

# **Woodrow Wilson International Center for Scholars Brazil Institute**

## **Sugarcane Ethanol and Land Use in Brazil**

**Andre M. Nassar**

- **President, Brazilian Institute for International Trade Negotiations**

**Washington  
28 April 2008**

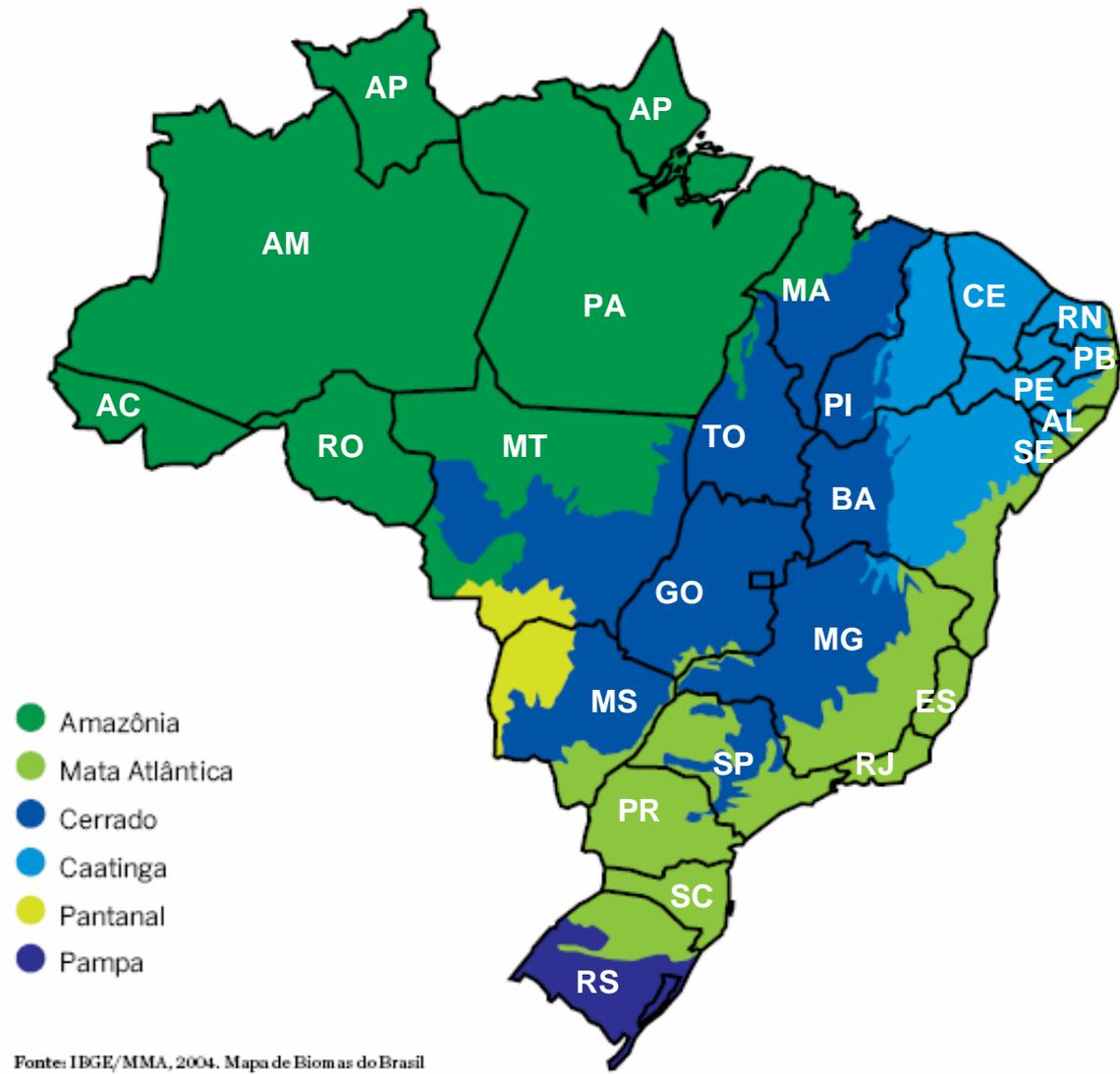
# Why the Issue of Land Use Has Become Important?

- Land is a scarce resource
  - In the short run: United States, Europe, China and India;
  - In the long run: Brazil and African Countries with Savannah Landscapes.
- Competition between food and fuel
  - Short run problem due to the excess of demand on corn (U.S. ethanol) and oil crops (EU biodiesel);
  - Countries with land available will respond to the high prices;
  - Agricultural supply will be reallocated and productivity will be improved;
  - Increasing importance of trade.
- Implications for avoided GHG emissions
  - Direct effect: energy crops displacing natural landscapes;
  - Unbalanced discussion: countries with natural landscapes are worst-off than countries with no natural landscapes.
- Indirect effect
  - Production expansion (excess of demand) of energy crops in one region stimulates the incorporation of natural landscapes into agricultural production in other regions.
  - It is not a problem of GHG emissions. It is a problem of land availability and avoiding deforestation.

# ICONE's Strategy on Agriculture Land Use

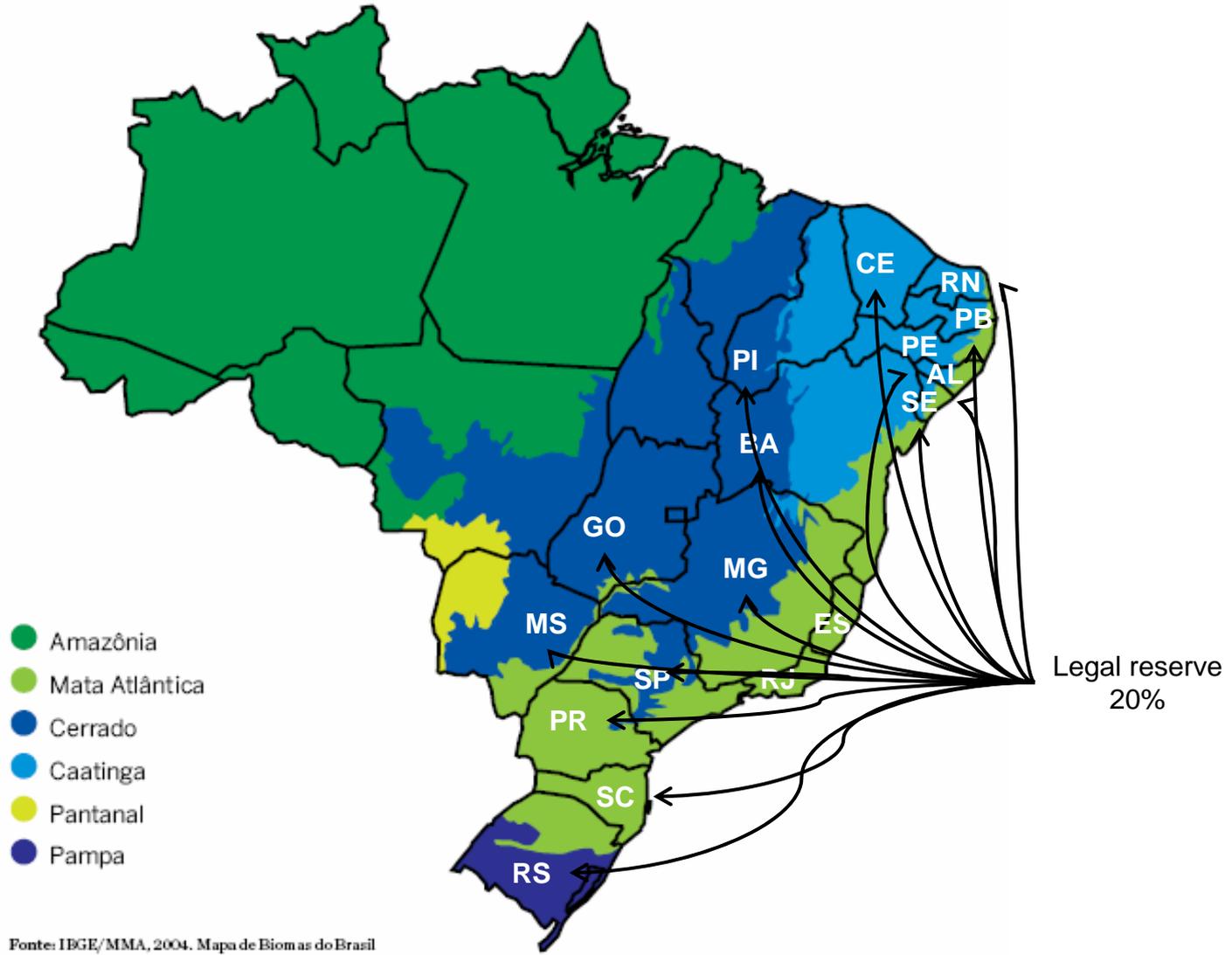
- **1<sup>st</sup> Step: estimation of Land Availability for Agriculture in Brazil**
  - Current agriculture land use: data;
  - Classification according to suitability (declivity, soil, rainfall and temperature): GIS;
  - Exclusion of land not available: conservation units, indigenous reserves, legal reserve, rivers, permanent preservation: GIS;
  - The World Bank: Brazilian Low Carbon Study.
- **2<sup>nd</sup> Step: projections on expansion**
  - Modeling Brazilian production and planted area (crops and pasture) expansion as a response to prices/costs changes, evolution of demand (world and domestic) and competition among suppliers;
  - Brazilian model will be integrated in a world model;
  - Partnership: CARD/FAPRI.
- **3<sup>rd</sup> Step: spatial reallocation**
  - Distribution of crop area and pasture area in the Brazilian territory;
  - Competition and substitution among crops/cattle and land availability;
  - The World Bank: Brazilian Low Carbon Study.
- **General support: ICONE's sponsors (private sector) and Inter-american Development Bank.**

