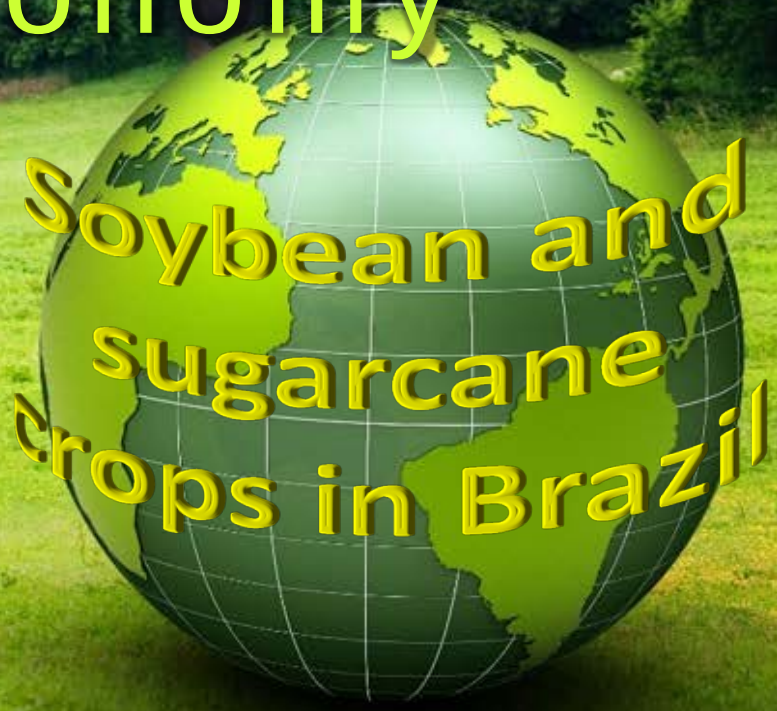
BIO economy

THIRD BIOECONOMY COURSE
UNIVERSITY OF SOUTH BOHEMIA
MAY 21 – 25, 2018

Food land *vs.* energy land in the bioeconomy



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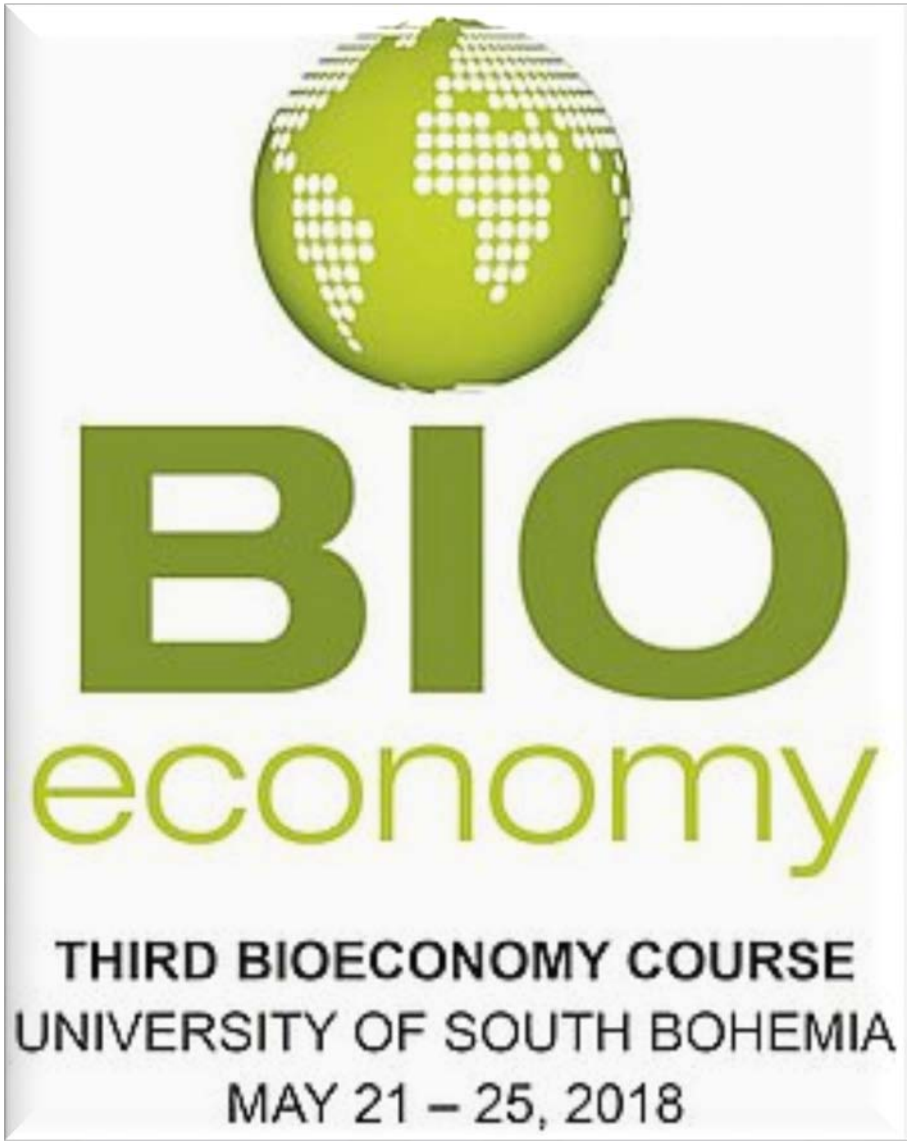
Overview

- Research problem
- Objectives
- Assumptions
- Definitions
  - Biofuels
  - Land grabbing
  - Food land (soybean)
  - Energy land (sugarcane)
- Hypotheses
- Methodology
  - Statistical and analytical model
- Results
- Discussion/Conclusions



Research problem and objectives

Research problem

- How much **land grabbing** is supposed to take place in Brazil, given the incoming push toward **bioenergy** production and consumption (bioeconomy)?

Objectives

- Look into the **trade-off** between **food land** and **energy land** in Brazil
- Check out **patterns and trends** in land-use changes in Brazil
- Estimate **future land grabbing** for **food** (soybean) and **energy** (sugarcane ethanol) in Brazil

Assumptions

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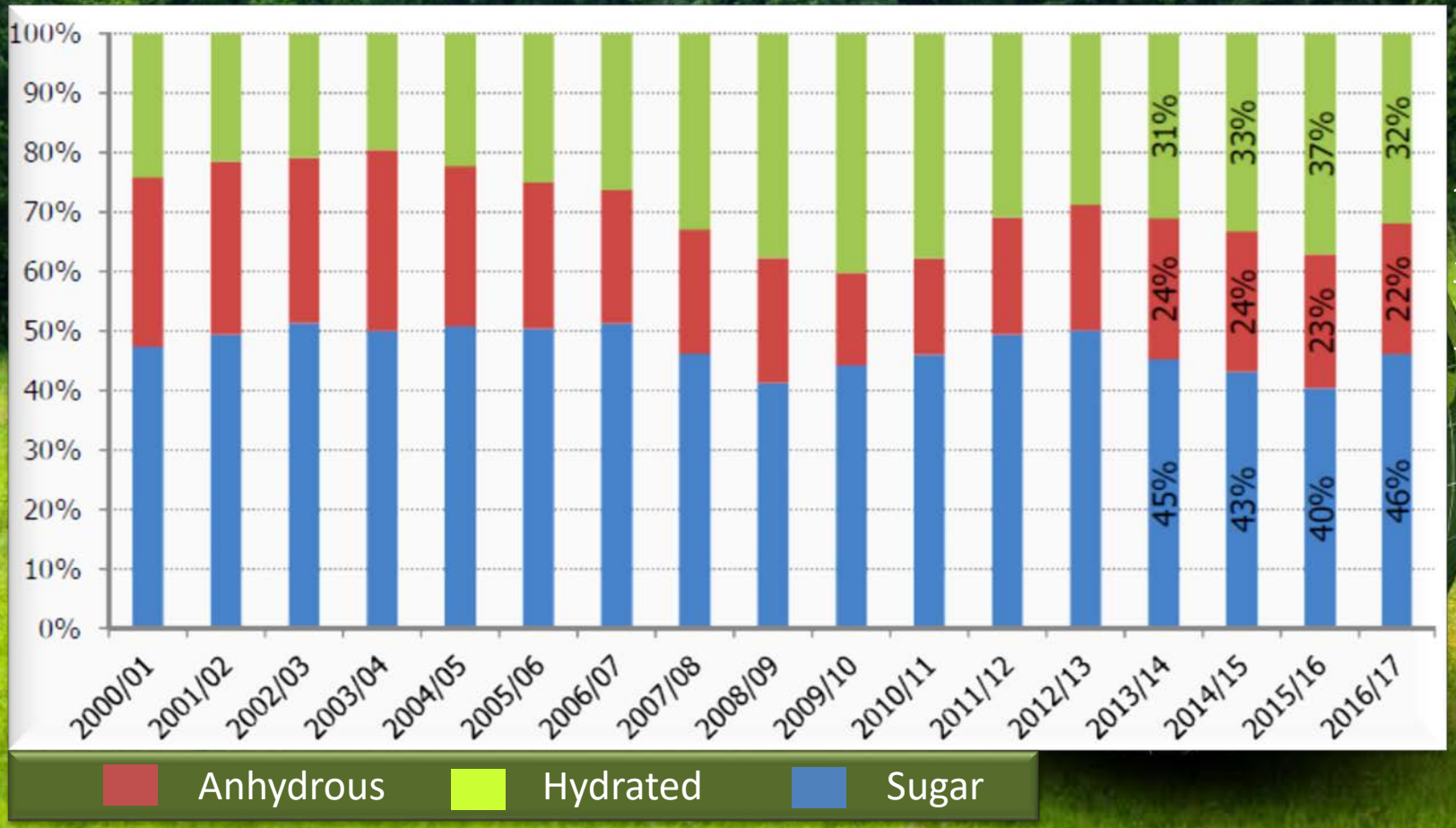
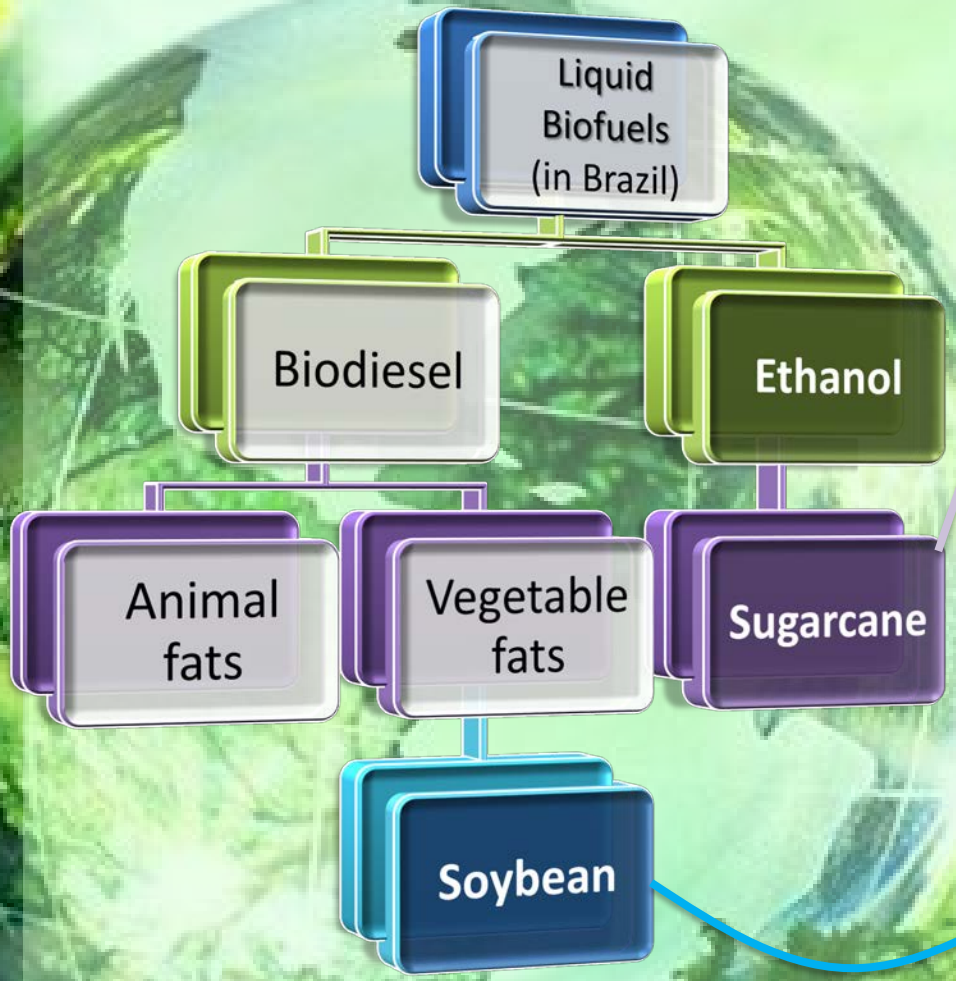
- **Sugarcane** crops **only** for **energy** (ethanol)
  - Actually sugarcane crops are also food crops, since they can produce either ***ethanol*** or ***sugar***
  - Population's energy consumption only met by biofuel/bioenergy from sugarcane (by-)products (BEN dataset on DPES = supply of "***sugarcane products***")
- **Soybean** crops = **food** crops **only**

