | SP |
| 2011 | Sug. & Ethan | Usina São Manoel | Copersucar | São Manoel | SP |
| 2011 | Sug. & Ethan | Usina Santa Adélia | Copersucar | Jaboticabal | SP |
| 2011 | Sug. & Ethan | Barra Gde Lençóis | Copersucar (Zilor) | Lençóis Paul. | SP |
| 2011 | Sug. & Ethan | Zillo Lorenzetti | Copersucar (Zilor) | Macatuba | SP |
| 2011 | Sug. & Ethan | Equipav Mill | Renuka do Brasil S.A. | Promissão | SP |
| 2011 | Sug. & Ethan | Usina Maracá | Raízen Energia S/A | Maracá | SP |



Application of sustainability indicators of the Global Bioenergy Partnership (GBEP) in ethanol mills in the State of São Paulo, Brazil (2014-2016 – CENBIO/IEE/USP – Forum of the Americas)

- Funding agency: Forum of the Americas (Government of Italy);
- Support: UNICA/SP, Secretariat for Environment of Sao Paulo, Brazilian Federal Government
- Coordinator: Suani T. Coelho (CENBIO/USP)
- Collaborators: J. Goldemberg (USP), C. Cerri, C.A. Cerri, Marcia Azanha (ESALQ/USP), among others
- Partners from Industries: importante support from industries
 - Odebrecht Agro Industrial
 - Grupo Raizen

Main Challenge



- Allocation of impacts;
- Production of both sugar and ethanol in some mills;
- Allocation on energy basis, mass basis, market basis



Three GBEP Sustainability Pillars

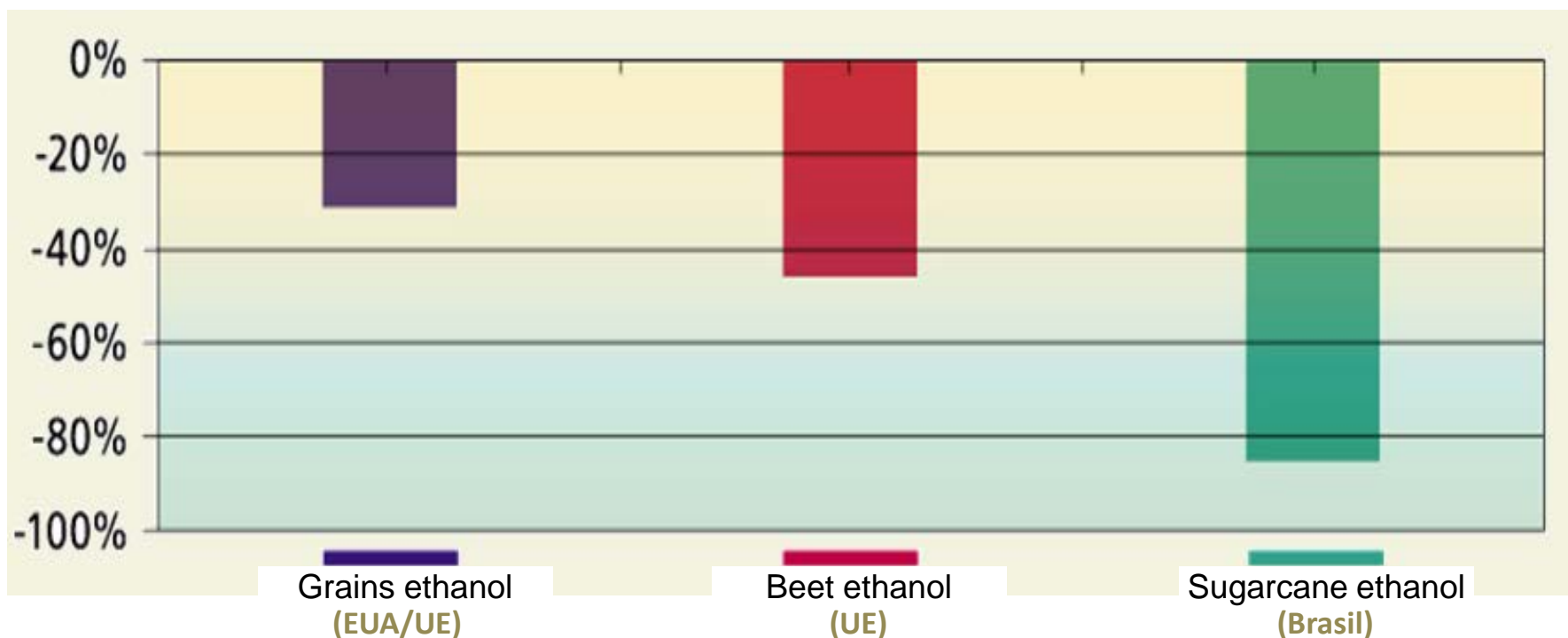
1. **Environmental Sustainability**
2. Social Sustainability
3. Economic Sustainability

Not applicable

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Reduction of GHG emissions

- Ethanol from sugarcane reduces GHG emissions by 90%, to replace gasoline





Water use in sugarcane ethanol

- Irrigation: most of the sugarcane produced in Brazil does not need irrigation.
- Industrial processes:
 - reduction on water consumption:
 - 1997: 5 m³ /t sugarcane
 - 2004: 1.83 m³/t sugarcane (average in São Paulo).
 - water recycling.
 - high efficiency in water treatment: 98%
 - environmental agency requirements : less than 1 m³/t sugarcane
 - sugarcane washing process = 5m³/tc (replaced by dry cleaning).

