

BIOEN

The Latin American Convention of The Global Sustainable Bioenergy Project



Land Use Change: the Brazilian Experience

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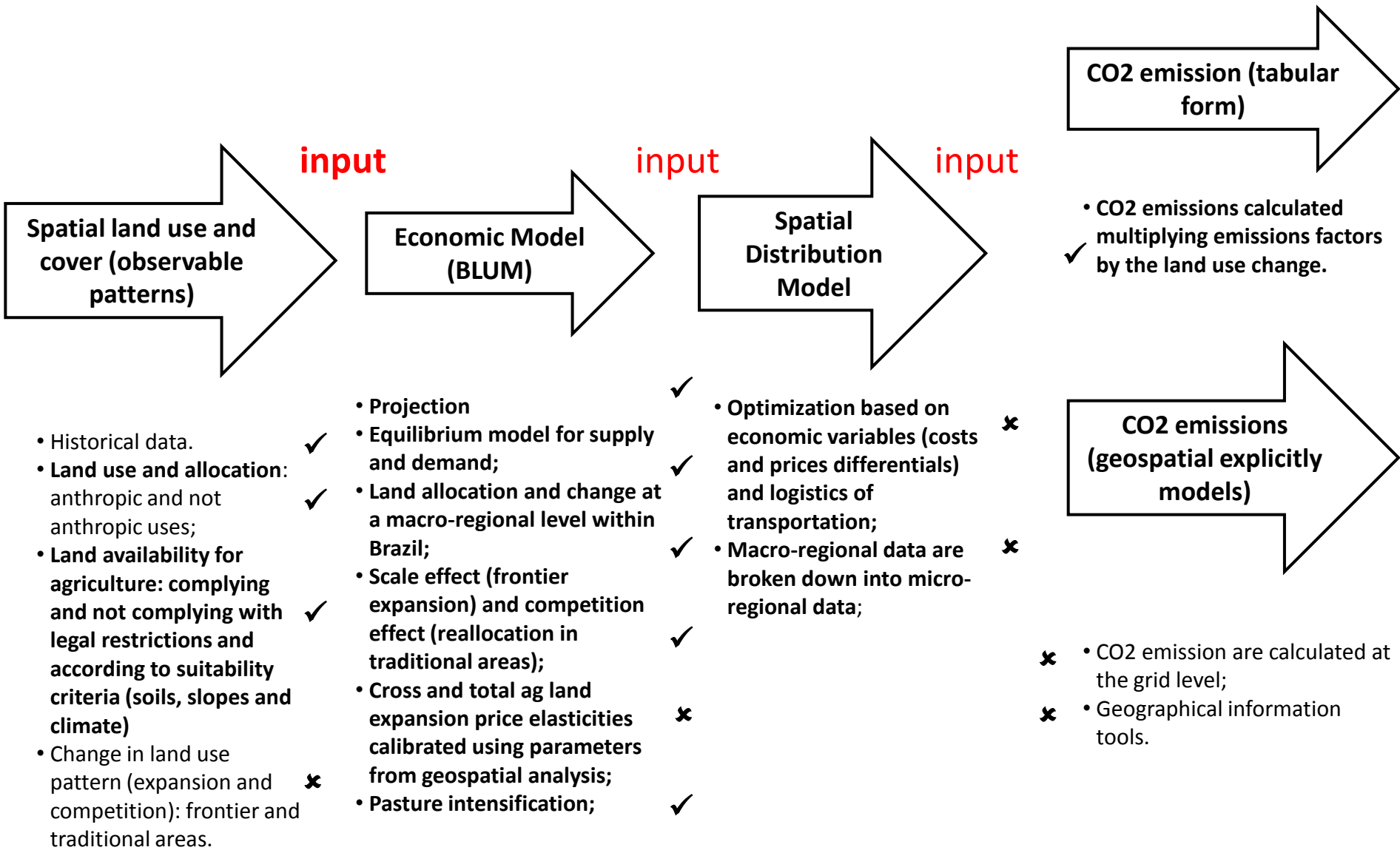
Key Issues on Land Use Change

- To establish a pattern (cause-effects relations) of land use change in Brazil as a result of the agricultural and forestry sector dynamics.
 - Data are more important than models/methodologies
 - Gather all data is very difficult
 - Combination of different sources and evidences
 - Incremental accumulation of data and knowledge
 - Two methodological aspects related to the data need
 - Competition effect (substitutions and direct displacement)
 - Scale effect (conversion of natural vegetation)
- Evidences available
 - Canasat (direct effect of sugarcane expansion)
 - Soybean moratorium (grains and pastures in recently cleared land in the Amazon Biome)
 - IBGE municipal agriculture production survey (PAM): shift share (allocation methodology, unfortunately no pasture data)
 - 1996 and 2006 Agriculture Census => pastures
 - Data combination: Ag. Census, IBGE Surveys (PAM, PPM, LSPA), Conab crop assessments and spatial information

Land Use Change: Recent Developments

- Improve our knowledge on the land dynamics of the agricultural and forestry sectors in Brazil
 - Competition and scale processes
 - Satellite images, secondary data
- Establish an routine to combine land use changes and GHG emissions calculations
 - Macro (regions, micro-regions), micro level (industrial unity), spatial analysis
- Improve the economic modeling (BLUM) to capture effects of new technologies on land demand and land allocation
 - To project supply of ethanol, sugar, co-generation replicating a mill behavior (optimizing the use of the sugarcane given an expectative of prices and returns) => number of mills equal to the number of regions
 - To project cattle herd and pastures demand maximizing production factors (land and capital) and different production systems
 - Incorporate market forces that drives productivity up
 - Effects of prices in yields (sugarcane and TRS)
 - Higher efficiency in the industrial process (crushing, fermentation, heating, etc.)