Product mix
Ethanol *vs.* sugar



Source: ANP (2017, p. 19)

Definitions



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Commodity land

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Real commodities

- *"The **economic** function is but **one of many** vital **functions of land**. It invests man's life with **stability**; it is the site of his **habitation**; it is a condition of his **physical safety**; it is the **landscape** and the **seasons**. We might as well imagine his being born without hands and feet as carrying on his life without land."* (Polanyi, 2001, p. 187)

Fictitious commodities

- Something produced **for sale** in a market
  - Labour (?!)
  - Land (?!)
  - Money (?!)
- *"It is the absence of the threat of individual **starvation** which makes primitive society more human than market economy"* (Polanyi, 2001, p. 172)

Land grabbing

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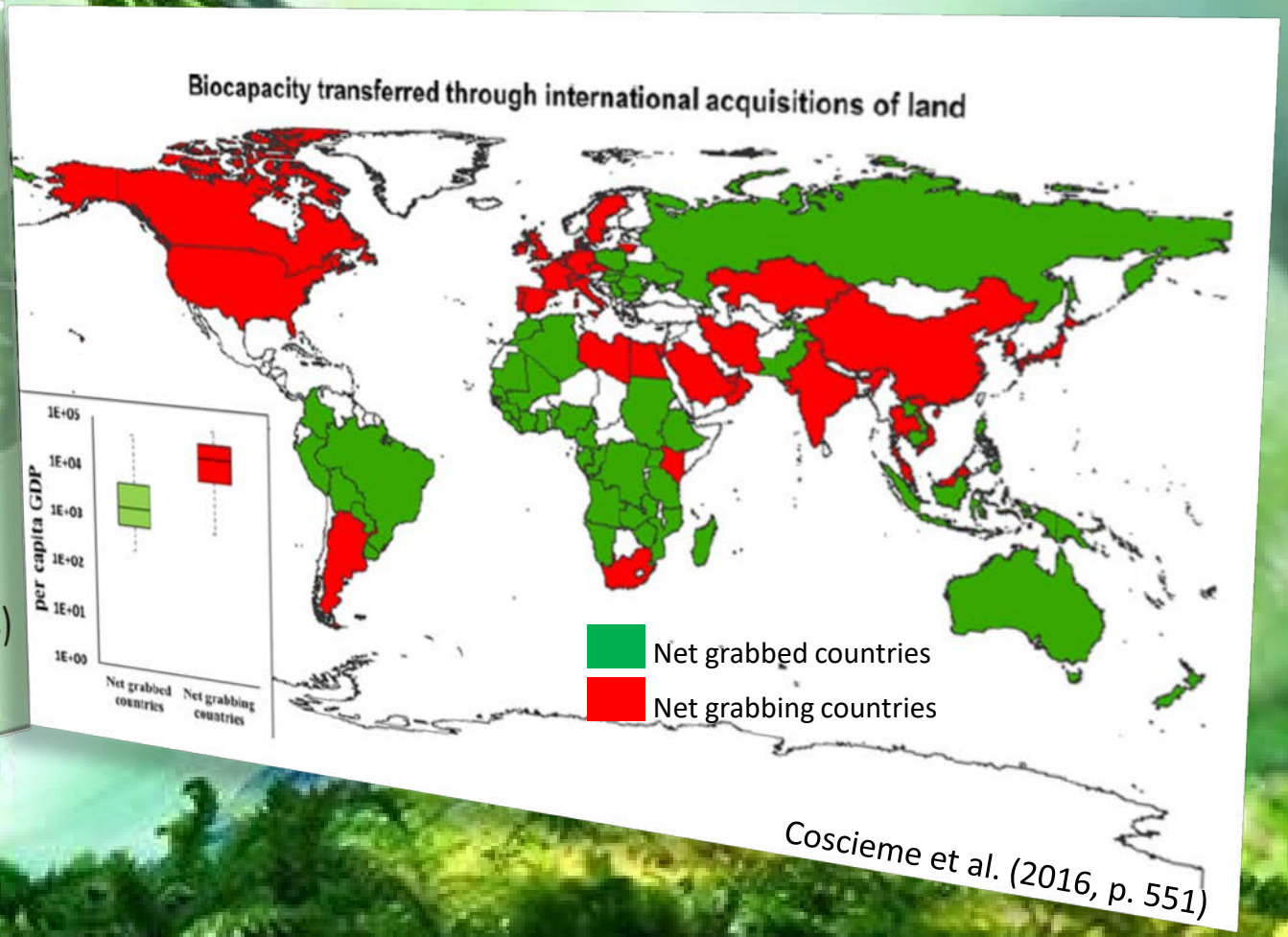
- Explosion of (trans)national commercial land transactions and land speculation, mainly around the ***large-scale production*** and ***export*** of ***food*** and ***biofuels*** (Borras & Franco, 2012, p. 34)

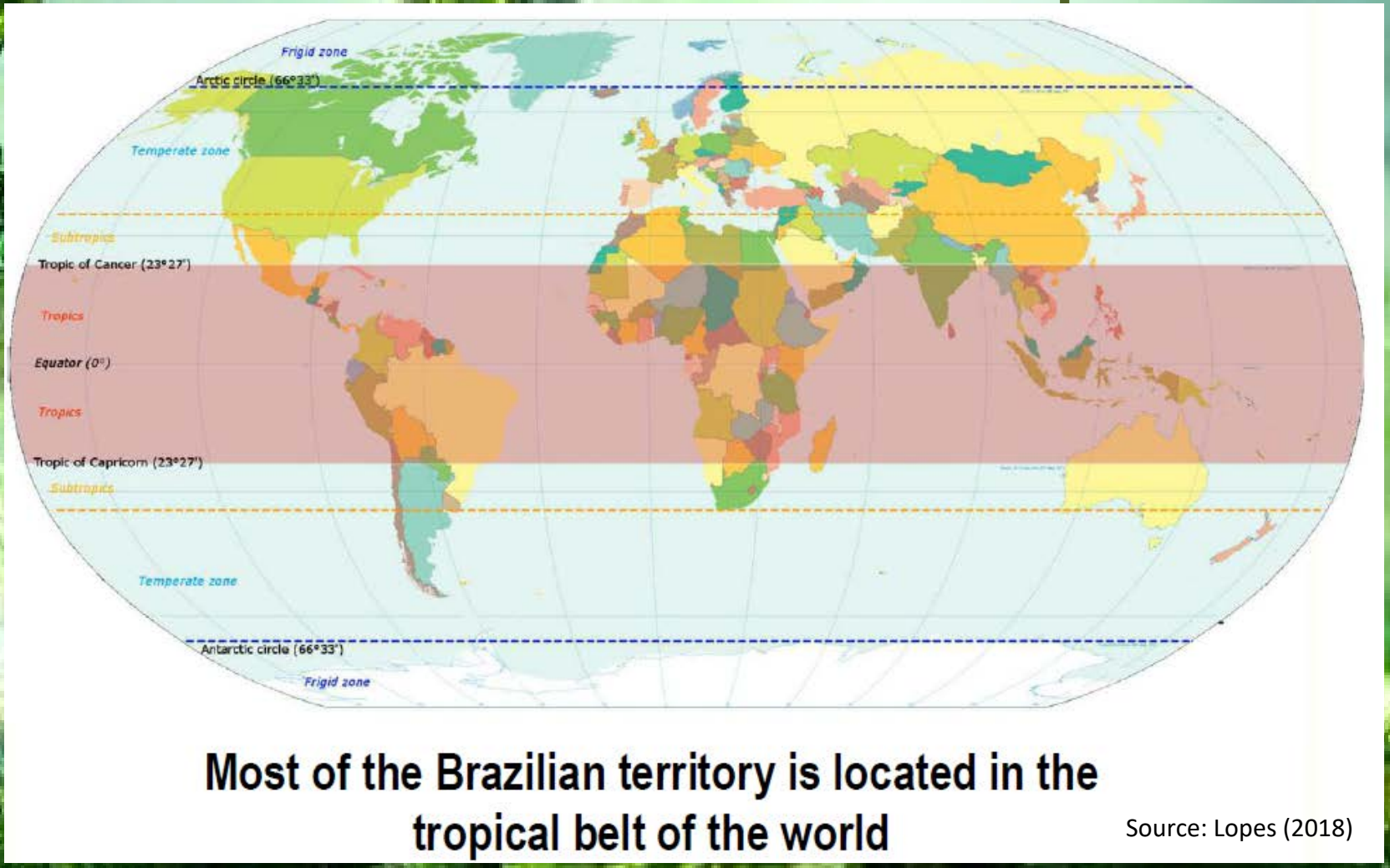


Coscieme et al. (2016, p. 551)

Hypotheses on land grabbing

- ***Surging commodity prices***, mainly internationally trade ***staple foods*** (maize, wheat, rice and ***soy***)
- Aftermath of 2007-08 economic crisis and worldwide food price spike
  - (Edelman et al., 2016, p. 1518)

Agriculture in the tropics

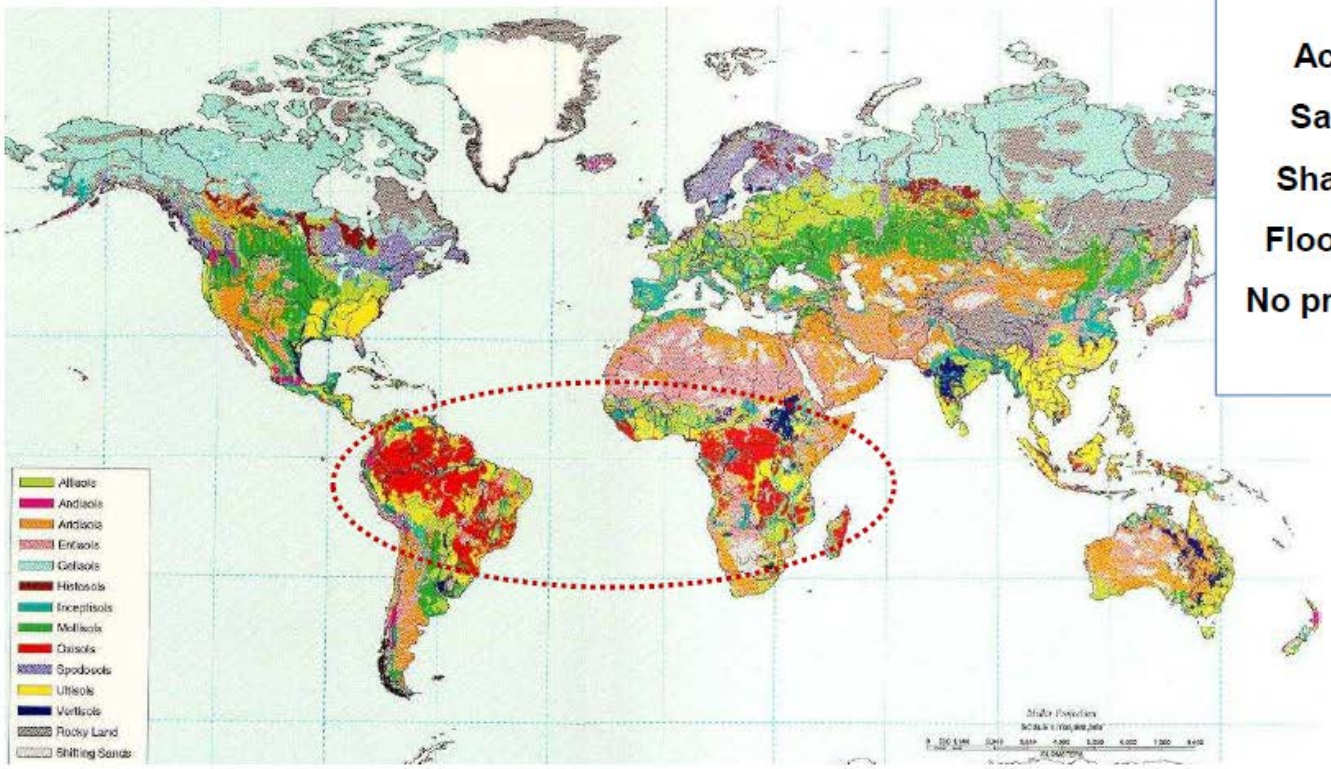


Most of the Brazilian territory is located in the tropical belt of the world

Source: Lopes (2018)