# Brazilian Biomes and States



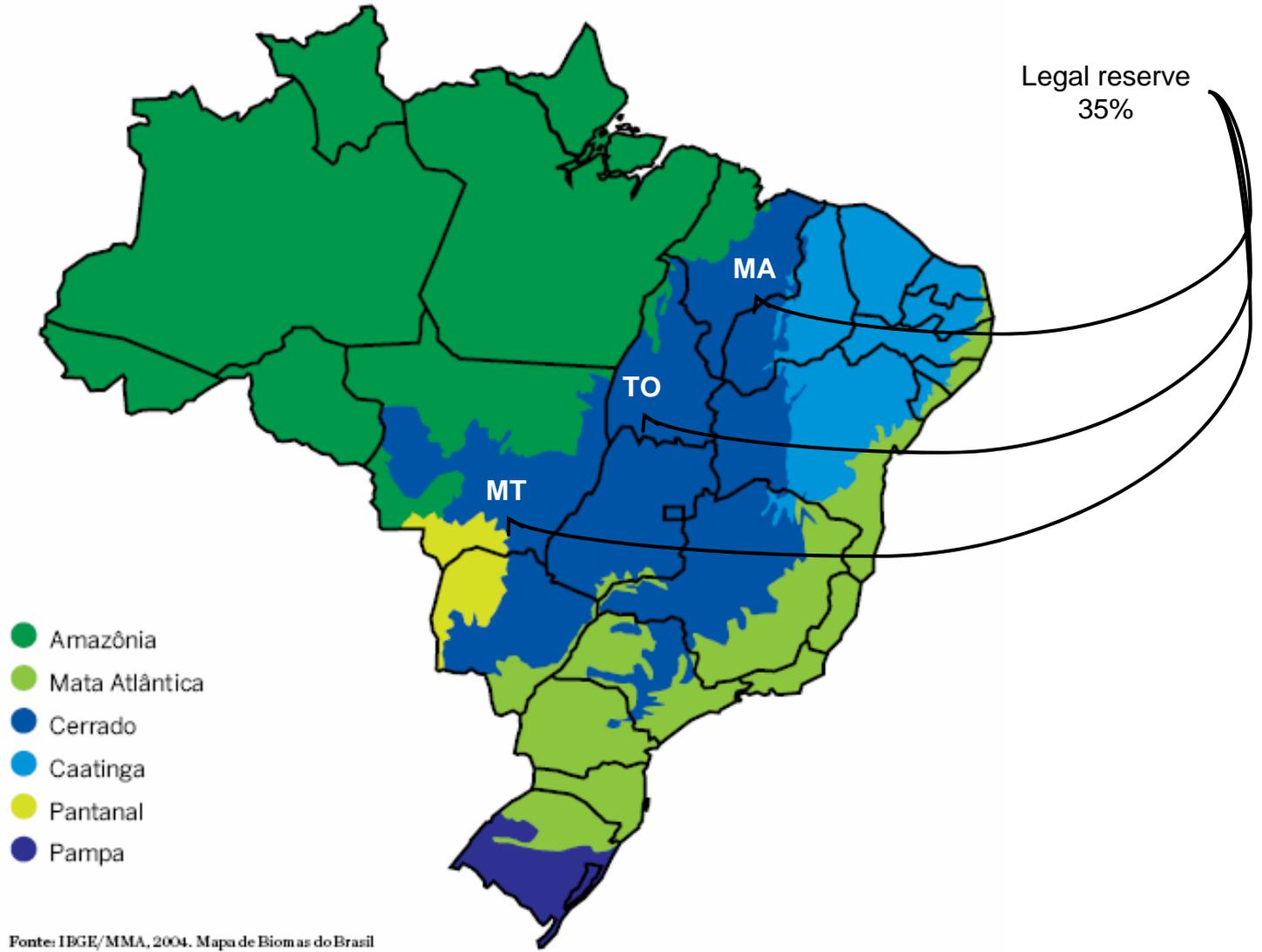
Fonte: IBGE/MMA, 2004. Mapa de Biomas do Brasil

