Bioenergy How2Guide

Biomass Resources and Bioenergy Potential in South America – Focus on Biofuels

Session 4 – Technology Focus – Prospects and Market

Application of GBEP indicators to sugarcane bioethanol production

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Ministry of Mines and Energy of Brazil

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

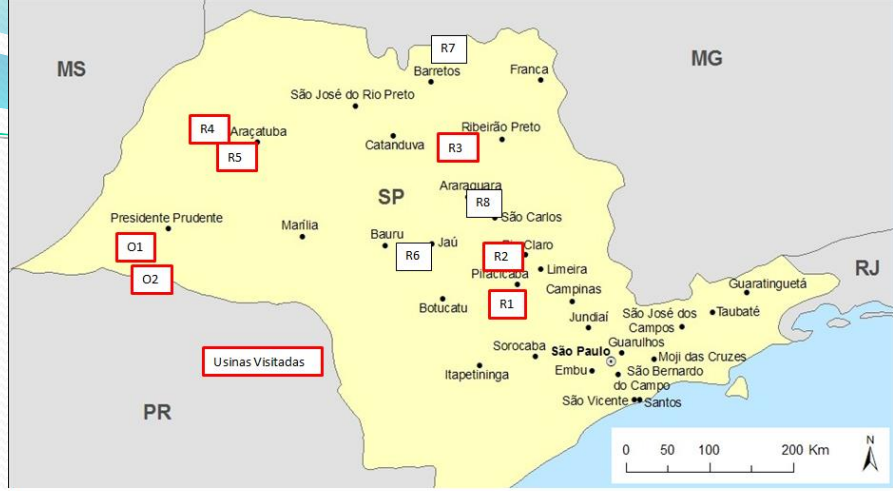
(2014-2016 – CENBIO/IEE/USP)

- 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 Tecnologicas Para Agricultura Ltda, Brazil; reprinted with permission)


N
W
E
S
0 1.000 2.000 3.000 4.000 Kilometers
GOIAS
MINAS GERAIS
MATO GROSSO DO SUL
Sertaozinho
Ribeirão Preto
SÃO PAULO
Araçatuba
PARANA
Atlantic Ocean
BRASIL
SANTA CATARINA
RIO GRANDE DO SUL


280 Km
Belo Horizonte
Araçatuba
Ribeirão Preto
Rio Paraná
São Paulo
Recent expansion
Traditional plants
Rio de Janeiro
Rio de Janeiro
São Paulo



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- Mills to be evaluated:
  - Ribeirao Preto/Piracicaba/Sertaozinho (traditional area)
  - Pontal do Paranapanema (recent expansion on cattle area - 2002 – 2008)
- Partners: Odebrecht and Raizen
- Harvesting seasons:
  - 2012/2013
  - 2013/2014
- Results to be presented consolidated for each region

Sugar/Ethanol/Electricity from Sugarcane

SOLAR ENERGY

SUGAR

Diesel oil

AGRICULTURE OPERATIONS

ETHANOL

FERTILIZERS

TRANSPORT

OTHERS

BIOELECTRICITY (sugarcane bagasse)

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

Preliminary Results

- Allocation – energy basis (energy contente)

	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 (prices)

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

Not applicable

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

Sustainability Indicators

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

Environmental indicators
Desk review

1. GHG	89% REDUCTION COMPARED TO GASOLINE	
2. SOIL QUALITY		
3. HARVEST LEVELS OF WOOD RESOURCES	NOT APPLICABLE	
4. EMISSIONS OF NON GHG	AGROCHEMICAL CONSUMPTION	90,2 (Sugarcane)-208,5 (corn) (kg/m3)
5. WATER USE	5m3/tc(1997)-0,85m3/tc(2010)	
6. WATER QUALITY		
7. BIODIVERSITY	riparian forests mandatory in SP	
8. LAND USE CHANGE	EXPANSION OVERCATTLE AREAS (SP)	1,28(2001)-1,56 (2008) heads/hectare
9. ALLOCATION AND LAND TENURE	Sugarcane suppliers: 40% of all sugarcane processed	

Field Assessment
(next steps-under development)

