

# Status of renewable energy development and use in Brazil

## References for a dialog towards a Brazil-Korea cooperation in bioenergy



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**September 29-30, 2010 - COEX Conference Center**  
**Seoul, Republic of Korea**

# Status of renewable energy development and use in Brazil

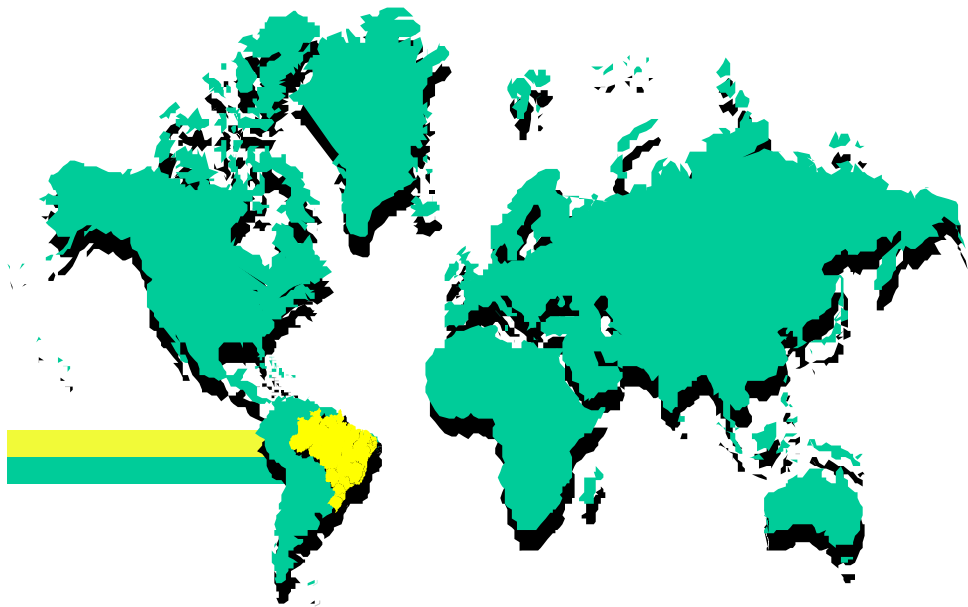
## References for a dialog towards a Brazil-Korea cooperation in bioenergy

### SUMMARY

Brazil is the acknowledged world leader in the generation and implementation of modern, tropical agricultural technology. A series of advantages, such as climate, advanced innovation capabilities and the availability of land to energy farming without having to reduce food-crop area or impose environmental impact beyond what is socially acceptable, have enabled Brazil to become a world leader in green energy. A striking example of the country's success in this area is the ethanol production chain. The production and use of ethanol from sugarcane in Brazil is a global model for bioenergy production, distribution, and use, and is recognized as one of the most efficient in the world. Like ethanol, biodiesel is also receiving increased attention in Brazil, with development of new source materials, production and industrial technologies. Investment in research and innovation is one of the pillars of sustainable production and rational use of renewable sources of energy in Brazil. This presentation will review the development of bioenergy programs in Brazil, emphasizing the key drivers that allowed the country to occupy a world leading position as green energy producer and user. Possibilities of a Brazil-Korea cooperation in bioenergy development will be presented and discussed.

# Status of renewable energy development and use in Brazil

References for a dialog towards a Brazil-Korea cooperation in bioenergy



Introduction

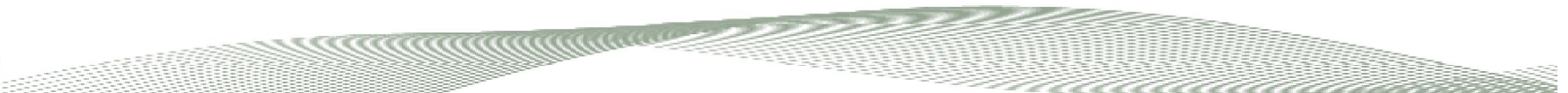
Renewable Energy in Brazil

Sugarcane and Ethanol – Biodiesel

Bioenergy R&D

Challenges for the Future

Potential Areas of Collaboration



# The Brazilian Agricultural Research Corporation – Embrapa

The largest component of the Brazilian ARD System

## Embrapa Network for R,D&I

- ✓ 41 Research Centres and Services Units
- ✓ 3 Virtual Laboratories Abroad (Labex)
- ✓ Offices for Technology Transfer:  
14 in Brazil and 2 abroad (Africa and Venezuela)

### North

- Embrapa Acre
- Embrapa Amapa
- Embrapa Western Amazon
- Embrapa Eastern Amazon
- Embrapa Rondonia
- Embrapa Roraima

### Northeast

- Embrapa Mid-North
- Embrapa Tropical Semi-Arid
- Embrapa Coastal Tablelands
- Embrapa Goat and Sheep
- Embrapa Cassava & Tropical Fruits
- Embrapa Cotton
- Embrapa Tropical Agroindustry

### Mid-West

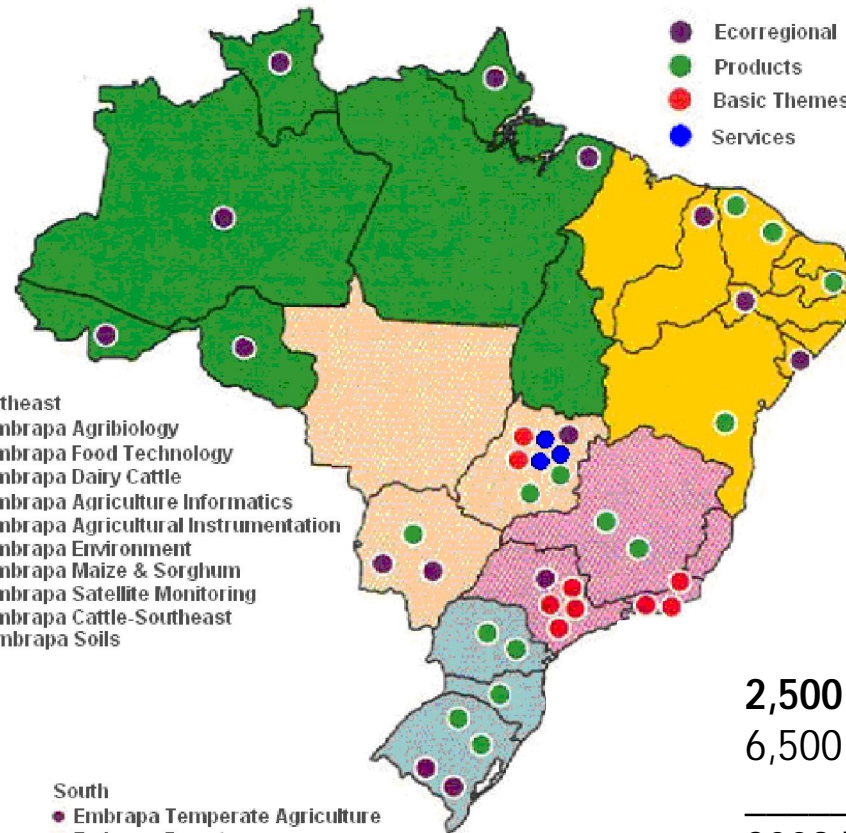
- Embrapa Agrienergy
- Embrapa Western Region Agriculture and Livestock
- Embrapa Rice & Beans
- Embrapa Coffee
- Embrapa Cerrados
- Embrapa Beef Cattle
- Embrapa Vegetables
- Embrapa Technological Information
- Embrapa Pantanal
- Embrapa Genetic Resources & Biotechnology
- Embrapa Technology Transfer

### Southeast

- Embrapa Agribiology
- Embrapa Food Technology
- Embrapa Dairy Cattle
- Embrapa Agriculture Informatics
- Embrapa Agricultural Instrumentation
- Embrapa Environment
- Embrapa Maize & Sorghum
- Embrapa Satellite Monitoring
- Embrapa Cattle-Southeast
- Embrapa Soils

