

Biomass 2009

Modeling Land Use and Land Use Change in Brazil

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Outline

1. The dynamic of land use in Brazil

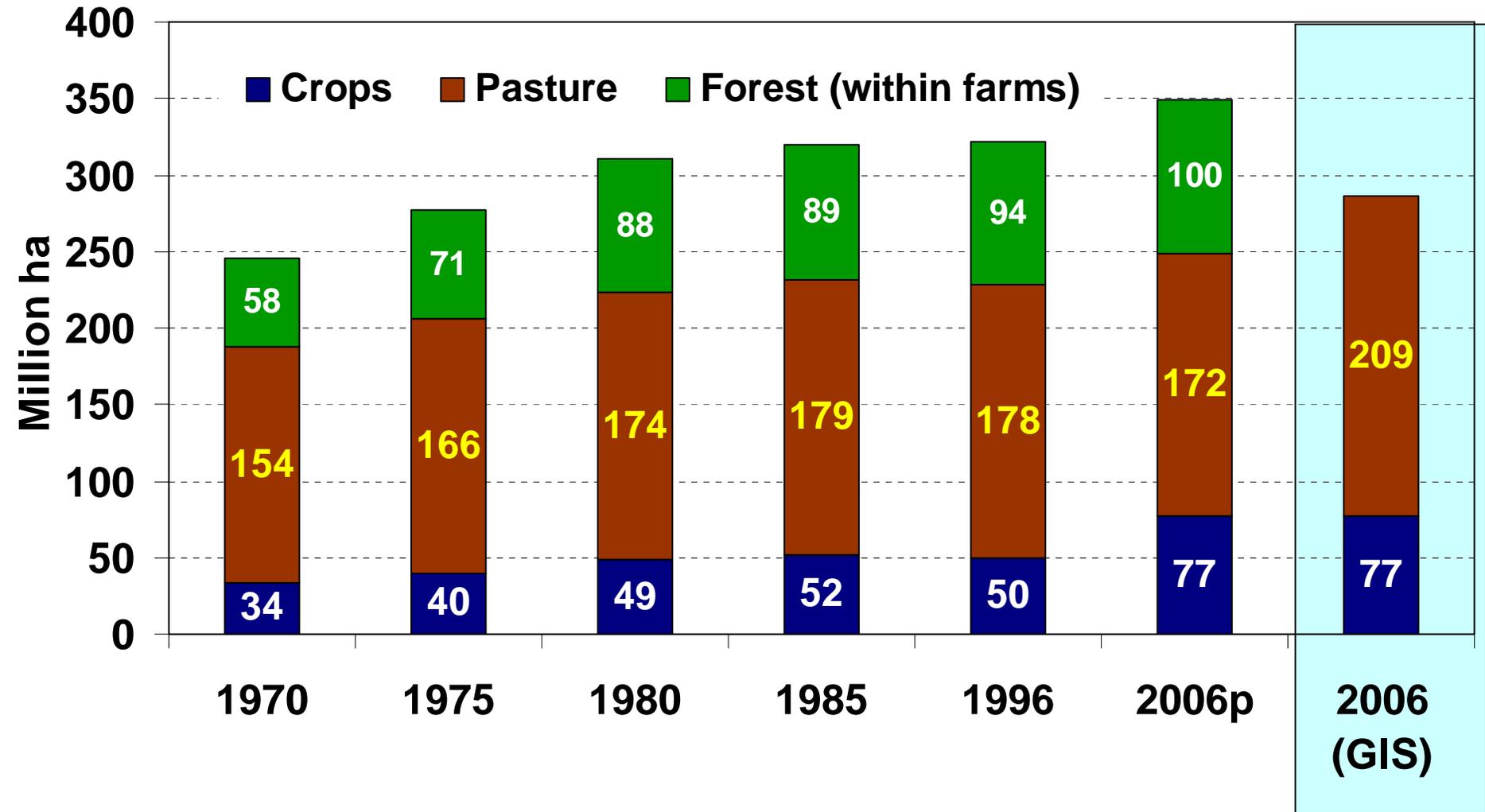
- Past data for agriculture expansion
- Deforestation dynamic

