

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

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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)



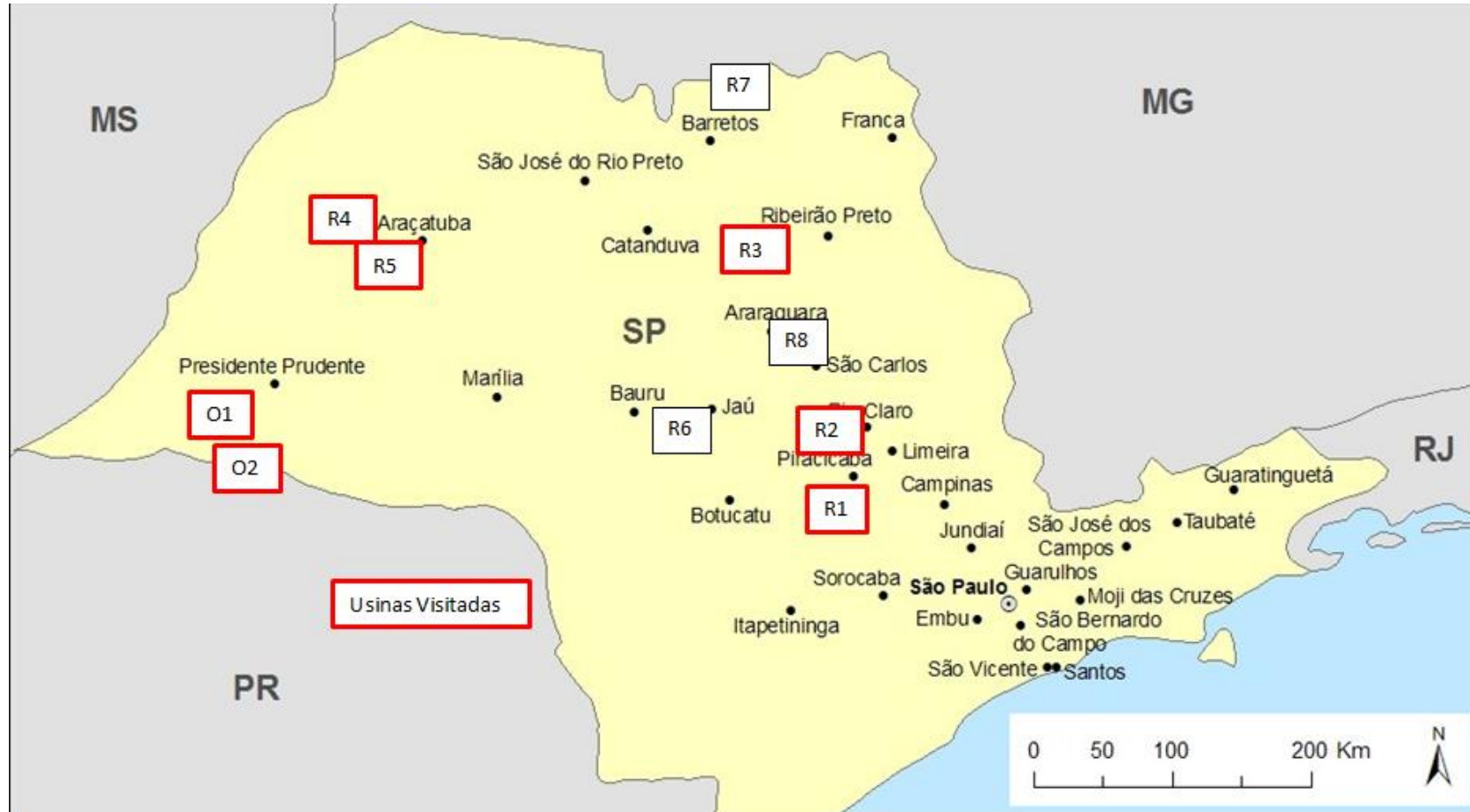
Fig. 3.12 Mechanical harvesting of green cane. (Photo courtesy of Agricef Soluções Tecnológicas Para Agricultura Ltda, Brazil; reprinted with permission)



Activities under development

1. Definition of sugarcane mills (done)
 - 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; (done/under development)
3. Term of Confidentiality signed (done 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)