### South

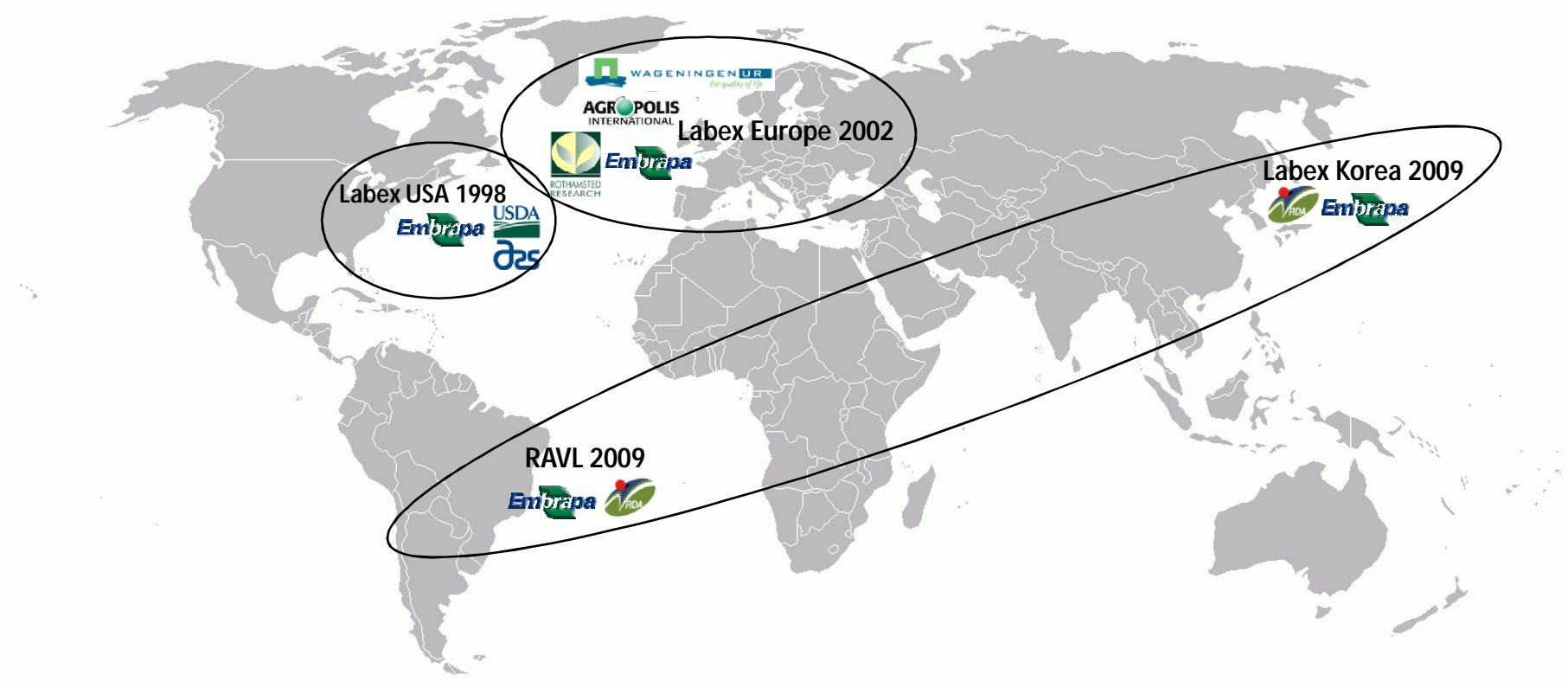
- Embrapa Temperate Agriculture
- Embrapa Forestry
- Embrapa South Animal Husbandry & Sheep
- Embrapa Soybean
- Embrapa Swine and Poultry
- Embrapa Wheat
- Embrapa Grape & Wine



2,500 Researchers  
6,500 Staff

2009 Budget: US\$ 1 Billion

# The Brazilian Agricultural Research Corporation – Embrapa Labex – cooperation in cutting-edge agricultural R&D



# The Brazilian Agricultural Research System



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**Brazil's agricultural miracle**

## How to feed the world

The emerging conventional wisdom about world farming is gloomy. There is an alternative

Aug 26th 2010



Bloomberg News

The image shows a vast agricultural field with numerous red combine harvesters working in neat, parallel rows. The machines are kicking up dust as they move across the golden-brown crop. The perspective is from an elevated angle, showing the scale of the operation.

<http://www.economist.com/node/16889019>

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**Brazilian agriculture**

## The miracle of the cerrado

Brazil has revolutionised its own farms. Can it do the same for others?

Aug 26th 2010 | CREMAQ, PIAUÍ



Bloomberg

The image shows a large agricultural field with many yellow combine harvesters working in rows. The field is divided into sections by long, straight paths. The harvesters are moving in a coordinated fashion, creating a sense of organized, large-scale farming.

<http://www.economist.com/node/16886442>

# Agribusiness in Brazil – Food, Feed, Fiber

## Exports

In 2008 Brazil exported more than 1500 types of agricultural products to foreign markets

## Commercial partners

Around 79% of the Brazilian food production is consumed domestically and 21% is shipped to over 212 foreign markets

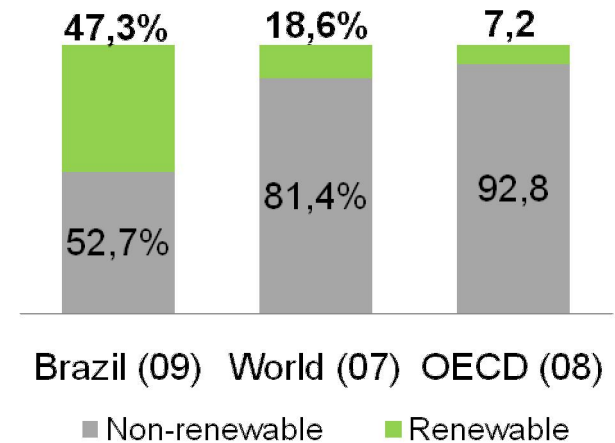
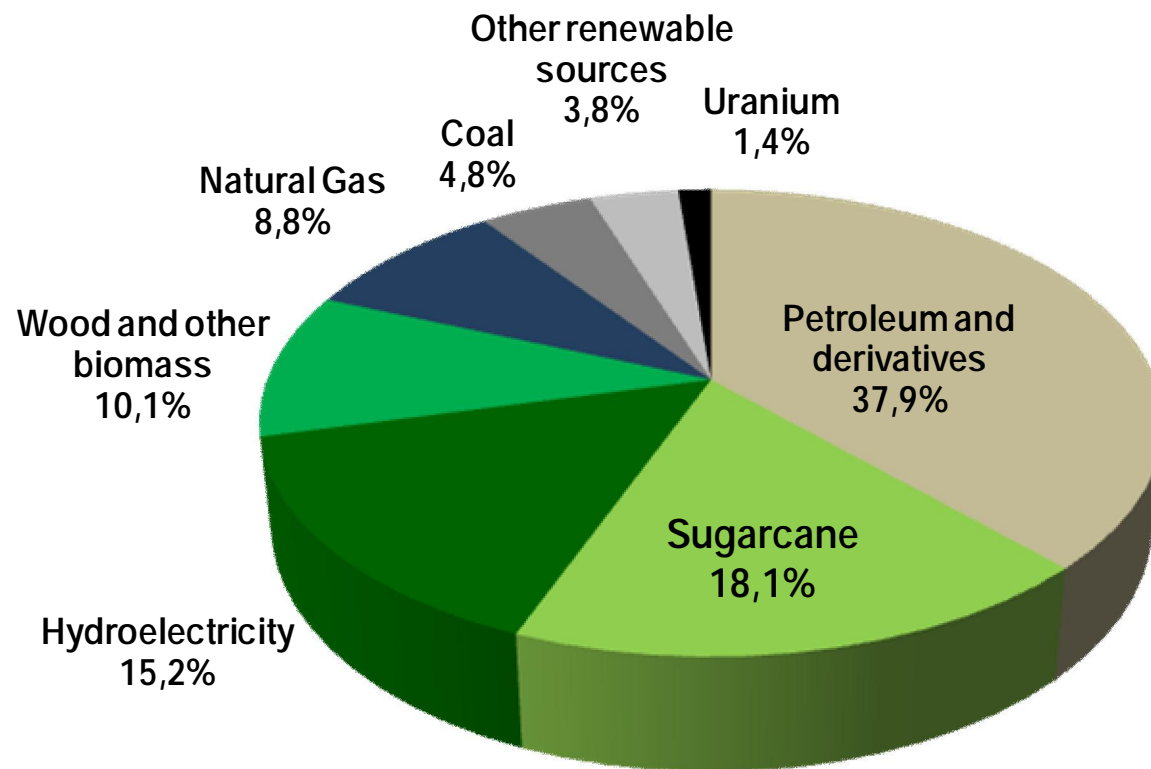
<u>Product</u>	<u>Production</u>	<u>Exports</u>
Sugar	1 <sup>st</sup>	1 <sup>st</sup>
Orange juice	1 <sup>st</sup>	1 <sup>st</sup>
Coffee	1 <sup>st</sup>	1 <sup>st</sup>
Beef	2 <sup>nd</sup>	1 <sup>st</sup>
Soybean	2 <sup>nd</sup>	1 <sup>st</sup>
Tobacco	3 <sup>rd</sup>	1 <sup>st</sup>
Broiler	3 <sup>rd</sup>	2 <sup>nd</sup>
Corn	3 <sup>rd</sup>	4 <sup>th</sup>