Agriculture in the tropics

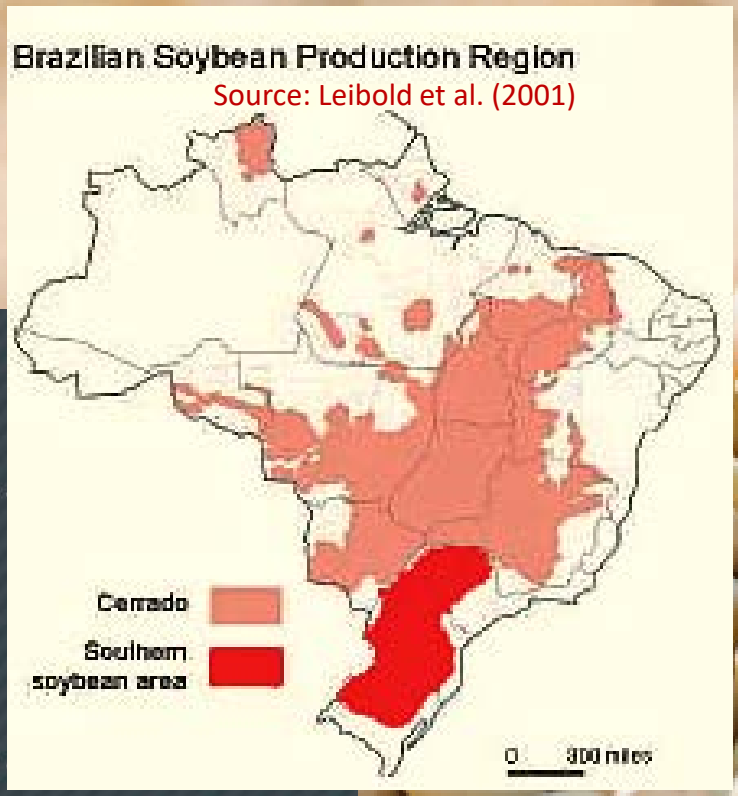
Source: Lopes (2018)



Concentration of acidic and nutrient-poor soils in the tropics

Food land Soybean

Source: Fischer et al. (2014, p. 252)



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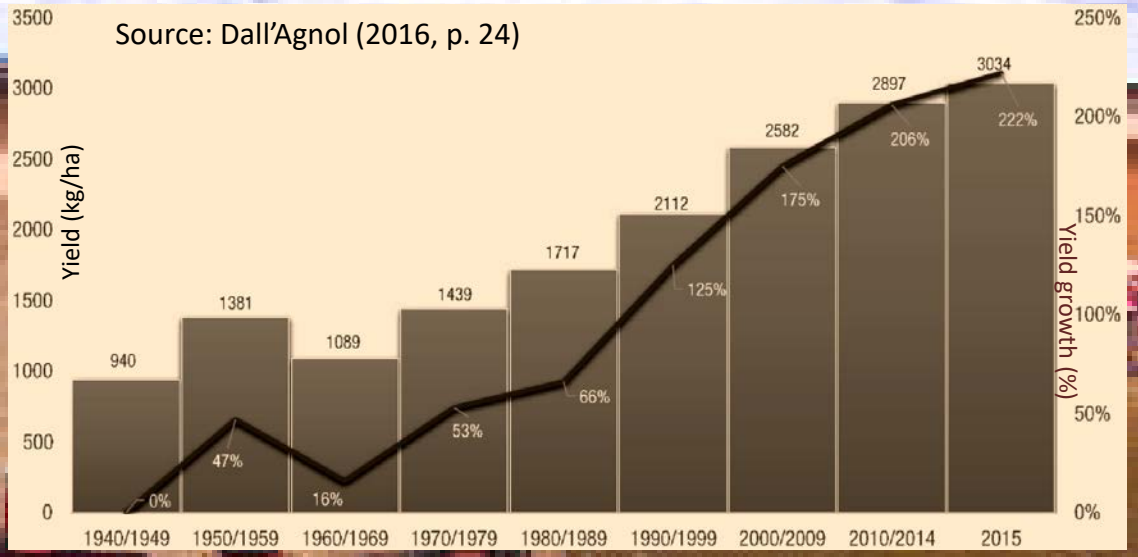
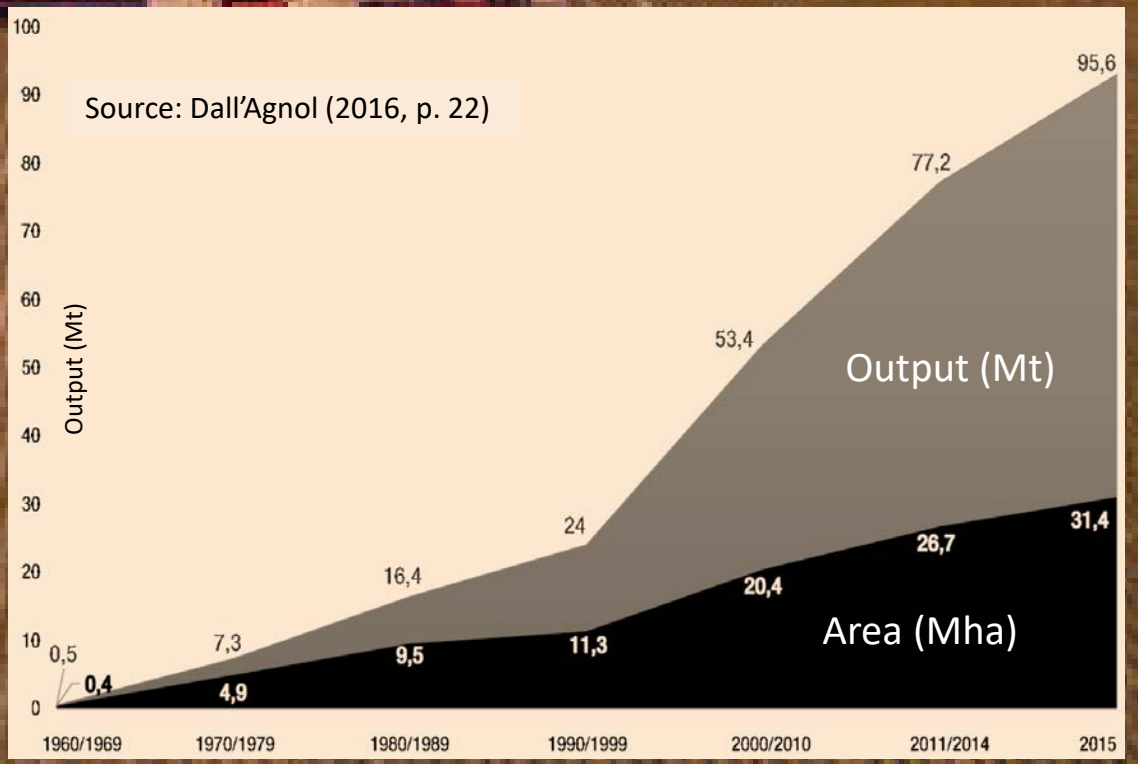
Food land Soybean

- 1914: First commercial soybean crop in Brazil (Santa Rosa, RS)
- 1940s
  - Soybean crops became economically important (457 t)
  - Production for fodder
  - Regardless its low output, the production increased >50 x (0.457 kt → >25 kt)
- 1950s: output growth >4 x
- 1960s: output growth >5 x
  - 1950/60: output growth due to area rather than to yield increase





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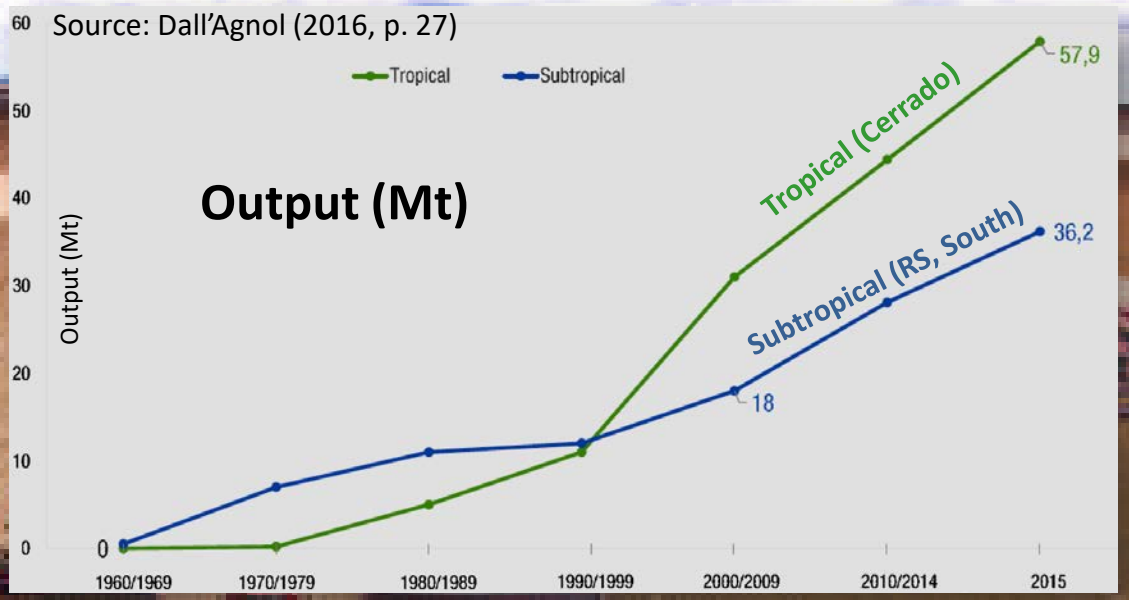
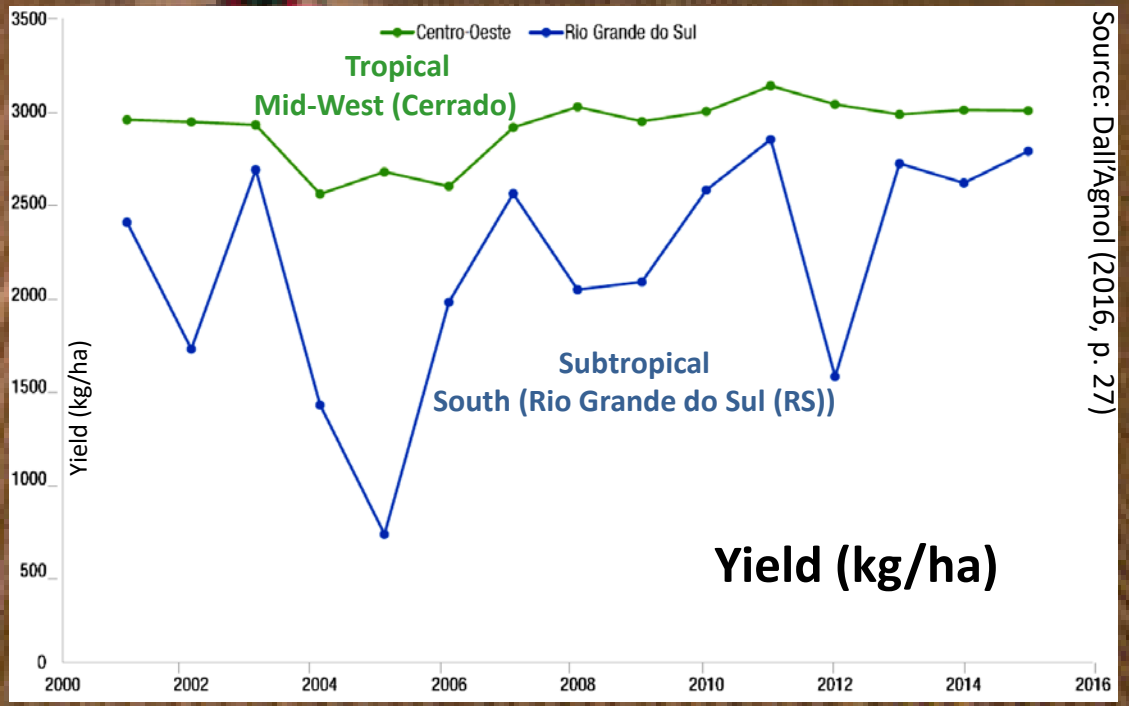
Food land Soybean

