

## SEMINARIO SOBRE INDICADORES DE SUSTENTABILIDAD DE LA BIOENERGÍA ARGENTINA

EXPERIENCIAS DE IMPLEMENTACION DE  
INDICADORES DE SUSTENTABILIDAD  
EXPERIENCIA DE BRASIL

**Application of sustainability indicators of the Global  
Bioenergy Partnership (GBEP) in sugar/ethanol mills in  
the State of São Paulo, Brazil**

**Suani Coelho – GBIO/IEE/USP  
Buenos Aires, 16/10/2015**

## Grupo de Pesquisa em Bioenergia – GBio (antigo CENBIO)

- Coordenação: prof Suani Coelho
- Contribuição especial: prof J. Goldemberg
- 12 colaboradores - 2015
  - 1 pos doc – Alessandro S. Pereira
  - 1 PhD – Vanessa Pecora
  - 4 doutorandos – Javier Escobar; Adriano Violante; Manuel Moreno; Luis G. Tudeschini
  - 4 mestrandos – Fernando Oliveira; Naraisa Coluna; Dafne P. Silva, Danilo Percin
  - 2 alunos de IC – Pedro Germani; Bruno Boyadjian



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

- Funding agency: Forum of the Americas (Government of Italy)
- Support: Brazilian Federal Government, Secretariat for Environment of Sao Paulo, UNICA/SP
- Coordination: Suani T. Coelho (CENBIO/IEE/USP)
- Collaboration: J. Goldemberg (USP), C. Cerri, C.A. Cerri, Marcia Azanha (ESALQ/USP), O. Lucon (USP/SMA/Cetesb)



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



# Activities

1. Definition of sugarcane mills (finished)
  - Survey maps and database on the geographical distribution of plants and production areas;
  - Selection of sugarcane mills - Piracicaba, SP;
  - Selection of sugarcane mills – Araçatuba/Pontal do Paranapanema.
2. Data assessment for each mills/local field survey (2014-2015);
3. Term of Confidentiality signed (Feb 2015)
4. Application of the indicators (under development)
5. Presentation – GBEP – Rome Nov 2014
6. Comparison with indicators for Brazil and São Paulo
7. Workshops to discuss the results with stakeholders (intermediate and final workshop)

# GENERAL INFORMATION

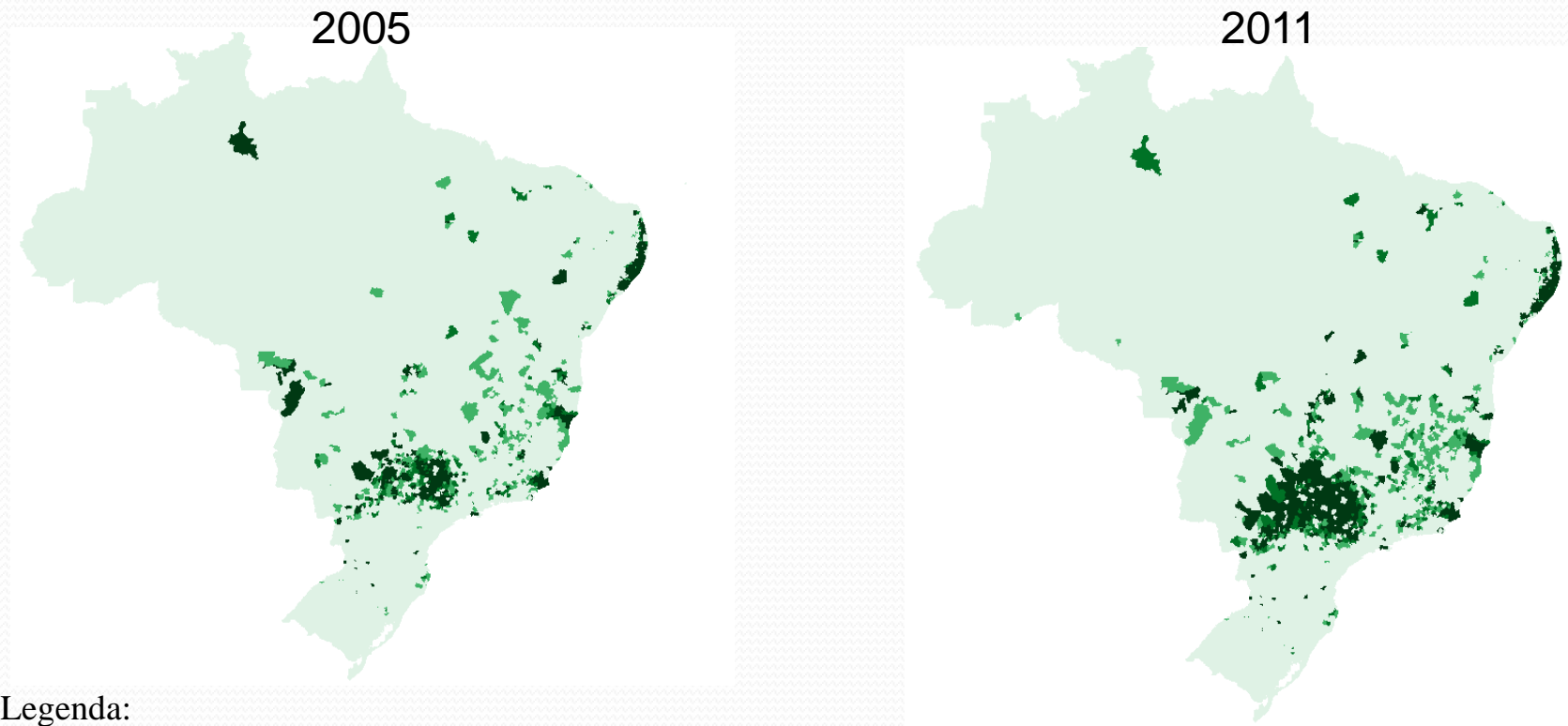
- The development of this Project has the support and contribution of the following partners until now, following the invitation of Project Coordination:
  - Odebrecht Agroindustrial;
  - Raízen;
  - UNICA – União da Indústria de Cana-de-Açúcar;
- For the development of the technical activities, according to the initial proposal, the following groups have started their activities
  - Delta CO<sub>2</sub> – Sustentabilidade Ambiental (Prof Carlos Cerri, Prof C. Eduardo Cerri, PhD Cindy Silva Moreira and Eng. Priscila Aparecida Alves);
  - Escola Superior de Agricultura Luiz de Queiroz” – ESALQ/USP (PhD Márcia Azanha F. D. Moraes and MSc candidate Leandro Gilio)

**Delta CO<sub>2</sub> and ESALQ partners are contributing to the indicators of environmental and social sustainability, respectively.**

**Odebrecht and Raizen: select the ethanol plants for technical visits and data collection and with the technical data referred on recent harvesting seasons (2012/2013 and 2013/2014).**

## ***General Information: Introduction***

Expansion of sugarcane: percentage of occupied area by the cultivation of sugarcane temporary crops in Brazilian cities