Dados das usinas (últimas duas safras) - Unidades	U1	U2	U3	U4	U5	U6	U7	U8	U9
Dados gerais									
Cana moída nas últimas duas safras (ton cana)									
Cana própria (ton de cana)									
Cana de fornecedores (ton de cana)									
Produção de açúcar (toneladas)									
Produção de Álcool (litros)									
Área Total da usina (plantação cana, preservação, usina)									
Área plantada (hectares)									
Área de cana própria (hectares)									
Área de fornecedores (hectares)									
Qdade de fornecedores									
Área (ha) processada de cana/dia									
Localização da usina (coordenadas geográficas)									
Teor médio de sacarose (pol)									
Diesel usado (litros/safra) caminhões, colheitad., tratores									
Fertilizantes nome (por safra)									
Fertilizantes (quantidade t por safra)									
Vinhaça na fertirrigação (m3/ha)									
Bagaço para caldeiras total (t/ano)									
Bagaço para caldeiras (ton/hora)									
Bagaço vendido para terceiros (t/safra)									
Vapor de processo -"vapor vivo" (ton/hora)									
Energia mecânica usada (kWh por ton/cana)									
Energia elétrica (kWh ton/cana)									
Excedente de eletricidade (kWh médio vendido p/ rede por mês e por safra)									
Quantidade de dias da safra 2013/2014									
Potência instalada - produção de eletricidade (MW)									

Some figures updated...

8. LUC - Evolution of the pasture area in the State of Sao Paulo
Desk review

	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

Source: Secretaria de Estado de Agricultura. Elaboration: Cenbio

Example of preliminar results

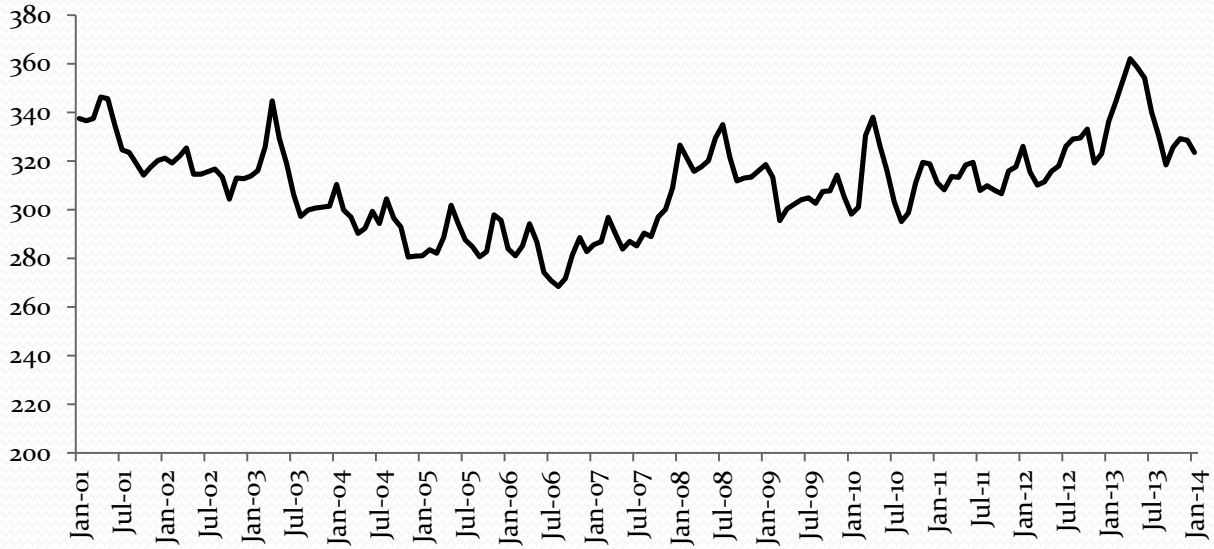
10. Price and supply of a national food basket