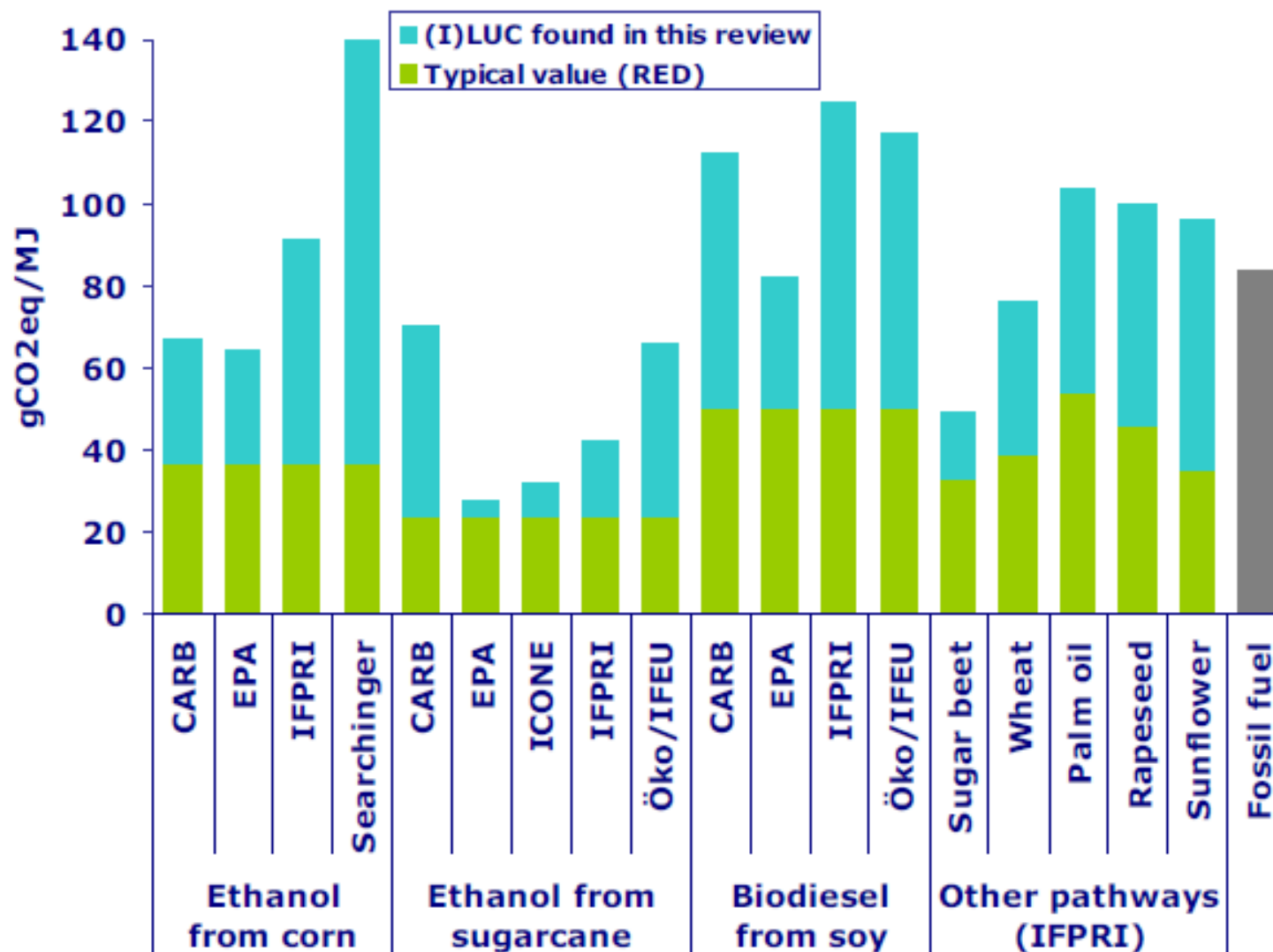
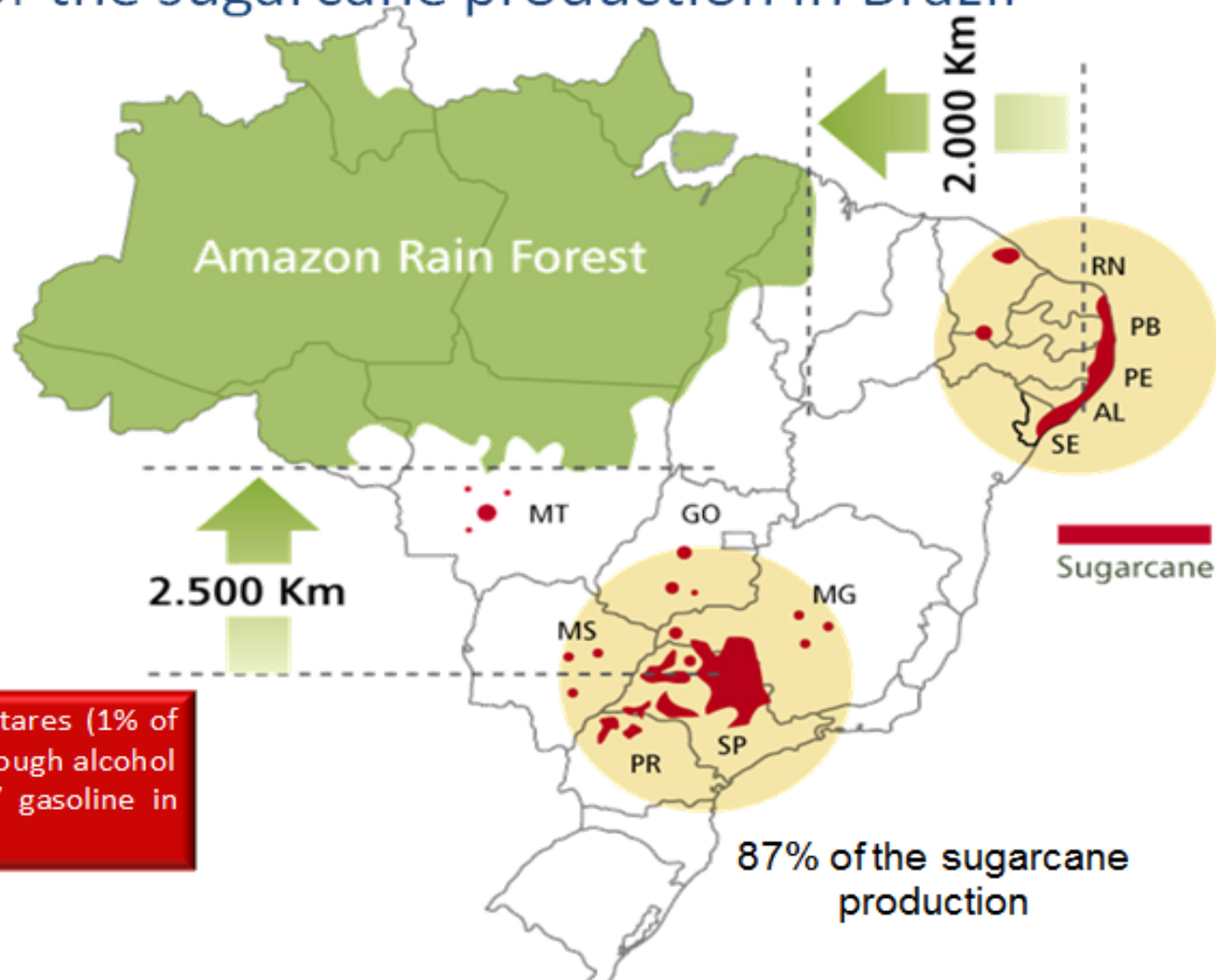