Source: SPA/MAPA (Agricultura Brasileira em Números)



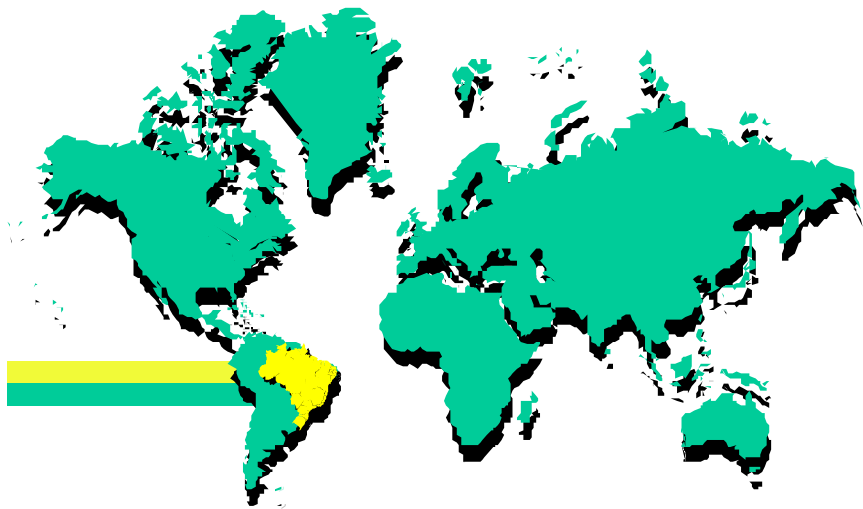
# Agribusiness in Brazil – Food, Feed, Fiber and Fuel

## Brazilian Energy Matrix





# Strong Public Policies Towards Bioenergy

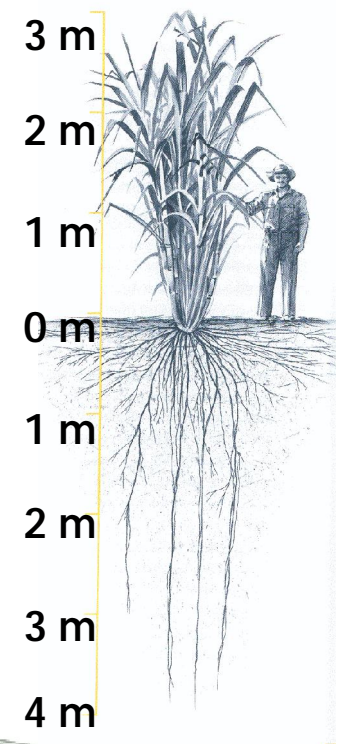


- **Environmental gains**
  - carbon sequestration
  - lower level of emissions
- **Sustainability - Renewable**
  - short production cycle
  - whole process controlled by man
- **Social aspects**
  - generation of new jobs
  - better income distribution
- **Economic aspects**
  - a new global energy demand
  - strong impacts on commerce & trade



# Sugarcane as an Energy Crop in Brazil

Sugarcane is the main source of bioenergy in Brazil



Sugarcane has been cultivated in Brazil since 1532 as sugar was one of the first commodities exported to Europe by the Portuguese settlers

# Sugarcane as an Energy Crop in Brazil

## Developing Ethanol as a Large Scale Bioenergy Source in Brazil

Brazil has been experimenting with sugarcane ethanol as an auto fuel since the beginning of last century

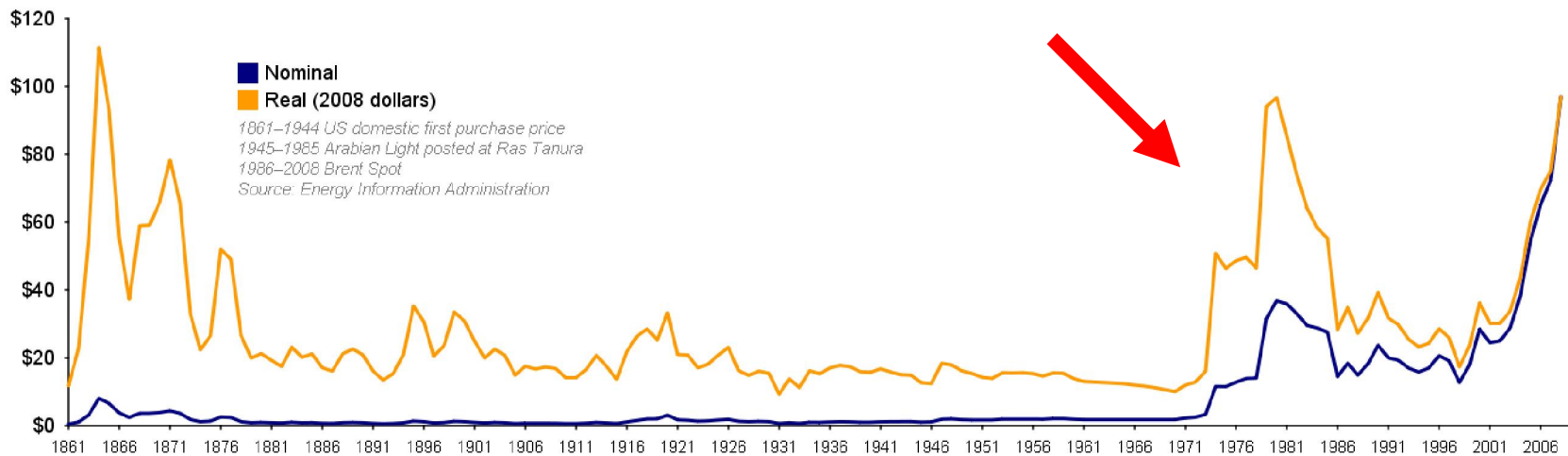


**First Brazilian car fuelled by a blend of ethanol and gasoline - 1925**

# Sugarcane as an Energy Crop in Brazil

## Developing Ethanol as a Large Scale Bioenergy Source in Brazil

Key driver was the energy crisis of 1973/1974 - huge increase in oil import costs