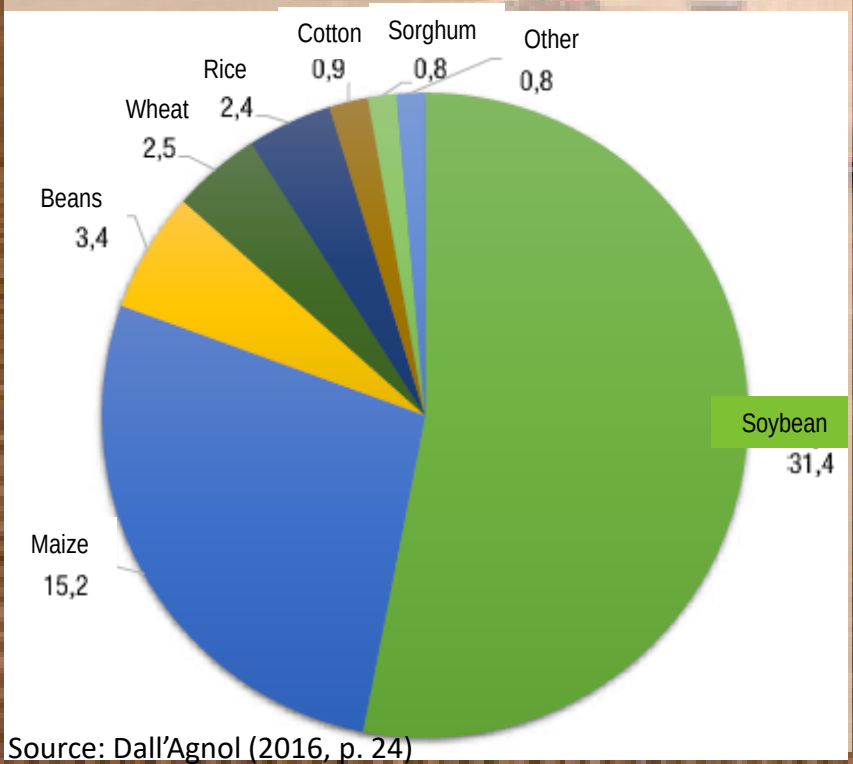
- 1970s
  - Soybean production in the **subtropical** region (South) boosted by exceptional **rising prices** in the **international market**
  - Expansion of soybean **subtropical** growing area constrained by **rising land prices**
  - Rise of **purchase of land** in Paraná and in the **tropical** region (**Cerrado**), where land prices were lower





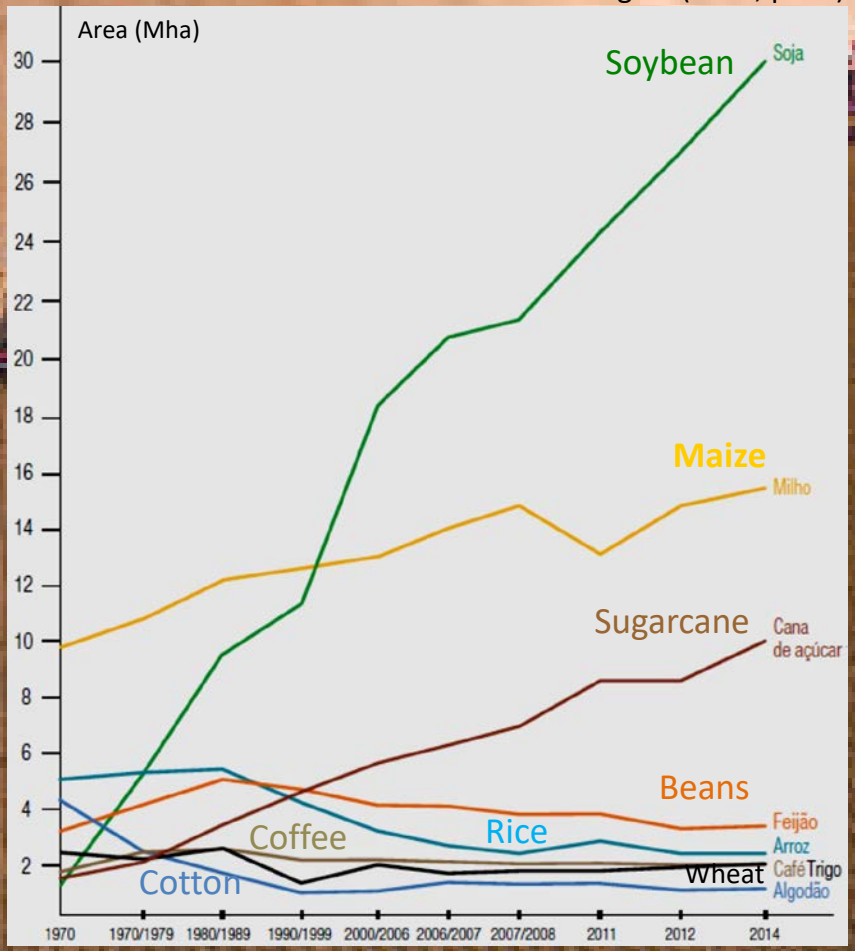
Food land
Soybean

- **Areas (Mha) of annual crops in Brazil, 2014/15**



Source: Dall'Agnol (2016, p. 24)

Source: Dall'Agnol (2016, p. 25)



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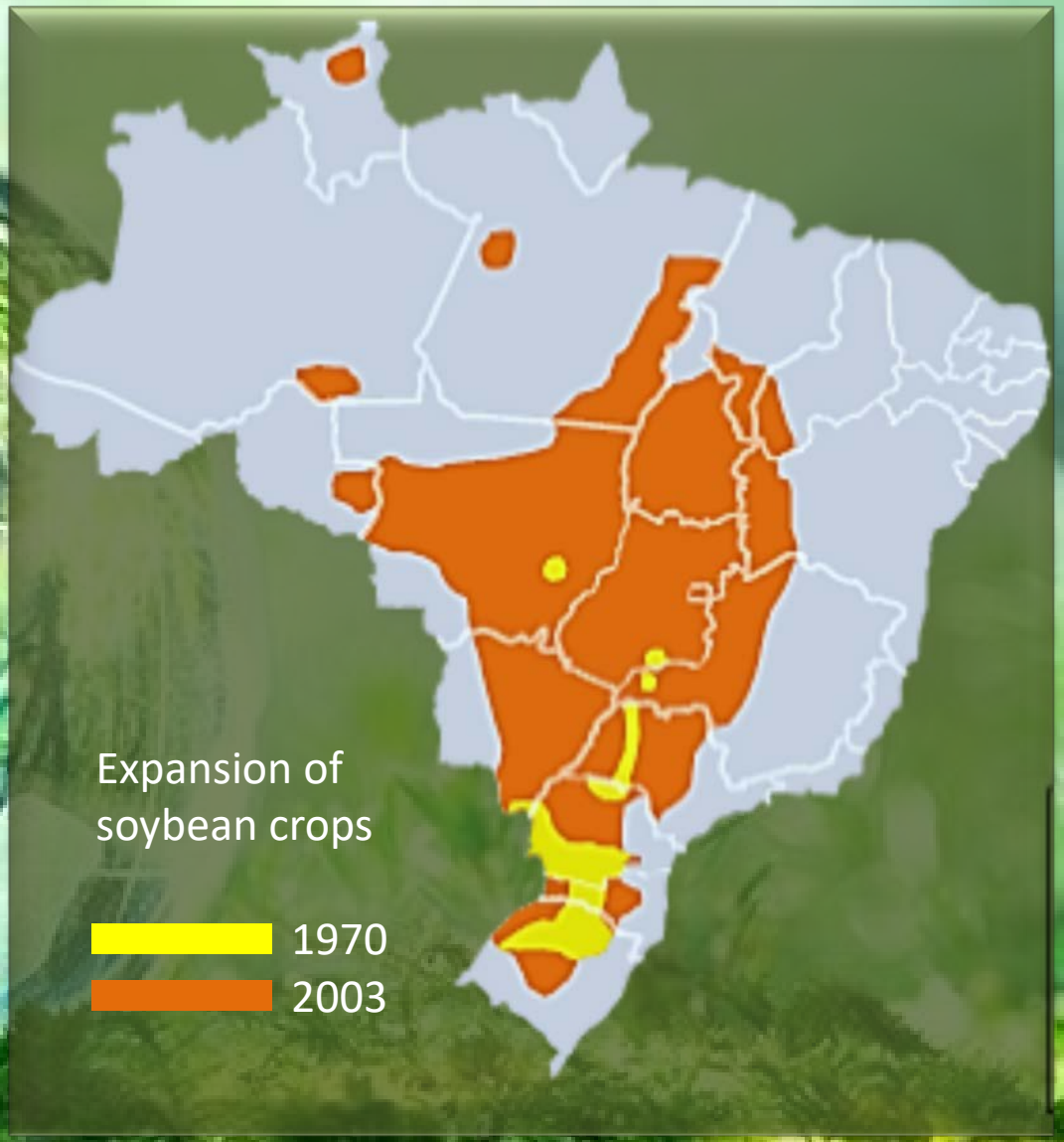
Soybean growing in Brazil

Source: Adapted from https://jornaloexpresso.wordpress.com



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Soybean expansion in Brazil

MATOPIBA or MAPITOBA

Área **414 381**km² = **41.44 Mha**

Source: Cunha (2015)

Energy land Sugarcane

- Ethanol (CH_3CH_2OH) = ethyl alcohol
  - Mostly obtained from fermentation of **sugarcane**, maize, beet, potatoes
- Brazil
  - Produces 1st and 2nd generation ethanol
  - Fuel ethanol
    - **Anhydrous ethanol** → blended into gasoline (18-25%)
    - **Hydrated ethanol** → used in Fuel Flex Vehicles (FFV)

Source: ANP (2017)

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Sugarcane growing over the world

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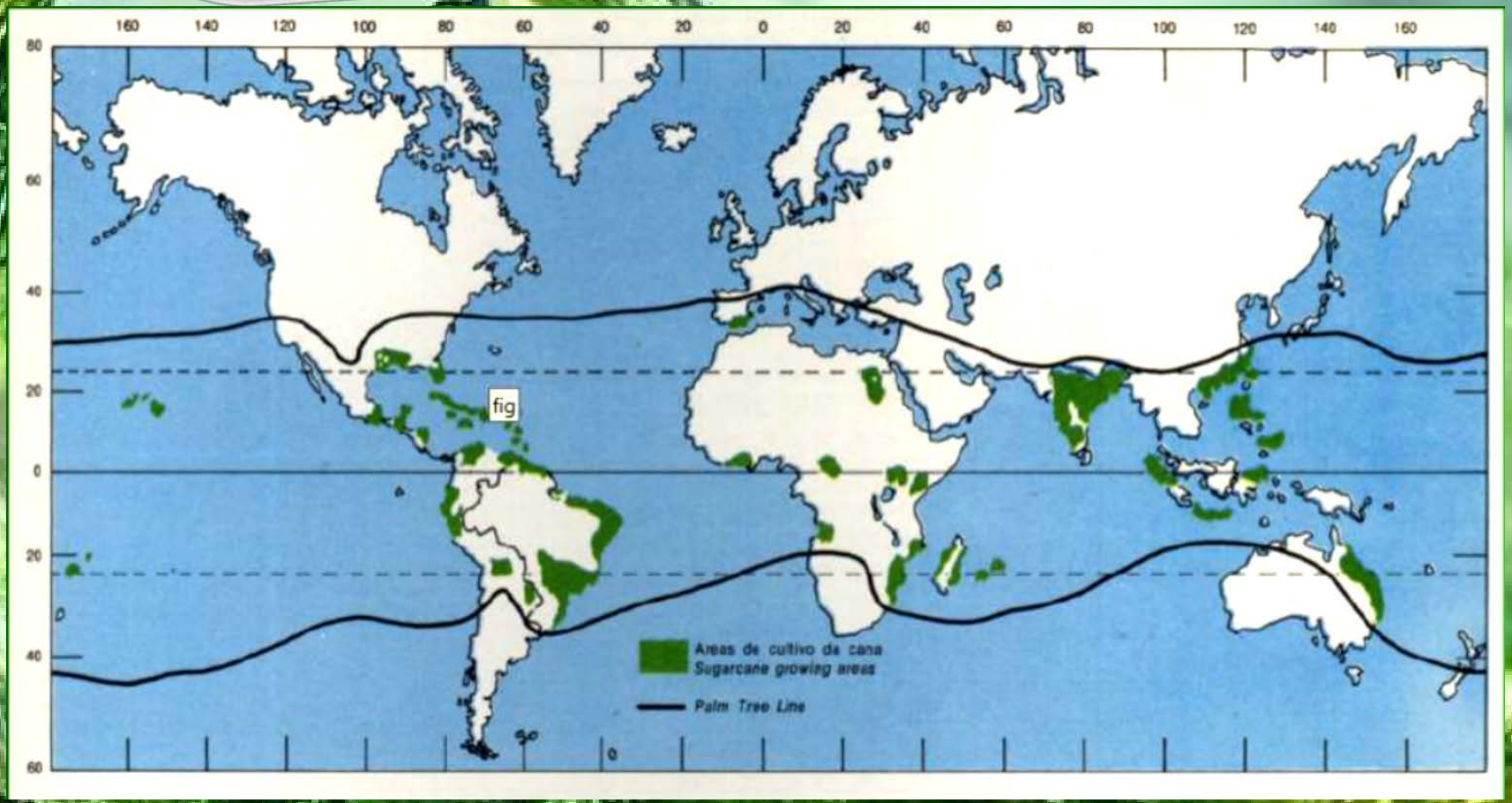