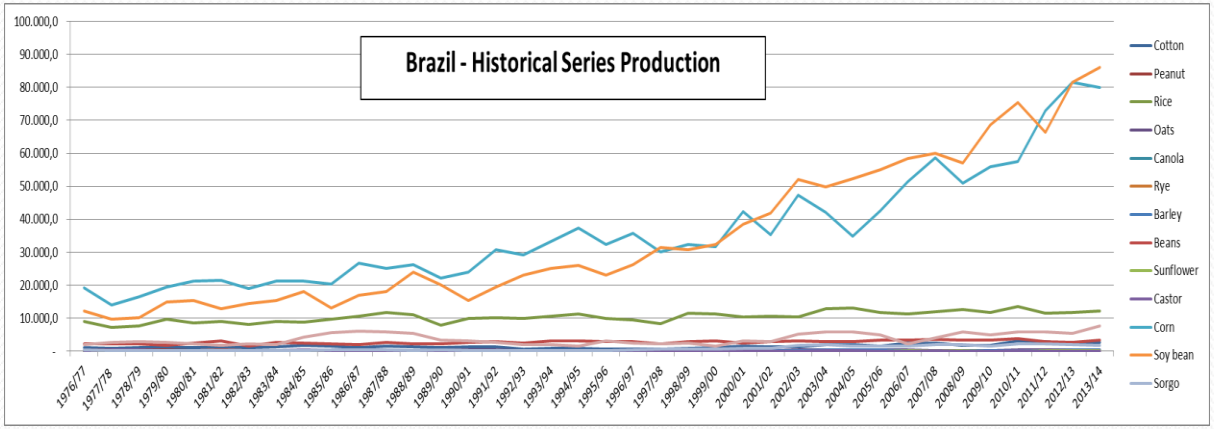
National food basket - São Paulo

Food	amount
Meat	6kg
Milk	7,5kg
Bean	4,5kg
Rice	3kg
floor	1,5kg
potato	6kg
vegetables	9kg
bread	6kg
coffee	600g
Fruits (banana)	90unid.
Sugar	3Kg
Oil	750g
Butter	750g

Source: Dieese (2014)

Real value of the food basket in the State of São Paulo (prices of jan / 14)