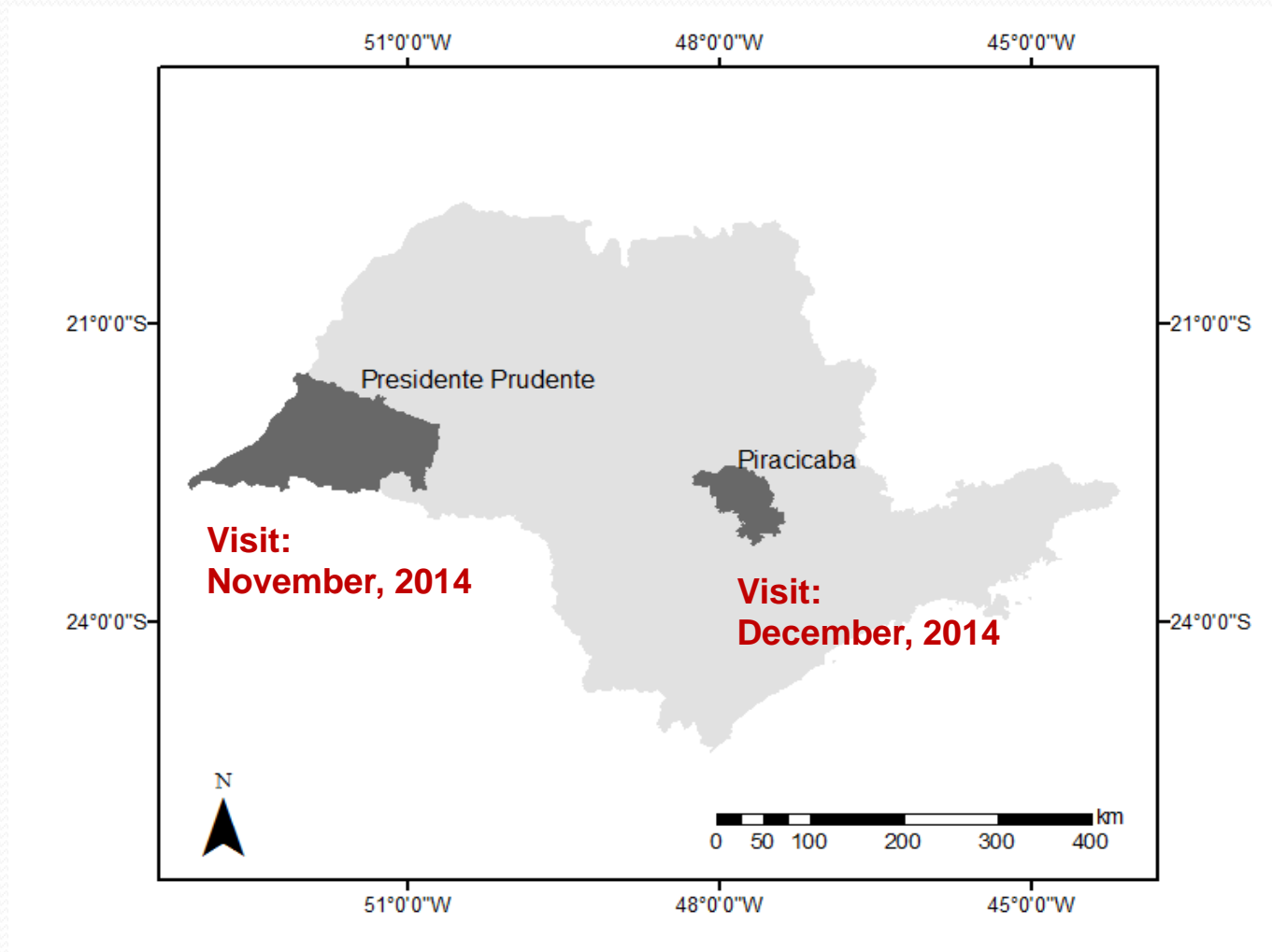


Legenda:

- < 15%;
- 15% - 30%;
- 30% - 50%;
- > 50%.

Source: GILIO (2015)

## Location of sugarcane production areas selected by the project





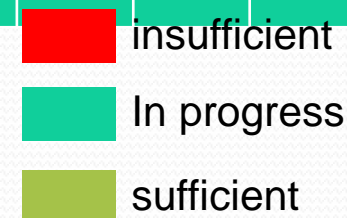
## PILLARS

GBEP's work on sustainability indicators was developed under the following three pillars, noting interlinkages between them:

Environmental	Social	Economic
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

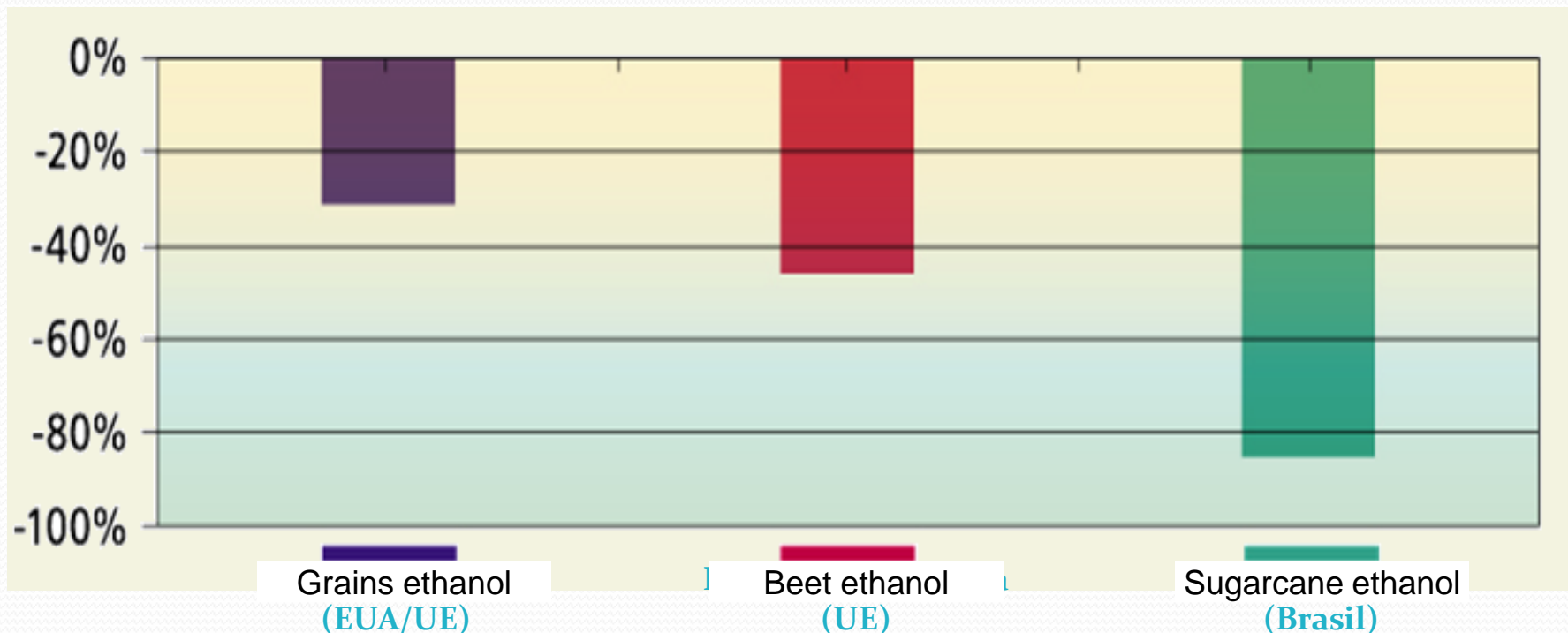
## Status of the assessment - Environmental indicators

Region	Traditional area				Recent expansion area			
	U1		U2		U3		U4	
Production unity (mills)	12/13	13/14	12/13	13/14	12/13	13/14	12/13	13/14
Crop year	12/13	13/14	12/13	13/14	12/13	13/14	12/13	13/14
Environmental indicator								
General informations about productivity, areas, etc								
1. GHG lifecycle emission								
2. Soil quality								
4. Emissions of non-GHG pollutants								
5. Water use and efficiency								
6. Water quality								
7. Biological diversity in the landscape								
8. LU and LUC related to Bioenergy feedstock production								