Sugarcane growing in Brazil (16th–17th centuries)

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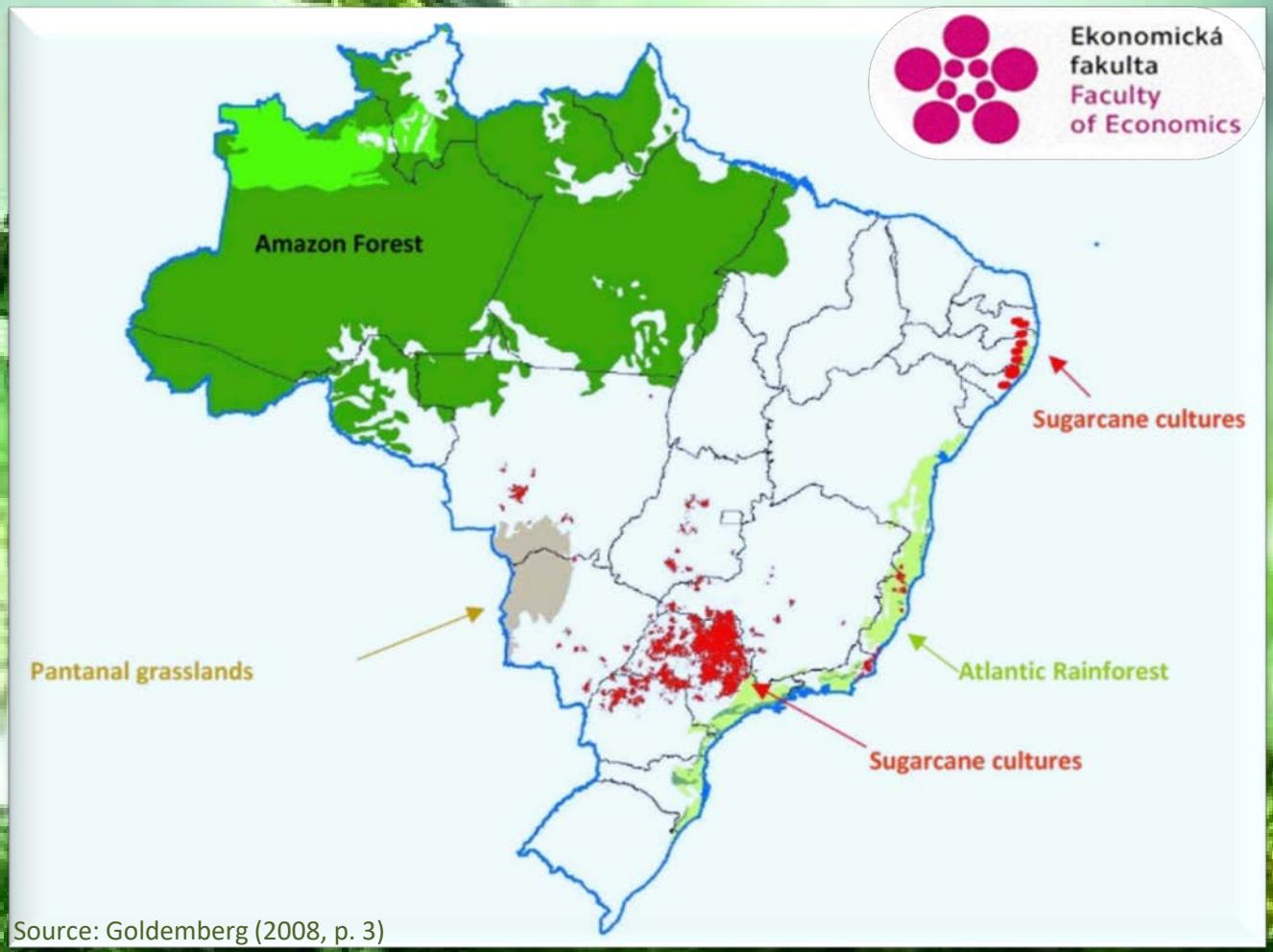
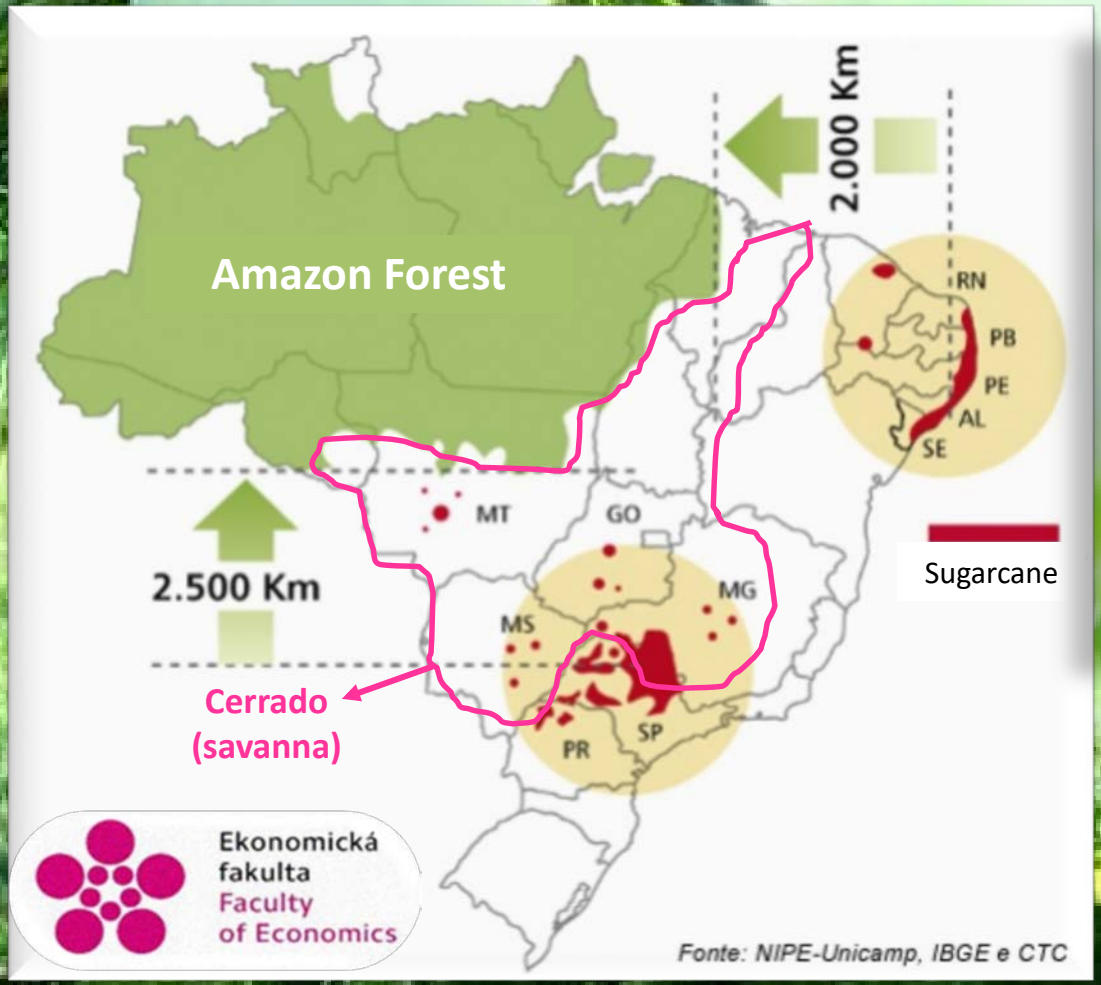
Source: EducaBras. Retrieved from: https://www.educabras.com/ensino_medio/materia/historia/historia_do_brasil/aulas/ciclo_da_canadeacucar

Current sugarcane growing in Brazil



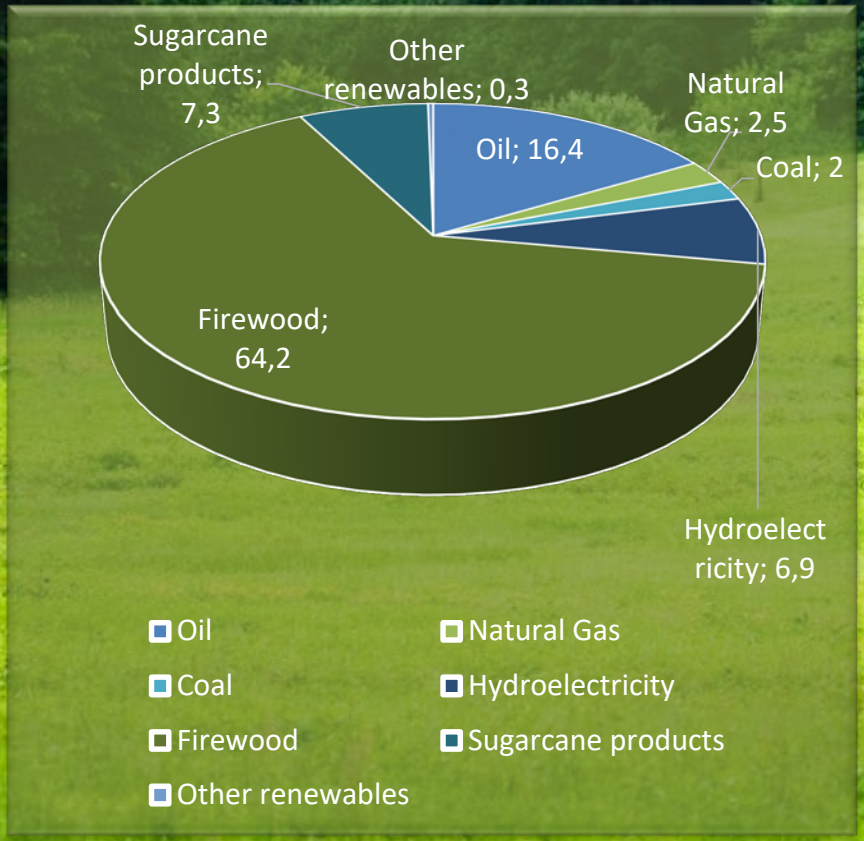
Source: Goldemberg (2008, p. 3)

