

The environmental sustainability of ethanol production from sugarcane

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Agenda

- Introduction
- Energy Balance
- Environment Aspects
 - Air
 - Impacts to air quality
 - Air emissions
 - Water
 - Water use
 - Water pollution
 - Land use
 - Expansion of sugarcane
 - Land competition: food versus fuel
 - Soil
 - Biodiversity
- Conclusions

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Introduction - The Brazilian Alcohol Program

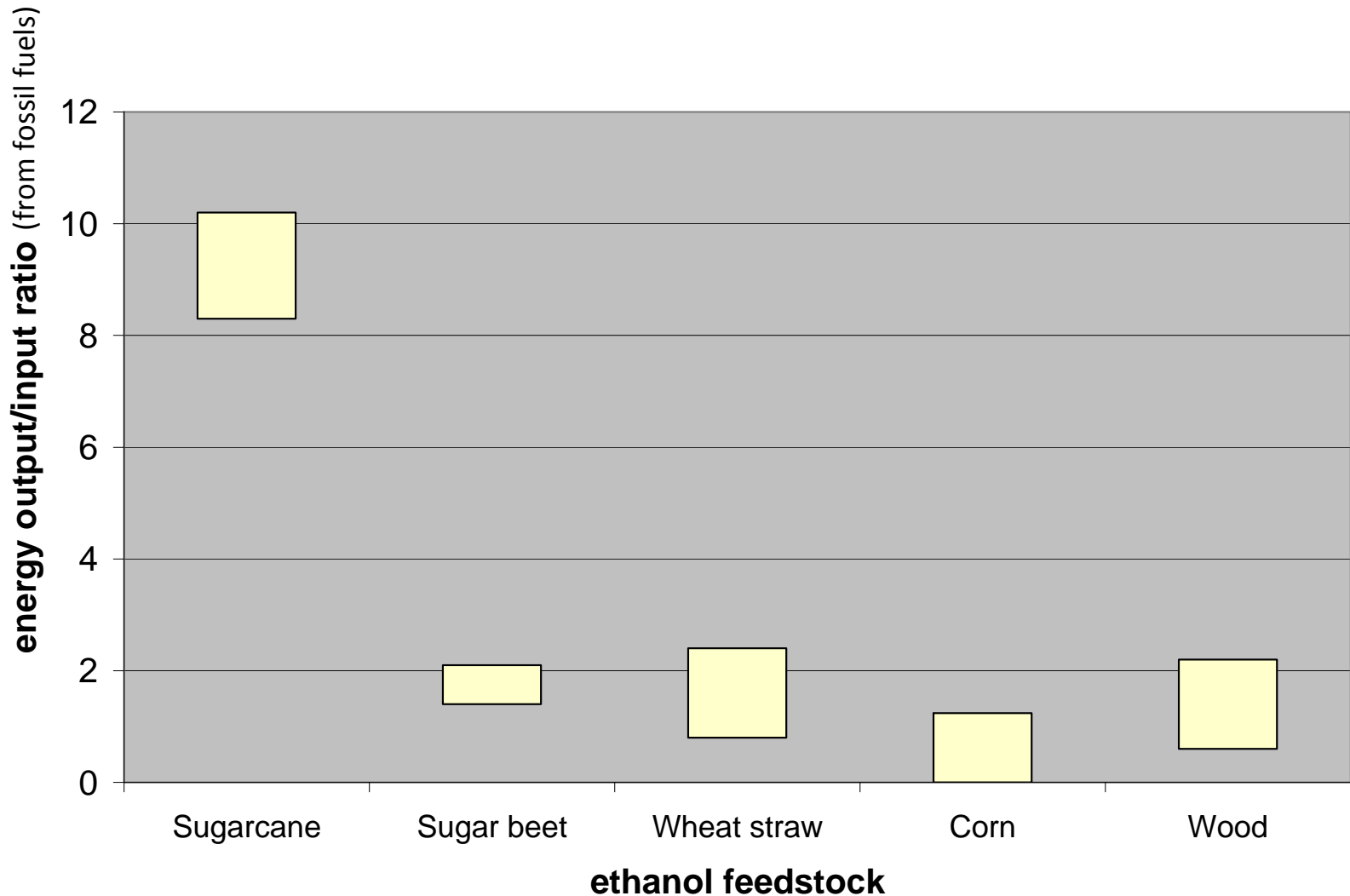
- The world largest commercial program on biomass
- Started in 1975 by Federal Government
- Decision from Brazilian Federal Government to produce ethanol in addition to sugar (from sugarcane): objective of reducing petroleum imports (Gulf War).
- High-octane fuel in vehicles, replacing and/or MTBE.
- 1,300,000 cars running on pure ethanol in Brazil
- 4,600,000 flex-fuel vehicles (both gasoline, any blend)
- all gasoline blended with (anhydrous) ethanol: 20 to 26% of ethanol in volume basis – gasohol
- Nowadays - economically competitive to gasoline