Field Assessment/Mills

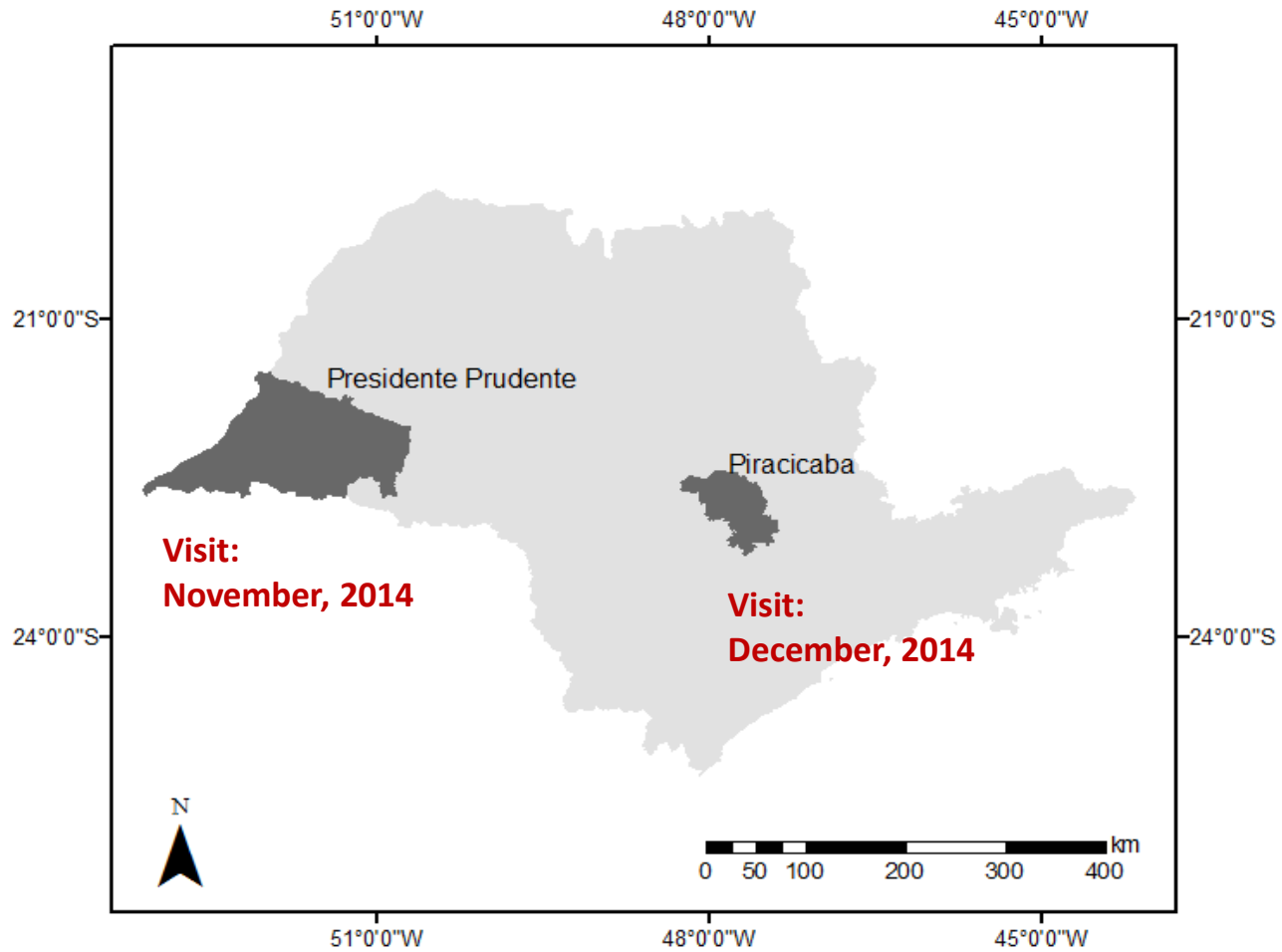


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O1 – Fazenda Conquista do Pontal, Mirante do Paranapanema. Odebrecht
 O2 – Fazenda Alcídia, Teodoro Sampaio. Odebrecht.
 R1 – Fazenda Bom Retiro, Capivari. Raizen
 R2 – Costa Pinto, Piracicaba. Raizen

R3 – Bonfim, Guariba. Raizen
 R4 – Gaza, Andradina. Raizen
 R5 – Univalem, Valparaíso. Raizen
 R6 – Fazenda Santo Antônio, Dois Córregos. Raizen

Location of sugarcane production areas selected by the project



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;
 - Other partners such as Copersucar are being invited.
- For the development of the technical activities, according to the initial proposal, the following groups have started their activities
 - Delta CO₂ – 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 CO₂ 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).

TECHNICAL VISITS

2014

- **Visits to Odebrecht Agroindustrial Mills:**
 - Presidente Prudente / SP (Conquista do Pontal Mill and Alcídia Distillery)
- **Visits to Raízen Mills:**
 - Piracicaba / SP region (Bom Retiro and Costa Pinto)
- **Data assessment:** social and environmental indicators for agricultural and industrial stages of sugarcane and ethanol production, such as: agricultural and industrial productivity, diesel consumption on agricultural and industrial phases, type and consumption of fertilizers, production and use of vinasse, soil quality, topography, water use, power generation, number of workers, labor standards and legislation, among others.