2. ICONE experiences on land use modeling

- Model and assumptions
 - Projecting agriculture expansion
 - Leakage effect: LUC and ILUC
- **Why is important to measure LUC and ILUC integrating economic and GIS methodologies?**

The Dynamic of Land Use in Brazil

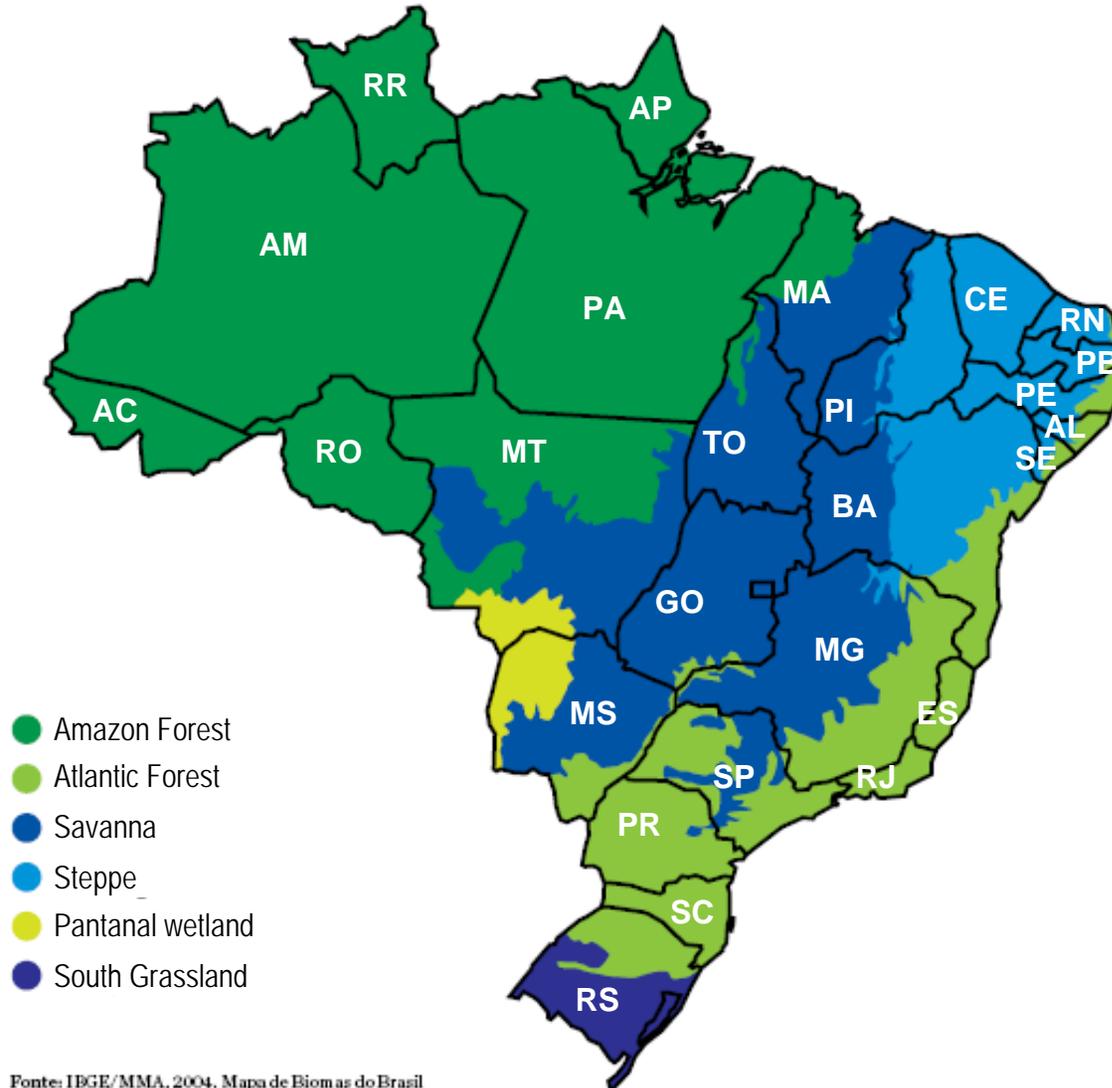
Agricultural Land Use in Brazil (Agricultural Census and GIS)



P = Preliminary

Sources: IBGE, ESALQ, UFMG, ICONE.