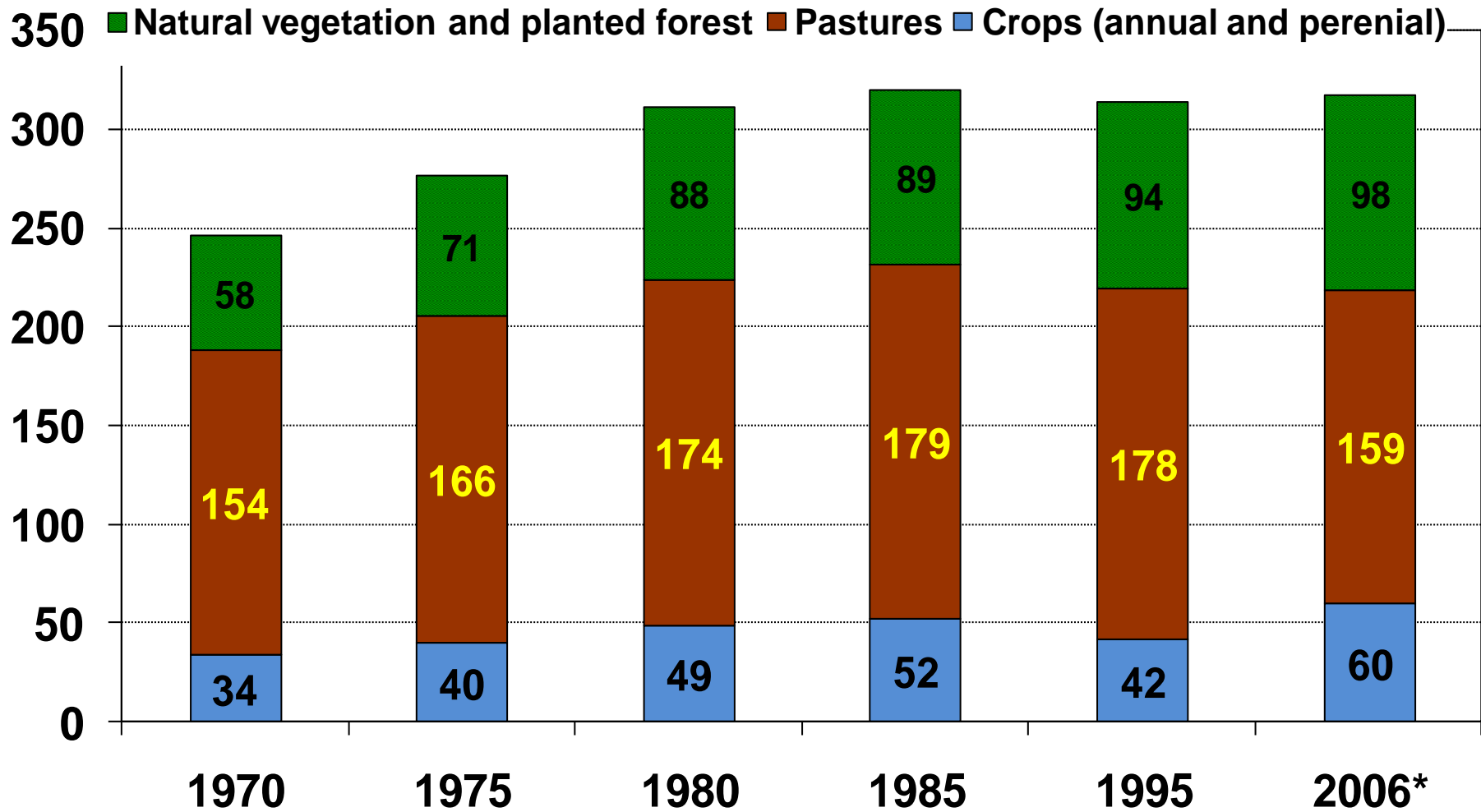
Conceptual Framework for Measuring LUC (using an economic model)



Evidences

Brazil: Agricultural Land Use

(Agricultural Census, million ha)

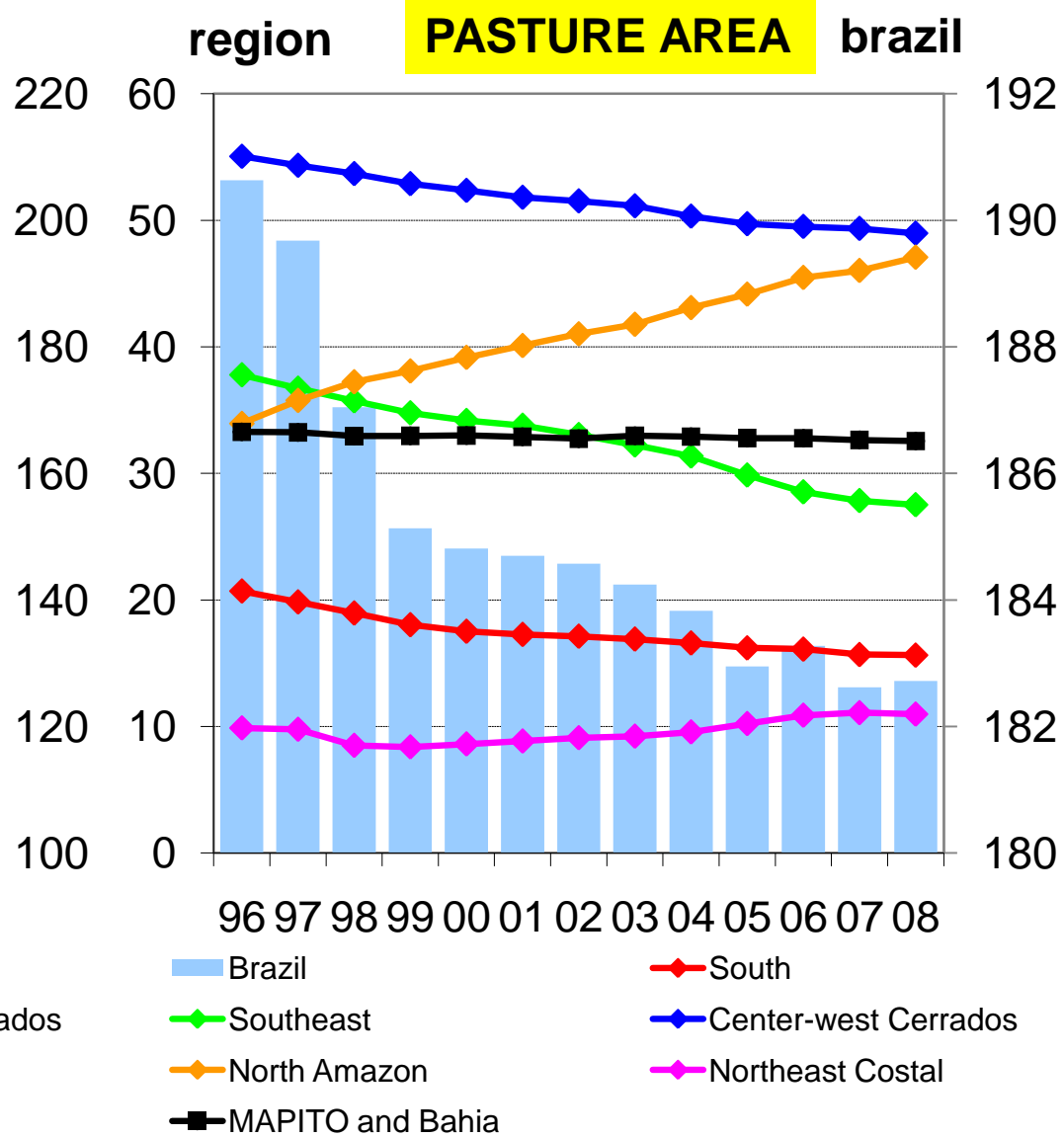
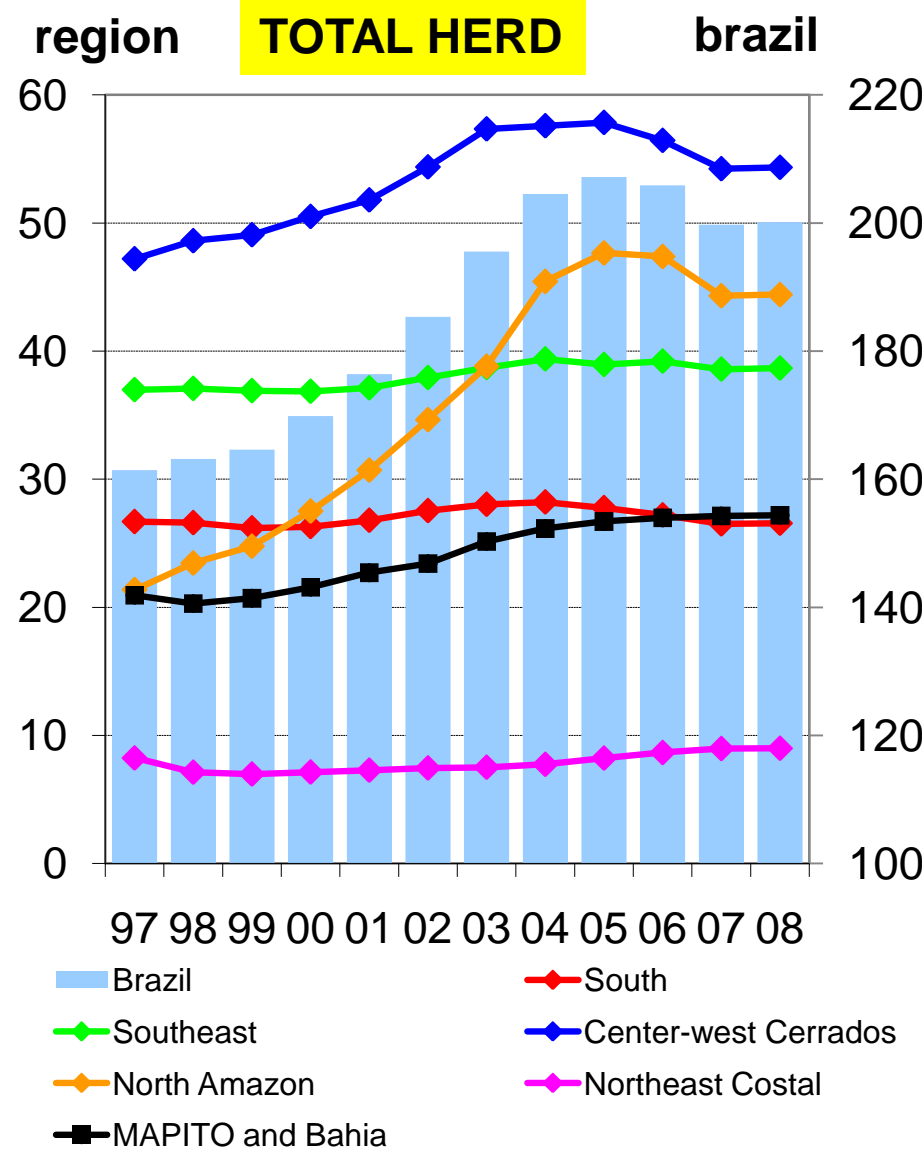