# Brazilian Biomes and Legal Reserve (preservation rate)



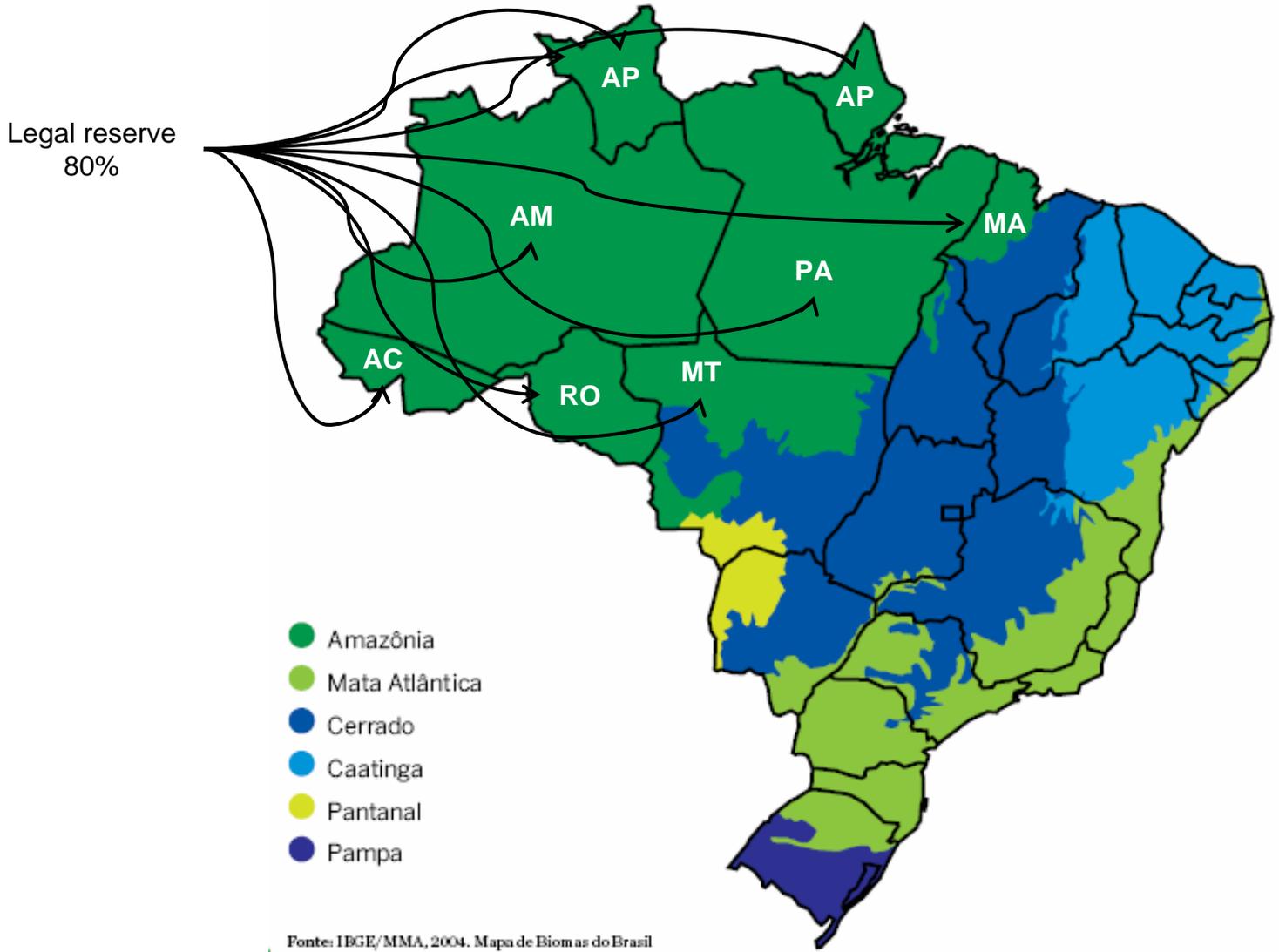
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# Brazilian Biomes and Legal Reserve (preservation rate)



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# Brazilian Biomes and Legal Reserve (preservation rate)



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

# Geographical Distribution of Agricultural Production in Brazil

**Corn**



**Cotton**



**Cattle**



**Chicken**



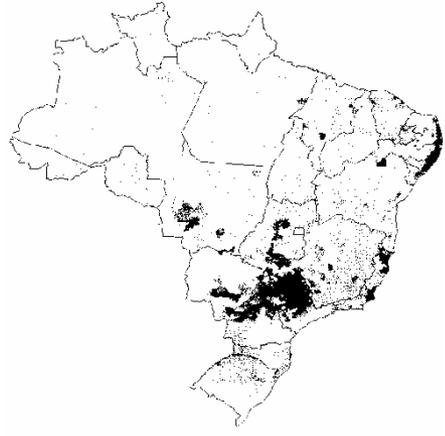
**Rice**



**Soybeans**



**Sugar cane**



**Pork**



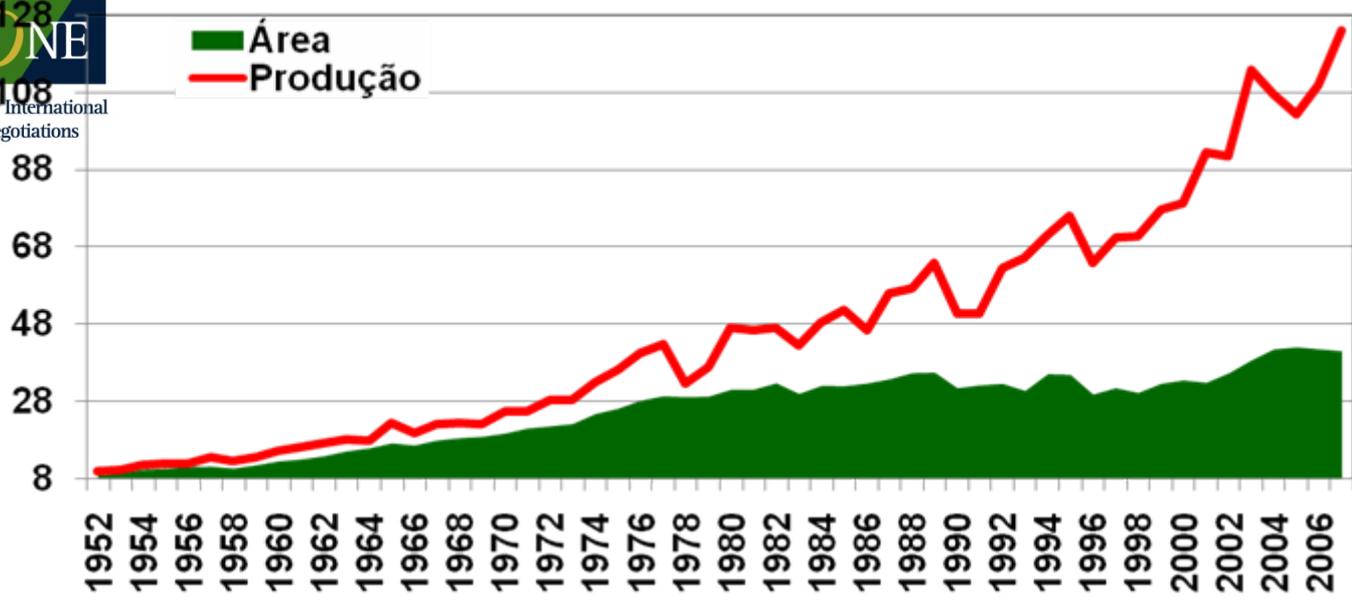
Realizado com Plinkato - <http://perso.club-internet.fr/zhilgeo>

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Million ton and ha

Área  
 Produção



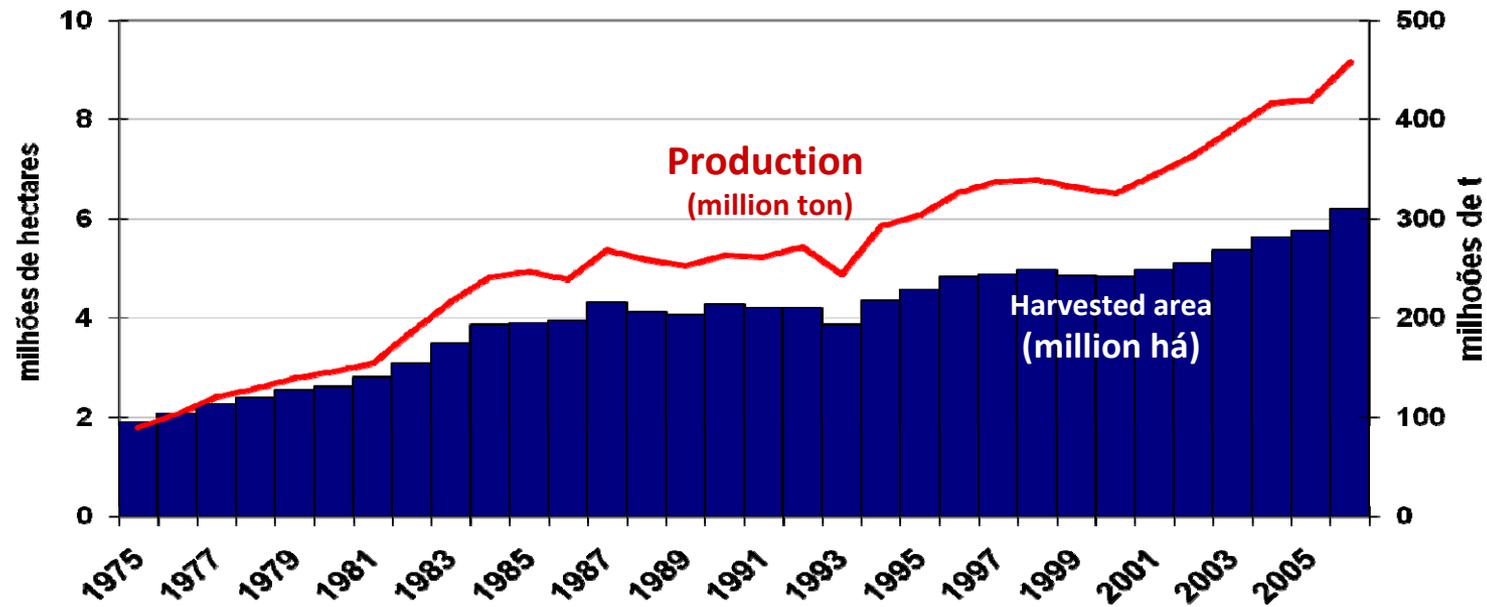
## Brazil Grains and Oilseeds: production and area