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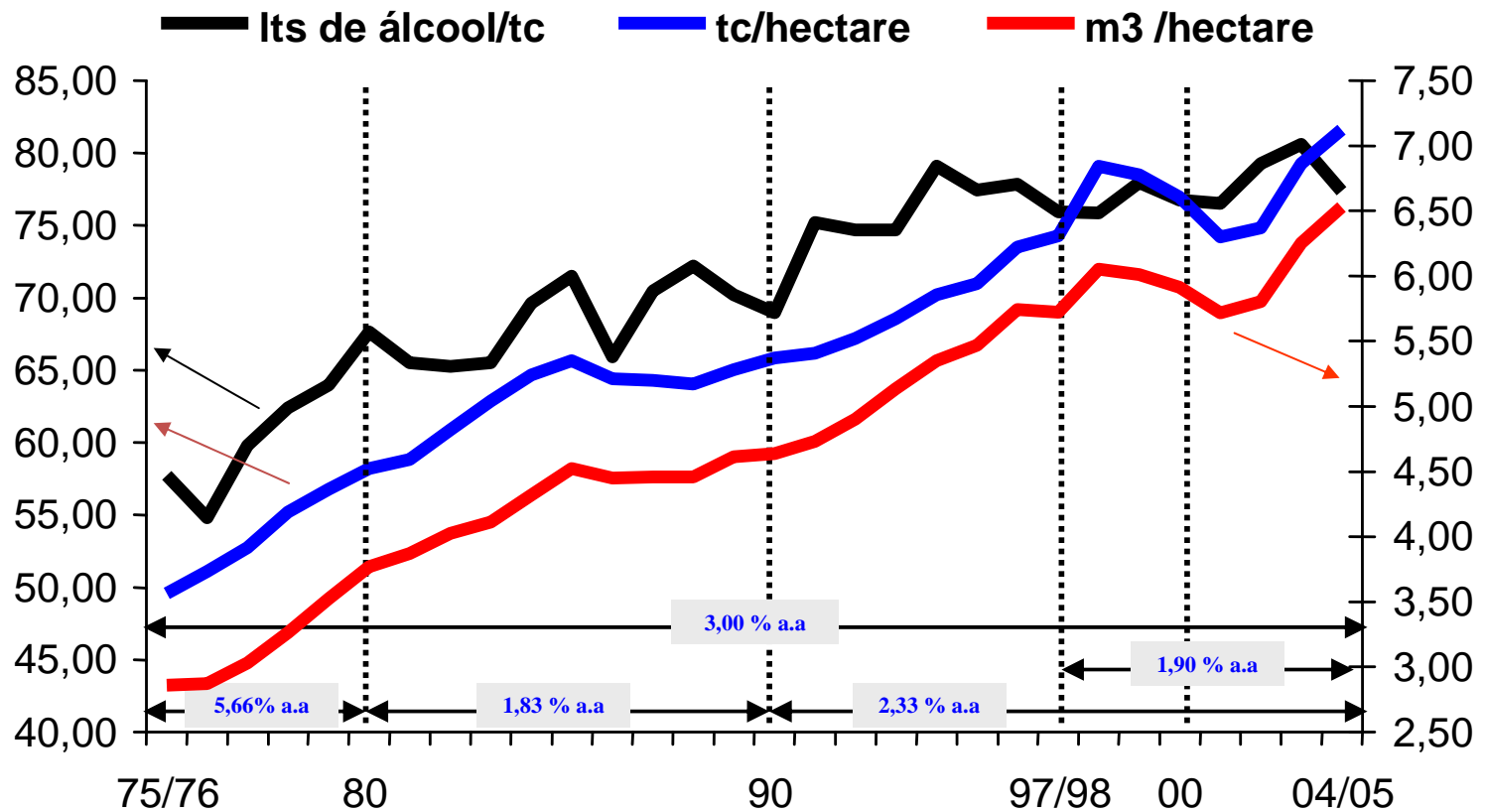
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Energy balance of alcohol production from different feedstocks