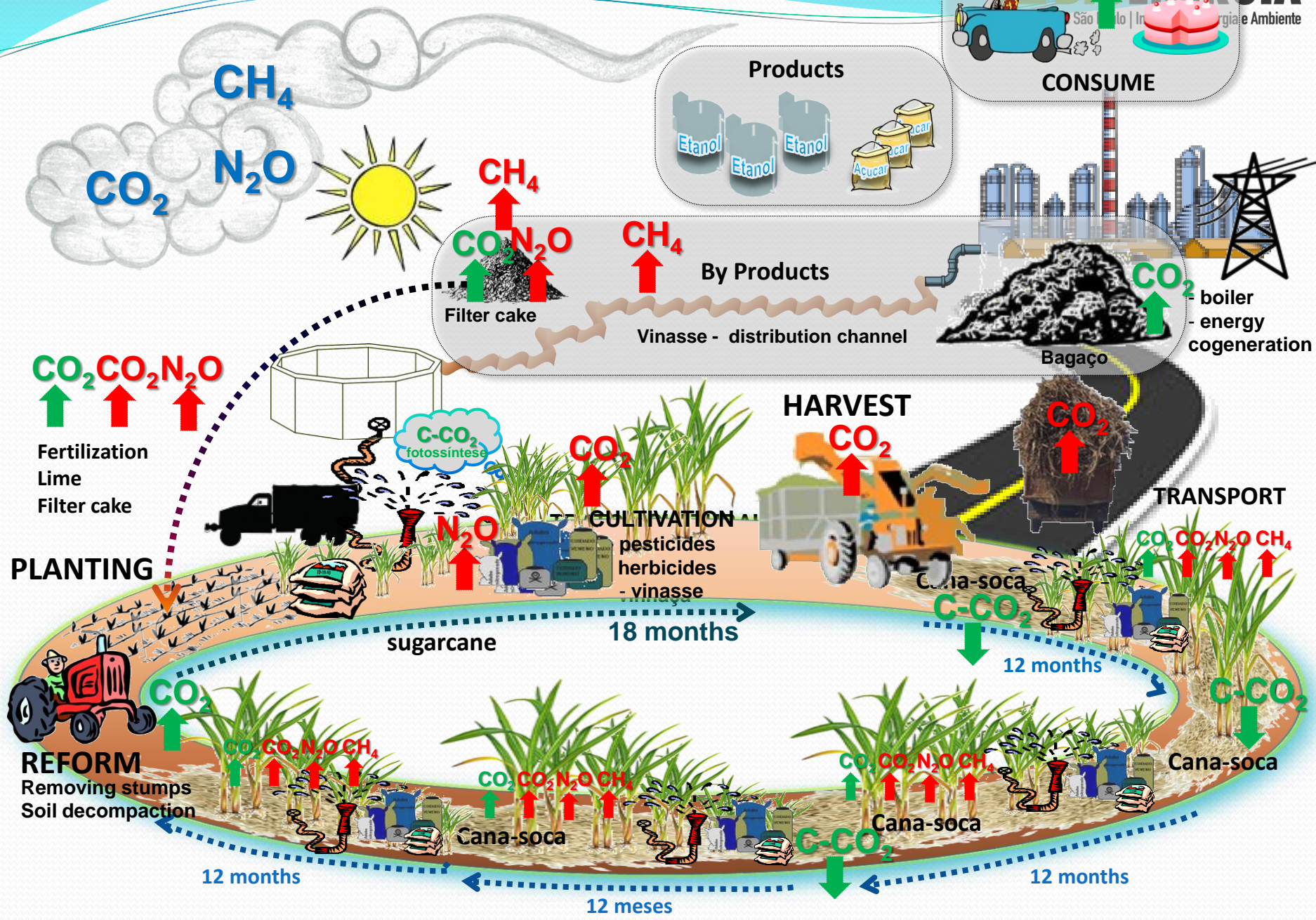


# 1. Reduction of GHG emissions

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



# Example of GHG lifecycle emission on ethanol production



## 5. Water use in sugarcane ethanol

- Irrigation: most of the sugarcane produced in Brazil does not need irrigation.

Industrial processes:

- reduction on water consumption (SP):

1997: 5 m<sup>3</sup> /t sugarcane

2004: 1.83 m<sup>3</sup>/t sugarcane

2013/14: 1,18 m<sup>3</sup>/tc

2014/15: 1 m<sup>3</sup>/tc (some mills 0.7)

- 2015 – Cetesb - 0.85 m<sup>3</sup>/t sugarcane
- water recycling
- high efficiency in water treatment: 98%
- sugarcane washing process replaced by dry cleaning
- mechanical harvesting of green cane – no cleaning

## 8. LUC - 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

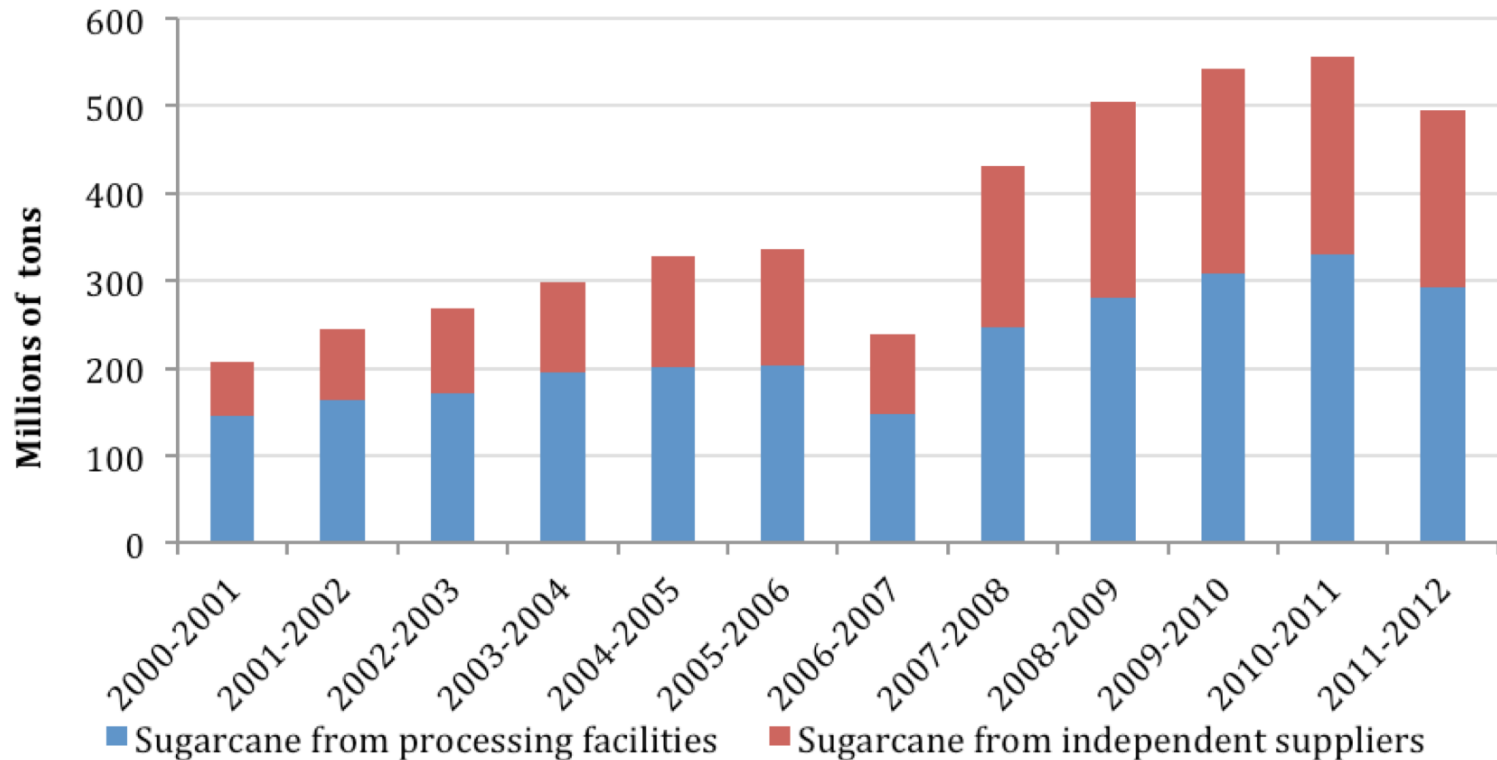
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## General Information: Introduction

Post-deregulation period: Sugarcane supplier figures



Sugarcane suppliers currently account for approximately 40% of all sugarcane processed for the production of sugar and ethanol in Brazil

Source: MAPA (2012)



**Indicator 9. Allocation and tenure of land for new bioenergy production**  
**preliminary findings**

**The land ownership is regulated by Brazilian law and São Paulo (state studied) is effective with respect to guarantees to landowners**

**The evaluated plants require its suppliers to respect the laws in force through contracts**

2005

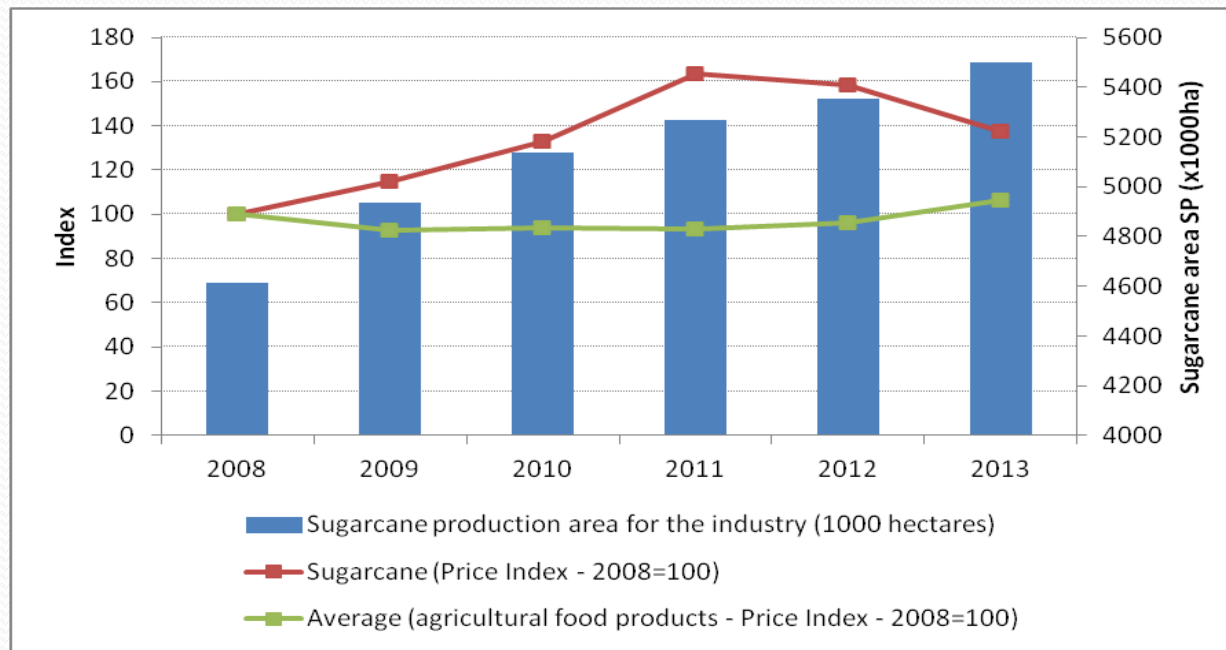


2011



## **Indicator 10. Price and supply of a national food basket**

Average of price index for the main agricultural food products produced in São Paulo vs expansion of sugarcane area for sugarcane industry