Source: IBGE (2007)

\*2007: preliminar results

Crops: rice, soybean, corn and beans

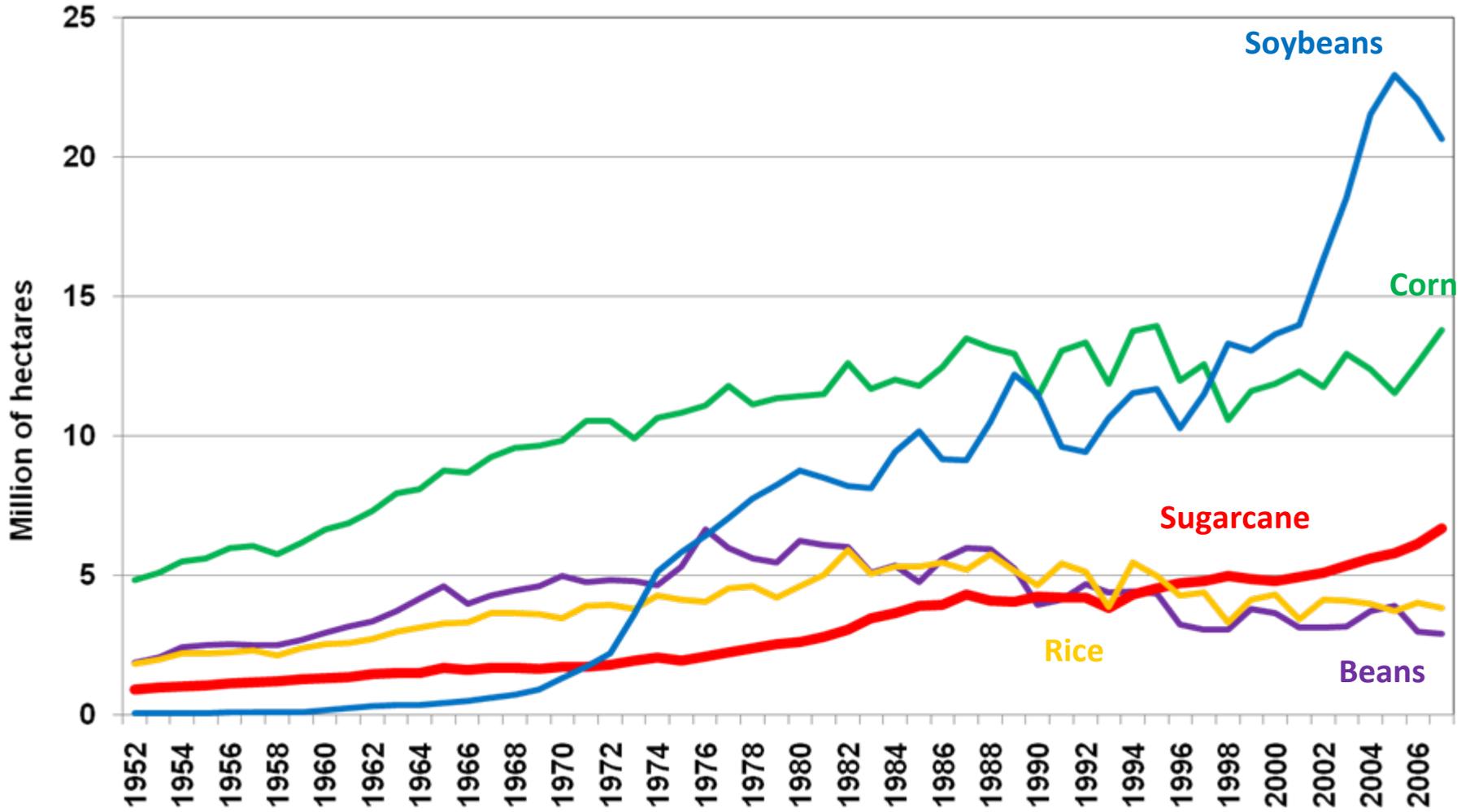
## Brazil Sugarcane: production and area



Source: Ministry of Agriculture, 2007.

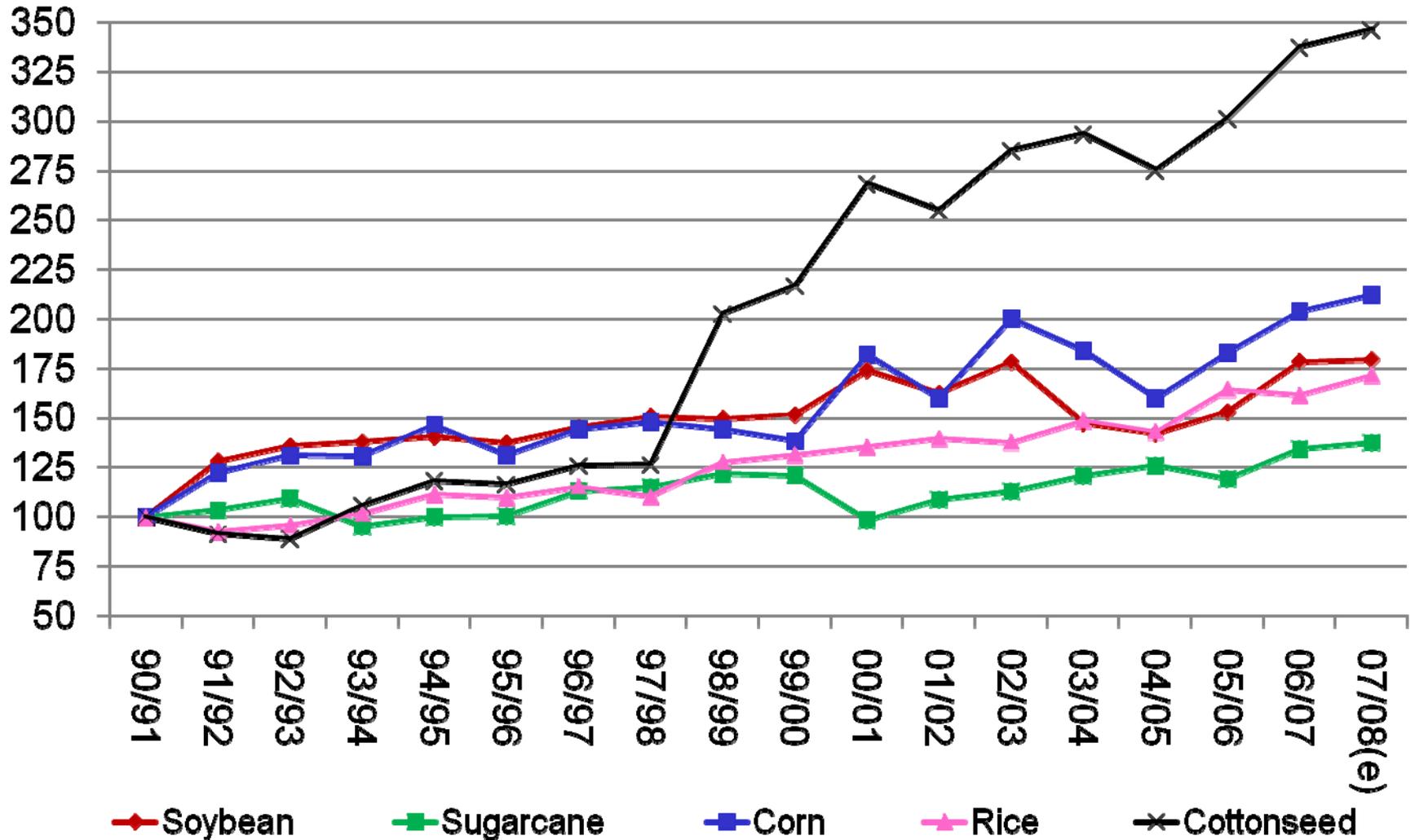
# BRAZIL: HARVESTED AREA FOR MAJOR CROPS