Sources: (Macedo et alii, 2004; UK DTI, 2003 and USDA, 1995)

Productivity curves for Ethanol, and Sugarcane in Brazil



(Rodrigues, Unicamp 2005).

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Pollutants Concentration in SP Metropolitan Region

- Lead: dropped from 1,4 $\mu\text{g}/\text{m}^3$ in 1977 to less than 0,10 $\mu\text{g}/\text{m}^3$ in 1991.
- Sulphur: dropped from 50 $\mu\text{g}/\text{m}^3$ in 1984 to 15 $\mu\text{g}/\text{m}^3$ in 2003.
- Particulate Matter: dropped from 90 $\mu\text{g}/\text{m}^3$ in 1986 to 50 $\mu\text{g}/\text{m}^3$ in 2003.

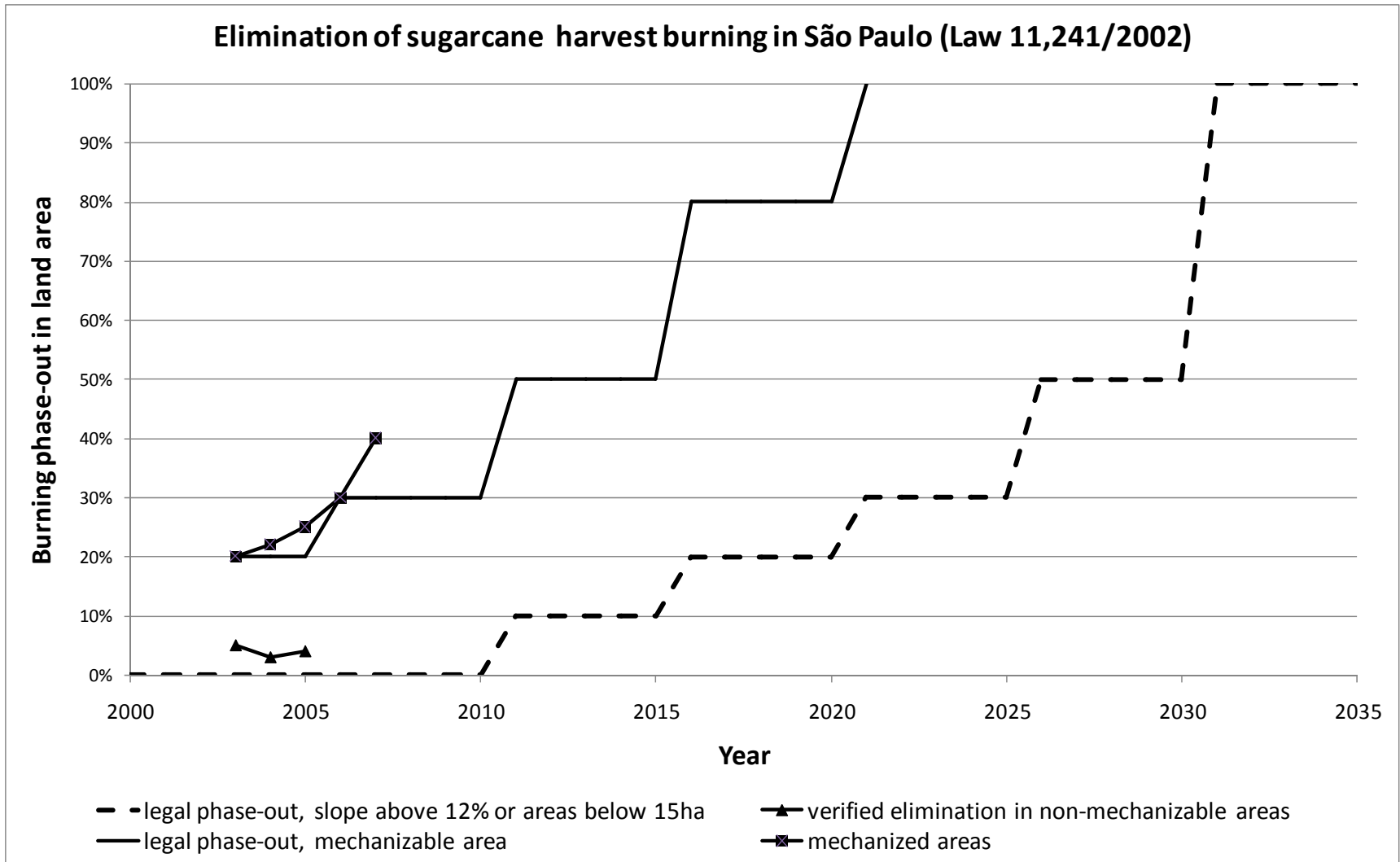