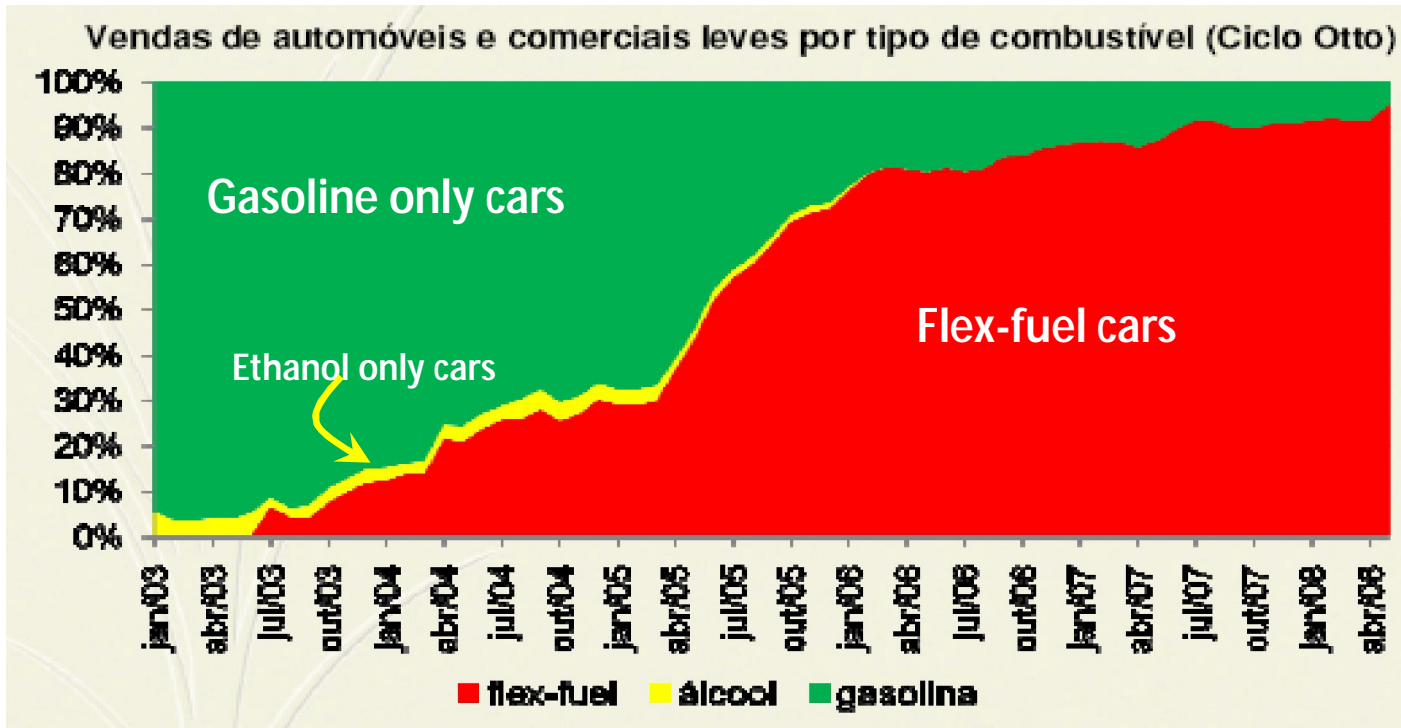


Graph of oil prices from 1861–2007, showing a sharp increase in 1973/1974, and again during the 1979 energy crisis. The orange line is adjusted for inflation.

Source: Energy Information Administration  
[http://upload.wikimedia.org/wikipedia/commons/8/87/Oil\\_Prices\\_1861\\_2007.svg](http://upload.wikimedia.org/wikipedia/commons/8/87/Oil_Prices_1861_2007.svg)

# Expansion of Sugarcane Ethanol Demand in Brazil

More than 95% of cars sold in Brazil are Flex-Fuel



Source: ANFAVEA and UNICA, 2008



# Expansion of Sugarcane Ethanol Demand in Brazil

## Key Numbers of the Brazilian Sugarcane sector

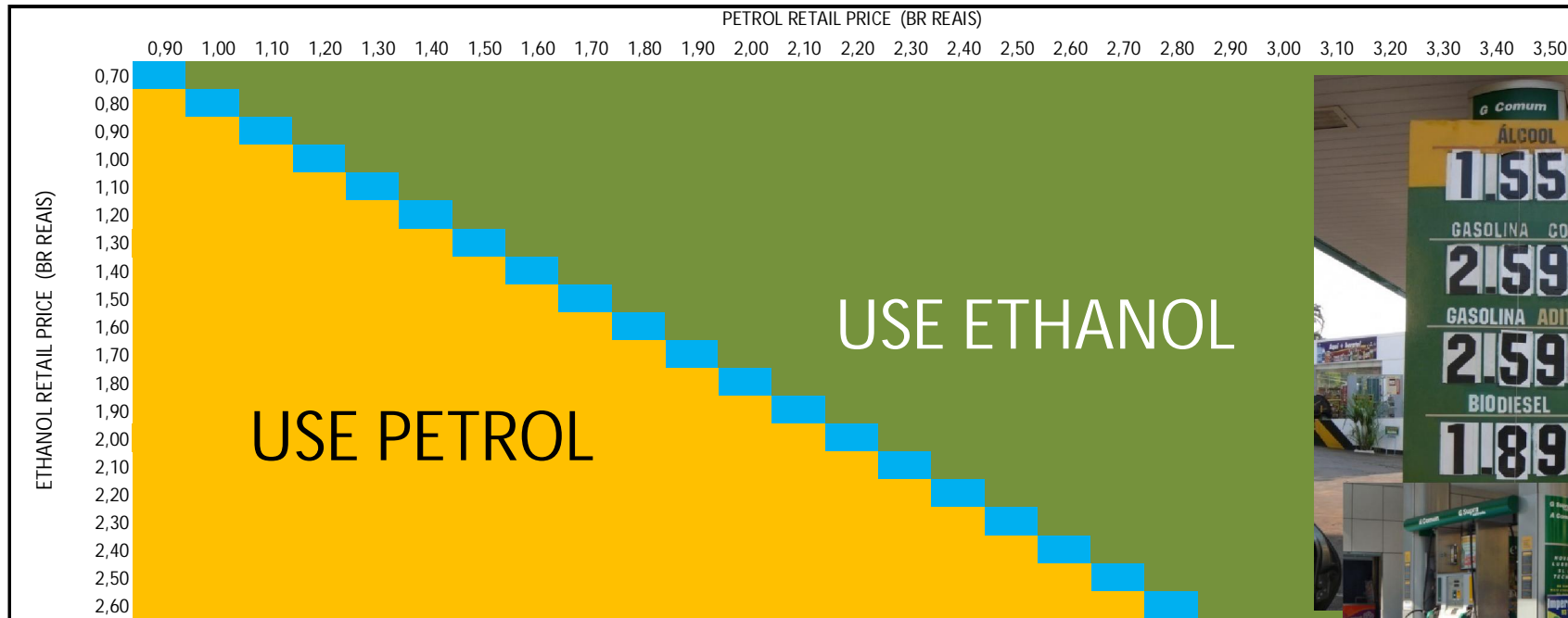


Annual gross earnings	US\$ 23 billion (08/09)
Foreign revenue	US\$ 9.8 billion (2009)
Direct investments	> US\$ 20 bln (2006-2009)
Composition	438 plants nationwide (2010)
Sugarcane growers	70,000
People directly employed	845,000
Avoided CO <sub>2</sub> emissions	> 600 mln tons since 1975

# Expansion of Sugarcane Ethanol Demand in Brazil

## The Evolution of Logistics and Distribution

Brazil has 33,000 gas + ethanol stations (out of 36,000)