Brazilian Biomes and States



Fonte: IBGE/MMA, 2004. Mapa de Biomas do Brasil

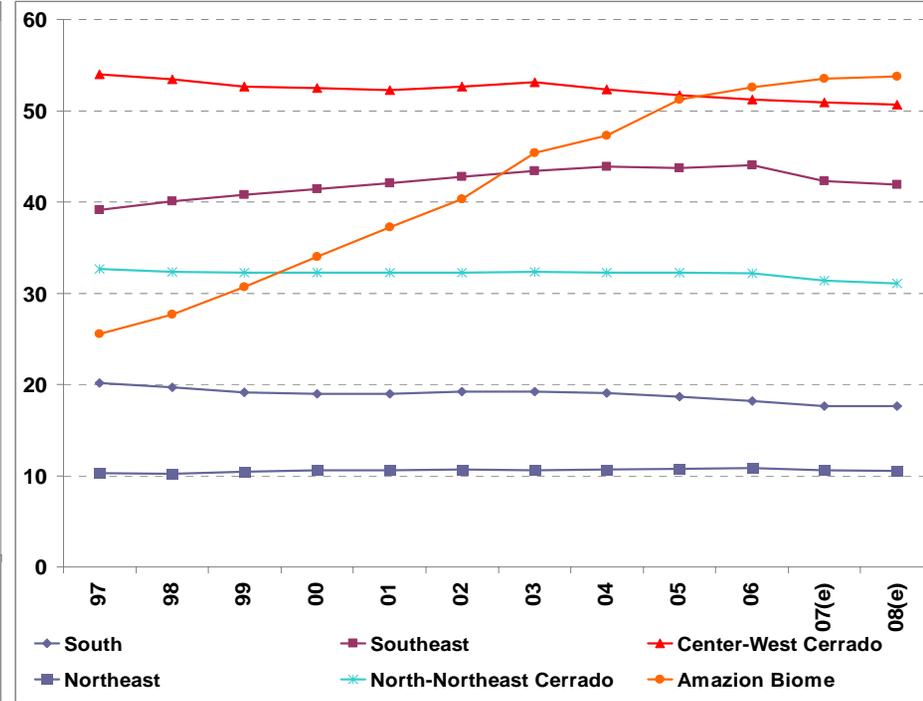
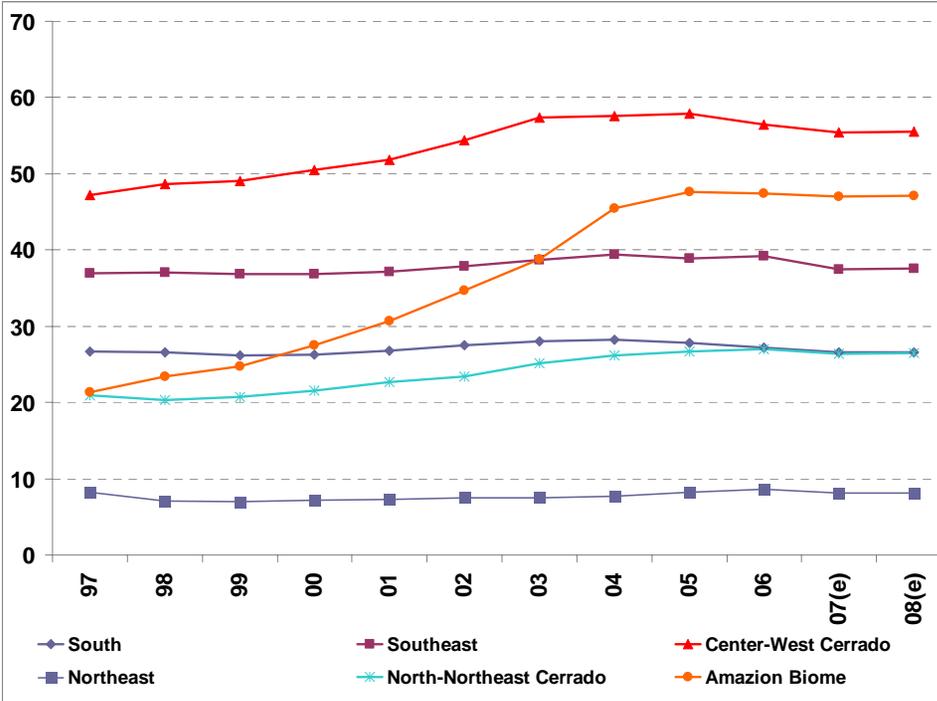
Deforestation Dynamic