Source: IBGE (Agricultural Census).
 * Crops: it includes silage for animal feeding.

Macro-Regions Used in the Brazilian Land Use Model (BLUM)

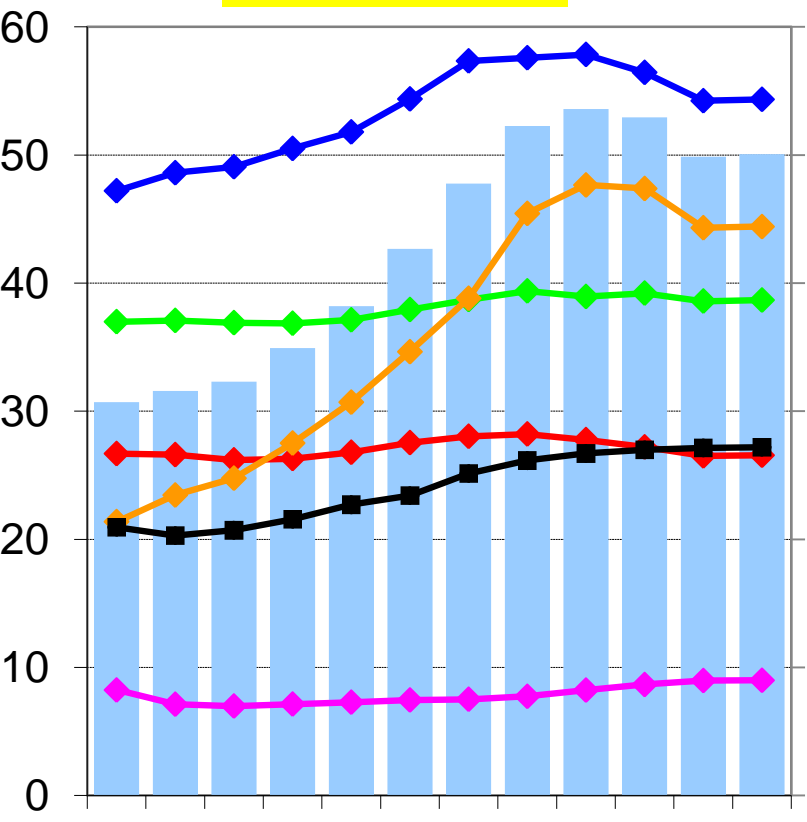


Total Herd (1,000 heads) and Pasture Area (1,000 ha)

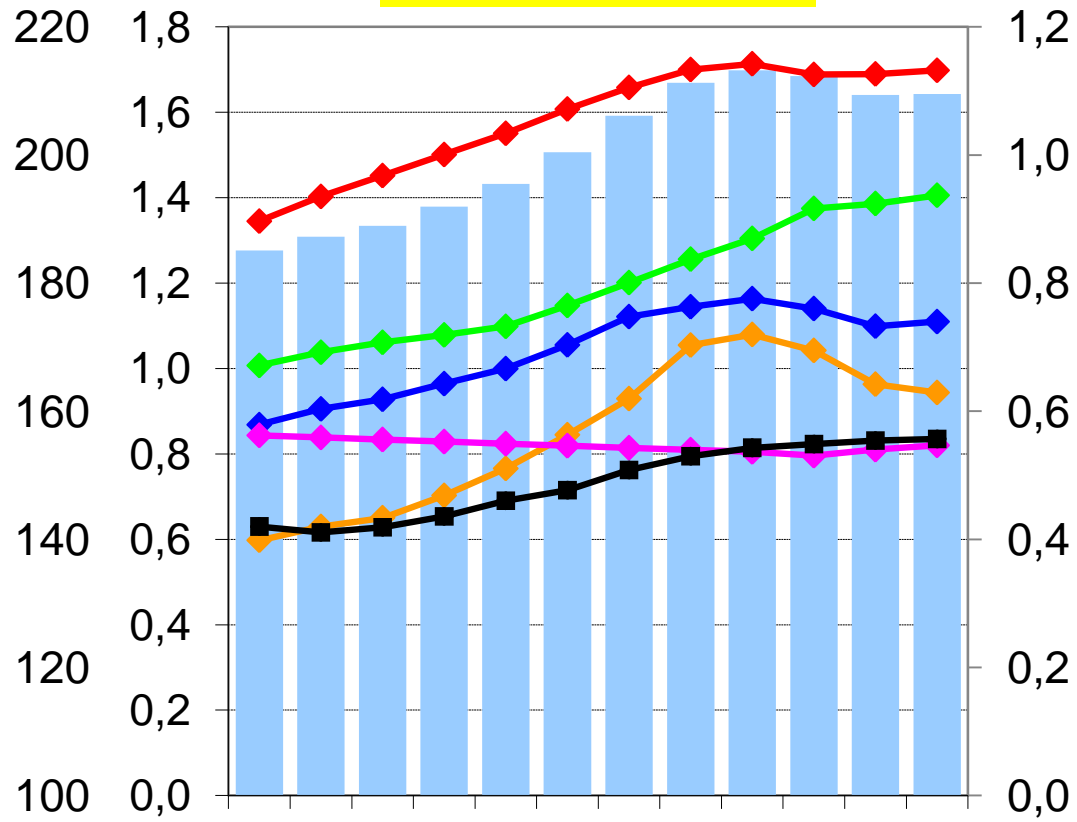


Total Herd (1,000 heads) and Stocking Rate (animals/ha)