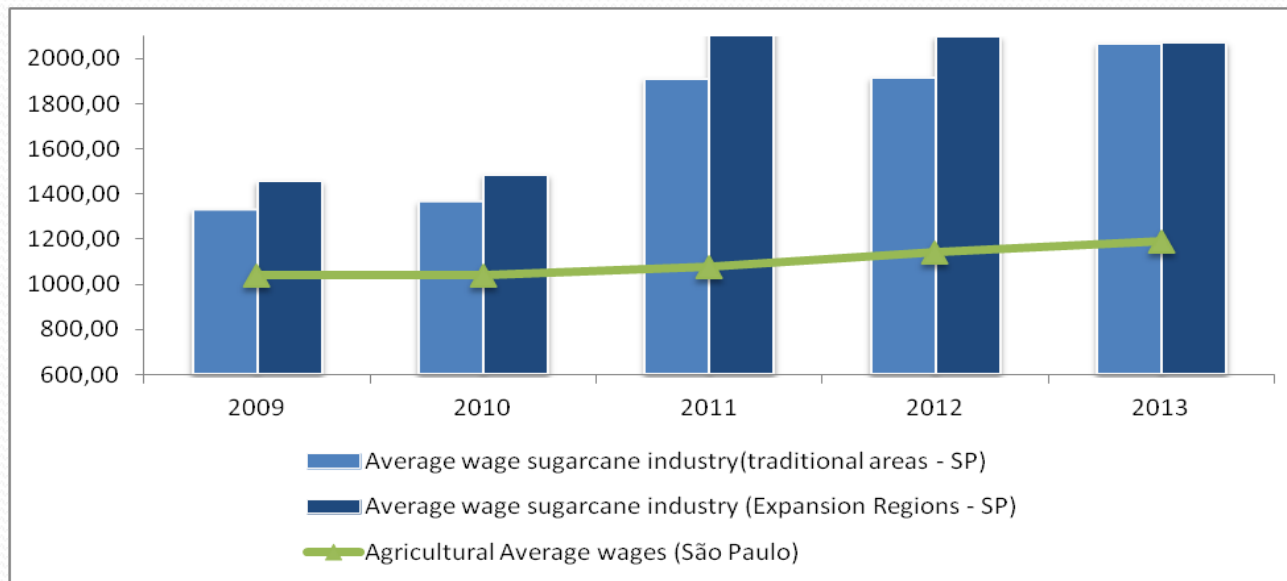


Source: CEPEA/USP(2015); IEA (2015)

**It is not possible to verify a direct relationship of expansion of bioenergy and food price increase**

## Indicator 11. Change in income

Wages paid for employment in the sugarcane sector in relation to the average of the sector (R\$)



**It is not possible to verify a direct relationship of expansion of bioenergy and food price increase**

Source: IEA/CAT (2015) and primary data from sugarcane industry for GBEP (2015)

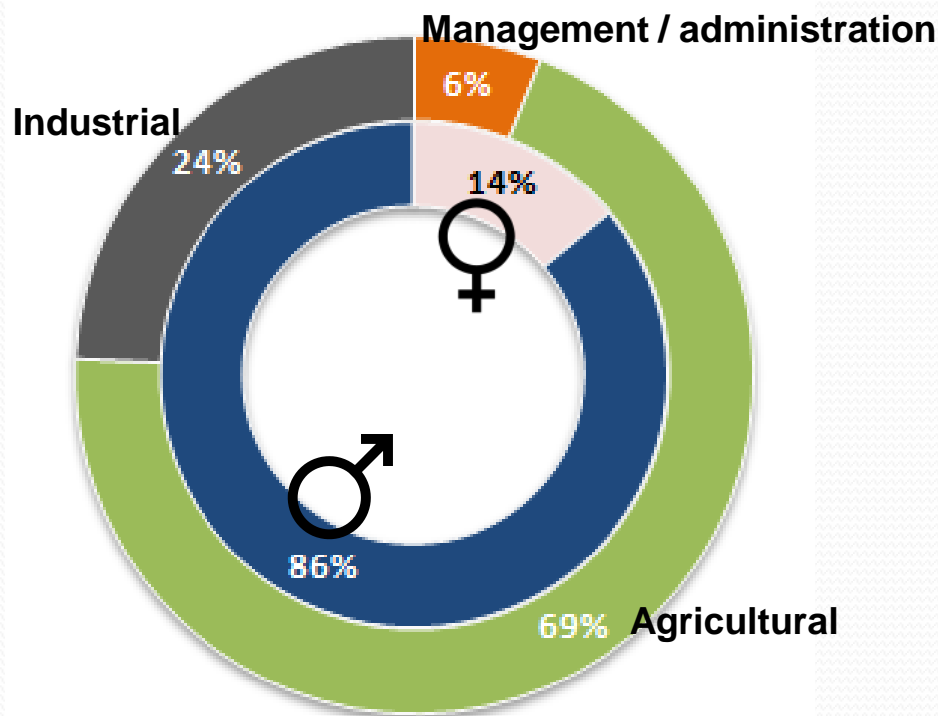
\* Deflated Data (R\$) - base year: 2014.

# SOCIAL PILLAR

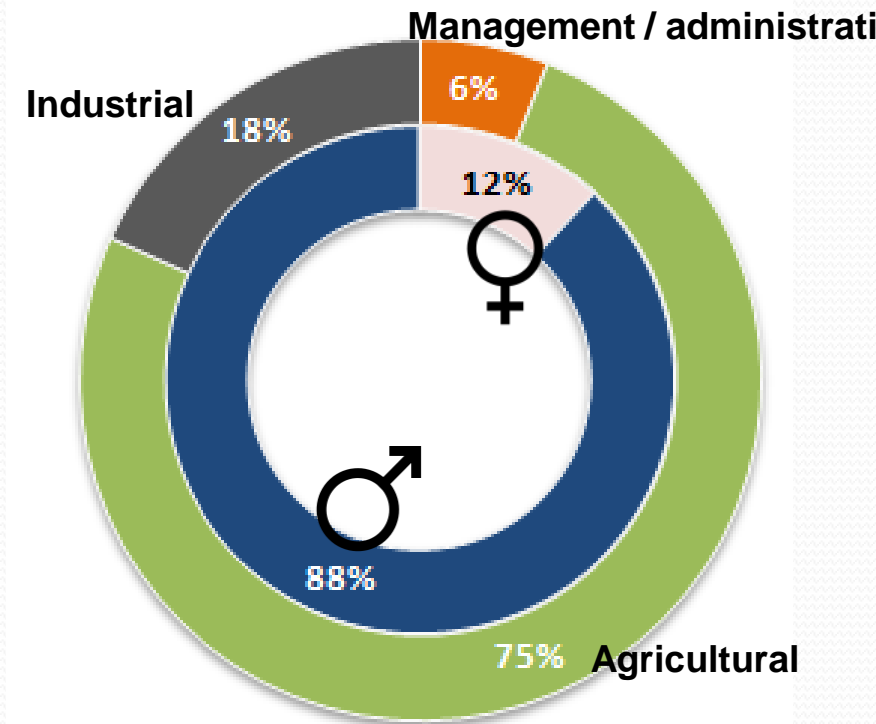
## Indicator 12. Jobs in the bioenergy sector

São Paulo: Data from the Sugarcane Industry (SP) – General Share (2013)