- Deforestation is a result of simultaneous actions of the following issues:
 - Lack of land Ownership
 - Logging/Timber
 - Energy (pig iron production)
 - Land price (income effect)
 - Agriculture/Cattle expansion
 - » Cause or result?

Brazil: Cattle Herd and Pasture Area

Cattle Herd (Million Heads)

Pasture Area (Million Hectares)



ICONE Experiences on Land Use Modeling

“Prospects of the Sugarcane Expansion in Brazil: Impacts on Direct and Indirect Land Use Changes”

André M. Nassar (ICONE)

Bernardo F.T. Rudorff (INPE)

Laura B. Antoniazzi (ICONE)

Daniel A. de Aguiar (INPE)

Miriam R. P. Bacchi (ESALQ)

Marcos Adami (INPE)

Methodology

Past Trend

- Mapping sugarcane expansion using remote sensing from the Canasat Project (www.dsr.inpe.br/canasat).
 - Displacement measured in an yearly basis and using planted area.
- Micro-regional secondary data, using adapted Shift-share model.
 - Displacement measured as the absolute variation of the harvested area.
- Case studies through environmental licensing reports.

Future Trend

- Partial equilibrium model to project land allocation for agricultural activities in a macro-regional level;
 - Adapted Shift-share to breakdown macro-regional projections in micro-regional data.
 - Projections based on harvested areas.