region **TOTAL HERD** brazil



region **STOCKING RATE** brazil



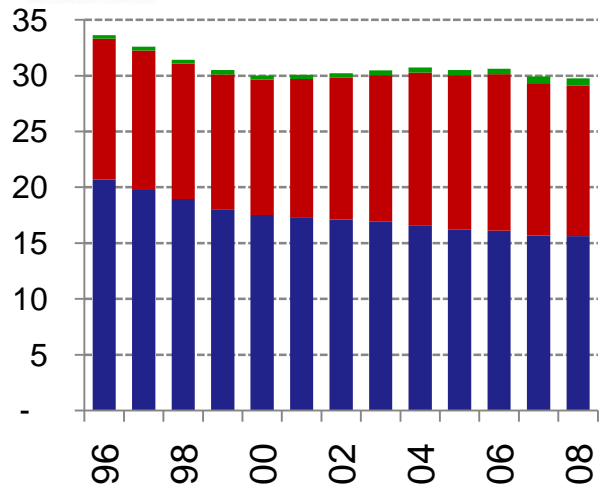
- Brazil
- ◆ Southeast
- ◆ North Amazon
- MAPITO and Bahia
- ◆ South
- ◆ Center-west Cerrados
- ◆ Northeast Costal

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(million ha)

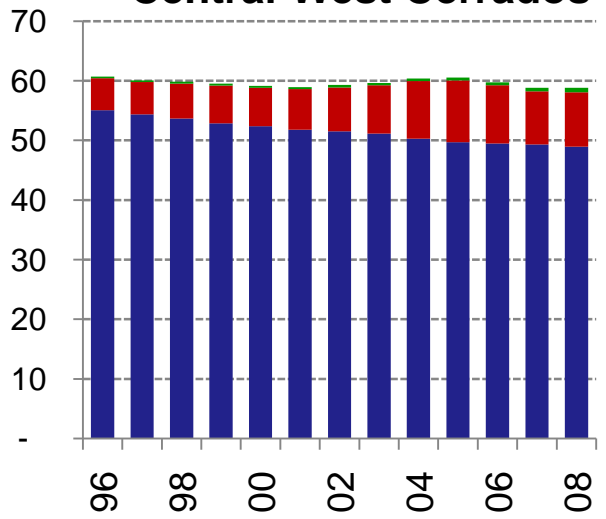
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South Region