PILLARS		
GBEP's work on sustainability indicators was developed under the following three pillars, noting interlinkages between them:		
Environmental	Social	Economic
THEMES		
GBEP considers the following themes relevant, and these guided the development of indicators under these pillars:		
Greenhouse gas emissions, Productive capacity of the land and ecosystems, Air quality, Water availability, use efficiency and quality, Biological diversity, Land-use change, including indirect effects.	Price and supply of a national food basket, Access to land, water and other natural resources, Labour conditions, Rural and social development, Access to energy, Human health and safety.	Resource availability and use efficiencies in bioenergy production, conversion, distribution and end use, Economic development, Economic viability and competitiveness of bioenergy, Access to technology and technological capabilities, Energy security/Diversification of sources and supply, Energy security/Infrastructure and logistics for distribution and use.
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

N.A.



Environmental Sustainability Indicators

- Under development for the selected mills
- Field assessment
- Desk review

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	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
1. GHG lifecycle emission	Sufficient	Insufficient	Sufficient	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient
2. Soil quality	In progress	In progress	In progress	In progress	In progress	In progress	In progress	In progress
4. Emissions of non-GHG pollutants	In progress	In progress	In progress	In progress	In progress	In progress	In progress	In progress
5. Water use and efficiency	In progress	In progress	In progress	In progress	In progress	In progress	In progress	In progress
6. Water quality	In progress	In progress	In progress	In progress	In progress	In progress	In progress	In progress
7. Biological diversity in the landscape	Insufficient	In progress	Insufficient	In progress	In progress	In progress	In progress	In progress
8. LU and LUC related to Bioenergy feedstock production	Insufficient	Insufficient	Insufficient	Insufficient	In progress	In progress	In progress	In progress



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Social Sustainability indicators

N.A.

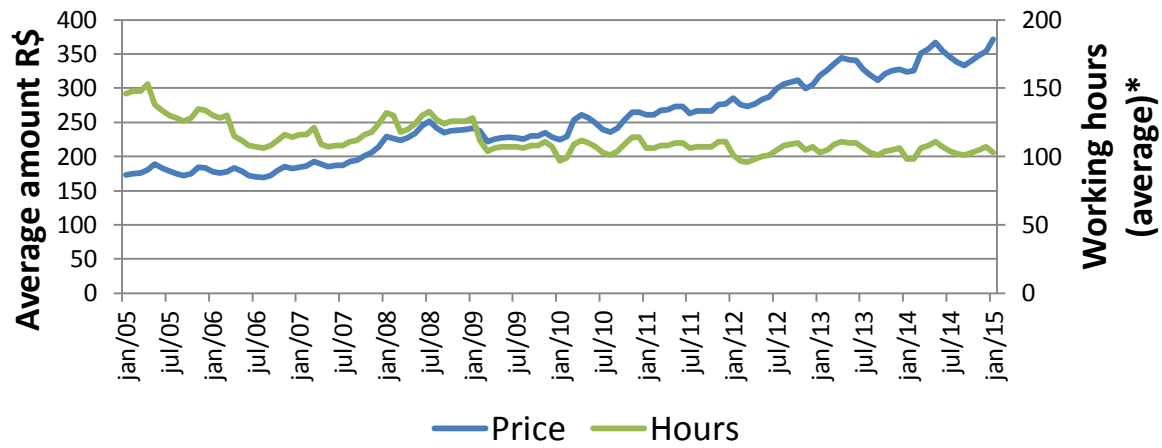
SOCIAL PILLAR

Comparison - Certification Schemes

Indicators	RSB	BSI	GBEP
Economic performance	X	X	X
Economic impacts on the local community	X		X
Social benefits to the local community	X		X
Efficiency and energy balance	X	X	X
Human rights	X	X	
Land use	X		X
Work conditions (ILO)	X	X	X
Health and safety	X	X	X
Freedom of association and negotiation (contracts)	X	X	X
Discrimination (ILO)	X	X	X
Wages	X	X	X
Workings hours	X	X	
Child labour	X	X	X
Forced labour (ILO)	X	X	X
Training, capacity building		X	X
Food Security	X		X
Legal issues		X	X

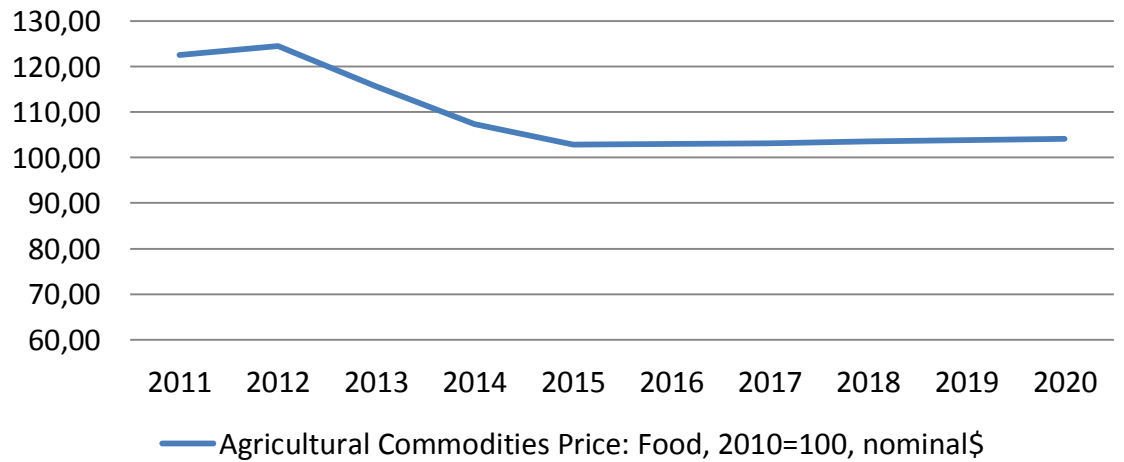
10. Price and supply of a national food basket