Institute for International Trade Negotiations

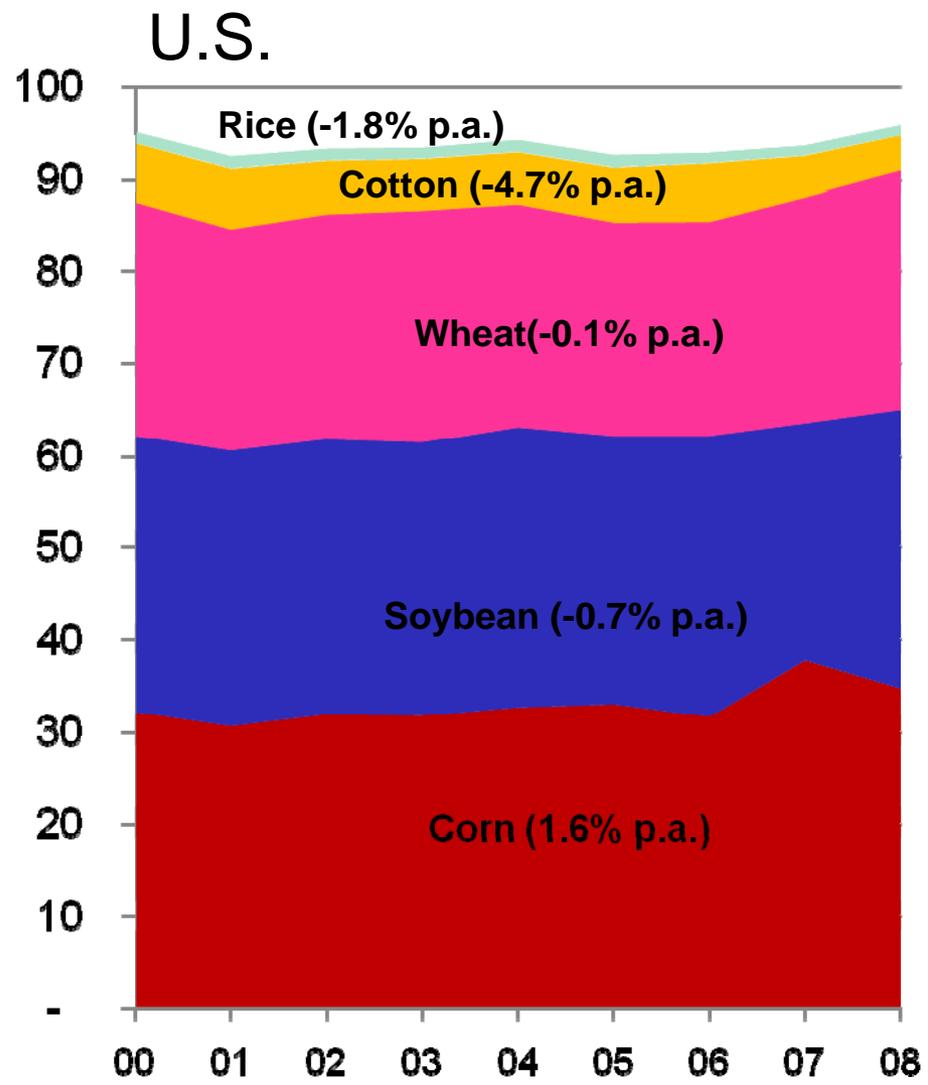
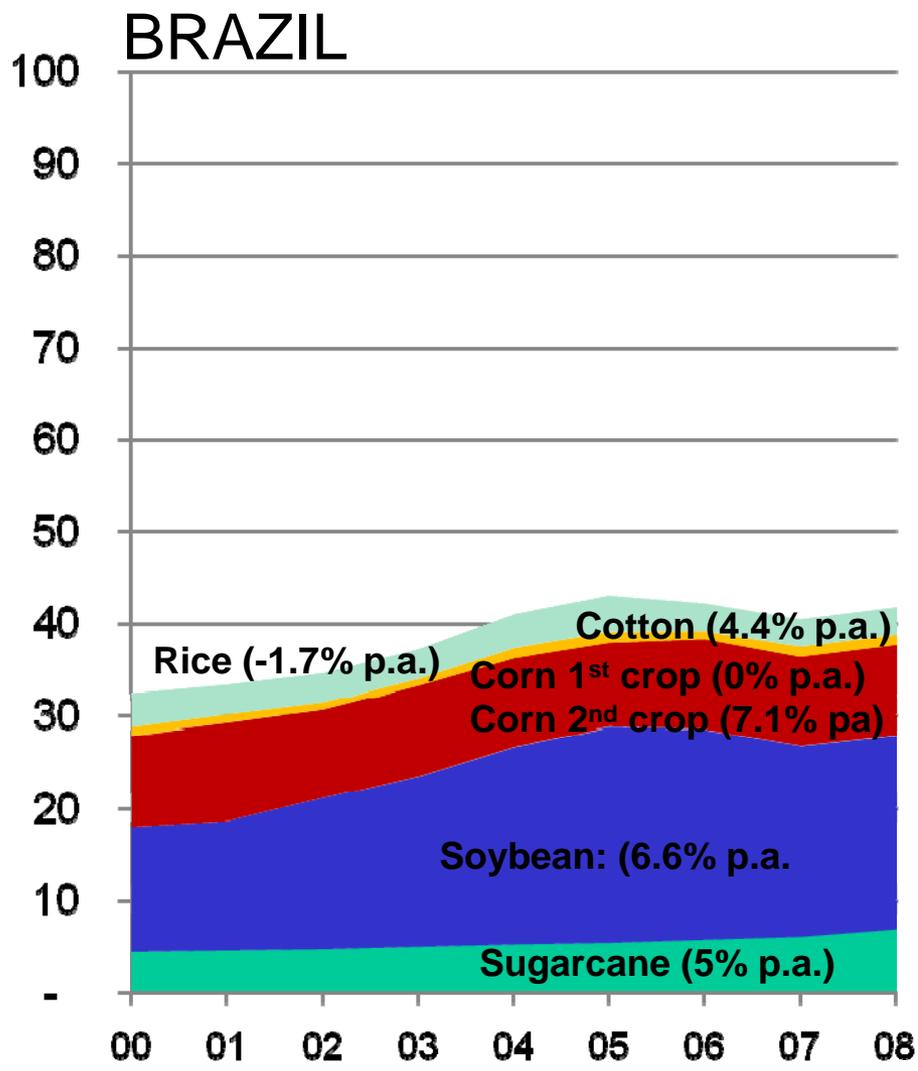