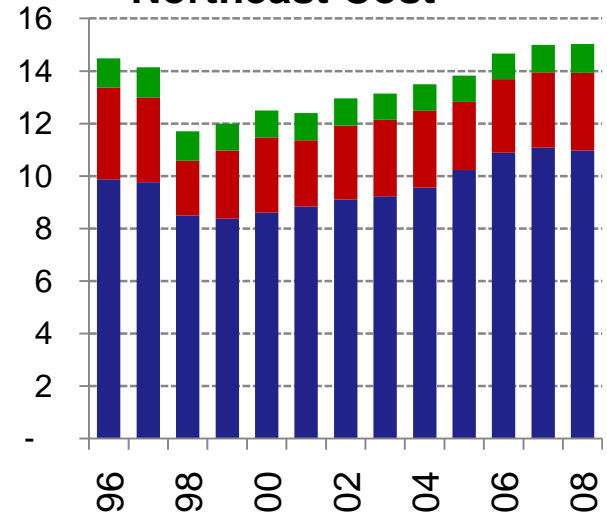
■ Pasture ■ Grains ■ Sugarcane

Central-West Cerrados



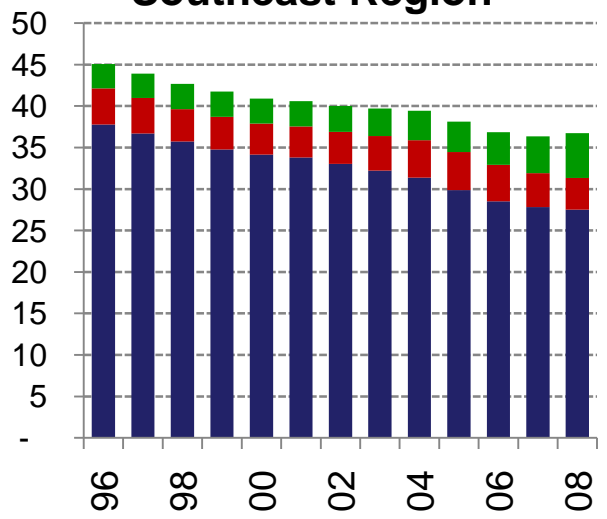
■ Pasture ■ Grains ■ Sugarcane

Northeast Cost



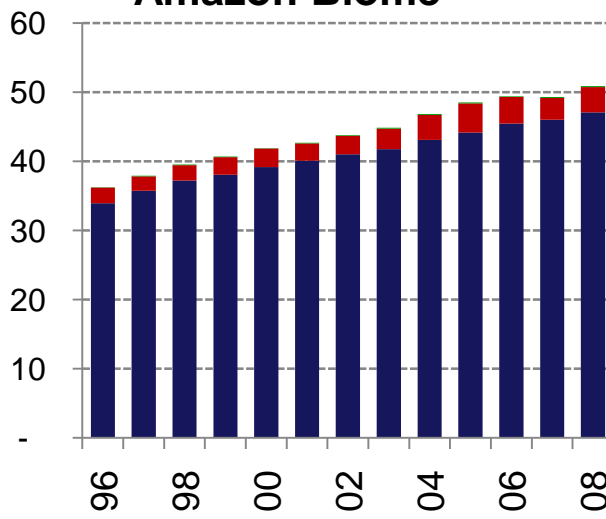
■ Pasture ■ Grains ■ Sugarcane

Southeast Region



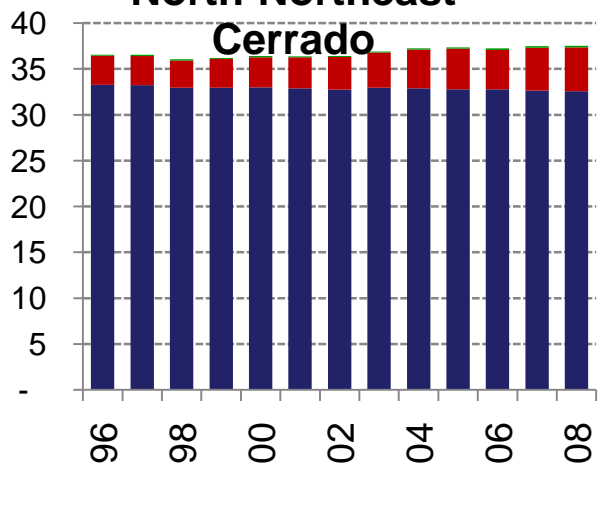
■ Pasture ■ Grains ■ Sugarcane

Amazon Biome



■ Pasture ■ Grains ■ Sugarcane

North-Northeast

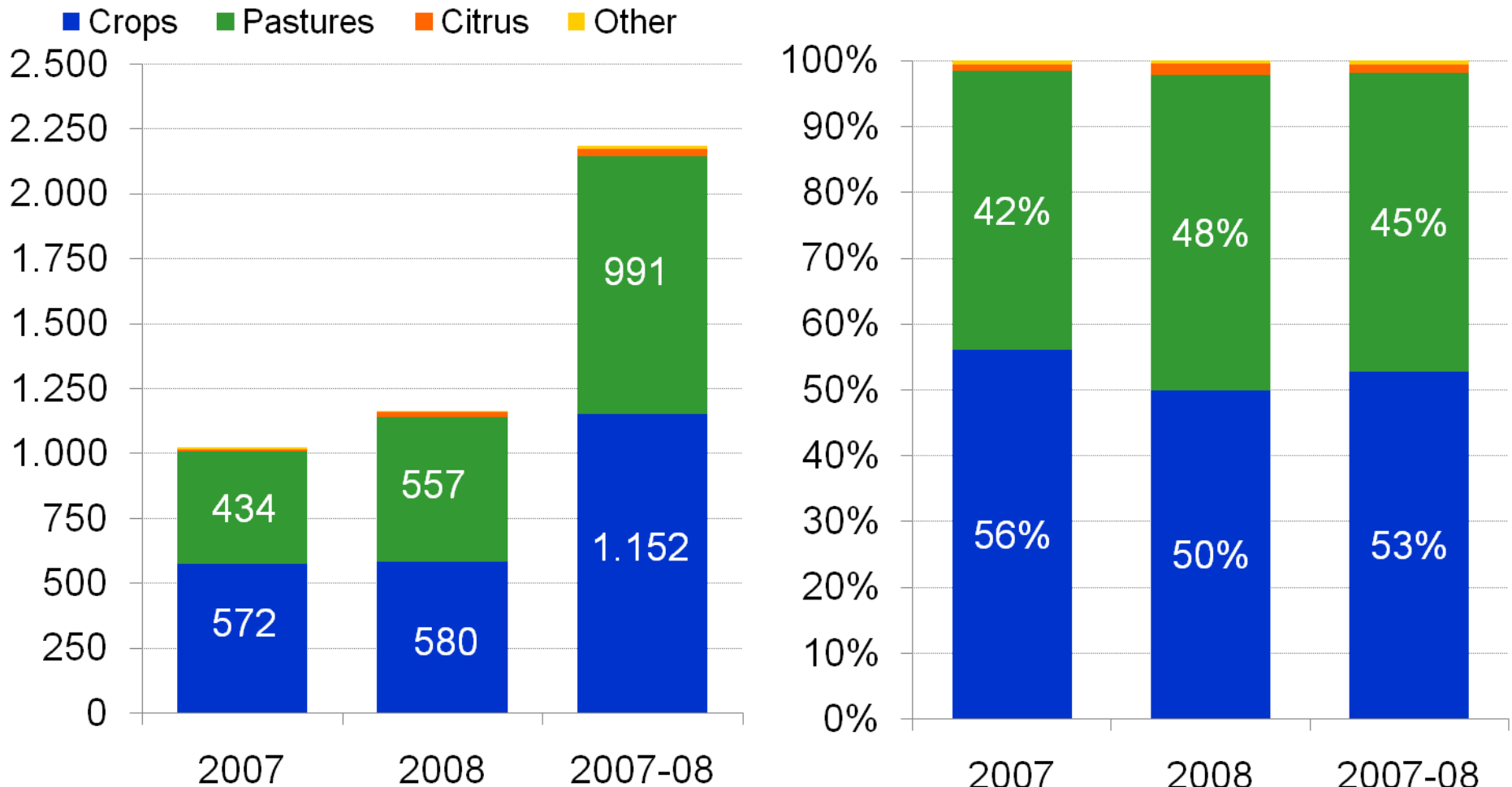


■ Pasture ■ Grains ■ Sugarcane

Source: data combination (Agricultural Census/IBGE, Producao Agricola Municipal/IBGE; Producao Pecuaria Municipal/IBGE, CONAB, spatial information).

Example of Direct Substitution: Remote Sensing

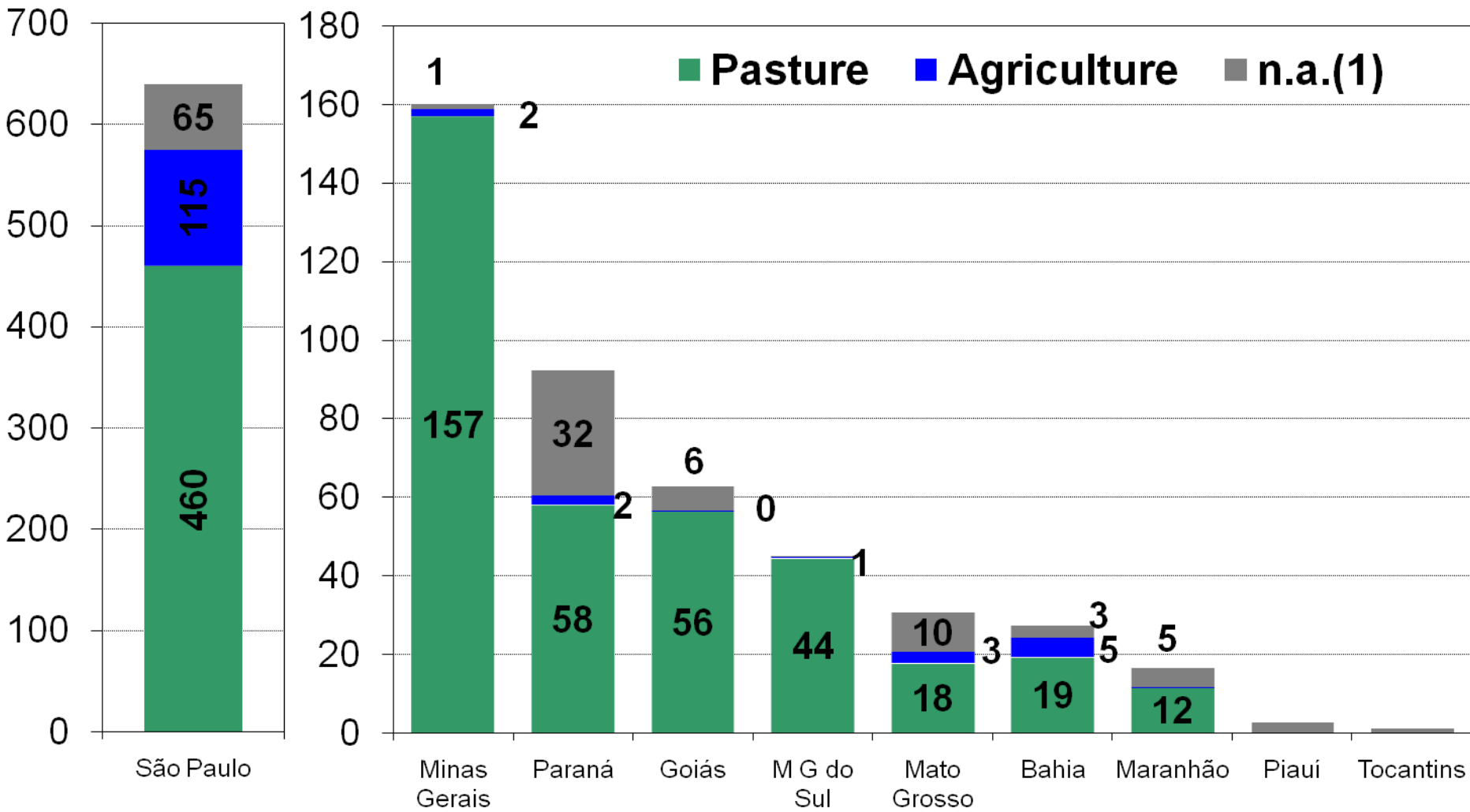
South-Central Region: Classes of Land Use Converted to Sugarcane, 2007 and 2008 (1,000 ha)