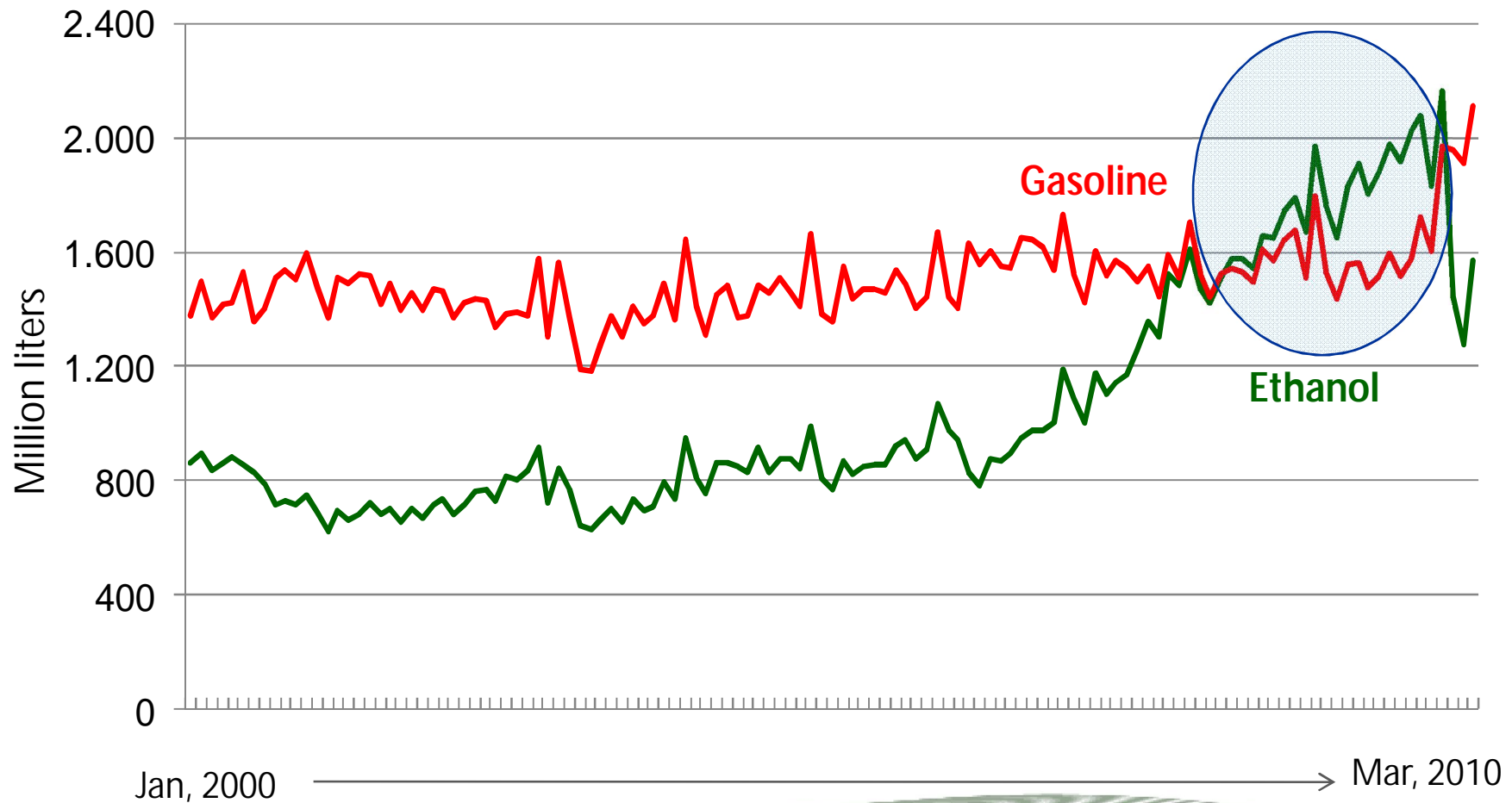
Source: Amatucci & Spers, 2008

Consumer choice: decision table to be used in the petrol station.

Source: based in a GM table distributed to flex car owners.

# Expansion of Sugarcane Ethanol Demand in Brazil

Gasoline is Becoming the Alternative Fuel in Brazil





# Sugarcane Ethanol as Energy Source in Brazil

## Ethanol Use not limited to cars



Ethanol-powered buses (E95) - still a pilot project in Brazil



Flex-fuel motorcycles



Brazilian-made crop dusting planes running on ethanol

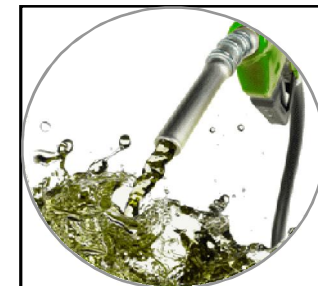


Production of bioplastics



Production of diesel from sugarcane at commercial scale by 2010

Biobutanol



# Sugarcane as an Energy Crop in Brazil

## Sugarcane Bagasse as Energy Source in Brazil

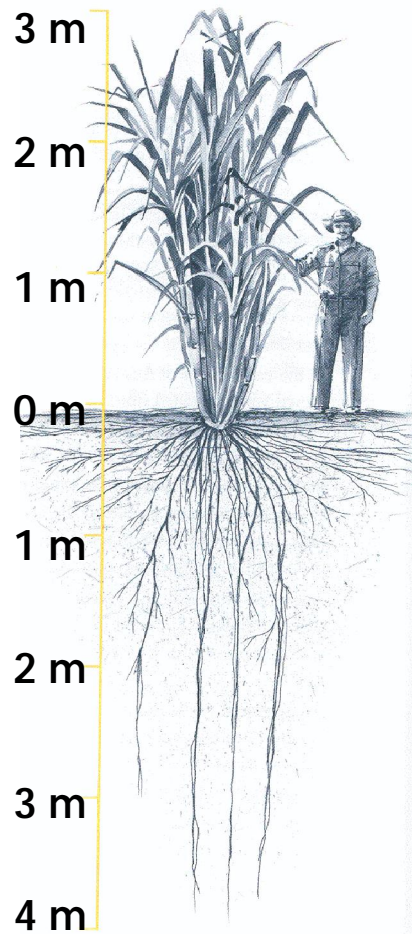


**Mills and distilleries also generate electric and mechanical power, most of it for self consumption. That is equivalent to 3% of the electric power consumed in the Brazil.**

**For every additional 100 million tons of sugar-cane, 12.6 million tons of CO<sub>2</sub> equivalent worth of emissions could be avoided using ethanol, the bagasse and the additional electric power surplus.**