Sugarcane expansion in Brazil

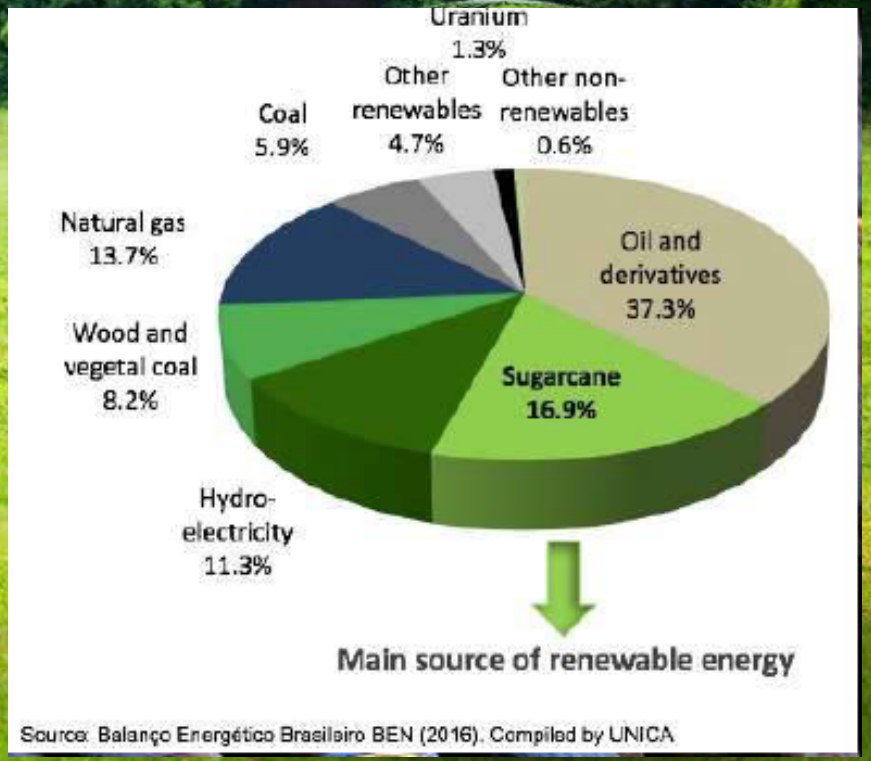


Sugarcane products and the Brazilian energy matrix

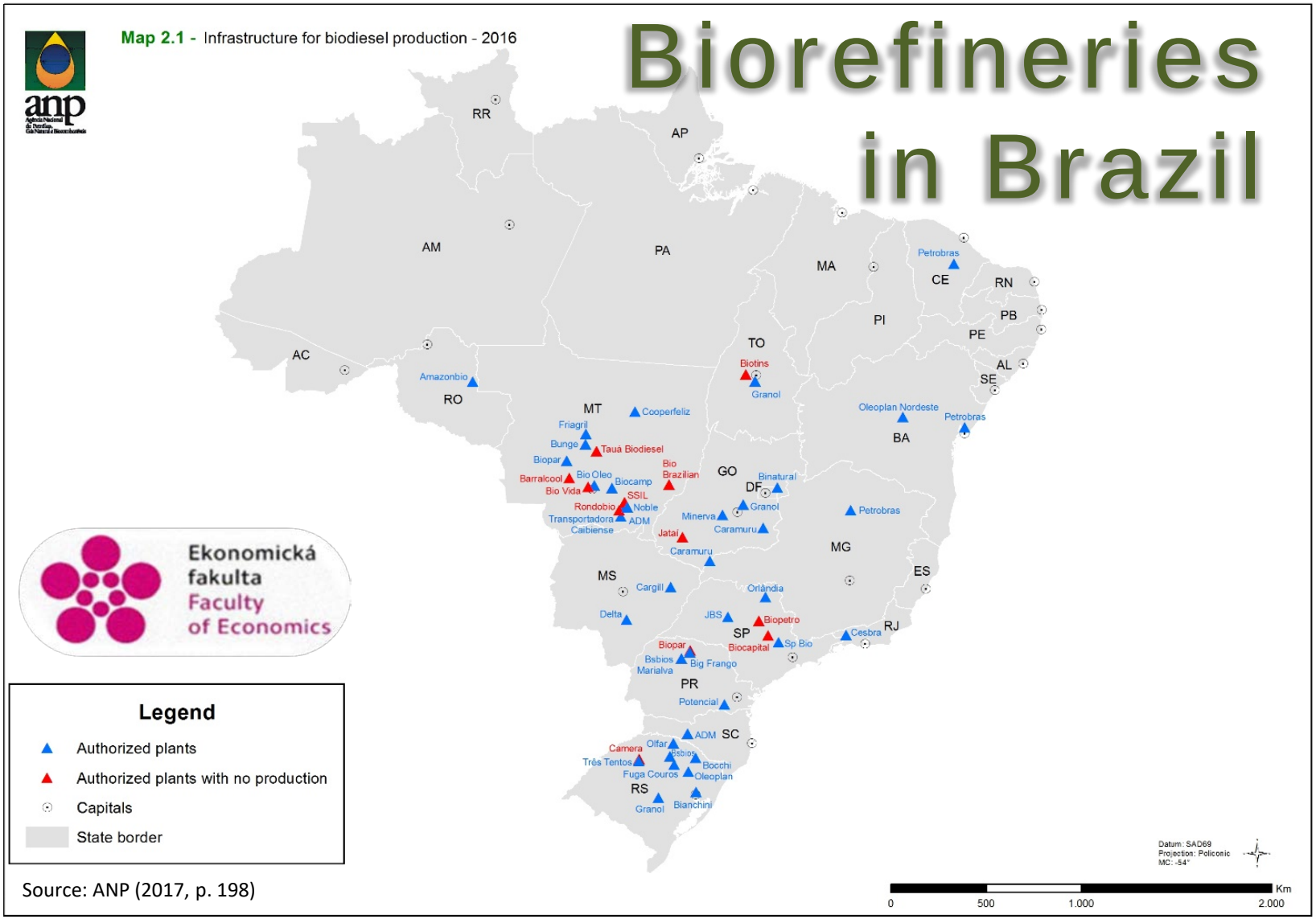
1970



2016



Biorefineries in Brazil



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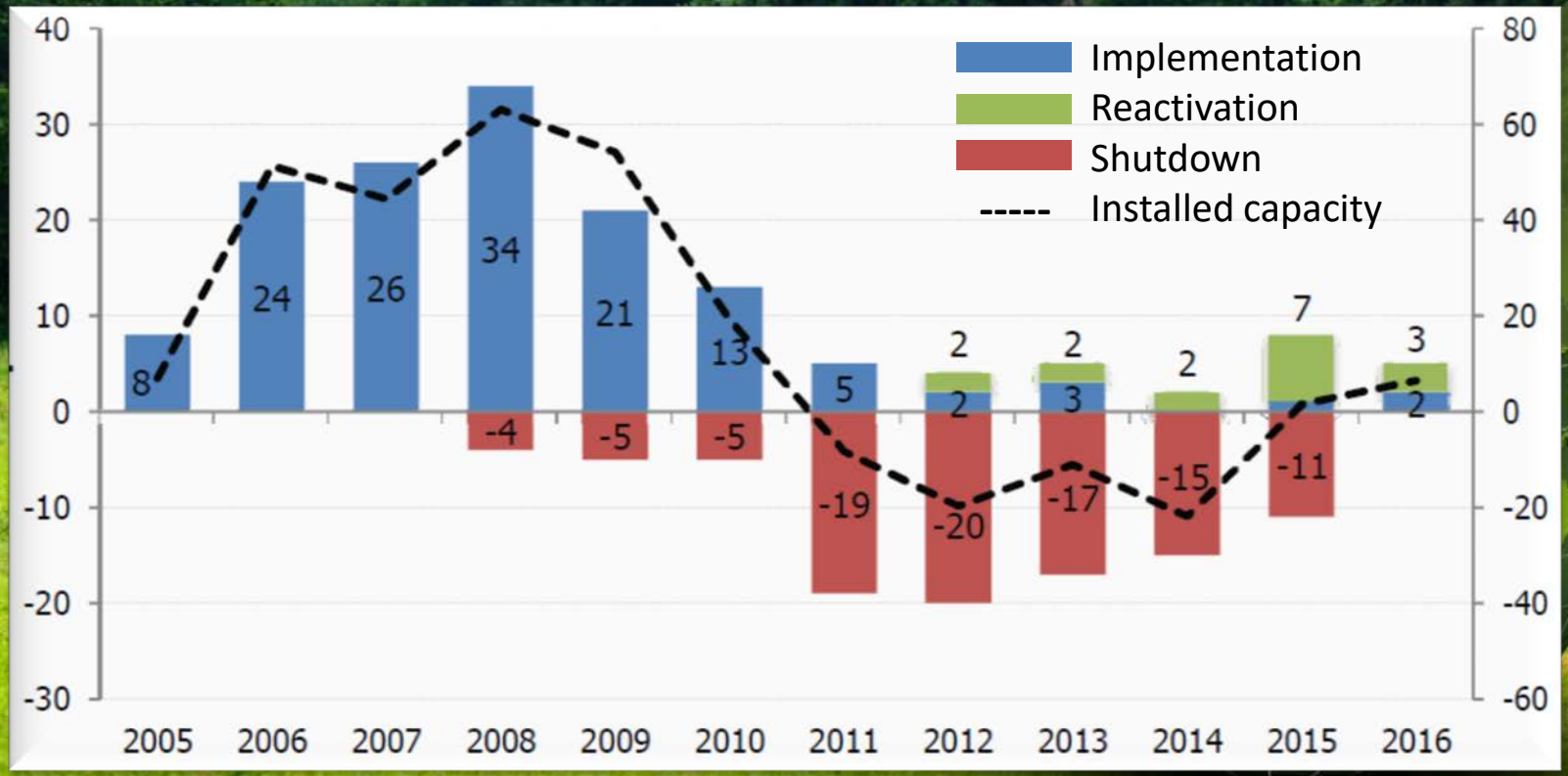
Source: ANP (2017, p. 198)

Biorefineries in Brazil Entry/Shutdown



Source: EPE (2017, p. 29)

Bioenergy (ethanol) in Brazil Historical overview

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Bioenergy

- ***Proálcool*** (Brazil's National Alcohol Program)
  - Launched as a response to the **1973 oil crisis**
  - Largest program of commercial biomass utilization in the world
  - Late **1980s – decline in ethanol production** due to $\downarrow p_{oil}$, $\uparrow p_{sugar}$, subsidies cutback
  - **2003 – FFVs** (Fuel Flexible Vehicles) → rise in ethanol consumption
  - 2012: FFVs = 87% of vehicle fleet

Source: Assunção & Chiavari (2015, pp. 11-2)

Bioenergy land

- Supply side investment **boom in sugarcane plantations** and greenfield mills **caused by**:
  - **FFVs** → increase in the demand for ethanol
  - **Fuel policy** → +18%-25% blending of anhydrous ethanol into gasoline
- Sugar cane crop area increase
  - Center-South
  - SP:12.4% (2005) → 20.7% (2012)
  - MS: 137 Mha (2005) → 559 Mha (2012) = >300% **conversion from pastureland**
  - PR, MG, GO – as land for crop expansions grew scarcer

Facts and figures

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- In Brazil, the cultivation of **sugarcane for ethanol** is increasing the **agricultural pressure**, which has **also** been increased in order to meet the **rising demand for sugar and soy in food** and feed **markets**
- The expansion of **sugarcane** production **has replaced pasturelands** and small farms of varied crops
- **Plantations for sugar and ethanol** production have expanded predominantly into **areas once used for cattle grazing**, as cattle are mainly confined to cattle ranching
- **50%** of **cerrado** is **not adequate for sugarcane plantation** or has low suitability for it
- **Cerrado** (24% ≈ **¼ of the territory**) has been extensively utilized for **agriculture and cattle breeding over the past 40 years**
- The **expansion of sugarcane crops in** areas covered by **the cerrado** vegetation has been **very small** so far, and **has replaced** other covers that had previously replaced the cerrado (usually **pastures**)

- Source: Goldemberg et al. (2008, p. 2093)

Hypotheses

Null hypothesis (H_0)

Land grabbing

- Low rates in yield improvements require increase land demand (Souza et al., 2015)
  - Expansion of soybean in the Brazilian Cerrado (savanna) occurred when policies did not address environmental issues explicitly (Assunção & Chiavari, 2015, p. 10)

Alternative hypothesis (H_1)

Technical change

- Increasing cropping intensity more than compensates for the decline of the rates in yield improvements (Souza et al., 2015)
- **Technological innovations** have induced **agricultural intensification**, thereby **reducing total land use**
- Bioenergy *vs.* food production (Assunção & Chiavari, 2015)
  - Bioenergy expansion displaces less productive farmers (cattle ranchers)
  - Bioenergy **co-benefits** → increases land-use intensity for cereal crops

Methodology

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Equations and data

- $D_i = (\text{Pop} \times c_i) + (X_i - M_i)$
- $S_i = (A_i \times \text{yield}_i)$
- $LG_i = (D_i - S_i) \times \text{yield}_i$
  - Data sources
    - World Bank (*Pop*, c_i)
    - IBGE (*Pop* estimates 2017-30)
    - FAO ($X_{Soybean}$, $M_{Soybean}$, A_i, $yield_i$)
    - BEN (MME/EPE) ($X_{Ethanol}$, $M_{Ethanol}$ 1970-2016)
    - BEN (MME/EPE) ($S_{sugarcane}$ 1970-2016 in toe = DPES = Domestic Primary Energy Supply, $yield_{Energy}$)