Emissions from bagasse boilers

Thermal power (MW)	PM ¹	NOx ¹ (as NO ₂)
Lower than 10	280	Not applicable
From 10 to 75	230	350
Higher than 75	200	350

¹ Figures in mg/Nm³, dry basis and 8% of excess oxygen.

Source: Resolution CONAMA 382/2006

Sugarcane harvest burning phase out



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Water

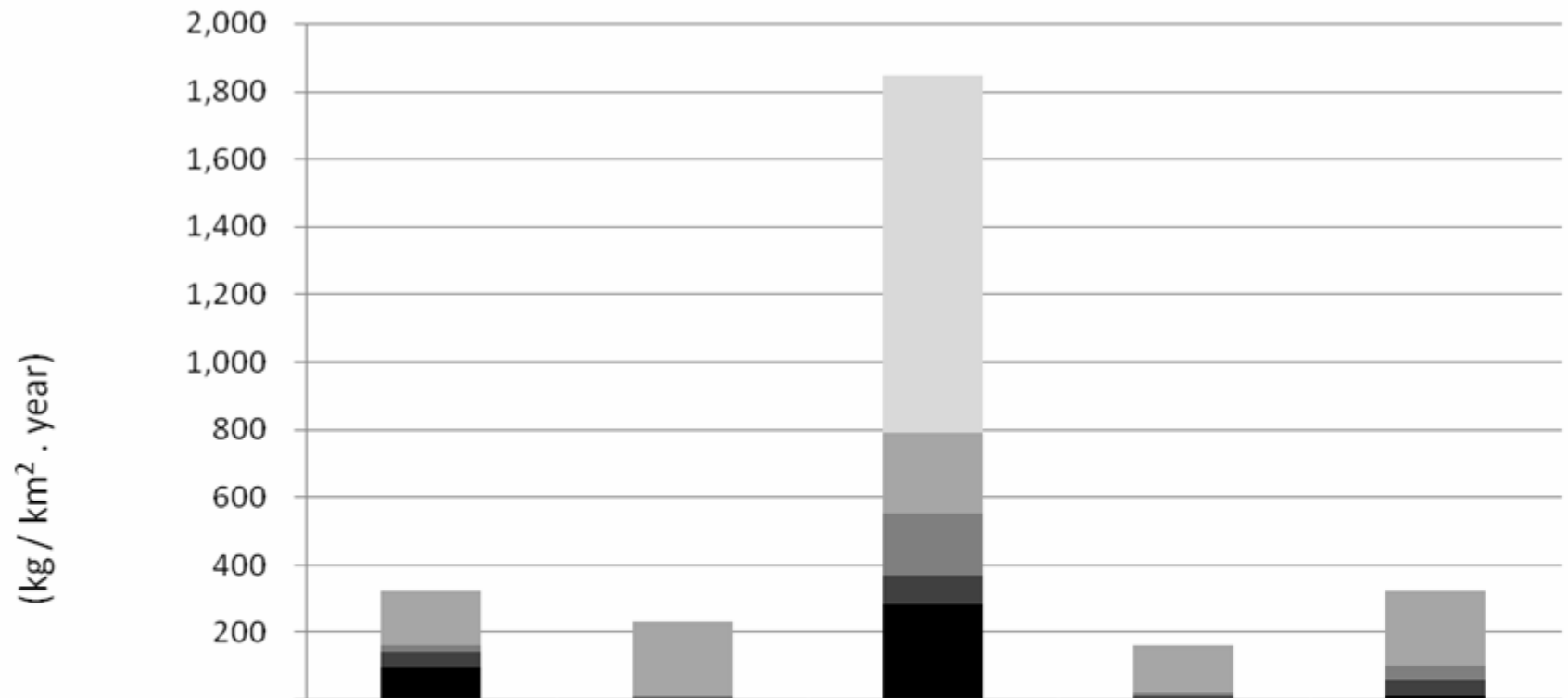
- Use of water:
 - Use for cane production:
 - Rainfall required: 1,500 – 2,500 ml/yr
 - Northeast – irrigation required
 - Use for ethanol production:
 - Total use of water: 21 m³/tonne of cane (1997)
 - Average collection of water (SP): 1.83 m³/tonne of cane