# Sustainability of Sugarcane Ethanol

Sugarcane is one of the most sustainable energy factories in the world



**Productivity**

**Favorable energy balance**

**Significant carbon emission reduction**

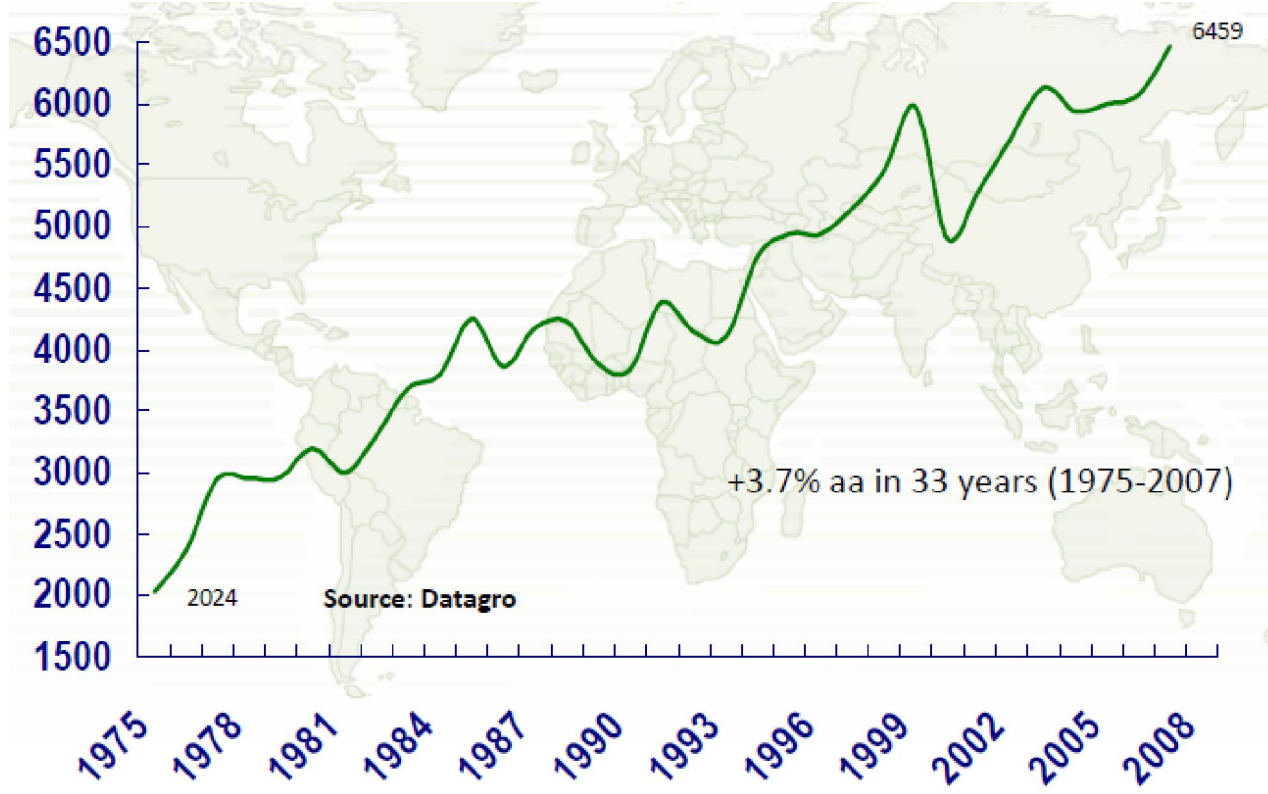
**Competitive fuel for consumers**

**Clear contribution to energy security**

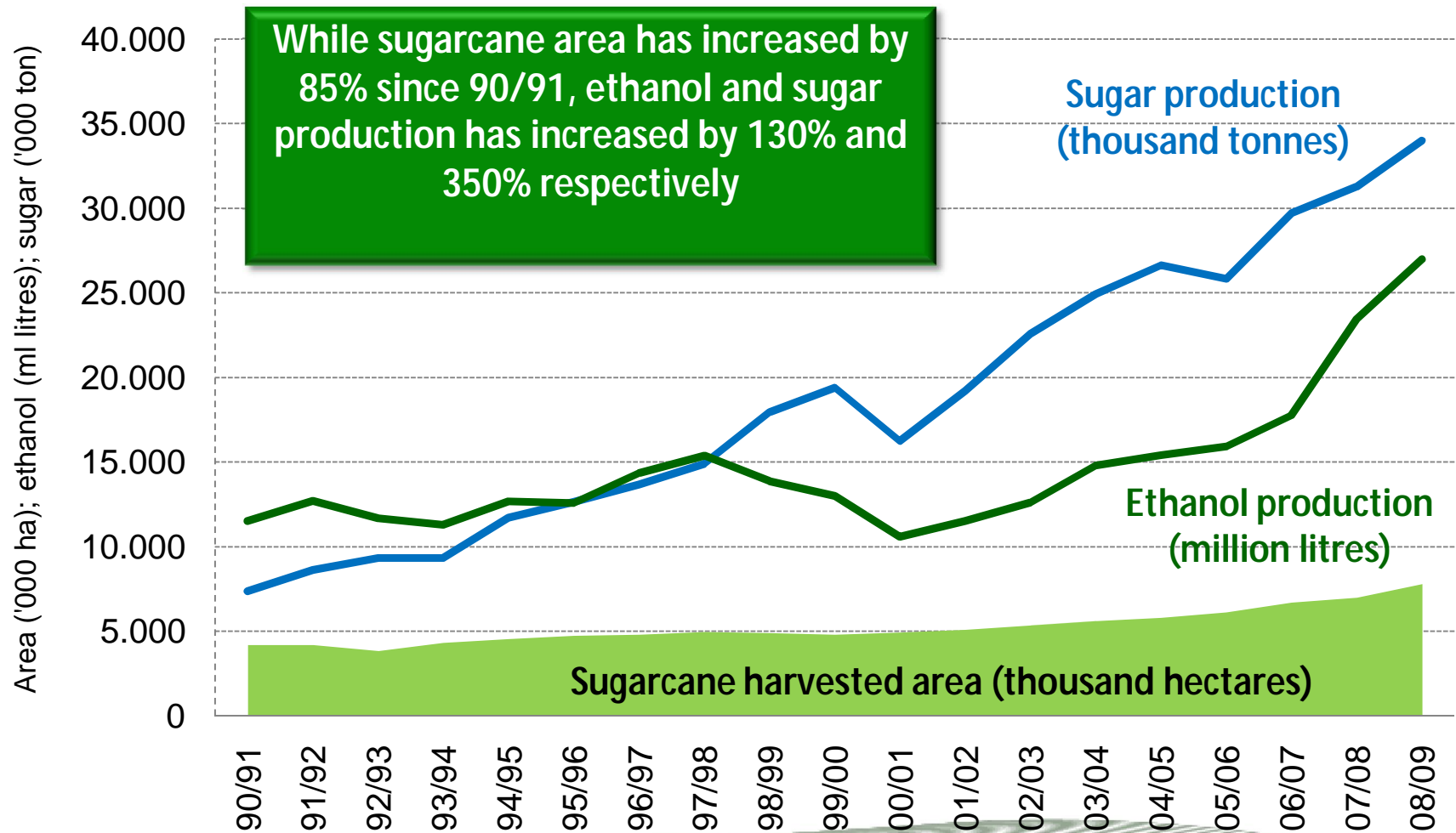
# Sustainability of Sugarcane Ethanol

## The Evolution of the Brazilian Ethanol Industry

R&D - Evolution of agro industrial yield – liters of hydrous ethanol equivalent per ha