Source: Lambin & Meyfroidt (2011, p. 3465-6)

Variables and units

- *D* = demand (Mt)
- *S* = supply (Mt)
- *Pop* = population
- *c* = consumption per capita
  - Energy crops (sugarcane) → toe/inhab
  - Food crops (soybean) → t/inhab
- *i* = product (sugarcane, soybean)
- *A* = agricultural area (in Mha)
- *Yield*
  - Energy crops (sugarcane) → toe/ha
  - Food crops (soybean) → t/ha
- *M* = imports (Mt)
- *X* = exports (Mt)
- *LG* = land grabbing (Mha)

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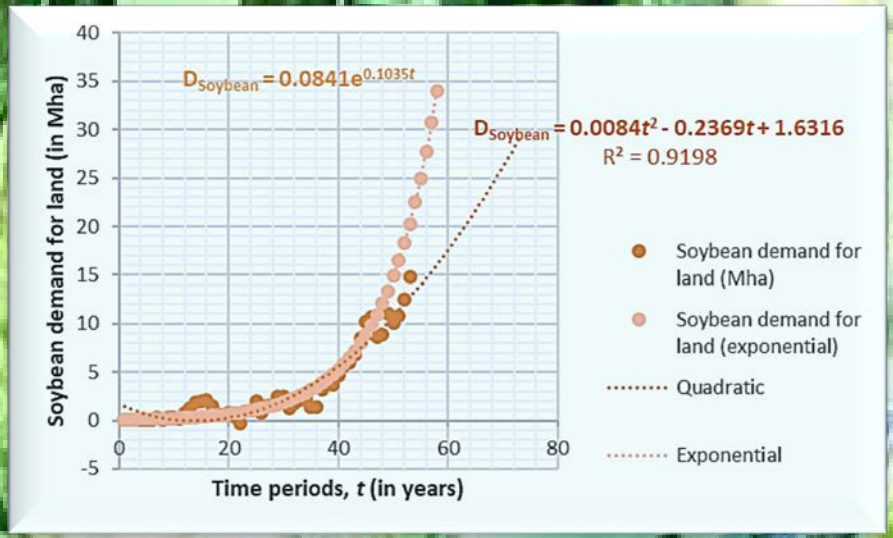
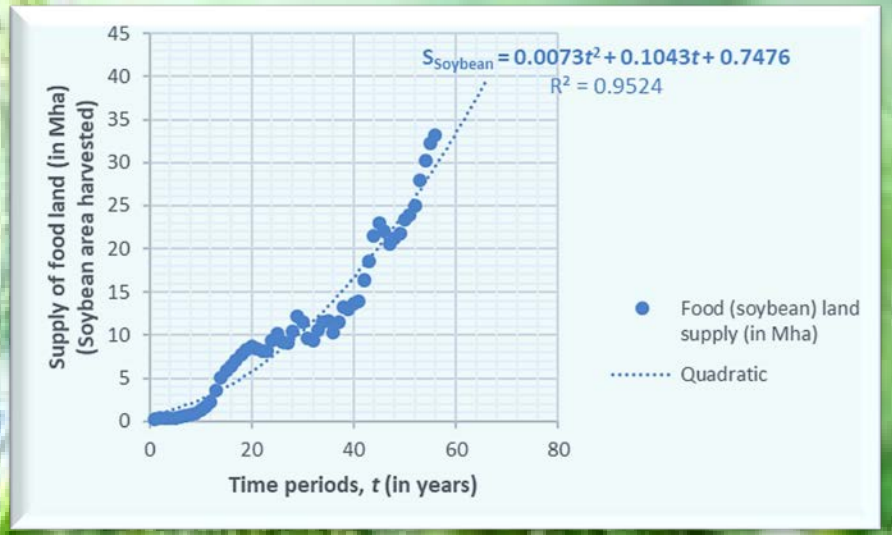
Results

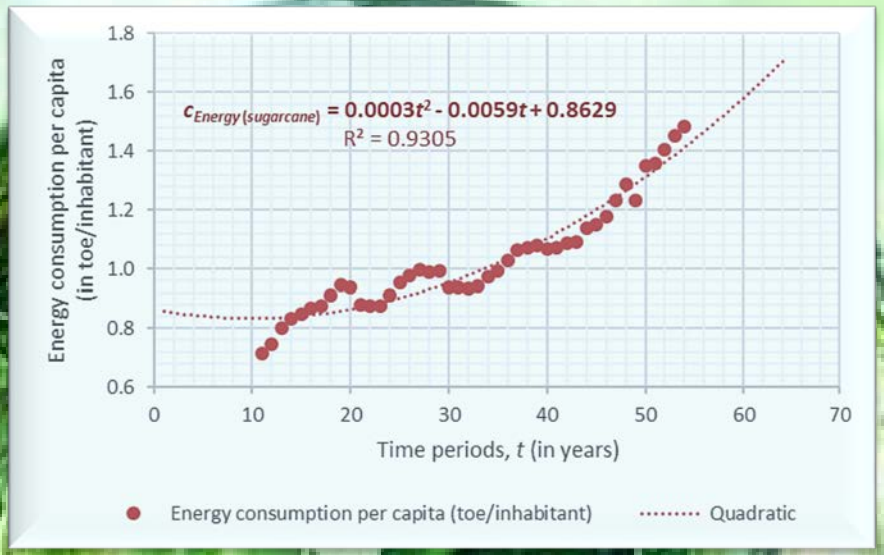
Demand for food land, Mha (soybean) (1961-2030)

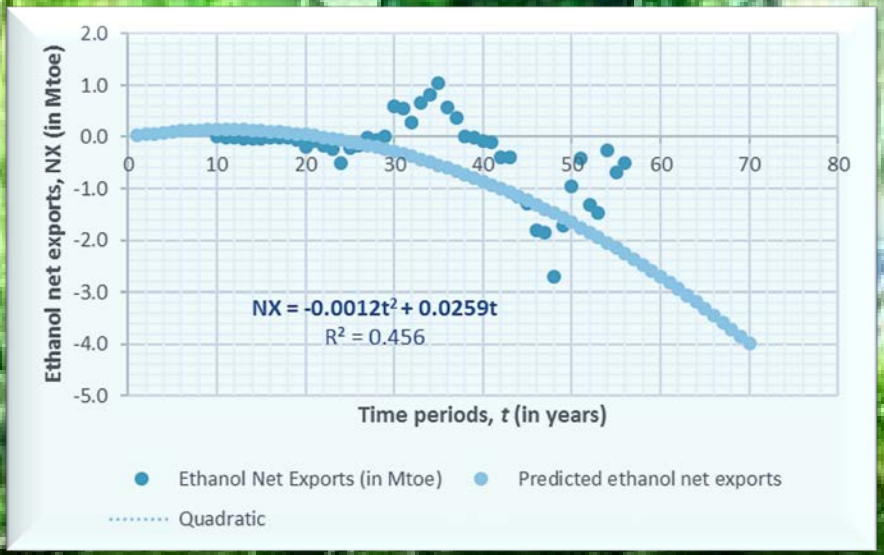


Supply of food land, Mha (soybean) (1961-2030)

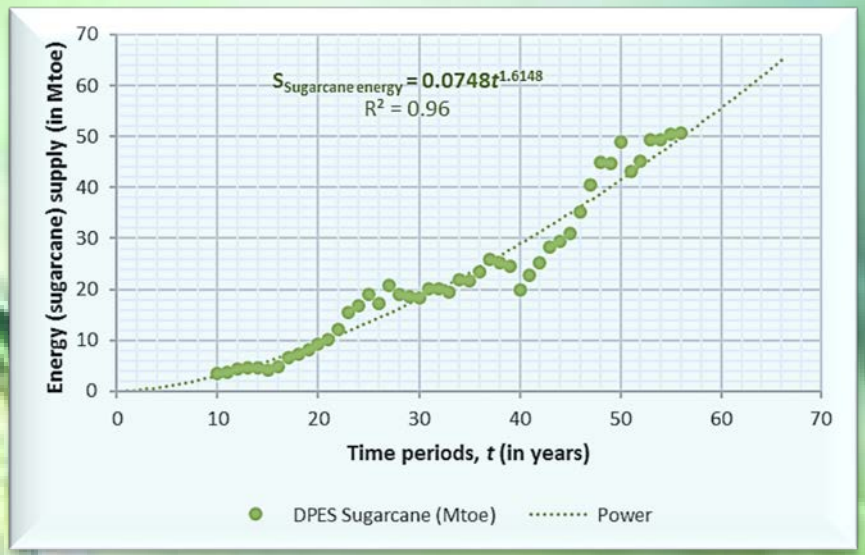


Demand for energy in Mtoe* (sugarcane) (1961-2030)





Supply of energy in Mtoe* (sugarcane) (1961-2030)



(*) 1 J = $2.388458966275 \cdot 10^{-11}$ toe

1 toe = 41.868 GJ = 41868000000 J

Results

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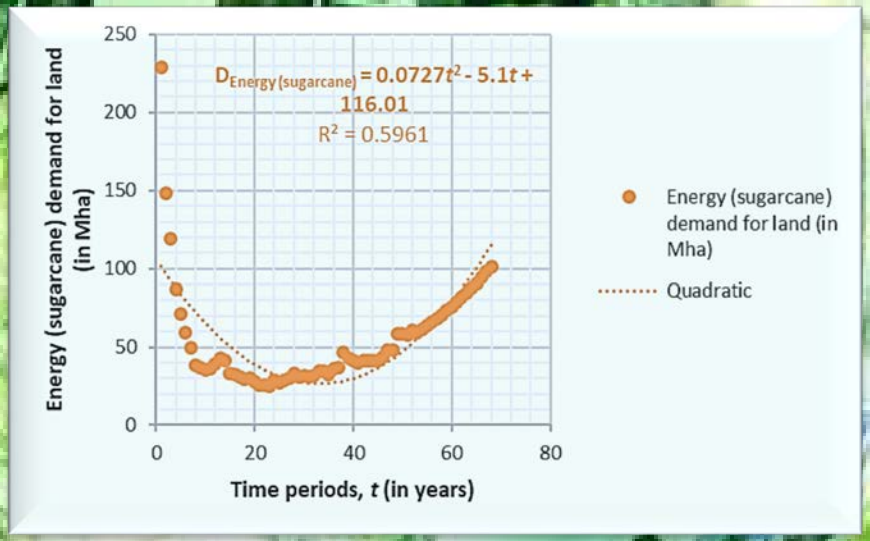
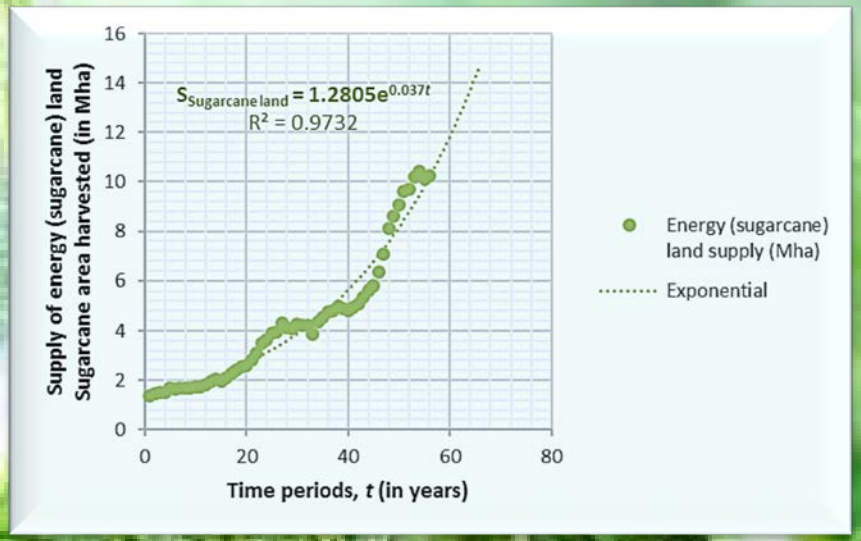
Results

Demand for energy land, Mha (sugarcane) (1961-2030)



Supply of energy land, Mha (sugarcane) (1961-2030)