Source: IBGE (2007)  
 \* 2007: Preliminar results

# Figure 10. Brazil: Productivity Index (1990/91=100)

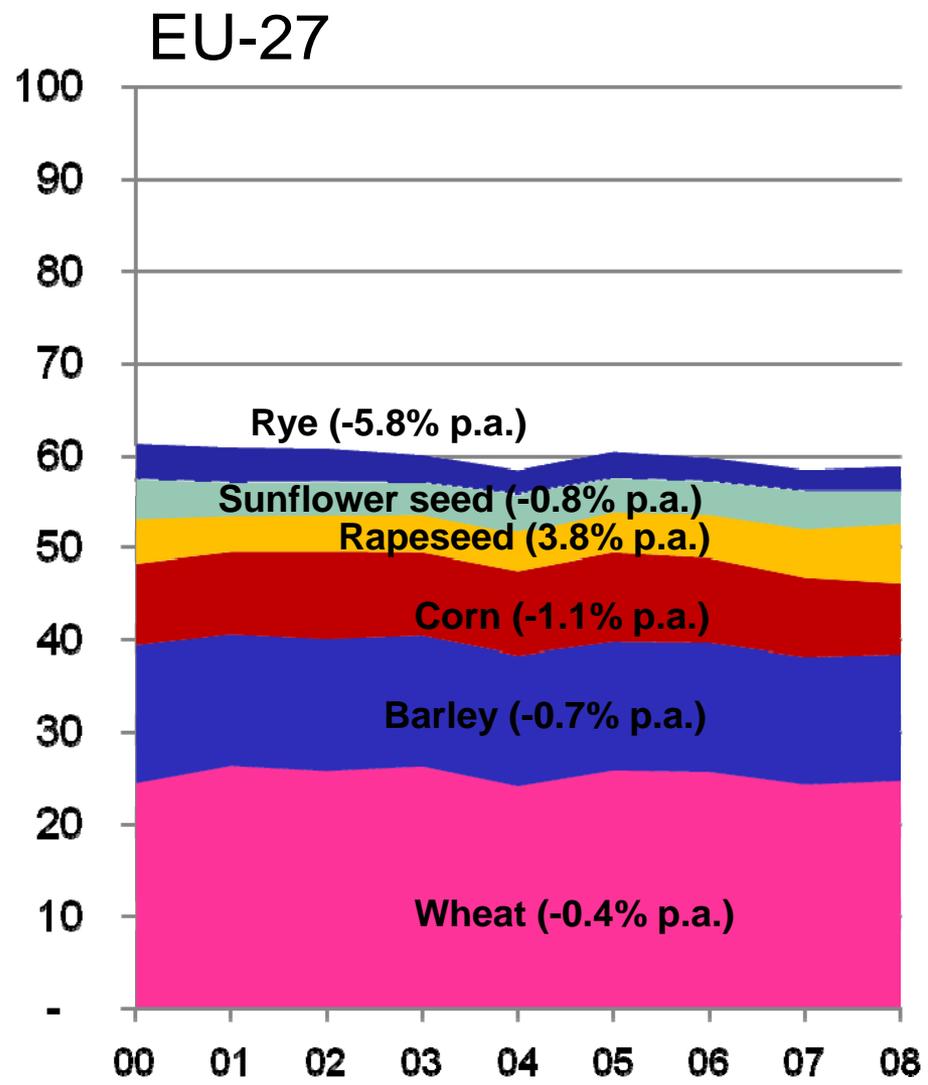
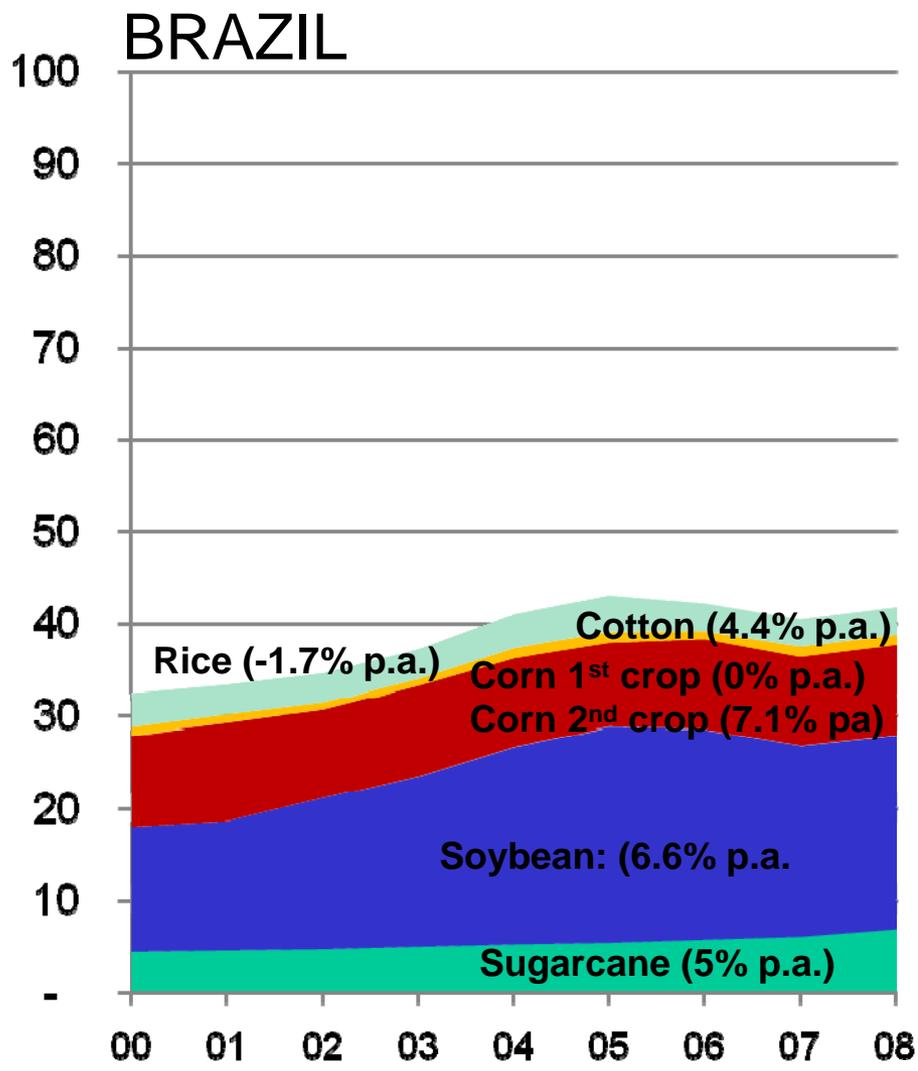