Figure 2 - 2 Graphical representation of the emissions caused by (I)LUC, direct and indirect land use change, for different biofuel pathways and different studies. For reference, typical non-land-use change emissions for the different pathways and a fossil reference from the EU Renewable Energy Directive (RED) have been added.

Location of the sugarcane production in Brazil

25 million hectares of degraded pastures are available



With just over 3 million hectares (1% of arable land), we produce enough alcohol to supply 50% of alcohol / gasoline in Brazil.

Land use in Brazil (2007-2011)



| Million hectares (2007-2011) | | TOTAL % | ARABLE LAND % |
|---|----------------|-------------------|------------------|
| BRAZIL | 851 | | |
| TOTAL ARABLE LAND | 354.8 | | |
| 1. CULTIVATED AREAS | 76.7 | 9.0% | 21.6% |
| SOY | 20.6 | 2.4% | 5.8% |
| CORN | 14.0 | 1.6% | 3.9% |
| SUGARCANE | 7.8-9.6 | 0.9%-1.26% | 2.2%-3.08% |
| SUGARCANE FOR ETHANOL | 3.4-4.8 | 0.4%-0.56% | 1.0%-1.4% |
| ORANGE | 0.9 | 0.1% | 0.3% |
| 2. CATTLE | 172.3 | 20.2% | 48.6% |
| 3. AVAILABLE LAND (ARABLE LAND – CULTIVATED LAND – CATTLE AREA) | 105.8 | 12.4% | 29.8% |

Evolution of the pasture area in the State of Sao Paulo



| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Cattle (million heads) | 13,15 | 13,46 | 13,76 | 13,77 | 14,07 | 13,75 | 12,20 | 11,95 |
| Pastures (million hectares) | 10,29 | 10,10 | 10,11 | 10,12 | 10,01 | 9,71 | 9,12 | 7,64 |
| Density (heads of cattle/ha) | 1,28 | 1,33 | 1,36 | 1,36 | 1,41 | 1,42 | 1,34 | 1,56 |

Trend for more intensive use

Evolution of the pasture area in the State of Sao Paulo (Cont)