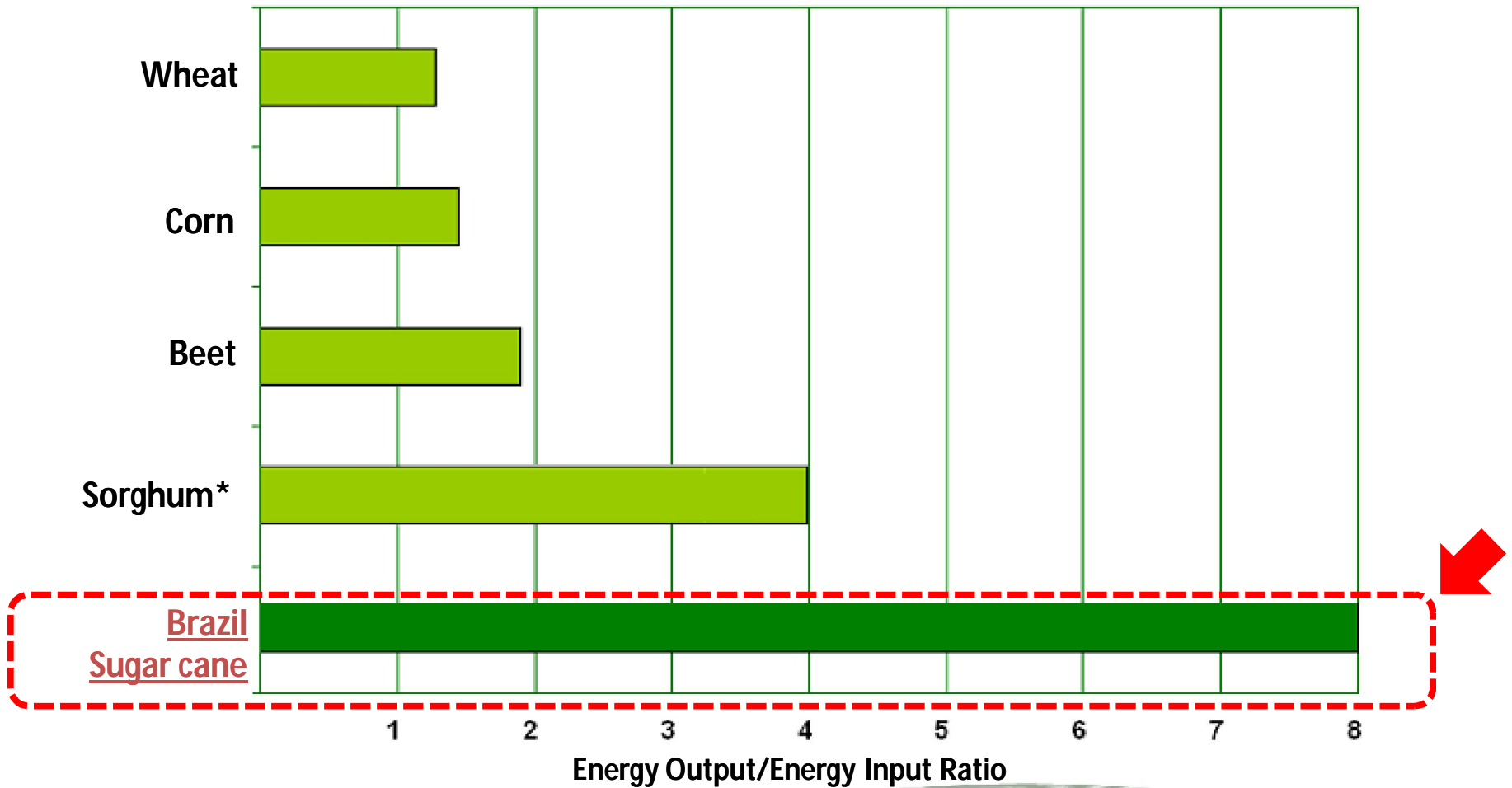


# Evolution of Sugar and Ethanol Productivity in Brazil



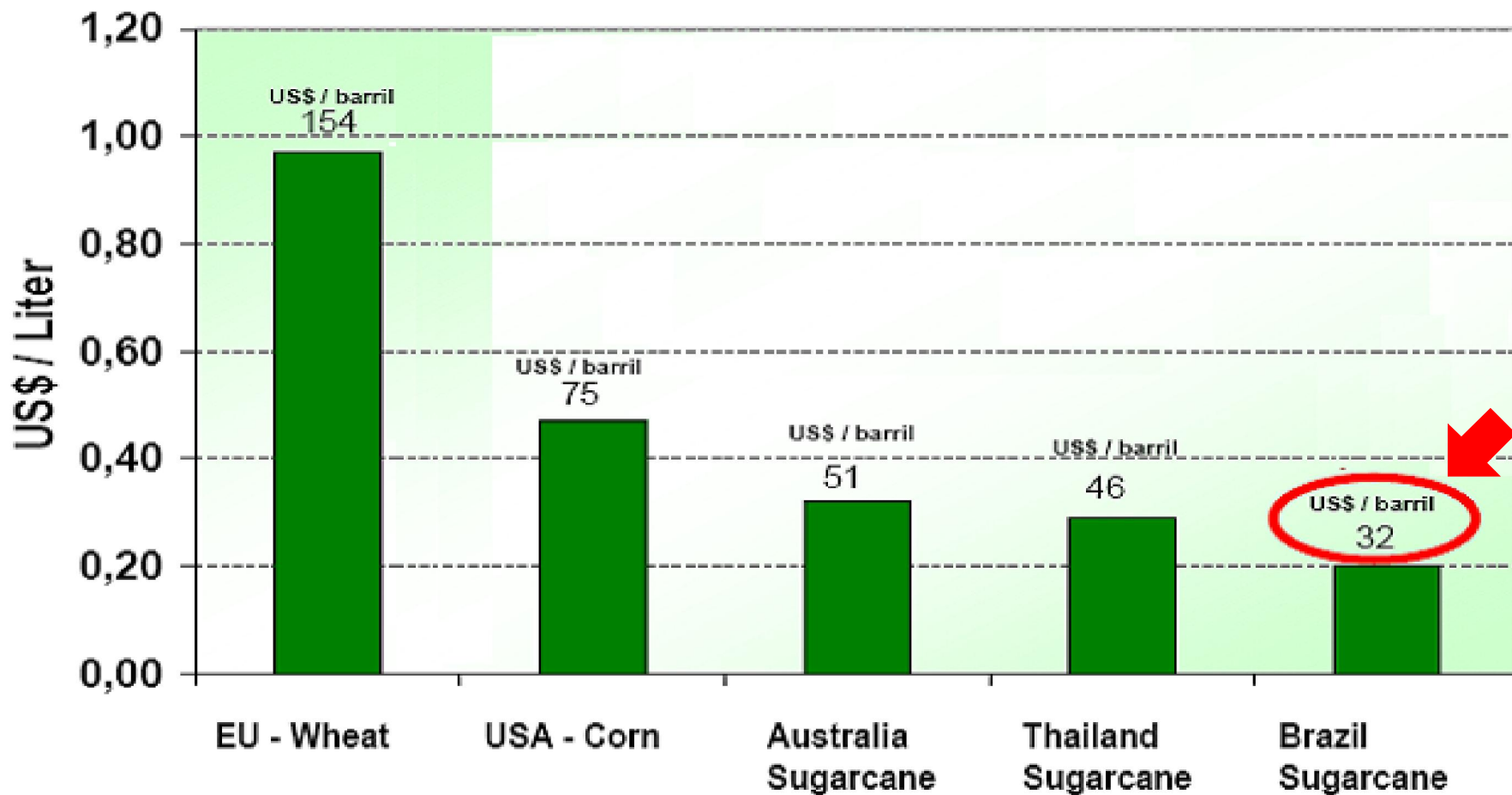
# Sustainability of Sugarcane Ethanol

Energy Balance of Bioethanol Production



# Sustainability of Sugarcane Ethanol

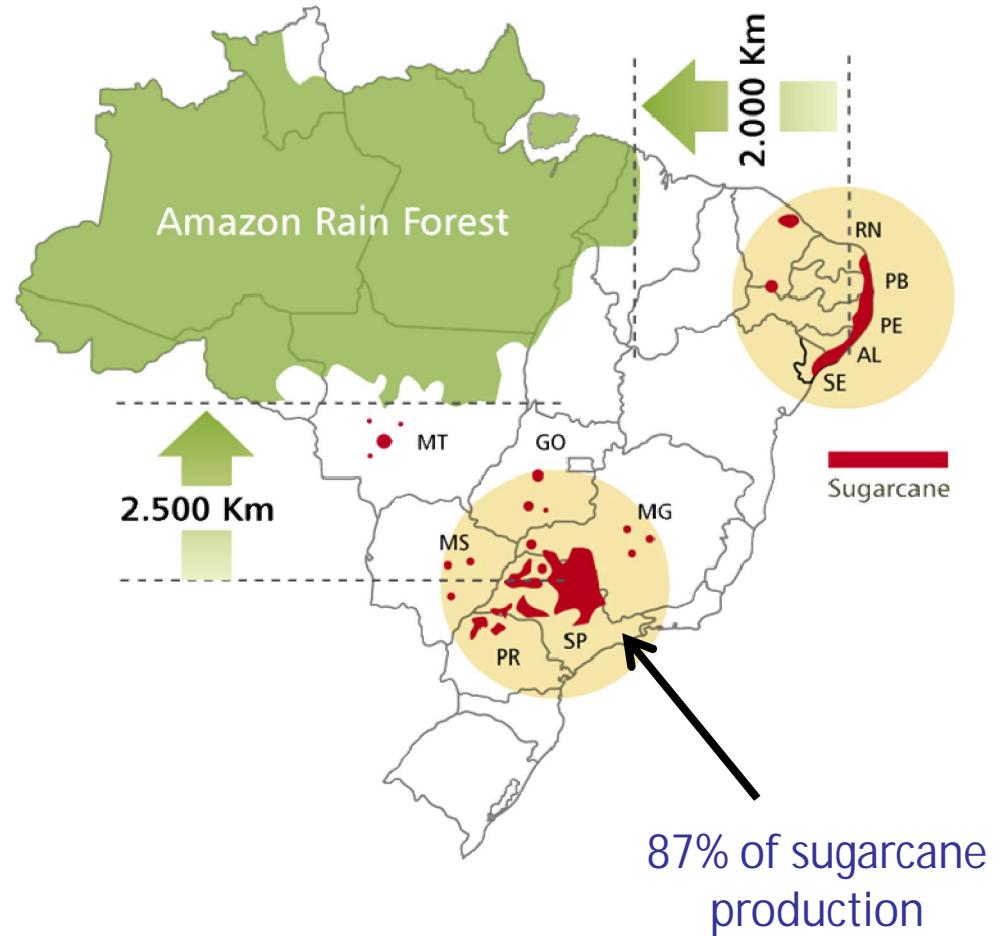
## Cost of Bioethanol Production



# Sustainability of Sugarcane Ethanol

## Brazil is Managing Sugarcane Expansion

Sugarcane for ethanol production occupies 1.5% of Brazil's arable land





# Sugarcane Zoning in Brazil

## Brazil is Managing Sugarcane Expansion

### Brazilian regulations...

#### 1. Prohibit:

- Sugarcane plantation in sensitive biomes such as the Amazon forest and Pantanal wetlands.
- Sugarcane cultivation on native vegetation (e.g., cerrado, grasslands)