Water

- Water pollution
 - Organic pollutants: vinasse and wastewater.
 - Vinasse:
 - Large amount produced (11 – 14 l/l of ethanol)
 - High organic loads
 - Low pH (4 to 5)
 - CETESB's technical standard regulates its disposal.
 - Inorganic pollutants: agrochemicals

Average Agrochemical Consumption in Different Crops.

Source: CTC, 2007

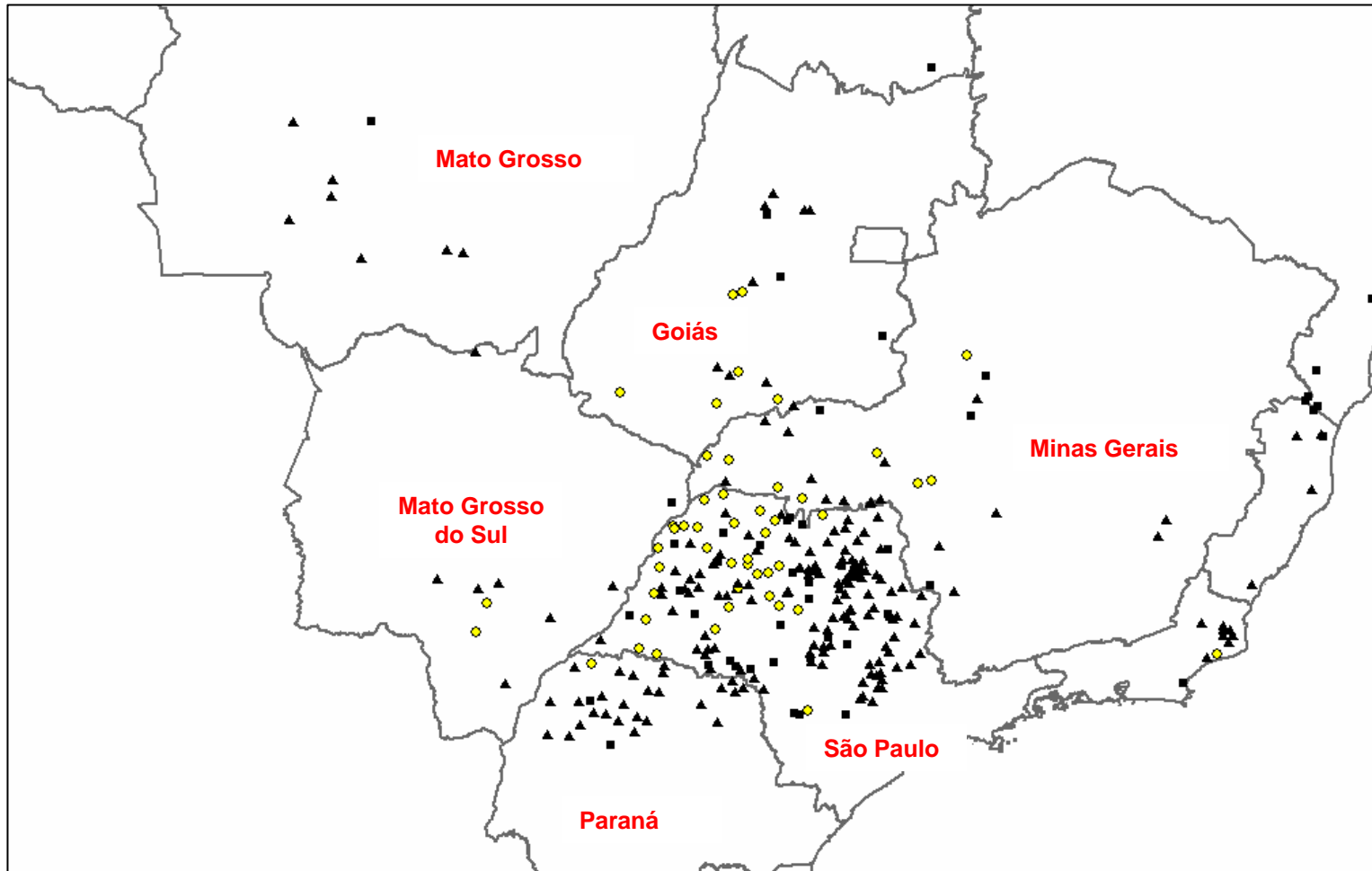


	coffe	sugarcane	citrus	corn	soy
■ miticide	4	-	1,053	-	1
■ herbicide	161	220	239	141	220
■ other pesticides	17	4	182	7	46
■ insecticide	46	11	86	15	43
■ fungicide	99	-	286	1	16