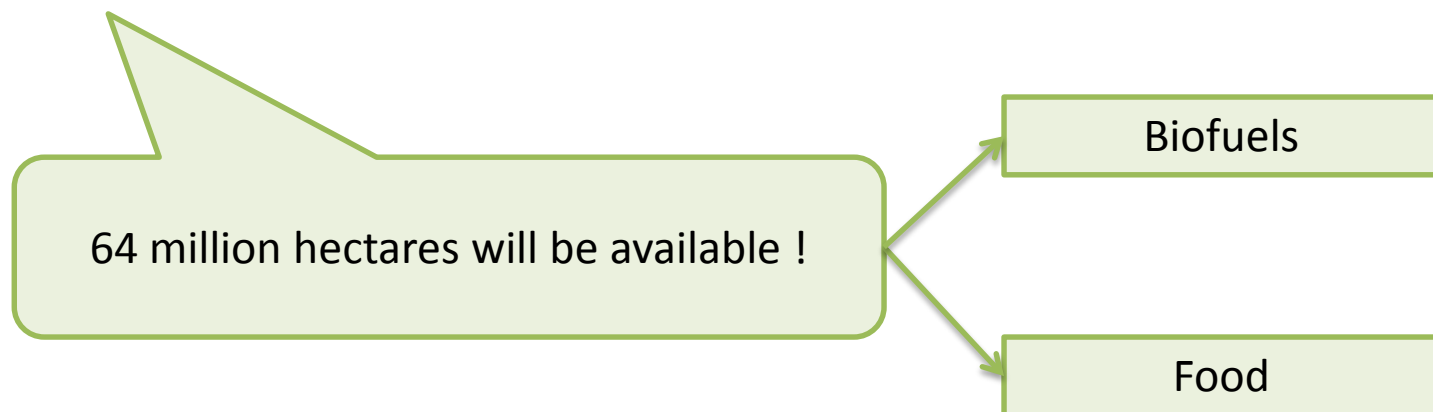
| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|-------|-------|-------|-------|------|
| Cattle (million heads) | 11,00 | 11,37 | 11,15 | 11,08 | 9,84 |
| Pastures (million hectares) | 7,77 | 7,86 | 7,43 | 7,41 | 7,14 |
| Density (heads of cattle/ha) | 1,42 | 1,45 | 1,50 | 1,50 | 1,38 |
| Trend for more intensive use | | | | | |

Source: Sec. Estado Agric. Instituto de Economia Agrícola. Elaboration: Cenbio

Pastures in Brazil



| Current situation | | |
|----------------------|-----------------------------|---------------------------------|
| Area | Heats of cattle | Density (Heats of cattle/ha) |
| 172 million hectares | 169 million | 0,98 |
| Prospects | | |
| 108 million hectares | 169 million heats of cattle | 1,56 (SP - 2008) |

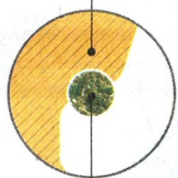


Agro-ecological Zoning of Sugarcane



ÁREA CORRESPONDENTE A AMAZÔNIA, PANTANAL E ALTO RIO PARAGUAI

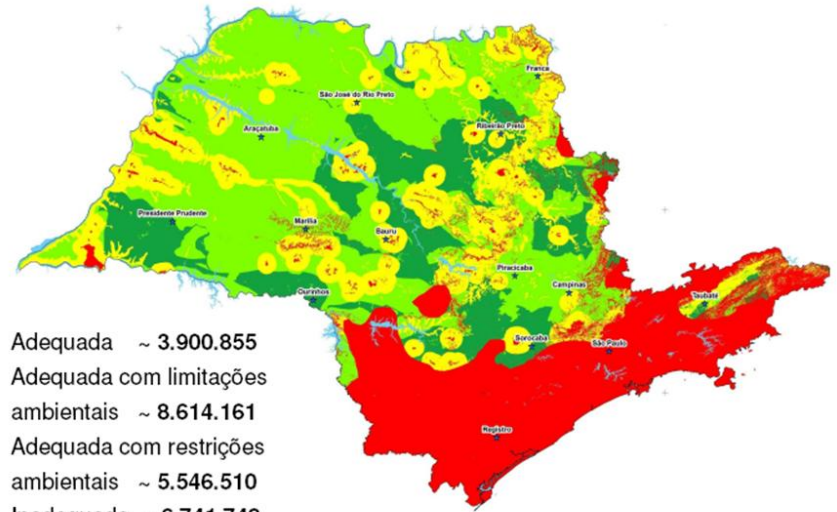
ÁREAS COM RESTRIÇÃO 92,5%
789,8 MILHÕES/HA



ÁREA PROPÍCIA 7,5%
64,7 MILHÕES/HA

7,8 milhões de hectares é a área atualmente cultivada com cana-de-açúcar no País

572 mil toneladas foi a produção de cana em 2008



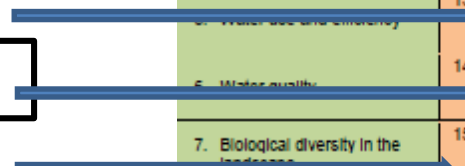
- Adequada ~ 3.900.855
- Adequada com limitações ambientais ~ 8.614.161
- Adequada com restrições ambientais ~ 5.546.510
- Inadequada ~ 6.741.748