Real value of the food basket in the State of São Paulo (DIEESE 2015)



Forecasting of agricultural food commodity prices

Source: World Bank (2015)



SOCIAL PILLAR

10. Price and supply of a national food basket

Summary of main agricultural products produced in São Paulo and their representativeness in gross value of agricultural production in São Paulo

	Average 2002/11
SUGARCANE	53,35%
ORANGE	14,29%
CORN	5,28%
ROUNDWOOD	4,56%
SOYBEAN	3,69%
COFFEE	3,54%
POTATO	2,26%
TOMATO	1,91%
BEAN	1,84%

Source: CEPEA/USP(2015)

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ECONOMIC PILLAR

- The economic pillar involves the economic feasibility and competitiveness of bioenergy; access to technology and technological capabilities; energy security and diversification of sources; energy supply and infrastructure and logistics for distribution and use;
- Activities performed: Literature review of the indicators of sustainability of the economic pillar of GBEP (indicators 17 to 24), also including indicator 10 (social pillar).

ECONOMIC PILLAR

Indicator	Description	Data Needed	Practical Data	Reviews
17	Industrial and agricultura productivity	Productivity of bioenergy feedstocks; processing efficiencies (industrial); production cost	Agricultural productivity (Brasil/SP) tc/hectare; industrial productivity (liters/tc); global (liters/hectare); production costs (USD/liter (anhydrous); USD/liter (hydrous))	
18	Net energy balance	Energy ratio of bioenergy value chain		updated values for Brazil / Sao Paulo
19	Gross value added	Gross value added (GVA) per unit of bioenergy produced and as % of gross domestic product	Value of output less the value of intermediate consumption (inputs and raw materials)	USD/litro; % GVA/GDP (to be developed)
20	Change in the consumption of fossil fuels and readitional use of biomass	NOT APPLICABLE		
21	Training and requalification of workforce	Percentage of trained workers in bioenergy sector out of total bioenergy workforce and % of requalified workers	Number of employed workers in bioenergy sector per year; number or workers trained; number of requalified workers per year; number of jobs lost in the bioenergy sector per year (due to mechanical harvesting)	Brazil/SP
22	Energy diversity	Change in diversity of total primary energy supply due to bioenergy	MJ of bioenergy per year in Total Primary Energy Supply (TPES); % of bioenergy on TPES	Brazil and SP
23	Infrastructure and logistics for the distribution of bioenergy	Number and capacity of routes for distribution system	Number and capacity of port facilities; capacity for handling and storage; number and capacity of pipelines	(Brazil/SP, includes ethanol pipeline and transportation by train)
24	Capacity and flexibility of use of bioenergy	Ratio of capacity for using bioenergy compared with actual use for each significant utilization route	Capacity for bioenergy use	number of (flex) vehicles; number of pump stations (?); installed power in the sector (Brazil/SP); electricity surplus generated