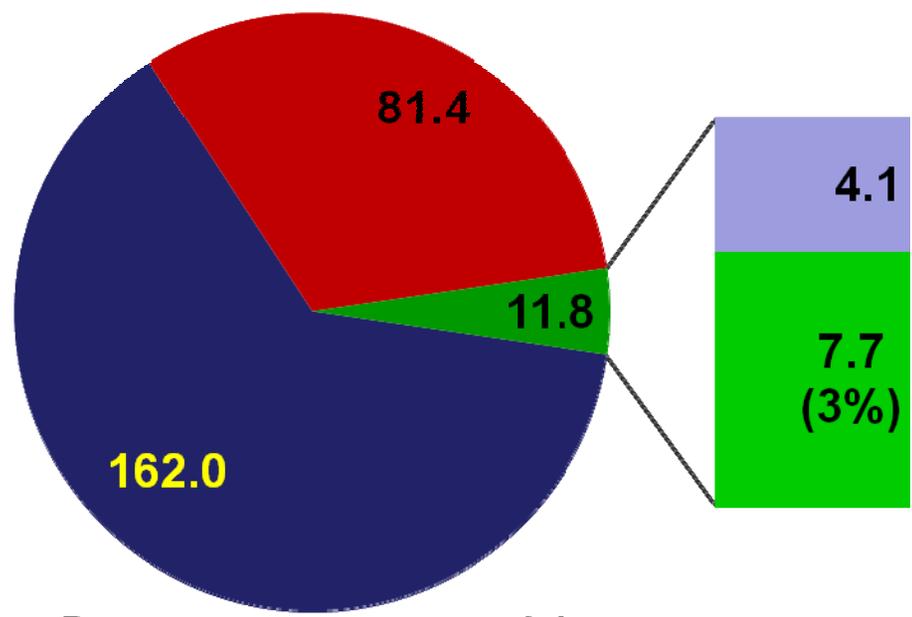
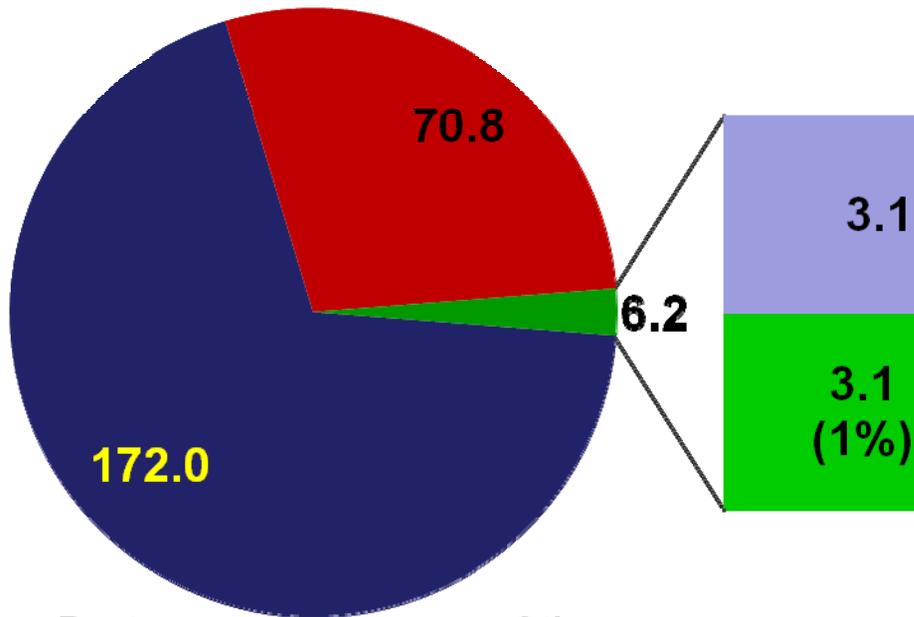
Land Competition Matrix

		Sector (dependant variable)						
		Cotton	Sugarcane	Soybean	Corn	Rice	Dry beans	Pastures
Region and Competitor Sector	South		Soybean Corn	Sugarcane Corn	Sugarcane Soybean		Soybean Corn Rice	Corn Soybean Rice Dry bean Sugarcane
	Southeast		Soybean Corn	Sugarcane Corn	Sugarcane Soybean		Soybean Corn Rice	Corn Soybean Dry bean Sugarcane
	Center-West Cerrados	Soybean Corn	Soybean Corn	Cotton Sugarcane Corn	Cotton Sugarcane Soybean	Soybean Corn	Soybean Corn Rice	Corn Soybean Cotton Dry bean Sugarcane
	Amazon North	Soybean Corn		Corn	Soybean	Soybean Corn	Soybean Corn Rice	Corn Soybean Rice Dry bean
	Coastal Northeast		Corn				Soybean Corn Rice	Dry bean Sugarcane
	MAPITO and Bahia	Soybean Corn Rice Dry beans		Cotton Corn	Cotton Soybean Dry bean	Soybean Corn	Soybean Corn Rice	Corn Soybean Cotton Dry bean

Overview of Sugarcane in Brazil

**Land Allocated in 2006
 (million ha)**

**Land Allocated 2018(p)
 (million ha)**



■ Pastures

■ Other crops

■ Pastures

■ Other crops

■ Sugarcane (sugar)