Three Sustainability Issues

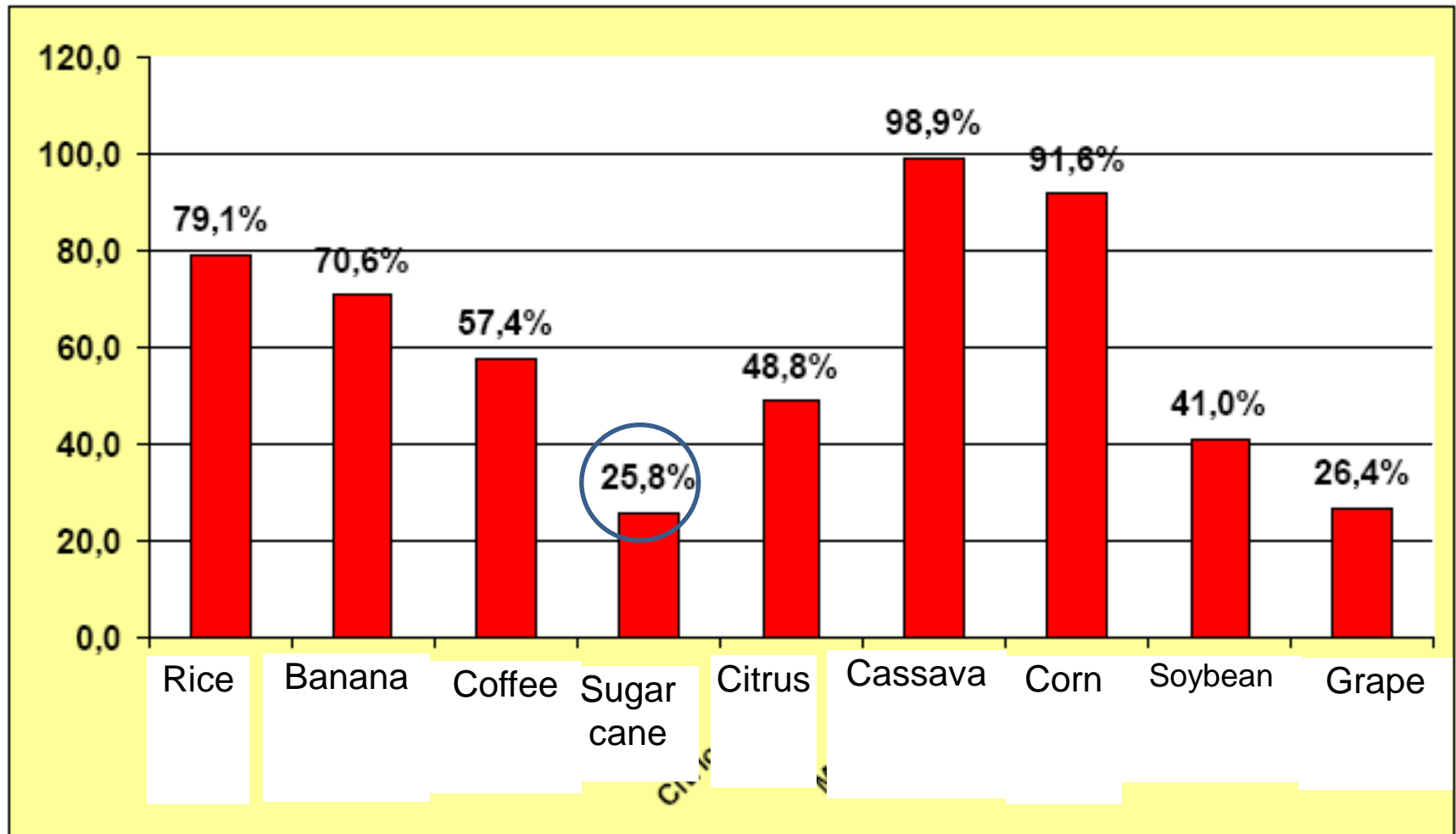
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