Source: CANASAT/INPE, published in Nassar, A.M., Rudorff, B. F. T., Antoniazzi, L. B., Aguiar, D. A., Bacchi, M. R. P. and Adami, M, 2008. Prospects of the Sugarcane Expansion in Brazil: Impacts on Direct and Indirect Land Use Changes. In: Sugarcane Ethanol: Contributions to Climate Change Mitigation and the Environment. Zuurbier, P, Vooren, J (eds). Wageningen: Wageningen Academic Publishers.

Secondary Data

Expanded South-Central Region: Land Use Classes Allocated to Sugarcane, 2002 to 2006 (1,000 ha)

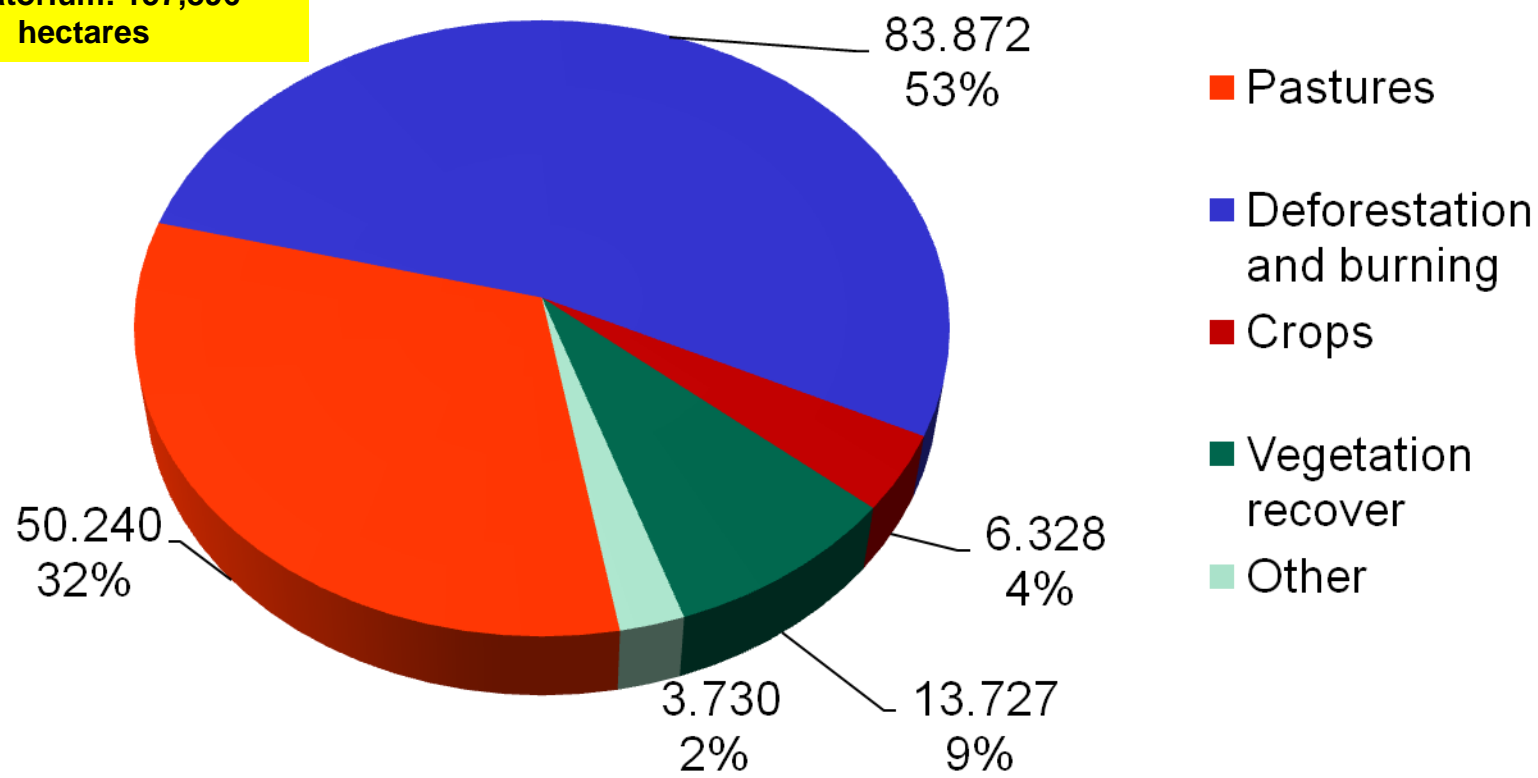


(1): n.a. (not allocated): means not allocated over previous productive area.