# Brazil and U.S.: Evolution of Planted Area (million hectares, growth rate in parenthesis)



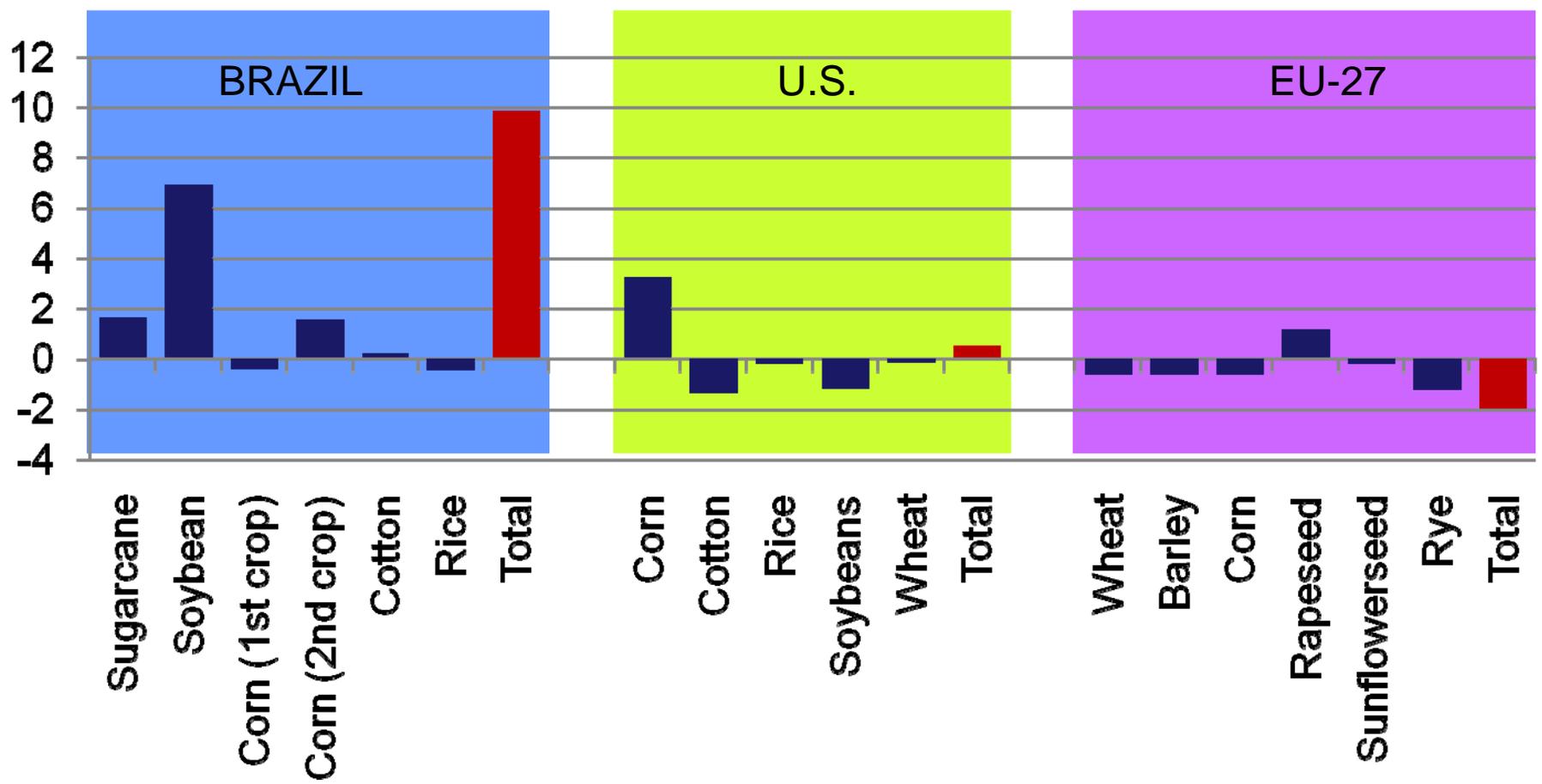
Source: IBGE; CONAB; USDA. Elaboration: ICONE. Note: information in parenthesis is the annual growth rate from 2000 to 2008.

# Brazil and EU-27: Evolution of Planted Area (million hectares, growth rate in parenthesis)



Source: IBGE; CONAB; USDA. Elaboration: ICONE. Note: information in parenthesis is the annual growth rate from 2000 to 2008.

# Planted Area of Selected Crops: Absolute Variation from 2000-02 to 2006-08 (million hectares)



# Land Availability in Selected Regions of Brazil: Preliminary Results (1,000 hectares, 2006)

|   | Planted Area |               |                | Pasture Area   | Total Land<br>Used for<br>Agriculture | Agricultural<br>Land<br>Available(e) | Potential<br>Land(p) | Legal<br>Reserve |
|---|--------------|---------------|----------------|----------------|---------------------------------------|--------------------------------------|----------------------|------------------|
|   | Sugarcane    | Grains        | Total<br>Crops |                |                                       |                                      |                      |                  |
| <b>Sao Paulo</b>                        | 3,285        | 1,522         | 6,611          | 8,780          | 15,391                                | 15,391                               | negligible           | 20%              |
| <b>Parana</b>                           | 433          | 5,515         | 9,247          | 5,560          | 14,807                                | 14,807                               | negligible           | 20%              |
| <b>Minas Gerais<br/>(Cerrado)</b>       | 431          | 2,446         | 4,725          | 10,161         | 14,886                                | 22,455                               | 7,570                | 20%              |
| <b>Goias</b>                            | 238          | 3,151         | 4,077          | 19,050         | 23,127                                | 24,684                               | 1,557                | 20%              |
| <b>Mato Grosso do<br/>Sul (Cerrado)</b> | 153          | 2,084         | 3,010          | 11,713         | 14,723                                | 16,424                               | 1,701                | 20%              |
| <b>Mato Grosso<br/>(Cerrado)</b>        | 202          | 6,647         | 6,884          | 6,442          | 13,327                                | 20,727                               | 7,401                | 35%              |
| <b>Tocantins<br/>(Cerrado)</b>          | 4            | 528           | 604            | 11,390         | 11,994                                | 14,033                               | 2,040                | 35%              |
| <b>Piaui (Cerrado)</b>                  | 10           | 688           | 1,169          | negligible     | 1,169                                 | 6,079                                | 4,910                | 20%              |
| <b>Maranhao<br/>(Cerrado)</b>           | 39           | 1,264         | 1,645          | 1,049          | 2,694                                 | 7,264                                | 4,570                | 35%              |
| <b>Bahia</b>                            | 106          | 1,931         | 3,398          | 909            | 4,307                                 | 10,538                               | 6,232                | 20%              |
| <b>Total</b>                            | <b>4,901</b> | <b>25,776</b> | <b>41,371</b>  | <b>75,053</b>  | <b>116,424</b>                        | <b>152,404</b>                       | <b>35,980</b>        | <b>n.a.</b>      |
| <b>Brazil Total</b>                     | <b>6,179</b> | <b>36,032</b> | <b>62,353</b>  | <b>172,333</b> | <b>217,456</b>                        | <b>n.a.</b>                          | <b>n.a.</b>          | <b>n.a.</b>      |

Source: IBGE; MMA; CONAB; EMBRAPA. Elaboration: ICONE.

**Notes:**

1. Conservation parks, indigenous reserves and legal reserve provisions have been excluded from the agricultural land available.
2. N.a. (not applicable). (e) estimation.