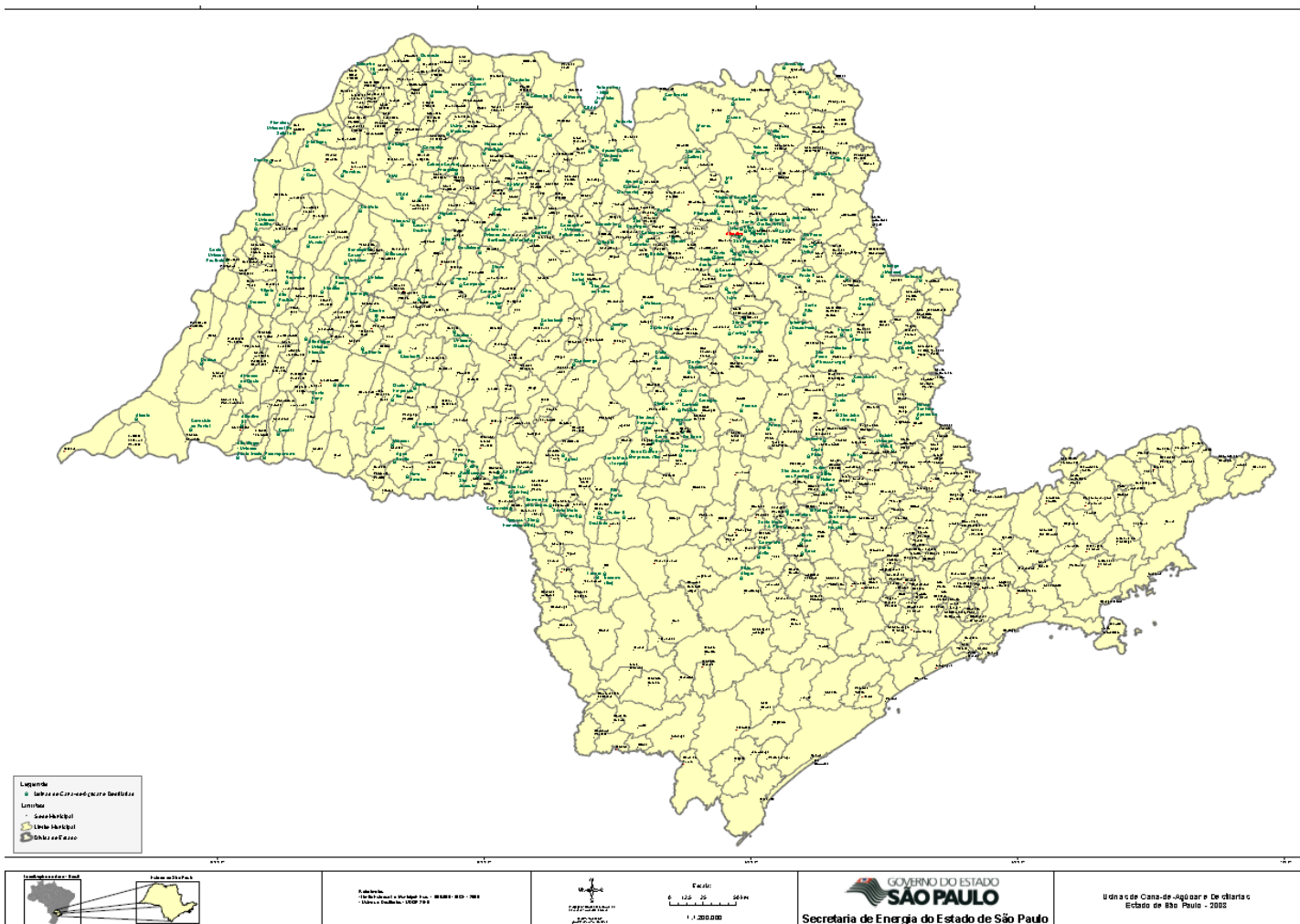
ECONOMIC PILLAR

- **UNICA, also a partner of this project, is contributing to general data from the sector for the economic indicators:**
 - Indicator 17: Agricultural productivity; Industrial productivity; Global productivity
 - Indicator 19: Number of jobs in bioenergy sector per year (Brazil and SP);
 - Indicator 22: Total Primary Energy Supply (TPES); Primary energy supply – Brazil;
 - Indicator 23: Number and capacity of port facilities; Capacity for handling and storage;
 - Indicator 24: Number of flex fuel vehicles; Number of pump stations; Installed power in the sector (Brazil and SP); Electricity surplus generated
 - **Indicator 19 Gross value added (??)**
- **At present: Assessment of data for the calculations of the indicators**
 - Indicator 17: Evaluation based on data supplied by the mills - Confidential Agreement (Raizen and Odebrecht)
 - Indicators 18, 21 to 24: collecting data
 - Indicator 20: not applicable in Brazil

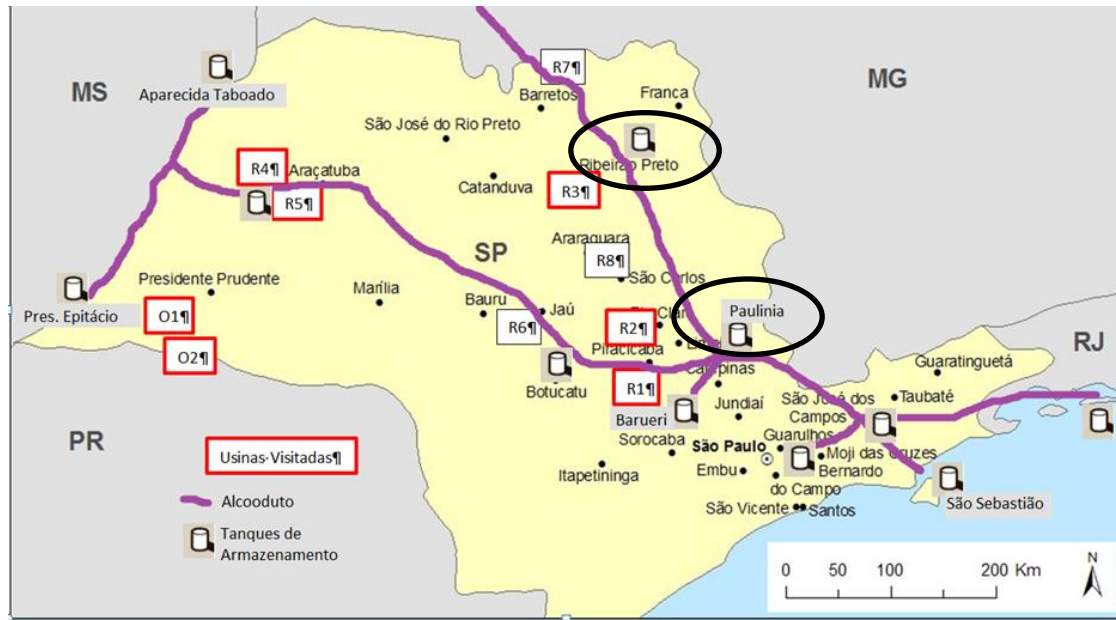
21. Requalification - social impacts from mechanized harvesting (desk review)