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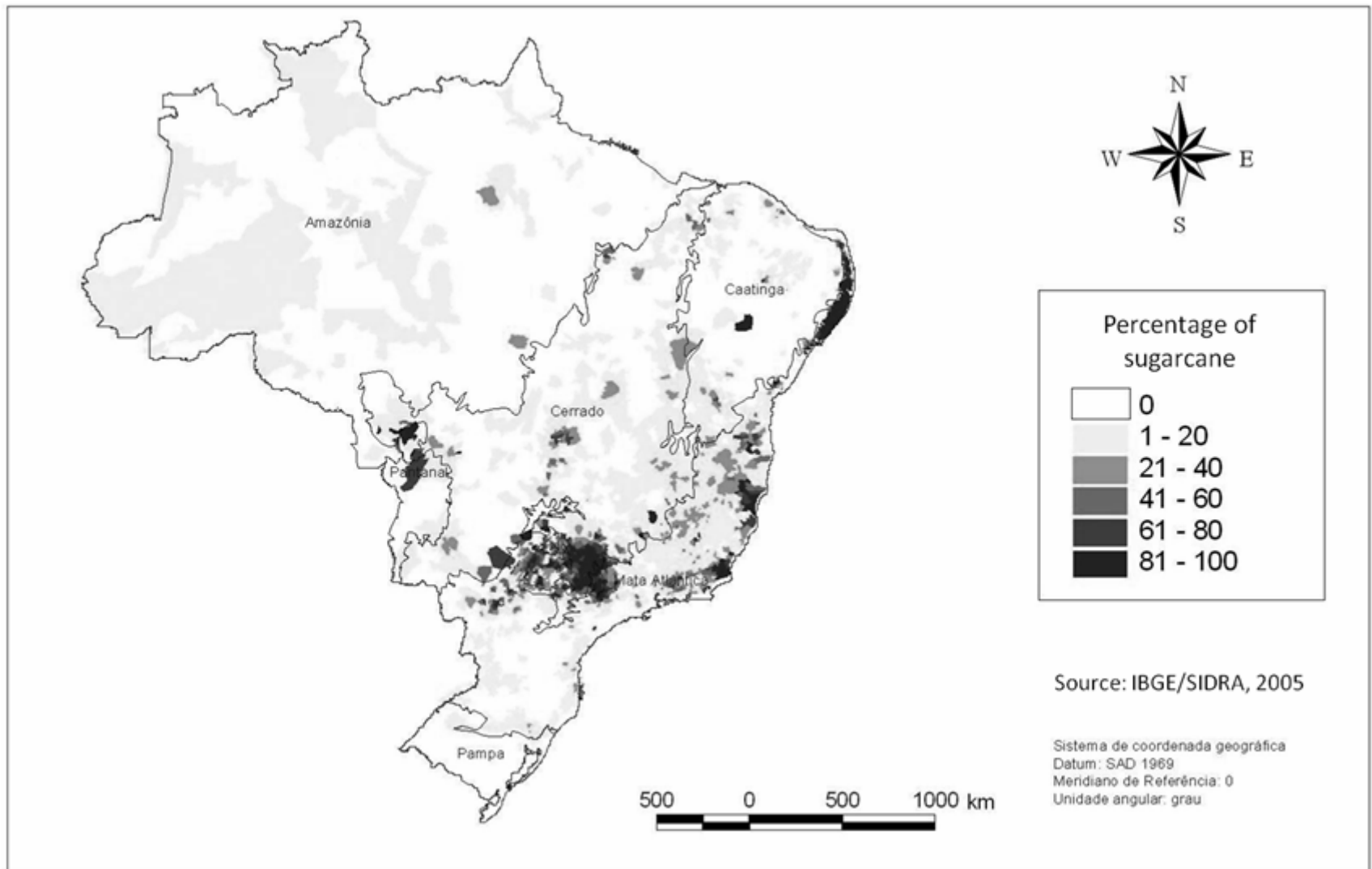
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Location of new mills as expected in the expansion plan (December, 2005)



Note: the dark triangles represent existing mills, the light circles the planned new mills.
Source: Leal, 2007.

Percentage of sugarcane in Brazilian municipalities



*Land use in São Paulo State, 2006
(in thousand square kilometers)*

Sugarcane	43.4	19.70%
Other cultures	35.7	16.21%
SUB-TOTAL CULTURES	79.1	35.91%
Natural forests	32.0	14.53%
Reforestation	11.4	5.17%
SUB-TOTAL FORESTS	45.4	20.61
Pasture land	97.8	44,39%
TOTAL	220.30	100%

Ethanol versus Food Crops

Cattle-breeding in São Paulo State

	2001	2005
Cattle		
(heads)	13.154.649	14.072.447
Pasture		
(hectares)	10.288.887	10.010.491
Density (heads of cattle/hectare)	1,28	1,41

Trend to more intensive cattle-breeding

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- Soil:
 - Protection against erosion, compacting and moisture losses.
 - Vinasse application (CETESB standards)
 - Small soil erosion loss (compared to soybean and corn) → rotation of cultures
- Biodiversity:
 - Limited direct impact: cane crops are established mainly in pasturelands.

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Conclusions

- Biomass and biofuels trade contribute to rural development allowing additional income and job creation for developing countries, contributing to the sustainability of natural resources, collaborating to greenhouse gases emission reduction in a cost-effective way and diversifying the world's fuel needs.

Thank you !

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