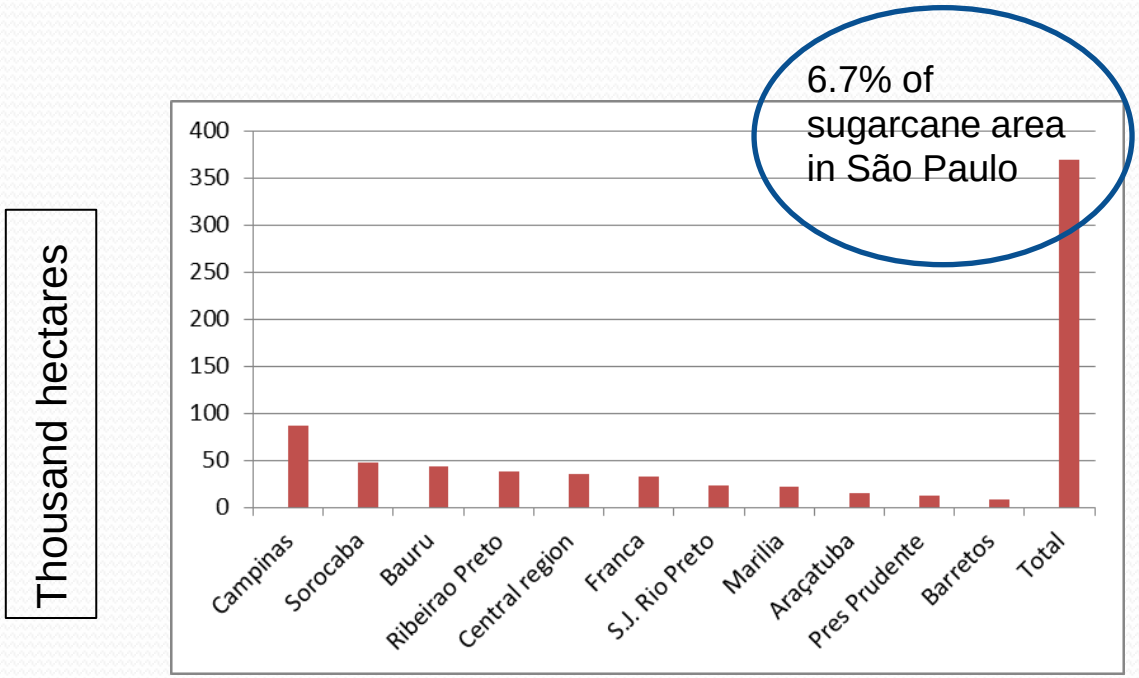




21. Social impacts from mechanized harvesting

Elimination of sugarcane crops in the state of São Paulo
Slopes higher than 12%

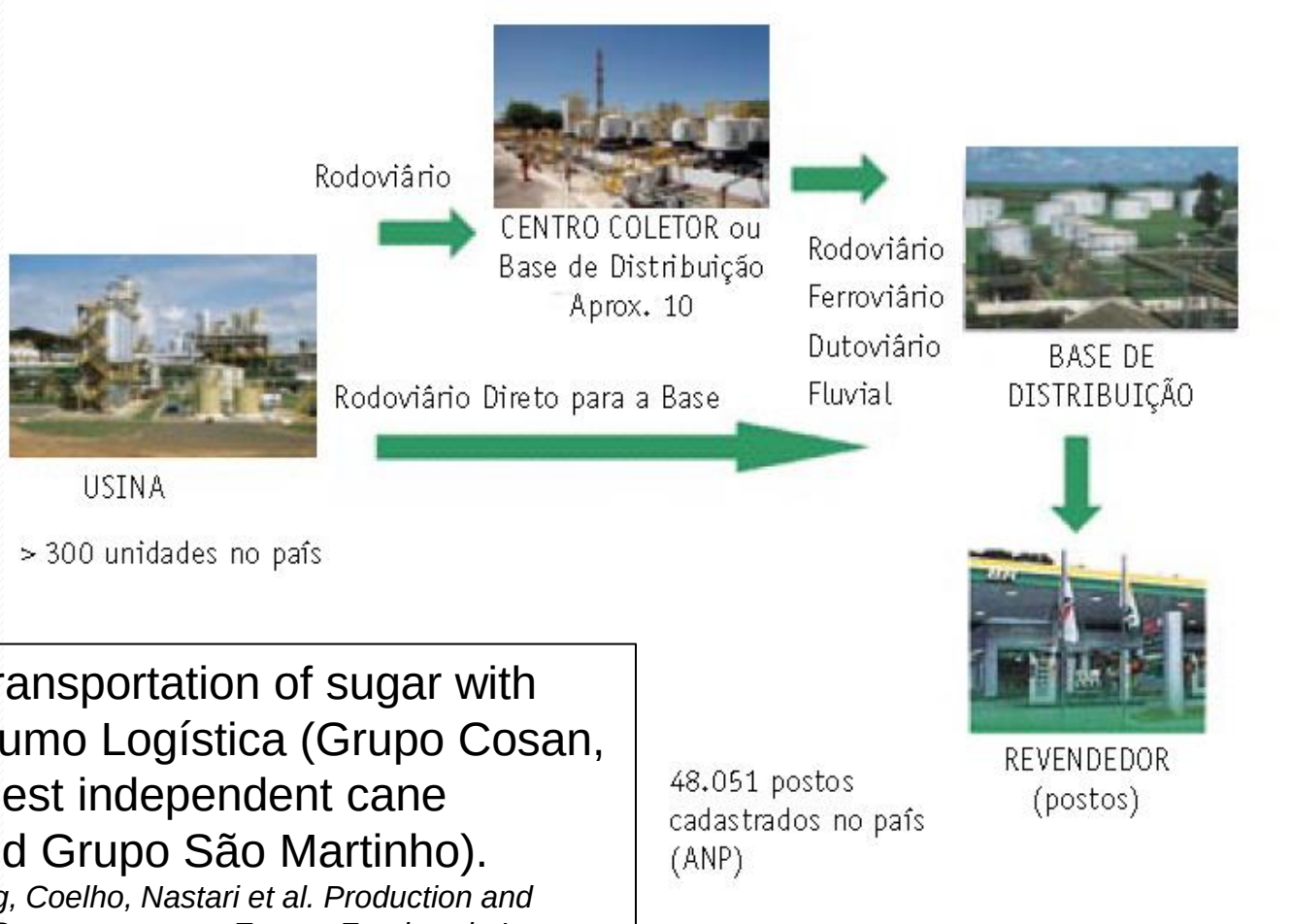
Other crops?
Or
New harvesting machines for slopes higher than 12%?