Example of Expansion in the Amazon: Data from Soybean Moratorium Project

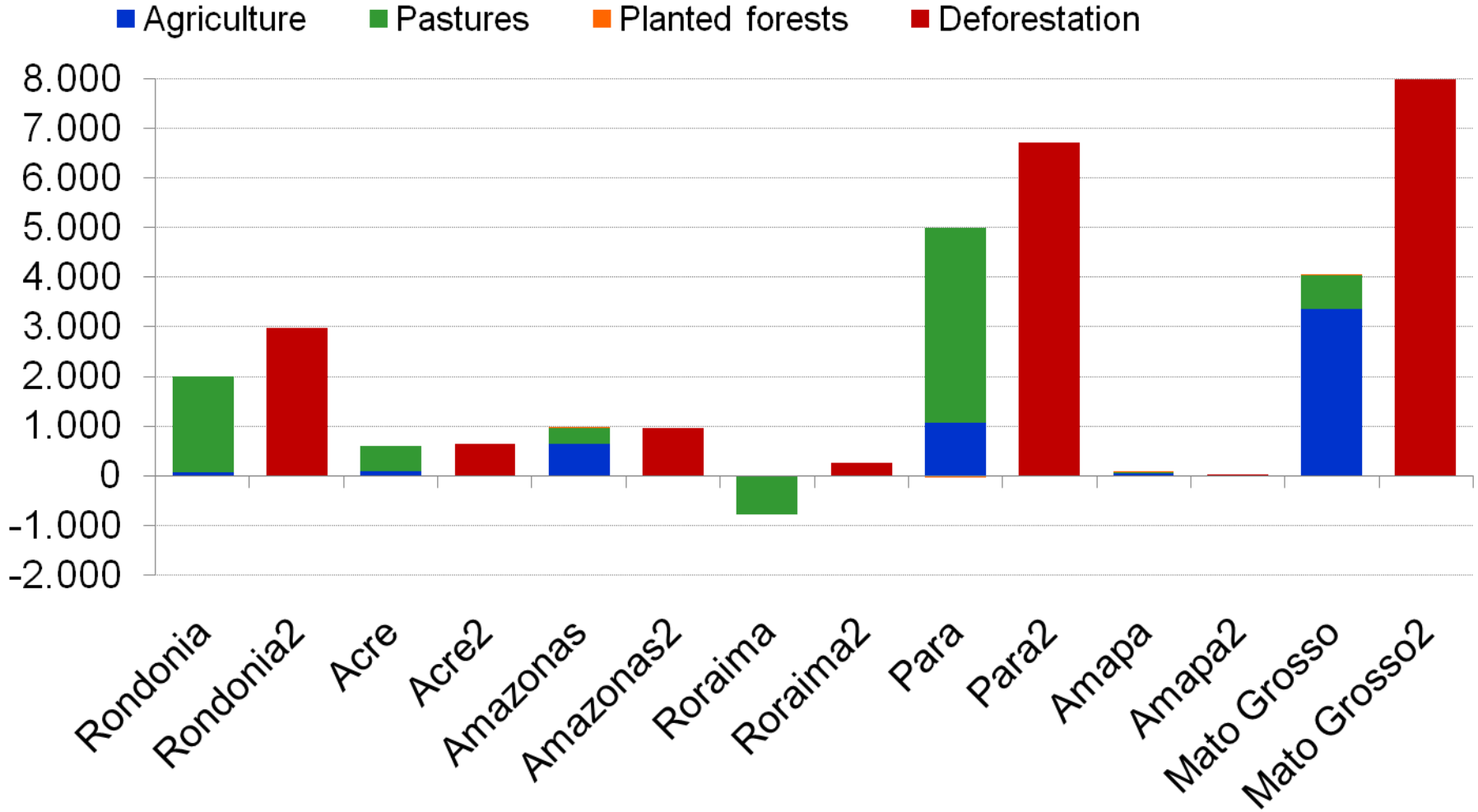
Amazon Biome: Deforested Area under Monitoring from 2006 to 2008 by Land Use Classes (hectares)

Total area cleared monitored by the moratorium: 157,896 hectares



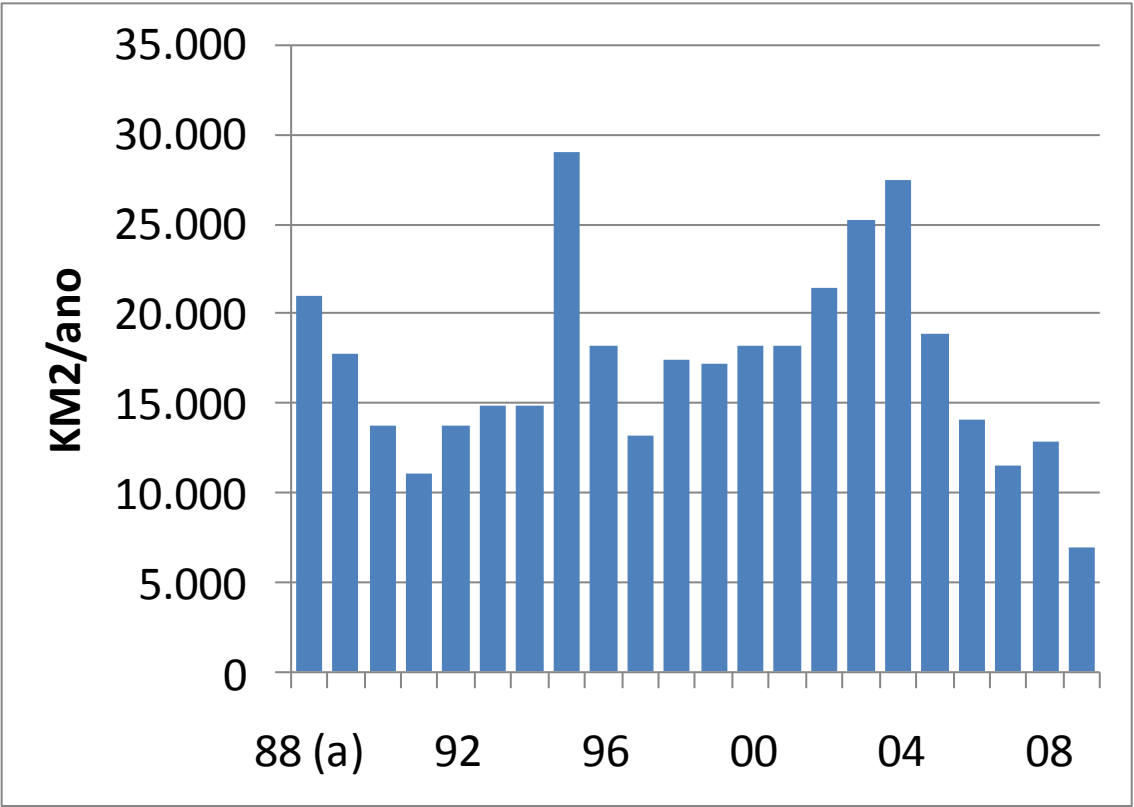
Effects of the Expansion of Agriculture, Forestry and Pasture on Amazon Deforestation

**Absolute Variation on Occupied Area with Productive Purposes and Deforestation from 1996 to 2006
 Captured by the Agricultural Census and Prodes-INPE**



Source: Censo Agropecuário de 2006/IBGE e PRODES/INPE

Deforestation of the Amazon



	Deter		Prodes
	jan-dec	jan-sep	
2005	23,230		18,846
2006	9,345		14,109
2007	6,929	4,544	11,532
2008	7,333	6,628	11,968
2009		2,845	

Source: INPE/PRODES and DETER

Source: INPE/PRODES

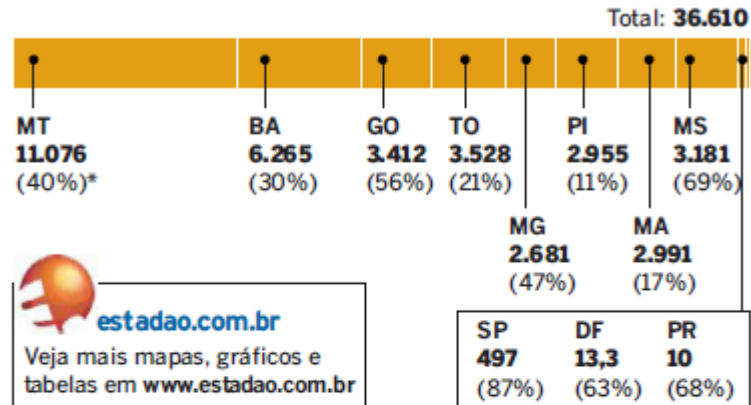
(a) Média entre 1977 e 1988 (b) Media entre 1993 e 1994 (c) Taxas Anuais Consolidadas (d) Taxa Estimada

Conversion of the Cerrado?????