- 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 Sugarcane mills in São Paulo State



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



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 R6 – Fazenda Santo Antônio, Dois Córregos. Raizen.
 R7 – Junqueira, Igarapava. Raizen.
 R8 – Serra, Ibaté. Raizen.

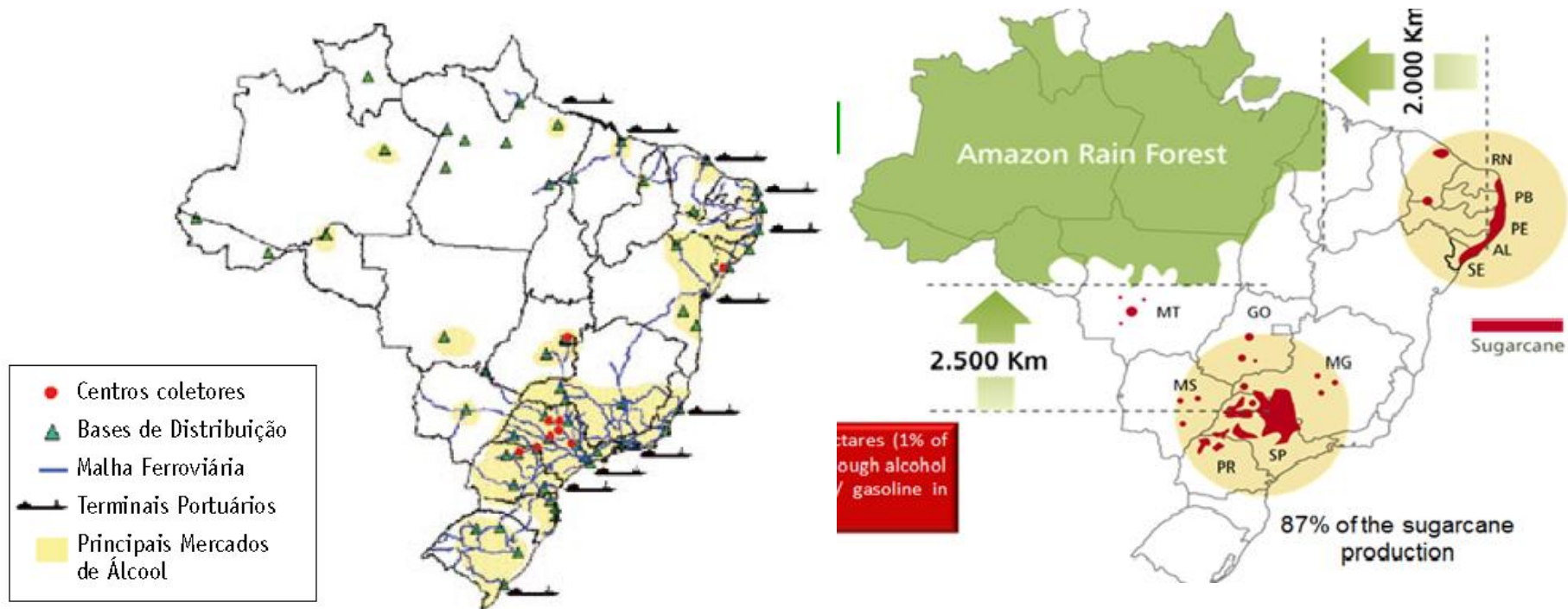
- Logum Co. was formed as a joint venture of Copersucar, Cosan, Petrobras, ETH Bioenergia, and other independent producers.
- To construct and operate a dedicated ethanol pipeline (21.8 billion liters per year when it becomes full operation).
- First section - linking Ribeirão Preto to Paulínia (later 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.