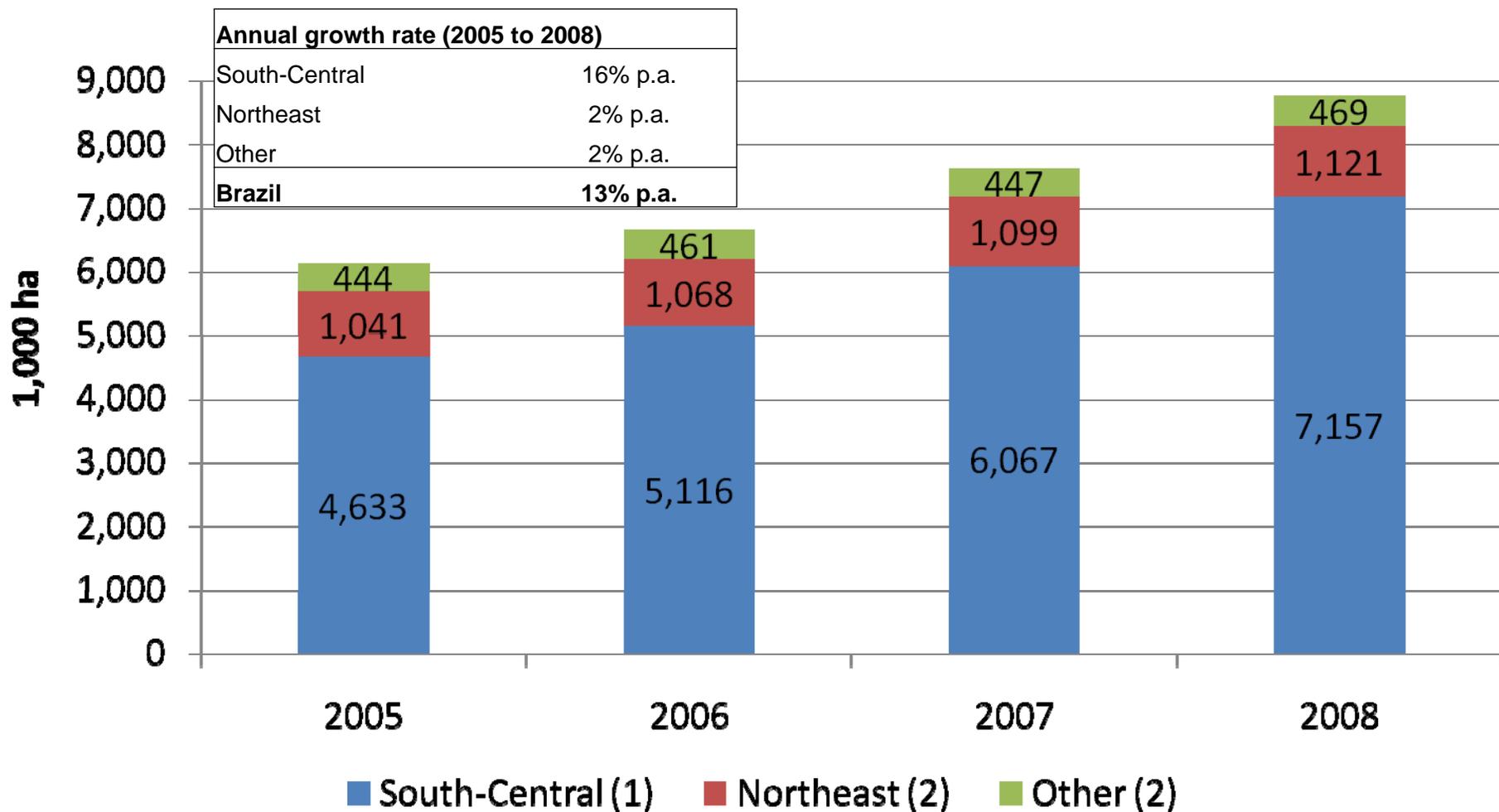
■ Sugarcane (ethanol)

■ Sugarcane (sugar)

■ Sugarcane (ethanol)

Ethanol Situation (million liters)	2006	2018
Consumption	12,295	40,908
Percentage Otto Market	(40%)	(54%)
Exports	3,502	13,700

Sugarcane Planted Area According to Production Regions, 2005 to 2008 (1,000 ha)



Notes: (1) Source: Canasat/INPE, comprising São Paulo, Minas Gerais, Paraná, Goiás, Mato Grosso and Mato Grosso do Sul. (2) Sources: PAM/IBGE (2005 and 2006); LSPA/IBGE (2007 and 2008).