LAPIG/UFG

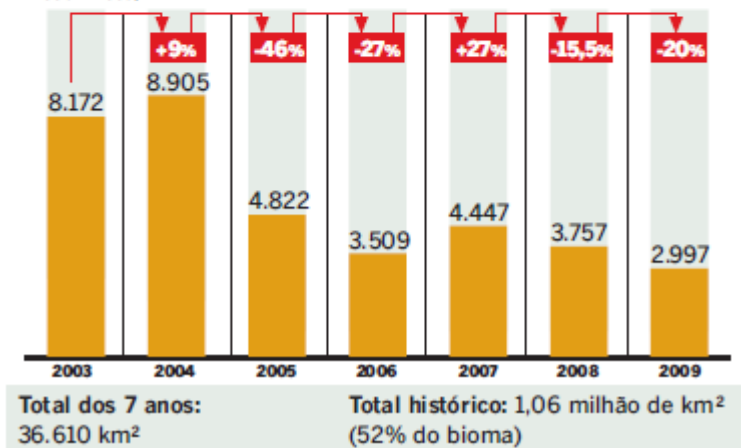
Champions of deforestation

By state, From 2003 to 2009, in km²



*Porcentagem desmatada da área original do bioma no Estado

Por ano
 DE 2003 A 2009, EM KM²



MMA/IBAMA

Deforestation on the Cerrado biome between 2002 and 2008, considering a total area of 2.039.386 km².

	2002 (%)	2008 (%)
Deforested areas	41,9	48,2
Remaining natural vegetation	57,5	51,2
Water	0,6	0,6

Deforestation of 127,6 (85,1) thousand hectares between 2002 and 2008 (6,3%).
 Average annual deforestation: 21.260 km² (1,04%) (14,179, 0,69%)

Using the models

Emissions Associated to Land Use Changes: Example of California

Assumptions	Scenario A	Scenario A Modified
Shock size (billion liters)	7.6	5.7
Elasticity of substitution among primary factors in livestock production	0.2	0.2 mundo e 0.4 Brasil
Crop yield elasticity / area expansion	0.5	0.9
Adjustment for yield	8.2%	16.7%

Results	Scenario A	Scenario A Modified
Total land converted (million ha)	1.28	0.6
Forest land (million ha)	0.43	0.01
Pasture land (million ha)	0.85	0.59
Brazil land converted (million ha)	0.89	0.35
Brazil forest land (million ha)	0.3	-0.07
Brazil pasture land (million ha)	0.59	0.42
ILUC Carbon Intensity (gCO ₂ e/MJ)	56.7	25.3
GREET Carbon Intensity (gCO ₂ e/MJ)	27.4	27.4
Emissions reduction ethnaolgasoline	-12%	-45%

Source: Elaborated by ICONE and Angelo Gurgel.

Note: gasoline emission according to ARB of 95.61 gCO₂e/MJ.

Emissions Balance: Example of California

Scenarios	ILUC Emissions (gCO2e/MJ)	Direct Emissions (gCO2e/MJ)	Ethanol/Gasoline
Scenario A Modified	25.3	27.4	-45%
Scenario A Modified + Forest gained + Crops uptake (18Mg CO2e/ha)	12.4	27.4	-58%
Scenario A Modified + Forest gained + Crops uptake (18Mg CO2e/ha) e sugarcane uptake in Brazil (244Mg CO2e/ha)	-9.4	27.4	-81%
Scenario A Modified + Forest gained + Crops uptake (160Mg CO2e/ha)	-10.7	27.4	-83%

Carbon stocks in different crops, considering both above and below content, in Mg C per hectare

	Below ⁽¹⁾		Above ⁽²⁾	TOTAL ⁽³⁾
	LAC	HAC	Vegetation	
Maize	31.0	42.0	3.9	40.4
Soybean	31.0	42.0	1.8	38.3
Cotton	23.0	31.0	2.2	29.2
Sugarcane ⁽⁴⁾	41.5	57	17.4	66.65
<i>Average</i>	<i>31.63</i>	<i>43.00</i>	<i>6.33</i>	<i>43.64</i>

Sources: (1): IPCC, 2006. Guidelines for national greenhouse gas inventories, prepared by the National Greenhouse gas Inventories Programme. In: H. S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.) Japan: IGES; (2): Macedo, I. C.; Seabra, J. E. A., 2008. Mitigation of GHG emissions using sugarcane bioethanol. In: Sugarcane ethanol: contribution to climate change mitigation and the environment. Zuurbier, P; Vooren, J. van de (eds). Wageningen: Wageningen Academic Publishers.; (3): it was considered the average of LAC and HAC values; (4): the average of burned and unburned sugarcane was considered.

Source: Elaborated by ICONE and Angelo Gurgel.
Note: gasoline emission according to ARB of 95.61 gCO2e/MJ.

Sugarcane Expansion: Simulation Using EPA RFS Scenarios (2.5 billion gallon demand shock)

			2008	2022 (baseline)	2022 (shock)
Sugarcane	Production	mil ton	648,848	969,046	1,082,989
	Area	mil ha	8,200	10,525	11,558
Sugar	Production	mil ton	31,947	43,845	43,767
	Domestic Consumption	mil ton	11,006	13,872	13,772
	Exports	mil ton	21,160	29,987	29,987
Ethanol	Production	mil m3	25,720	53,646	63,188
	Domestic Consumption	mil m3	22,778	41,326	41,326
	Exports	mil m3	4,137	12,367	21,816

ILUC Resulting from Sugarcane Expansion: Estimate Using EPA RFS Scenarios (2.5 billion gallons demand shock)

Table 5 – Sugarcane displacement for the shock scenario comparing to baseline scenario

	South	Southeast	Center West	North Amazon	Northeast Coast	MAPITO & Bahia	Brazil
a) Sugarcane Expansion	79.1	708.5	101.5	8.8	118.9	15.7	1,032.5
b) Grains to Sugarcane	72.9	470.4	98.7	5.5	0.2	13.6	661.3
c) Pasture to Sugarcane	6.2	238.1	2.8	3.3	118.7	2.1	371.2
d) Total Ag Land Expansion	21.2	99.6	48.4	23.2	4.0	9.4	205.8
e) Grains Expansion	-39.0	-342.4	-66.3	8.3	12.1	5.5	-421.7
f) Pasture to Grains	34.0	128.0	32.5	13.8	12.3	19.1	239.6
g) Pasture Total Loss	40.1	366.2	35.2	17.1	131.0	21.2	610.8
h) Pasture Net Loss	19.0	266.5	-13.2	-6.1	127.0	11.8	405.0

Sugarcane Ethanol GHG Emissions in Relation to Gasoline: Different ILUC Cenarios

	100 years 2% discount rate	30 years 0% discount rate
EPA original	- 44%	- 26%
EPA without the 2nd Step	- 57%	- 43%
BLUM results without changing carbon uptake*	- 64%	- 52%
BLUM results using 17 t C/ha uptake for sugarcane	- 69%	- 60%

* EPA original analysis have considered an average uptake for crops of 5 t CO₂ e / ha.



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Muito obrigado!

Mantenedores



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