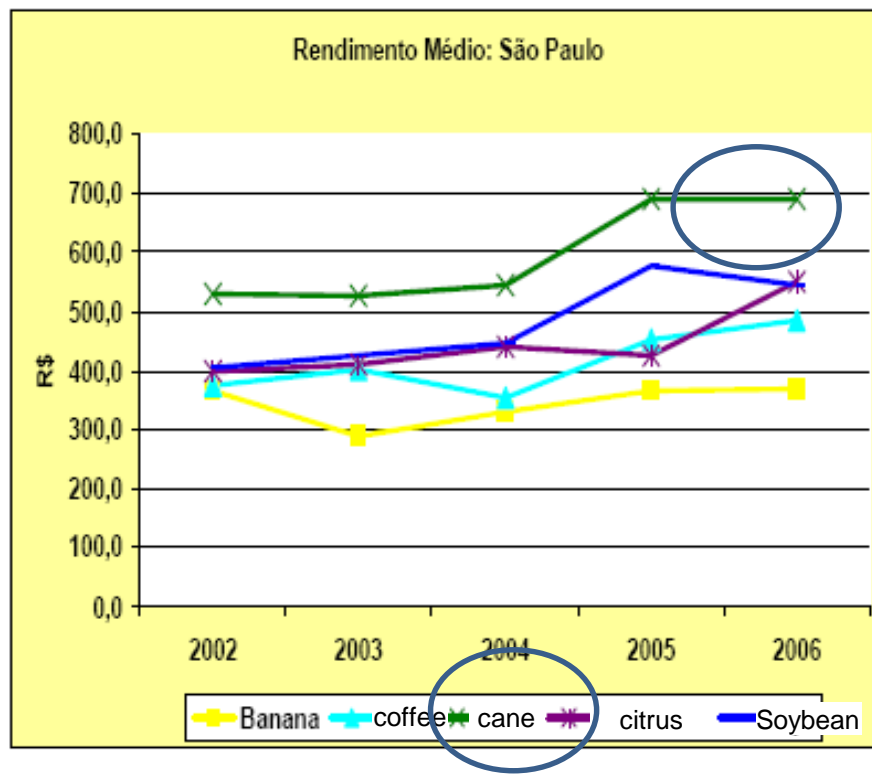
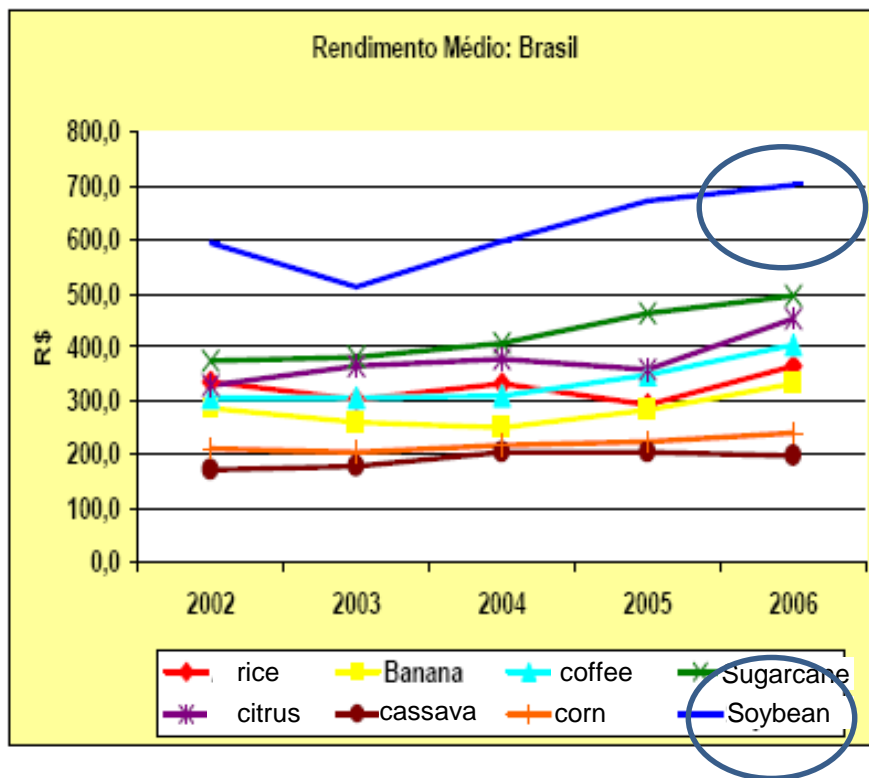
N.A.