### Traditional Area



### Expansion Area

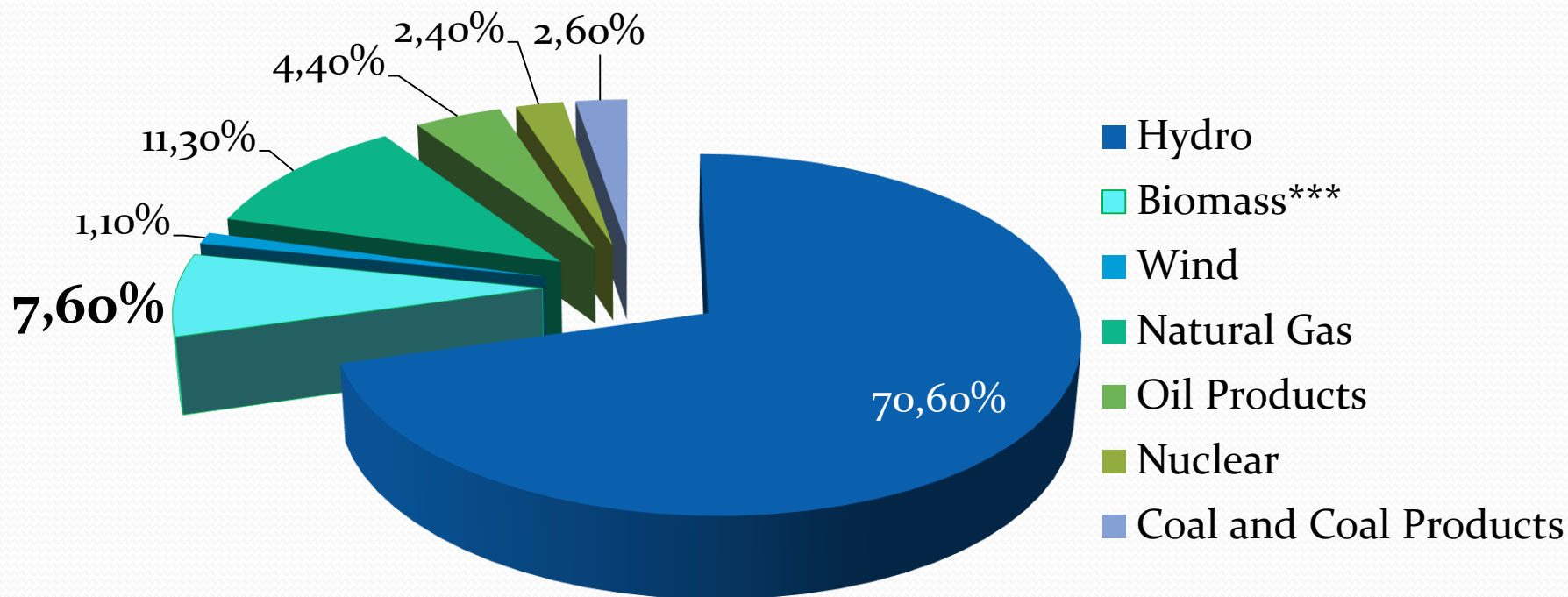


Source: primary data from sugarcane industry for GBEP (2015)

# SOCIAL PILLAR

## Indicator 14. Bioenergy used to expand access to modern energy services

Brazilian Electric Energy Matrix: participation of different sources

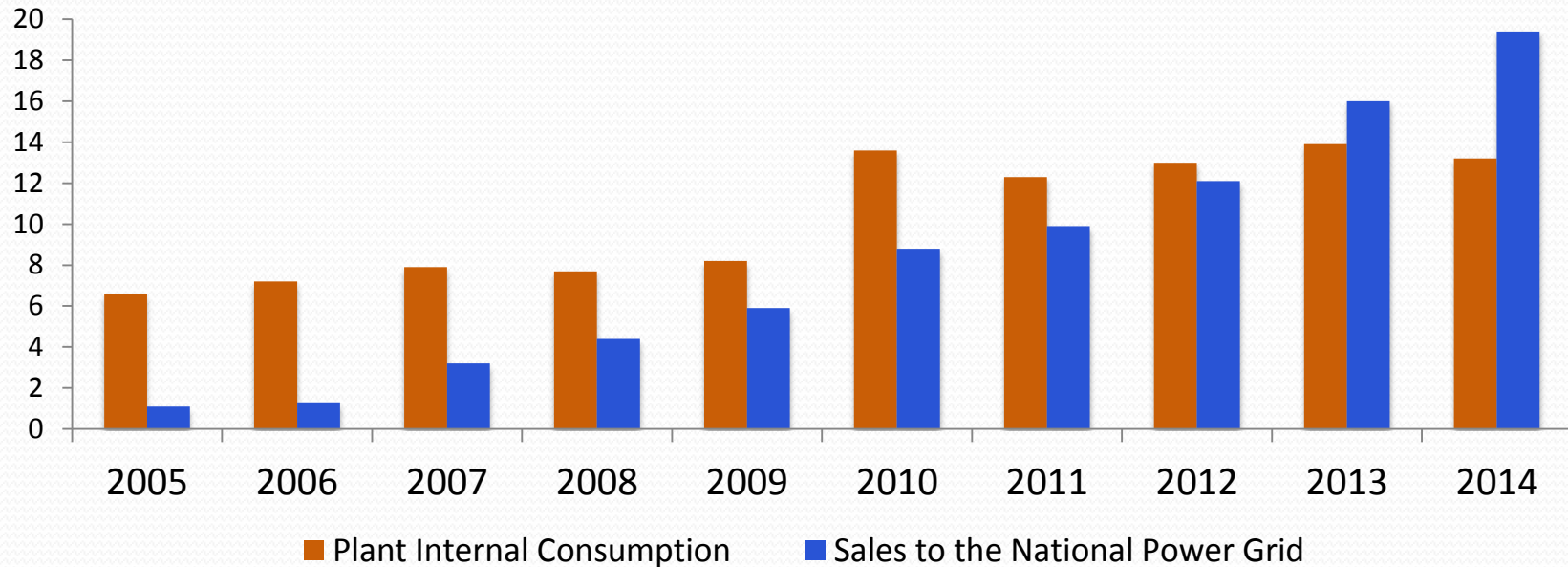


Source: Prepared from MME data (2014)

\*\*\* Includes wood, bagasse, bleach and other recoveries

## *Indicator 14. Bioenergy used to expand access to modern energy services*

### Generation of Bioelectricity from Sugarcane (1000GWA)



Source: Souza, Z. (2015)

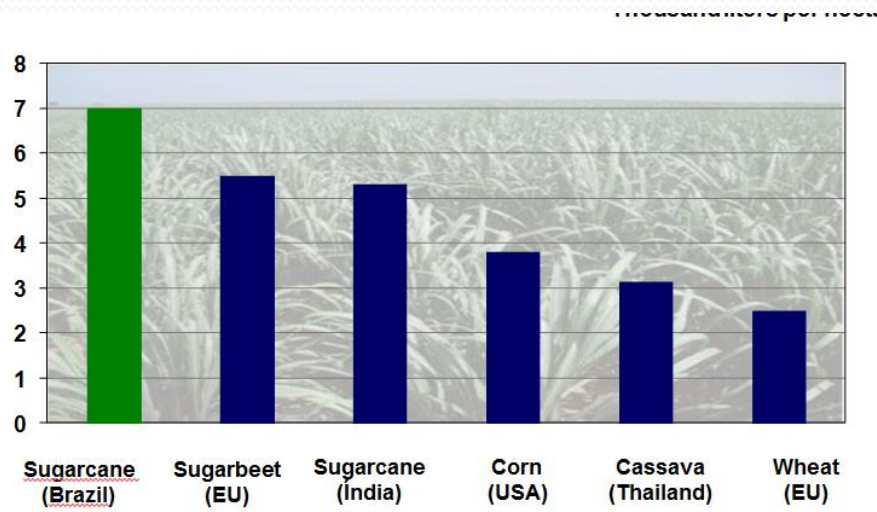
2014: Sugarcane Bioelectricity accounts for 4% (19,400 GWh) of national consumption. Potential (straw + bagasse): 27% (Souza, Z. 2015)