Land Use Classes Converted to Sugarcane: Compared Results in the South-Central Region (1,000 ha)

	Period/Measurement Method		
	Secondary Data 2002 - 06 (1) (harvested area)	Remote Sensing 2007 - 08 (2) (planted area)	Projection Model 2008 -18 (3) (harvested area)
Sugarcane expansion	1,030	2,184	3,848
Agriculture	122 (12%)	1,152 (53%)	1,594 (41%)
Pasture	793 (77%)	991 (45%)	2,369 (62%)
Other	114 ₍₄₎ (11%)	42 (2%)	24 (1%)

Source (1): Secondary data from IBGE; (2): Satellite images; (3): Projection model; (4) 3 percent of the total agricultural expansion.

Projections 2008 – 2018

South-Centre: Expected Land Allocation for Sugarcane, Crops and Pastures (1,000 ha and heads)

	2008	2018	Absolute growth
Sugarcane (ha)	6,359	9,654	3,295
Grains (ha)	26,332	29,529	3,198
Pasture (ha)	92,328	86,215	-6,113
Total (ha)	125,018	125,398	380
Cattle Herd (hd)	119,399	125,501	6,102

Grains: soybean, corn, cotton, rice and dry beans.

Net Growth of Agricultural Land Uses Area and Cattle Herd, 2002-06 (1,000 ha and heads)

State	Sugarcane (ha)	Other crops (ha)	Pasture (ha)	Total used area (ha)	Cattle Herd (hd)
São Paulo	622	-224	-882	-484	-909
Minas Gerais	153	389	-625	-82	1,644
Paraná	74	850	-1	287	-284
Mato Grosso do Sul	41	1	-985	-210	558
Goiás	34	576	-2,041	-1,431	545
Bahia	26	492	143	661	912
Mato Grosso	25	1,634	-1,437	0	3,881
Maranhão	16	298	-463	-148	1.835
Pará	3	115	2,502	2,620	5,311
Piauí	3	206	-112	97	34
Rondônia	1	124	-363	-239	3,444
Tocantins	1	0	-595	-355	1
Acre	1	13	109	123	635
South-Centre	949	3,226	-5,971	-1,920	5,435
Total	1,000	5,446	-5,385	1,061	18,383

Land Use and the Leakage Effect

- Expansion on planted area for crops and sugarcane are located on the Center South region
 - Competition among crops, sugarcane and pasture area;
 - Pasture area reduction
- Amazon Biome as an agriculture frontier?
 - Indirect land use: less pasture in Center-South means more pasture in the Amazon?
 - Amazon biome has its own dynamic and many economic incentives for deforestation:
 - Illegality, lack of land ownership, wood, pig iron, land value;
 - After deforestation: pasture as an economic use
 - Can not be proven as a cause or effect
 - It can not be said that 1 ha less of pasture in the Center South needs more than 1 ha of pasture in the agriculture frontier.

**Why is important to measure LUC
and ILUC integrating economic
and GIS methodologies?**

Economic and GIS Methodologies

- Pasture data: Agricultural Census 2006 is still preliminary
- LUC and ILUC:
 - Economic analysis based on assumptions;
 - GIS for deforested area occupation;
 - Elasticities of substitution among crops, sugarcane and pasture estimated by econometric models can be confirmed by GIS using past trend remote sensing data, so projections can be more confident.
- Degraded pasture area: 50 million hectares where? How to improve pasture yields and/or convert into agriculture areas?
- Project to improve modeling: FAPRI, FASOM, GTAP as part of bilateral Brazilian and US governments cooperation

Thank You!!

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