Percentage of informal jobs in agricultural sector. Brazil, 2006



Evolution of the average income of employees in several crops. Brazil and São Paulo, 2002-2006 (BRL - August 2007)



Evolution of Mechanical Harvesting São Paulo State

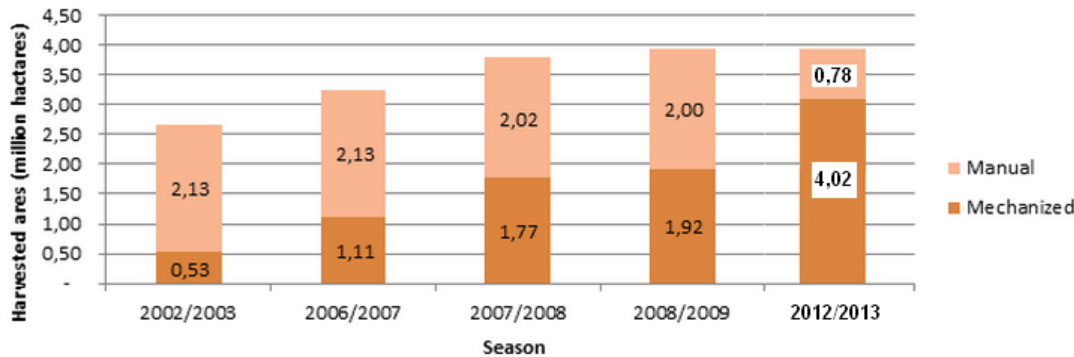


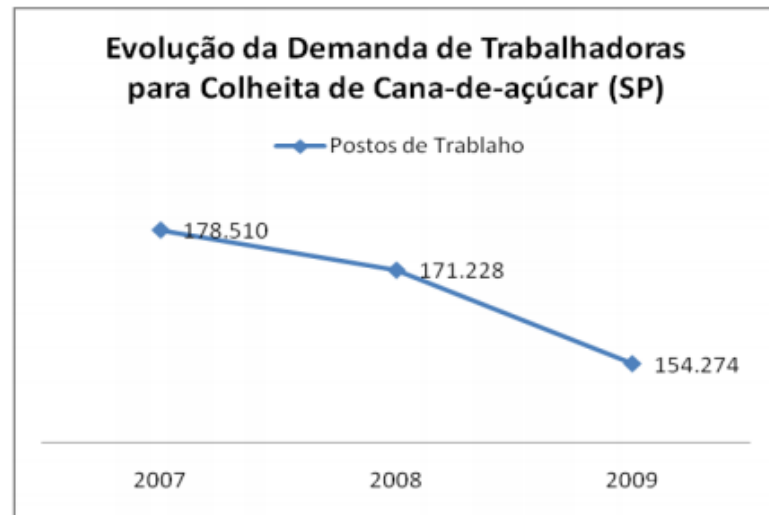
Fig. 3.12 Mechanical harvesting of green cane. (Photo courtesy of Agricef Soluções Tecnológicas Para Agricultura Ltda, Brazil; reprinted with permission)

Mechanical harvesting in São Paulo:

May 2013: 72.6% of the areas that could be mechanized were harvested without burning, corresponding to 3.38 million hectares, against **34.2% in 2006**

Source: Coelho, S. T., Guardabassi, P. "Ethanol". In: B. D. Solomon, R. Bailis (eds.), *Sustainable Development of Biofuels in Latin America and the Caribbean*, DOI 10.1007/978-1-4614-9275-7_3 © Springer Science+Business Media NewYork

Evolution of jobs for manual harvesting of sugarcane in São Paulo



Dados: TEM (Ministério do Trabalho e Emprego)

Social impacts from mechanized harvesting



- Lost of jobs in compliance with the elimination of burning.
- Since 2007 Unica associates **retrain more than 5,000 people.**
- New requalification program:
 - Unica, Feraesp and companies in the production chain,
 - support of the Interamerican Development Bank (IADB) - a program of training and retraining of workers
 - workers and members of the communities in six regions of São Paulo.
 - capacity building: drivers, tractors operators and harvesters, other areas (mechanic, electrician and welder); programs for other sectors such as forestry, horticulture, handicrafts, construction, computing, sewing, catering and tourism.
- **Renovação project** : 4,350 workers qualified in 2012/2013 season (<http://www.unica.com.br>)

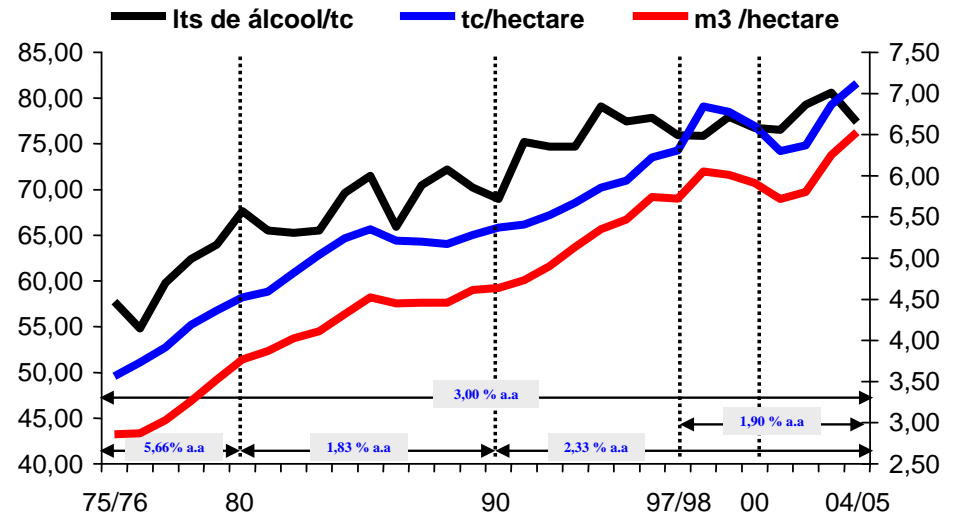
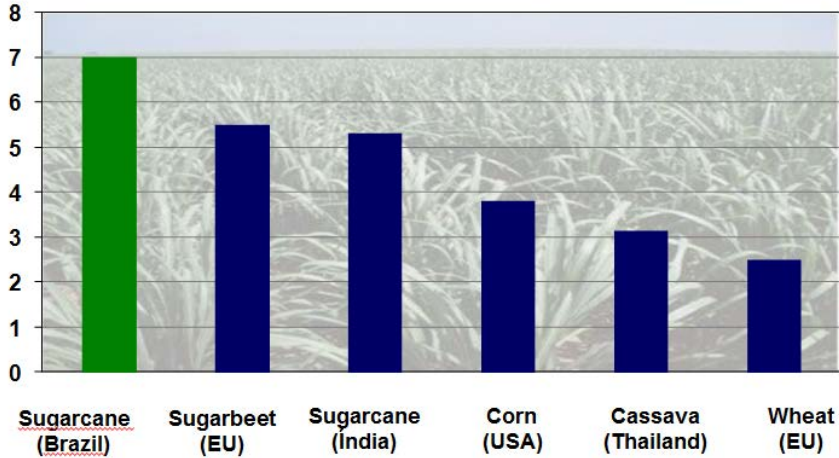