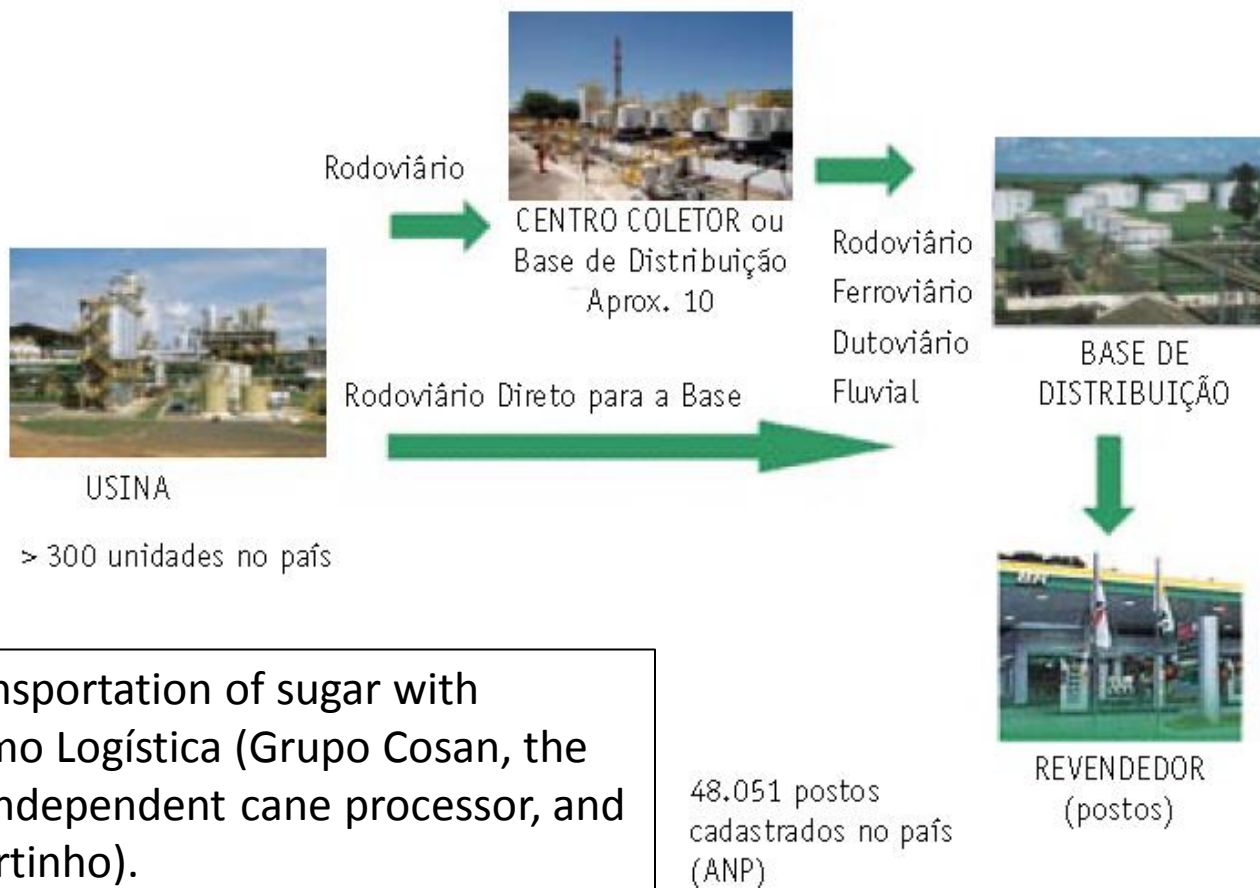
23. Infrastructure and logistics

Petrobras fuel distribution system

Figura 5 – Infra-estrutura logística da Petrobras



23. Infrastructure and logistic Ethanol distribution system



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.

48.051 postos cadastrados no país (ANP)