**The cogeneration has the potential to provide energy to rural areas which are deficient in modern services.**

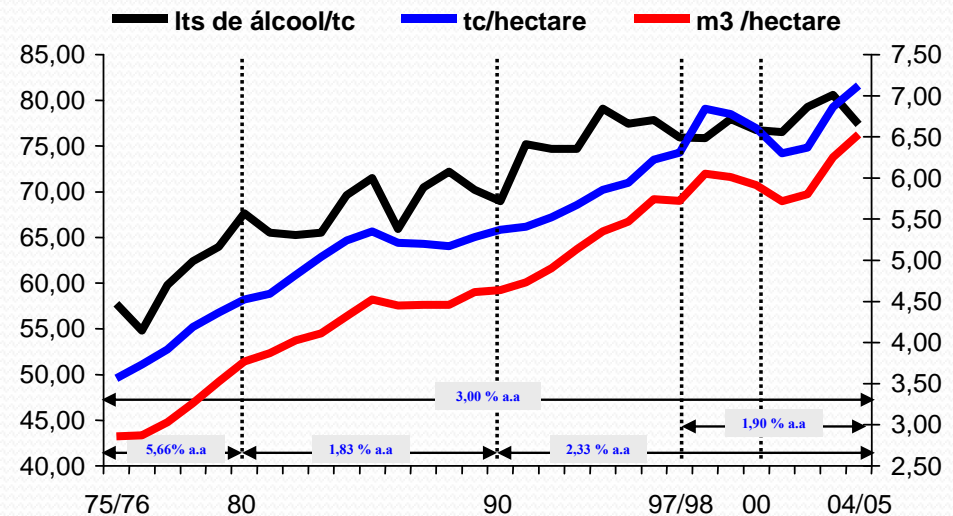
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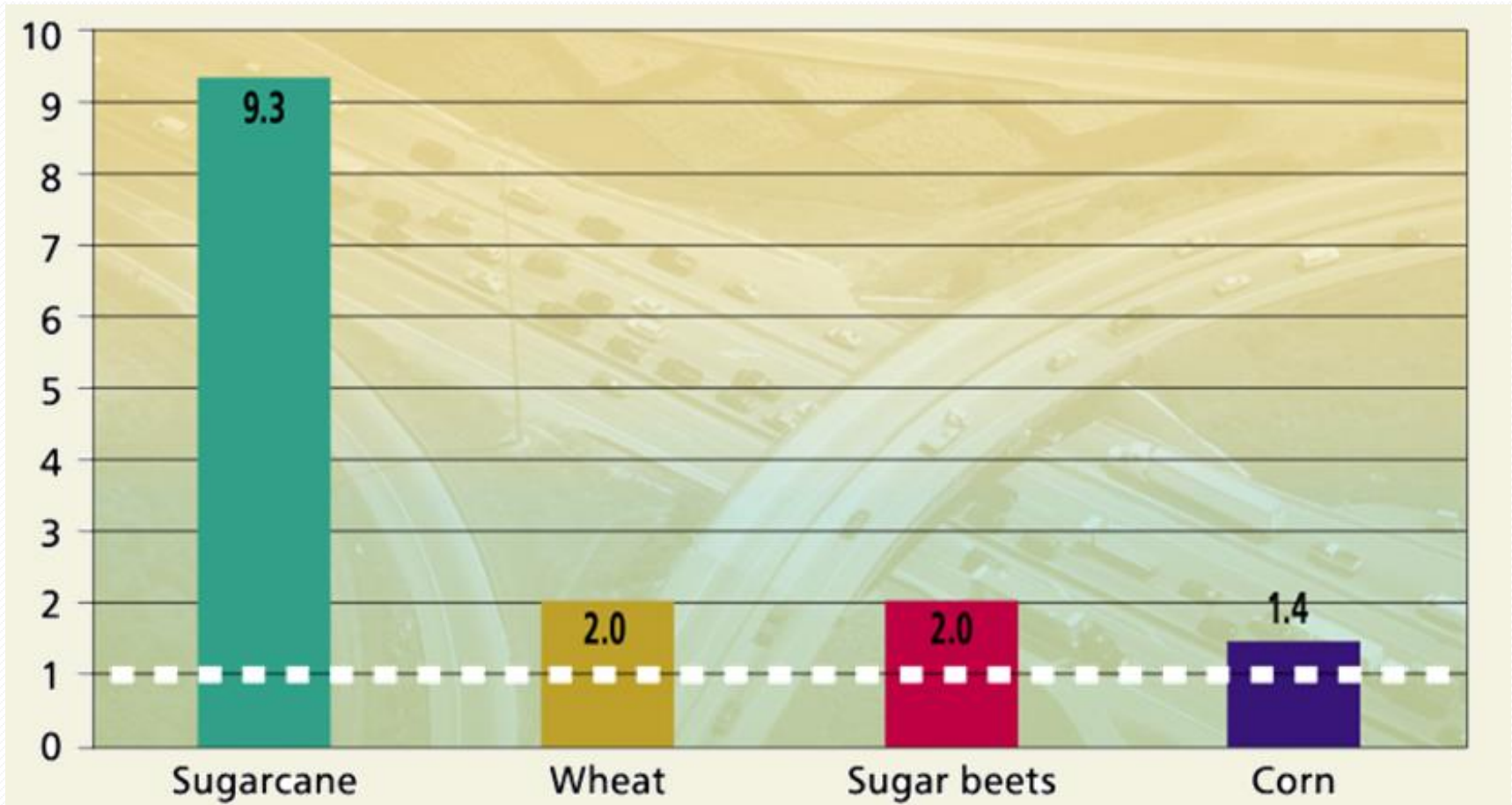


## 17. Ethanol productivity (liters per hectare)





## 18. Ethanol Energy Balance



(SAFRA 2013/2014)

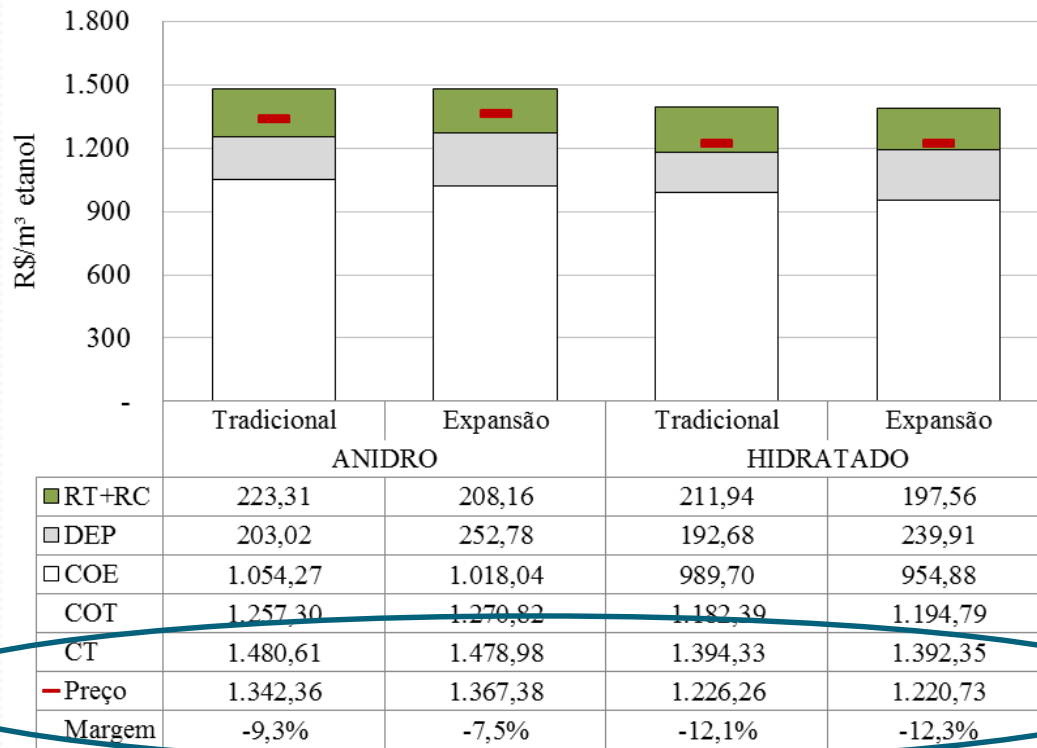
Tabela 3. Custos de produção de cana de açúcar

DESCRIÇÃO	Tradicional	Expansão
<b>Matéria-prima</b>	<b>79,52</b>	<b>80,15</b>
COE	59,28	57,95
Cana de fornecedores	27,51	18,56
COE cana própria	31,77	39,39
Depreciações	11,77	15,41
Remuneração do capital e terra	8,48	6,79
<b>Industrial</b>	<b>26,09</b>	<b>26,26</b>
Operação industrial	13,47	12,82
Deprec.	3,88	4,14
Custo de Capital	8,74	9,31
<b>Administrativo</b>	<b>9,36</b>	<b>7,70</b>
<b>Custo Total</b>	<b>114,97</b>	<b>114,11</b>

Fonte: PECEGE/ESALQ/USP, 2015

*Os custos de produção na região Tradicional superam os custos da região Expansão, algo não esperado quando são comparados os indicadores agrícolas e industriais de ambas as regiões. A explicação para isso é o **elevado custo da terra na região Tradicional**, que acaba por mais que compensar os ganhos de eficiência obtidos no campo e na baixa ociosidade da indústria (PECEGE/ESALQ/USP, 2015).*

## Custos, preços e margens do etanol anidro e hidratado (SAFRA 2013/2014)



- Custos Operacionais Efetivos (COE)
- Custos Operacionais Totais (COT)
- Custo Total (CT).
- Custos desembolsáveis: COE.
- COT: COE mais as depreciações.
- CT = COT mais os custos de oportunidade (uso do capital e da terra)

Fonte: PECEGE/ESALQ/USP, 2015

## INDICATOR 19

**Tabela 2: Estimativa do Produto Interno Bruto do setor sucroenergético na safra 2013/14.**

Produto	Mercado Interno (MI)	Mercado Externo (ME)	Total (MI + ME)
	US\$ (milhões)	US\$ (milhões)	US\$ (milhões)
Hidratado <sup>a</sup>	12.861,31	590,65	13.451,96
Etanol Anidro <sup>b</sup>	8.890,08	1.075,71	9.965,79
	Não-Energético <sup>c</sup>	654,85	-
Açúcar <sup>d</sup>	6.926,80	11.109,85	18.036,65
Bioeletricidade <sup>e</sup>	894,05	-	894,05
Bioplástico <sup>f</sup>	90,00	210,00	300,00
Levedura e Aditivos <sup>g</sup>	21,20	34,13	55,33
Crédito de Carbono <sup>h</sup>	-	0,27	0,27
<b>Total</b>	<b>30.338,29</b>	<b>13.020,61</b>	<b>43.358,90</b>

a- Estimativa das vendas realizadas pelos postos de combustível.

b- Estimativa das vendas realizadas pelas usinas para as distribuidoras

c- Estimativa das vendas realizadas pelas usinas para a indústria de bebidas e cosméticos.

d- Estimativa das vendas de açúcar realizadas pelas usinas para ser utilizada como matéria-prima de produtos industrializados e vendas realizadas de açúcar in natura pelo varejo.

e- Estimativa das vendas realizadas pelas usinas.