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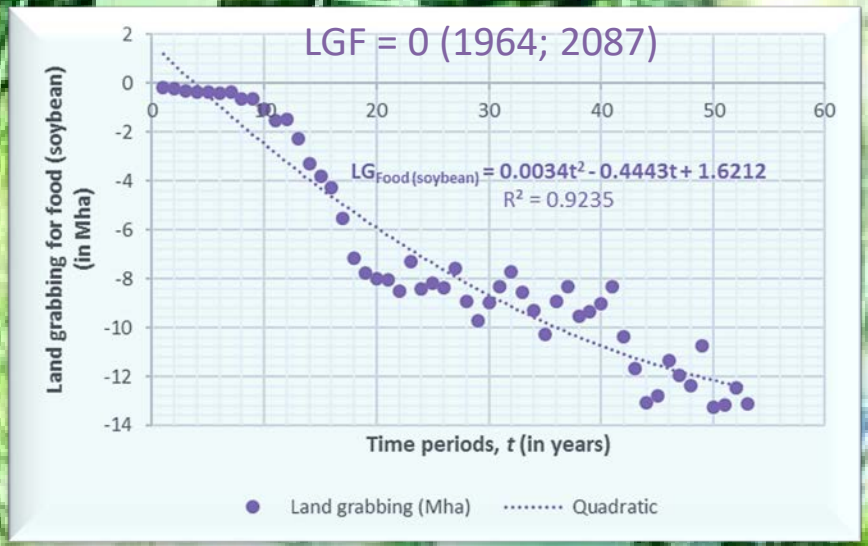
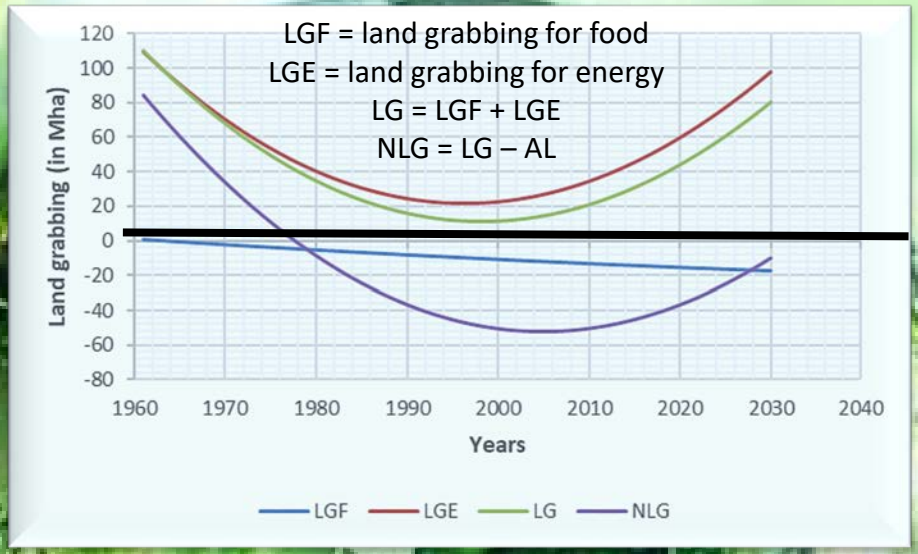
Results

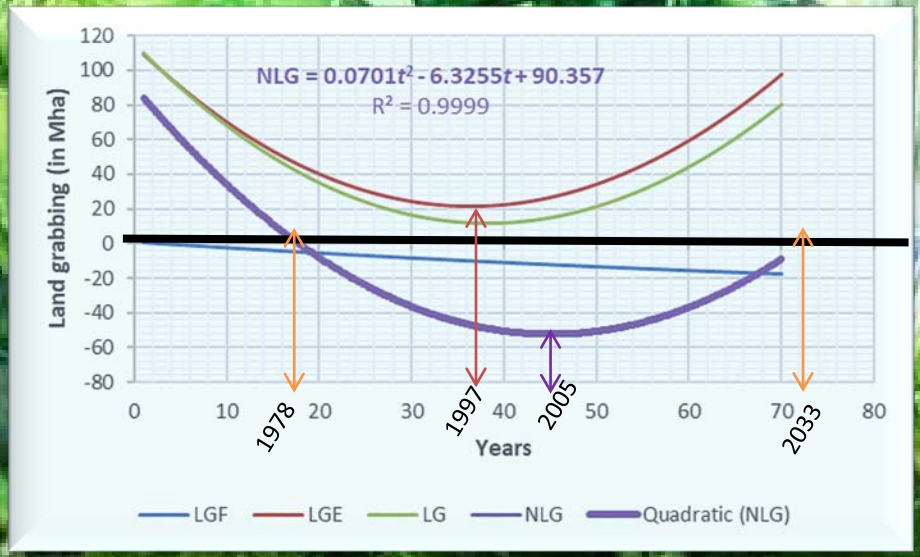
Land grabbing for food, Mha (soybean) (1961-2030)



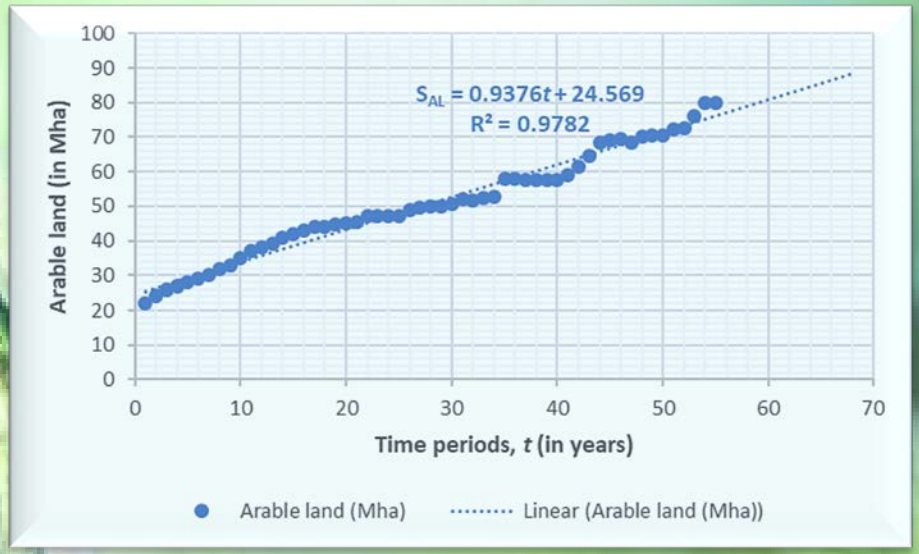
Land grabbing for energy, Mha (sugarcane) (1961-2030)

Land grabbing in Mha (1961-2030)





Supply of arable land (AL) in Mha (1961-2030)



Results

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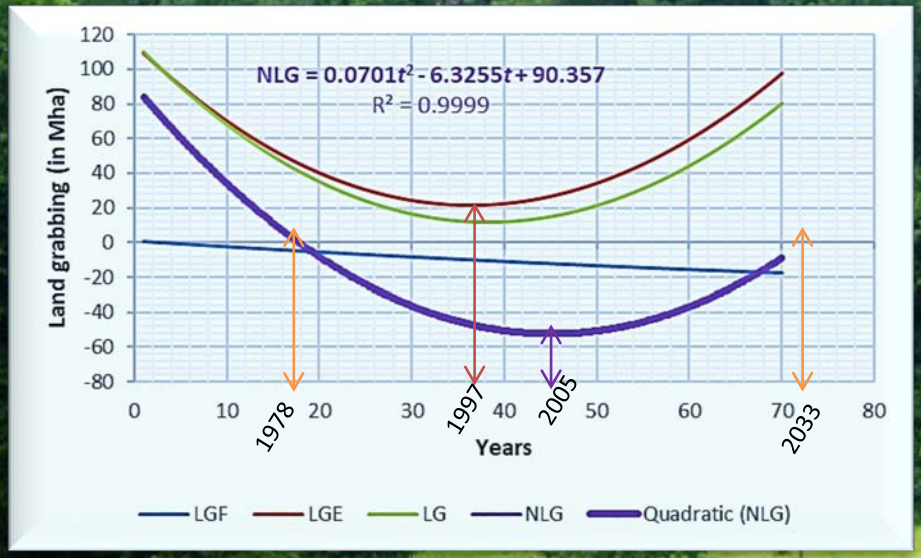
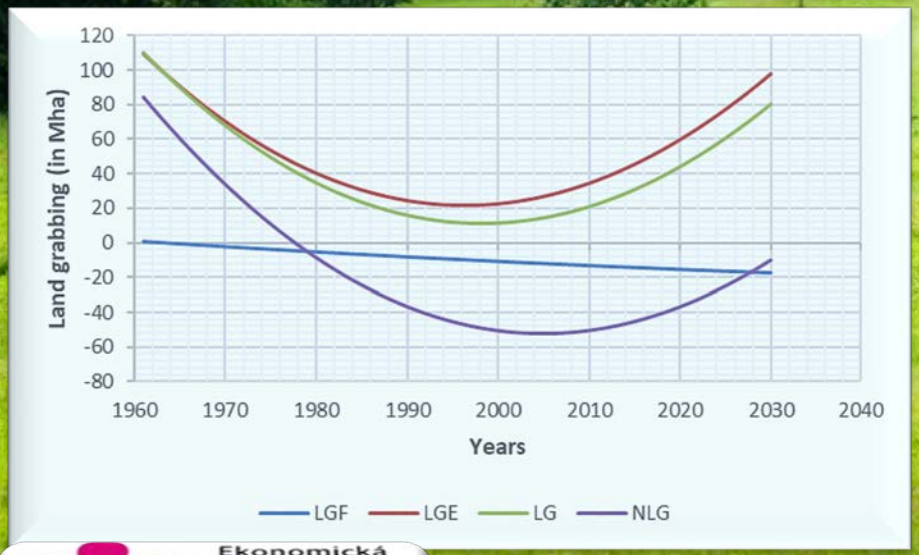
Discussion & Conclusions





- **NLG < 0** in **1980**, due to the **decline in ethanol production** (LGE) and to LGF<0, which make NLG reach a **minimum** in **2005**
- NLG begins to **grow again** after the launching of the **Biodiesel National Program**, in **2003**
- LGF < 0
  - 1960/70s: **rising land prices** in the **subtropical** region (South)
  - 1970/80: **shift from food crops to sugarcane** (ethanol) (Goldemberg et al., 2008, p. 2091)
  - 1980 onwards: **increasing land productivity** in the **tropical** region (Cerrado) and also in the more traditional subtropical areas
- **LGE** starts increasing **near 2000**, due to **FFVs (2003)**
- **LGE growth** has caused **soybean productivity** to **increase**, thereby keeping **LGF < 0**
- NLG > 0 from 2033 onwards
- The actual **push for land grabbing** seems to be caused by **sugarcane (energy land)**

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Land figures

Land category	1970 (Mha)	2015 (Mha)
Country area	835.81	835.81
Agricultural land	195.40	282.59
Arable land	35.00	80.02
Forestland	546.71 (1990)	493.54

Source: World Bank

On land grabbing for energy (sugarcane)

Source: GRAIN (2015, p. 14)

The Cosan connection

Sitting at the centre of TCGA's complex corporate structure is **Cosan, Brazil's largest sugar producer**. **Cosan is controlled by Brazilian billionaire Rubens Ometto Silveira Mello and his Ometto Group**. It is **one of three conglomerates** that are said to produce about **1/3 of the country's sugar** and that are **largely responsible for the explosive growth in sugar production in the country**. Around **3/4 of the expansion of sugar cane production in the world over the past decade has occurred in Brazil, where the sugar cane area has grown by an average of 300,000 ha per year**.

Cosan and the other conglomerates have relied on various public subsidies and, most importantly, foreign capital to drive their growth. **Cosan** is considered the **pioneer in opening up the Brazilian sugar industry to foreign capital**. Beginning at the end of the 1990s, it established several joint ventures with French and Asian sugar companies, and then, **in 2005, it became the first Brazilian agribusiness corporation to go public on the Brazilian stock exchange**, ceding **27% of its shares to foreign stockholders**.

In 2008, Cosan merged all of its sugarcane and ethanol operations into a new joint venture company with the Anglo-Dutch oil corporation, Shell, called Raízen S/A.

Cosan has been quickly converting this influx of foreign capital into more plantations, particularly in Brazil's massive savanna region, the Cerrado, in the centre–south of the country. By 2015, Cosan says Raizen aims to have 1 million ha under cultivation, up from 700,000 ha in 2011.

Cosan's land speculation ventures with TIAA-CREF and other pension funds fit neatly within this larger ambition. Radar's principal business is to speculate on farmland, which it does by identifying and purchasing land and then selling it a higher price a few years later. But Radar also derives revenue from the operations of the farms, primarily by renting the lands out to Brazil's largest commodity producers, including Cosan itself.

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- **Ευχαριστώ**! Thank you! **Dzięki**! **Хвала**! Hvala! Obrigado! **Sağol**!

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