Preliminary comments

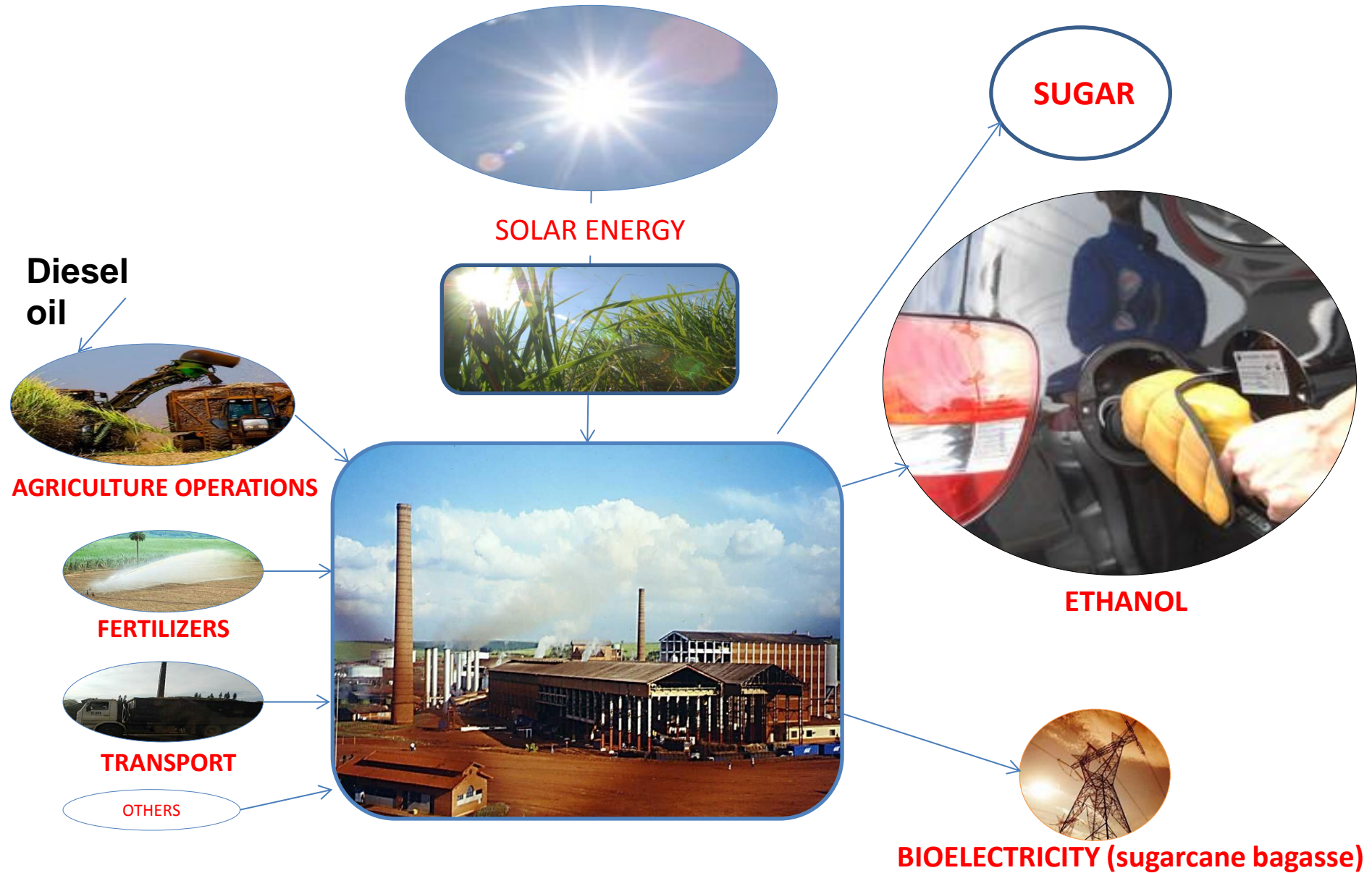
- Challenges:
 - Data assessment – technical discussion to allow a good understanding of the methodology
 - Production costs ?
 - Compatibility of the data – harvesting seasons
 - **Allocation of indicators – three products**
 - **Sugar**
 - **Alcohol**
 - **Electricity**

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)

Sugar/Ethanol/Electricity from Sugarcane



Methodology proposed for impacts allocation

Study case for an average sugarcane mill

SUGARCANE CRUSHED		300	tc/h
SUGAR PRODUCTION		17	t/h
ETHANOL PRODUCTION	anhydrous	7375	litters/h
	hydrous	7375	litters/h
ELECTRICITY TO THE GRID		40	kWh/tc

To be adapted to each mill

Allocation methods

- Energy basis

Sugar		3865kcal/kg
Anhydrous ethanol		6750LHV (kcal/l)
Hydrous ethanol		6300LHV (kcal/l)

- Economic basis (average prices in September 2014)

Sugar		1,0367	R\$/kg
Hydrous ethanol		1,1683	R\$/litter
Anhydrous ethanol		1,3366	R\$/litter
			R\$/MWh
Electricity		197	(marginal expansion cost)

- Allocation – energy basis

	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%

- Allocation – economic basis

	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%

Mills in SP State (preliminary)

	Energy equivalent		Percentage
	kcal eq/season		
Sugar	3,46118E+11		32,3%
Ethanol	6,3222E+11		59,0%
Electricity	93740000000		8,7%
Total	1,07208E+12		100,0%

	Energy equivalent		Percentage
	kcal eq/season		
Sugar	647.213.575.000		42,5%
Ethanol	740.678.850.000		48,7%
Electricity	134.160.000.000		8,8%
Total	1.522.052.425.000		100,0%

	Economic equivalent		Percentage
	R\$/season		
Sugar	92.838.558		39,4%
Ethanol	121.352.385		51,5%
Electricity	21.473.000		9,1%
Total	235.663.944		100,0%

	Economic equivalent		Percentage
	kcal eq/season		
Sugar	173.600.599		50,1%
Ethanol	142.170.609		41,0%
Electricity	30.732.000		8,9%
Total	346.503.208		100,0%

NEXT STEPS

- Evaluation of the environmental, social and economic indicators for each mill and for the region
- Discussion of the results
- Preparation of the final report
- Organization of the Final Workshop



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THANKS!
OBRIGADA!



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