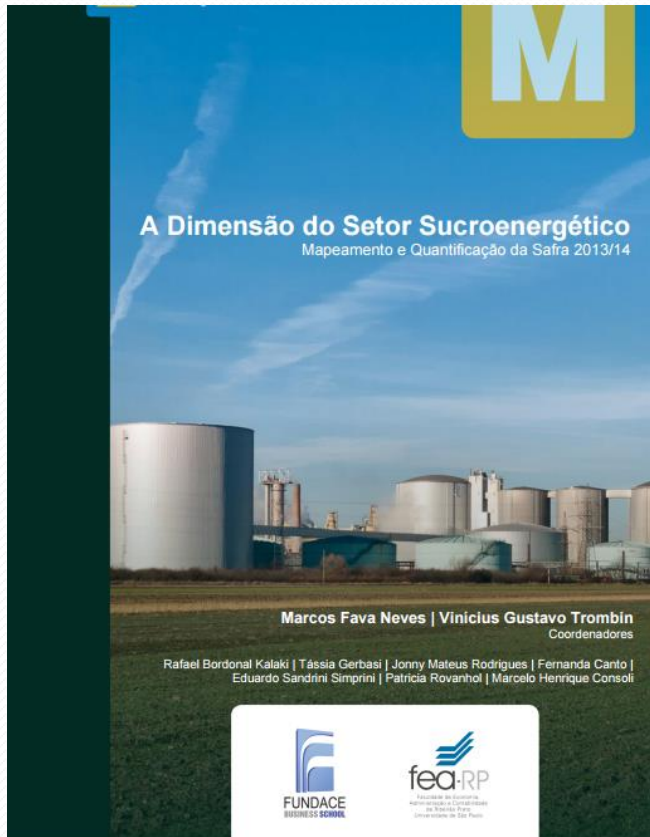
f- Estimativa das vendas de bioplástico produzido a partir de etanol de cana de açúcar.

g- Estimativa das vendas realizadas pelas usinas para a indústria de ração animal.

h- Estimativa dos projetos no mercado de crédito de carbono realizadas pelas usinas.

Fonte: Elaborada pela Markestrat a partir de diversas fontes.

GDP sector = PIB setor  
= 2% Brazil (2013)



**M**

**A Dimensão do Setor Sucroenergético**  
Mapeamento e Quantificação da Safra 2013/14

Marcos Fava Neves | Vinicius Gustavo Trombin  
Coordenadores

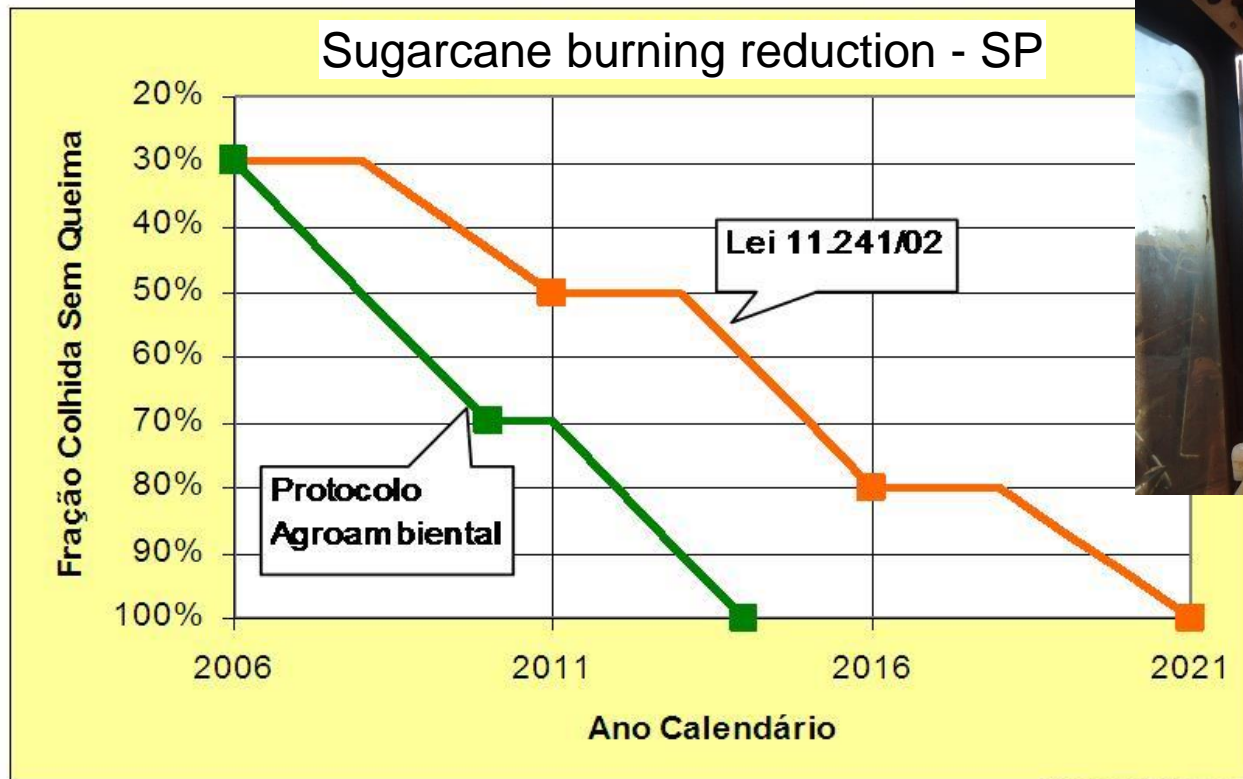
Rafael Bordonal Kalaki | Tássia Gerbasi | Jonny Mateus Rodrigues | Fernanda Canto |  
Eduardo Sandrini Simprini | Patricia Rovanhof | Marcelo Henrique Consoli

FUNDACE BUSINESS SCHOOL

fea-RP  
Faculdade de Engenharia  
de Alimentos e Processamento  
da Universidade de São Paulo

<http://www.unica.com.br/download.php?idSecao=17&id=25818107>

## 21. Phase out of sugarcane burning - Training



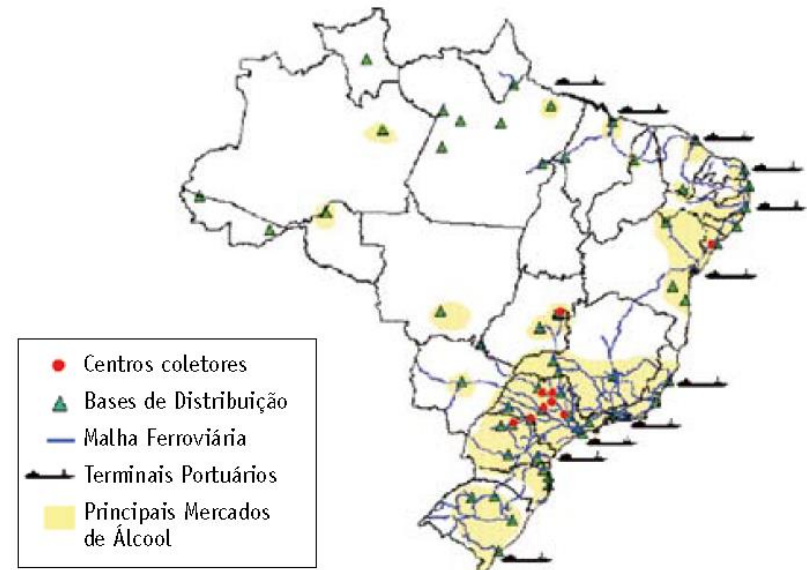
## 21. Requalification - social impacts from mechanized harvesting

- Reduction on the number of jobs in compliance with the elimination of burning.
- Since 2007 Unica associates **retrained more than 5,000 people**.
- Requalification program:
  - Unica, Feraesp and companies in the production chain,
  - support of the Interamerican Development Bank (IADB),
  - 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>)