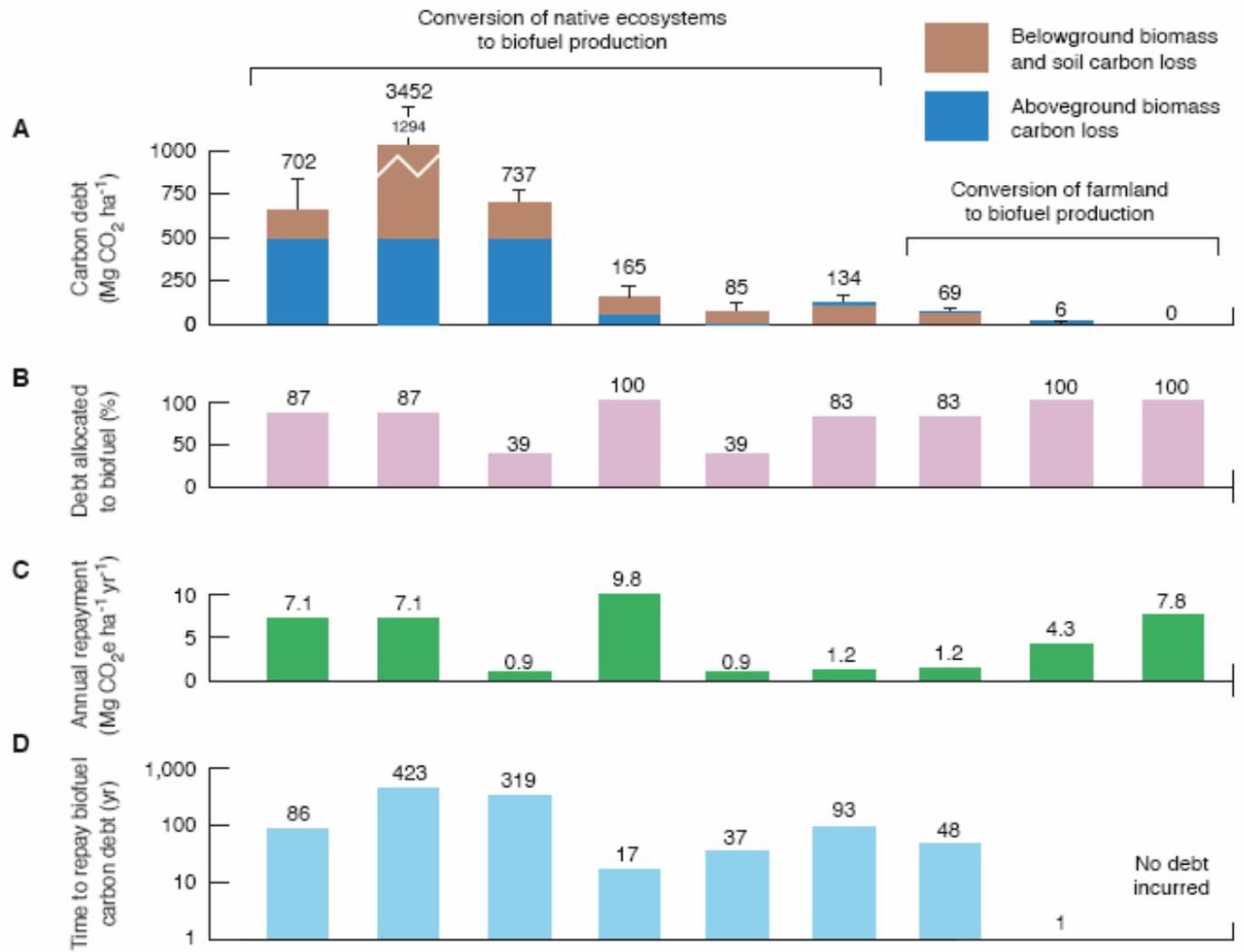
# Sugarcane Expansion: Pasture and Crops Substitution from 2002 to 2006

|                 | Planted Area (1,000 ha) |       |           | Substitution 2006-2002 (1,000 ha) |           |          |          |
|-----------------|-------------------------|-------|-----------|-----------------------------------|-----------|----------|----------|
|                 | 2002                    | 2006  | Abs. Var. | Pasture (p)                       | Crops (p) | Total(p) | Cane (p) |
| Sao Paulo       | 2,662                   | 3,285 | 623       | 558                               | 66        | 624      | -1       |
| Minas Gerais    | 278                     | 431   | 153       | 148                               | 16        | 165      | -11      |
| Parana          | 359                     | 433   | 74        | 92                                | 3         | 95       | -21      |
| Mato Grosso Sul | 112                     | 153   | 41        | 42                                | 10        | 52       | -11      |
| Goias           | 204                     | 238   | 34        | 50                                | 8         | 59       | -25      |
| Mato Grosso     | 177                     | 202   | 25        | 26                                | 10        | 35       | -10      |
| Tocantins       | 3                       | 4     | 1         | 1                                 | 0         | 1        | 0        |
| Bahia           | 80                      | 106   | 26        | n.a.                              | n.a.      | n.a.     | n.a.     |
| Maranhao        | 23                      | 39    | 16        | n.a.                              | n.a.      | n.a.     | n.a.     |
| Piaui           | 8                       | 10    | 3         | n.a.                              | n.a.      | n.a.     | n.a.     |

Source: IBGE; ICONE. Elaboration: ICONE.

**Notes:**

1. Calculated in a micro-regional level (295 groups of municipalities).
2. Sugarcane area absolute variation was compared to the absolute variation of pasture and crops areas.
3. Crops: temporary crops area without including sugarcane area.
4. N.a. (data not available). (p) preliminary.



|                  |                     |                     |                     |                   |                   |                   |                    |                         |                         |
|------------------|---------------------|---------------------|---------------------|-------------------|-------------------|-------------------|--------------------|-------------------------|-------------------------|
| Biofuel          | Palm biodiesel      | Palm biodiesel      | Soybean biodiesel   | Sugarcane ethanol | Soybean biodiesel | Corn ethanol      | Corn ethanol       | Prairie biomass ethanol | Prairie biomass ethanol |
| Former ecosystem | Tropical rainforest | Peatland rainforest | Tropical rainforest | Cerrado wooded    | Cerrado grassland | Central grassland | Abandoned cropland | Abandoned cropland      | Fertile cropland        |
| Location         | Indonesia/Malaysia  | Indonesia/Malaysia  | Brazil              | Brazil            | Brazil            | US                | US                 | US                      | US                      |

Fonte: Land Clearing and the Biofuel Carbon Debt. Joseph Fargione, Jason Hill, David Tilman, Stephen Polasky, Peter Hawthorne.

# Direct Effect and Carbon Cycle: Situation of Cerrados by 2002 (1,000 ha)

|                 | Cerrado in the State (%) | Remaining Natural Vegetation | Anthropic Vegetation | Forest Vegetation | Savannah Vegetation | Grassland    | Remaining Natural Vegetation (%) |
|-----------------|--------------------------|------------------------------|----------------------|-------------------|---------------------|--------------|----------------------------------|
| Sao Paulo       | 33%                      | 1,079                        | 6,934                | 833               | 210                 | 35           | 13%                              |
| Parana          | 2%                       | 119                          | 256                  | 21                | 14                  | 84           | 32%                              |
| Mato Grosso Sul | 61%                      | 6,935                        | 14,723               | 2,867             | 3,600               | 468          | 32%                              |
| Goiias          | 97%                      | 14,707                       | 18,190               | 2,929             | 11,090              | 688          | 45%                              |
| Minas Gerais    | 57%                      | 17,795                       | 15,419               | 3,280             | 11,322              | 3,193        | 54%                              |
| Mato Grosso     | 40%                      | 23,740                       | 12,148               | 7,717             | 15,868              | 155          | 66%                              |
| Bahia           | 27%                      | 11,210                       | 3,963                | 3,334             | 7,358               | 518          | 74%                              |
| Tocantins       | 92%                      | 20,252                       | 4,838                | 4,640             | 13,363              | 2,249        | 81%                              |
| Maranhao        | 65%                      | 18,754                       | 2,318                | 12,338            | 6,033               | 383          | 89%                              |
| Piaui           | 37%                      | 8,591                        | 758                  | 2,319             | 6,210               | 61           | 92%                              |
| <b>Total</b>    |                          | <b>123,181</b>               | <b>79,548</b>        | <b>40,278</b>     | <b>75,068</b>       | <b>7,834</b> | <b>61%</b>                       |

# Indirect Effect: Expansion of Sugarcane, Pasture and Crops Compared (2002 to 2006)

|                 | 2006-2002 Absolute Variation of Planted Area (1,000 ha) |            |           |
|-----------------|---|------------|-----------|
|                 | Sugarcane   | Pasture    | Crops     |
| Sao Paulo       | 623,061   | -1,392,954 | 97,731    |
| Minas Gerais    | 153,361   | 793,512    | 400,607   |
| Parana          | 73,941  | -616,296   | 575,485   |
| Mato Grosso Sul | 40,647  | -131,694   | 867,413   |
| Goiias          | 33,862  | 376,822    | 546,349   |
| Mato Grosso     | 25,432  | 902,913    | 2,350,852 |
| Tocantins       | 971   | 51,966     | 240,842   |
| Bahia           | 26,023  | n.a.       | 317,762   |
| Maranhao        | 16,192  | n.a.       | 296,919   |
| Piaui           | 2,513   | n.a.       | 200,012   |

Source: IBGE; ICONE. Elaboration: ICONE.

Notes:

1. Calculated in State level.

2. Crops: temporary crops area without including sugarcane area.

3. N.a.: data not available.