Source: Embrapa/FIESP (2014)

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

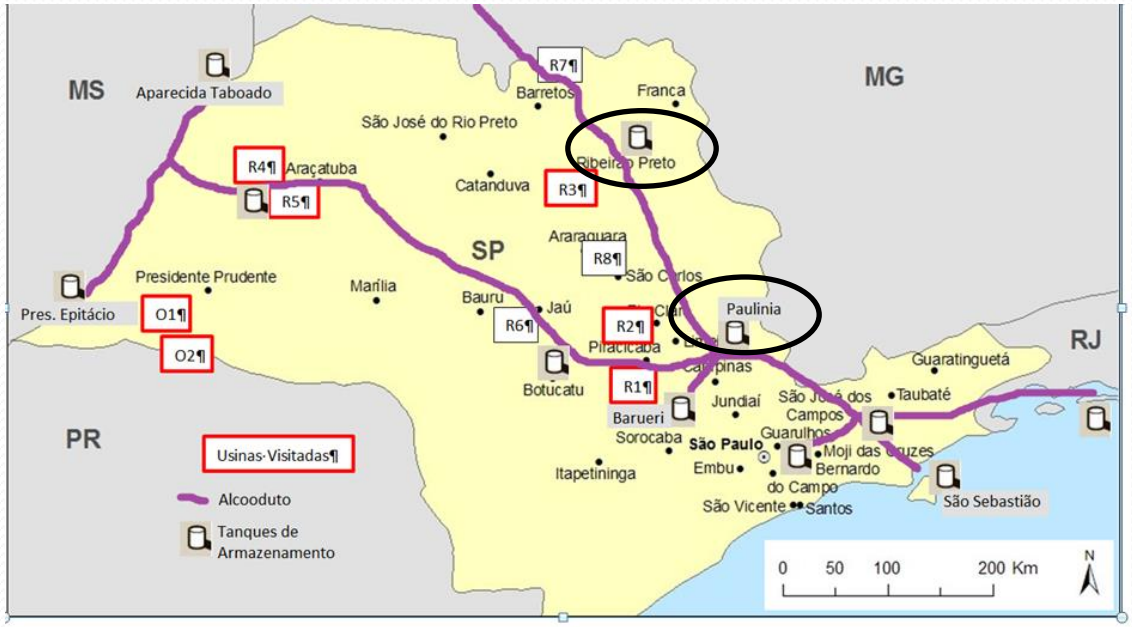
23. Infrastructure and logistic Ethanol distribution system



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.

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



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R7 – Junqueira, Igarapava. Raizen.
R8 – Serra, Ibate. 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 litters per year when it becomes full operation).
- First section - linking Ribeirao Preto to Paulinia (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.

Next steps

- Field visits - Data assessment for each selected mill (under development)
- Evaluation of indicators for each mill
- Comparison with data available from desk review
- Comparison of the average figures between the two regions
  - Araçatuba/Pontal do Paranapanema (nov-14)
  - Ribeirao Preto/Piracicaba (dec-14)

Timetable

	Timetable 18months																	
	2014					2015												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2014-2015	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Preliminary report (Primeira parcela)	X																	
Desk review	X	X	X	X	X													
Definition of technical experts	X	X																
Contact to mills and stakeholders		X	X	X														
Field visits					X	X	X	X	X	X	X							
GBEP meeting					Rome								X			X		
Selection of indicators				X	X	X												
Evaluation of environmental indicators						X	X	X	X	X	X	X	X	X	X			
Evaluation of social indicators							X	X	X	X	X	X	X	X	X	X		
Evaluation of economic indicators							X	X	X	X	X	X	X	X	X	X		
Workshops with stakeholders									x					x				Final
Intermediate reports						X				X				X				
Final report																		X

Thanks!

Obrigada!

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