Three GBEP Sustainability Pillars

1. Environmental Sustainability
2. Social Sustainability
3. **Economic Sustainability**

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Ethanol productivity (liters per hectare)



Source: Rodrigues, Unicamp .2005

Sugarcane ethanol in Brazil
Growth rate 3.8% per year

Current situation of ethanol in Brazil due to gasoline prices' control



Ethanol exports - Brazil (UNICA, 2014)

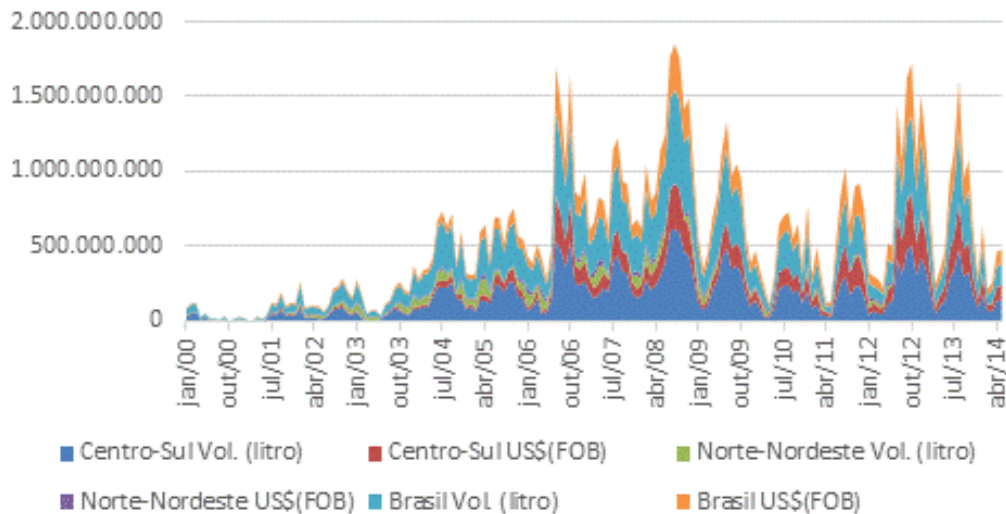
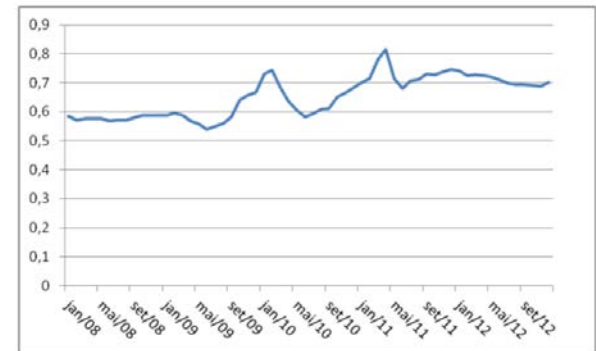


Figura 3 - Preço relativo do etanol hidratado (razão preço etanol/preço gasolina C)

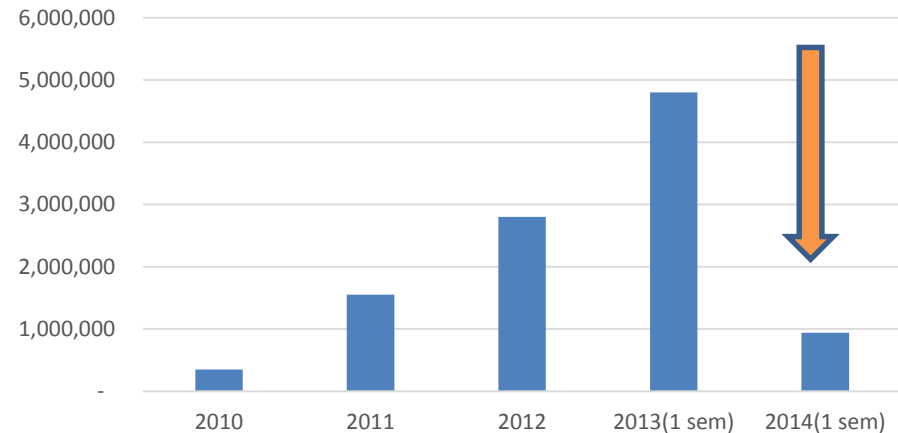


Fonte: ANP

**Increase on ethanol blend to gasoline
25% in 2014**



Gasoline imports in Brazil (metric tonnes)





INSTITUTO DE ENERGIA E AMBIENTE
UNIVERSIDADE DE SÃO PAULO



Obrigada / Thank you

RCN Conference on
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Golden Tulip Recife Palace,
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Prof Suani T. Coelho, PhD
Cenbio/IEE/ USP
suani@iee.usp.br
[Http://cenbio.iee.usp](http://cenbio.iee.usp)