## 23. Infrastructure and logistic Ethanol distribution system



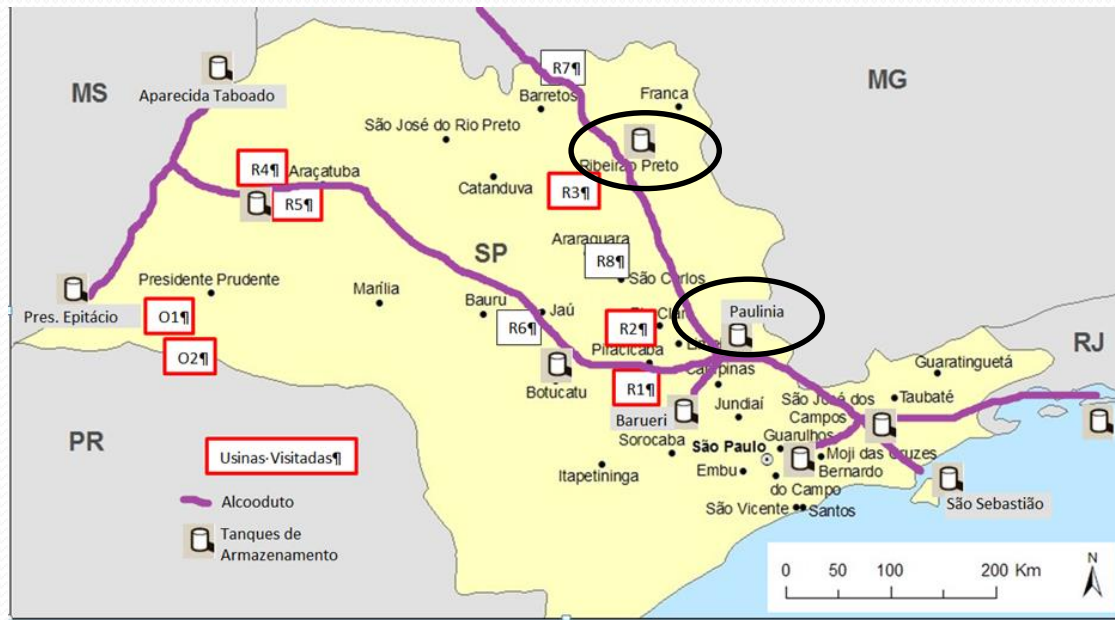
Figura 5 – Infra-estrutura logística da Petrobras



Sao Paulo: Transportation of sugar with **railcars** by Rumo Logística (Grupo Cosan, the world largest independent cane processor, and Grupo São Martinho).

Source: Goldemberg, Coelho, Nastari et al. *Production and Supply Logistics of Sugarcane as an Energy Feedstock*. In Wang, L. (ed), "Sustainable Bioenergy Production", 2013.

## 23. Infrastructure and logistic Logistic - Ethanol pipelines in São Paulo



O1 – Fazenda Conquista do Pontal, Mirante do Paranapanema. Odebrecht  
O2 – Fazenda Alcídia, Teodoro Sampaio. Odebrecht.  
R1 – Fazenda Bom Retiro, Capivari. Raizen.  
R2 – Costa Pinto, Piracicaba. Raizen.  
R3 – Bonfim, Guariba. Raizen.

R4 – Gaza, Andradina. Raizen.  
R5 – Univalem, Valparaíso. Raizen.  
R6 – Fazenda Santo Antônio, Dois Córregos. Raizen.  
R7 – Junqueira, Igarapava. Raizen.  
R8 – Serra, Ibaté. Raizen.

- Logum Co. was formed as a joint venture of Copersucar, Cosan, Petrobras, ETH Bioenergia, and other independent producers.
- To construct and operate a dedicated ethanol pipeline (21.8 billion liters per year when it becomes full operation).
- First section - linking Ribeirão Preto to Paulínia (later on to Ilha d'Água terminal in Rio de Janeiro) - commissioned in March 2013.

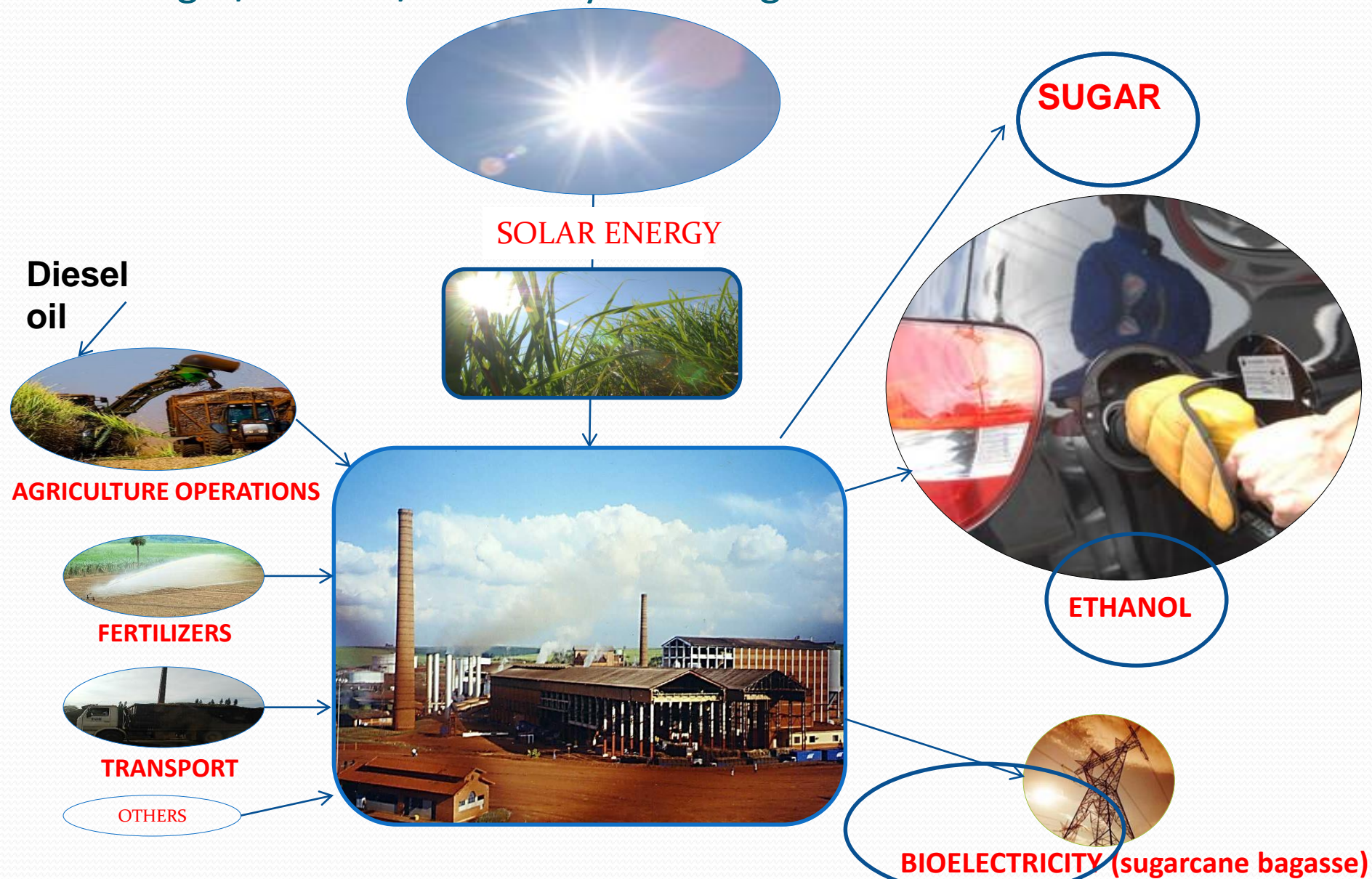
Source: Goldemberg, Coelho, Nastari et al. *Production and Supply Logistics of Sugarcane as an Energy Feedstock*. In Wang, L. (ed), "Sustainable Bioenergy Production", 2013.



# Preliminary comments

- Challenges:
  - Data assessment – technical discussion to allow a good understanding of the methodology
  - Low interest from mills
  - Compatibility of the data – harvesting seasons
  - **Allocation of indicators – three products**
    - **Sugar**
    - **Alcohol**
    - **Electricity**

# Sugar/Ethanol/Electricity from Sugarcane



# Methodology proposed

## Allocation of impacts

- Allocation of impacts – proposed methodology
- Environmental indicators (data source: field assessment)
- Social indicators – (data source: field assessment; desk review for the state of Sao Paulo/Brazil)
- Economic indicators – (data source: desk review for the state of Sao Paulo/Brazil)

- Allocation – energy basis  
(energy content)

	Energy equivalent	% in energy equivalent
Sugar	64.416.667 kcal eq/season	38%
Ethanol	96.243.750 kcal eq/season	56%
Electricity	10.320.000 kcal eq/season	6%
Total	170.980.417 kcal eq/season	100%

Methodology  
proposed for  
impacts allocation

- Allocation – economic basis  
(prices)

	Economic equivalent	Percentage
Sugar	88.191.493,06 R\$/season	45%
Ethanol	94.292.524,74 R\$/season	48%
Electricity	12.066.250,00 R\$/season	6%
Total	194.550.267,80 R\$/season	100%



Gracias!  
Obrigada!

[suani@iee.usp.br](mailto:suani@iee.usp.br)  
[www.iee.usp.br/gbio](http://www.iee.usp.br/gbio)



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