#### 2. Authorize:

- **64.7 million** hectares for sugarcane expansion; equivalent to **7.5%** of the Brazilian territory (currently **0.9% of the area** is used for sugarcane)



# Other Alternative Biofuels in Brazil - Biodiesel -

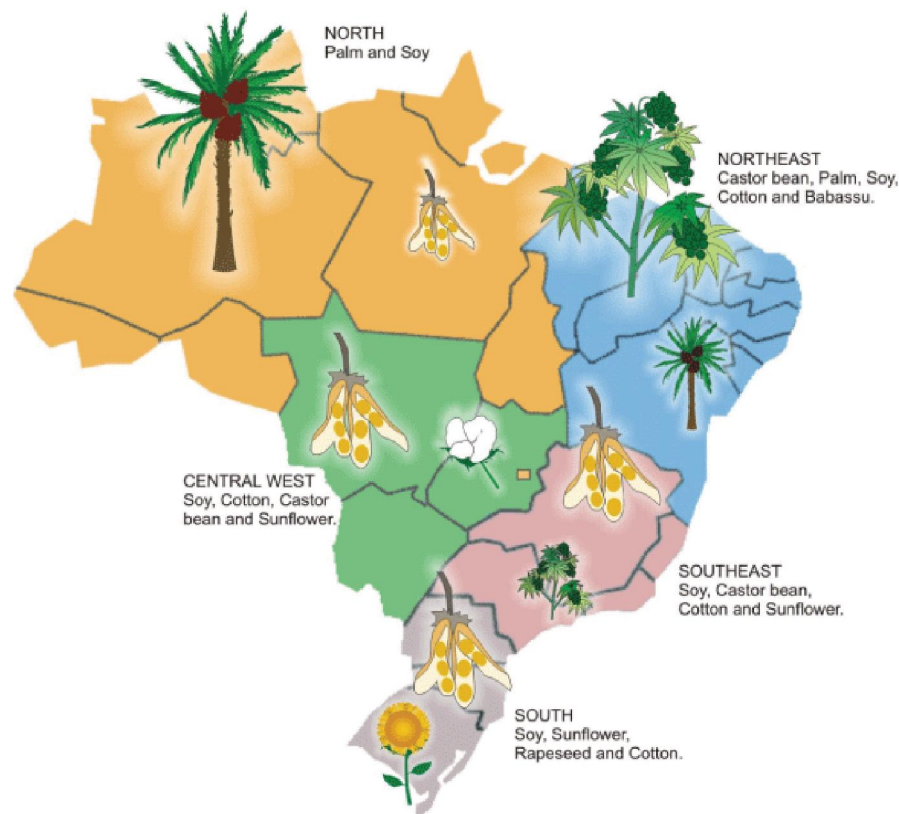


Figure 7. Biodiesel sources according to Brazilian regions.

**Biodiesel production in 2008:  
1,166 billion liters**

[Law 11.097/2005:](#)

2005 to 2007

(2% permitted) => 0 – 840 million liters

2008 to 2012

(3% mandatory)

(5% permitted) => 1,3 – 2,5 billion liters

From 2013 on

(5% mandatory) => 2,5 billion liters

# Challenges and Opportunities

Capacity Building

Better Feedstocks

Water use Efficiency

Environmental Impacts

Standards and certification

Brazil has shown that large scale production of bioenergy is possible

New Cropping Systems

Alcohol Chemistry

S&T advances will make biofuels more widely available, helping improve their contributions to energy security, sustainable growth and social inclusion

Markets and Incentives

Industrial Processes

Better Engines

Genetic Resources

Social Impacts

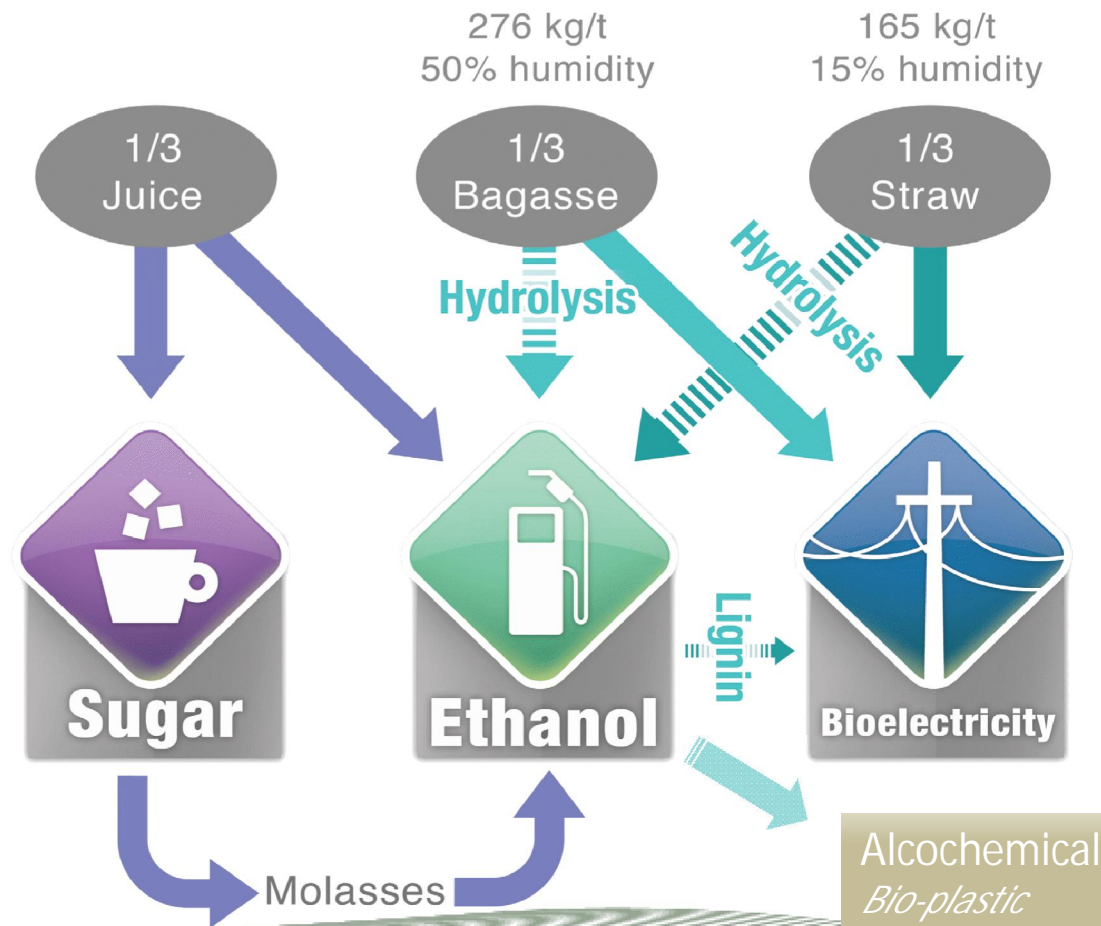
Infrastructure and Logistics

# Challenges and Opportunities

## Breakdown of sugarcane's energy



Energy equivalent of  
1 ton of sugarcane  
= 1.2 oil barrel



# Challenges and Opportunities

Brazil has around 100 plant species in the Cerrado and Amazon Biomes with potential to be developed as oil crops for energy and other industrial purposes

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Source

# Brazil-Korea Cooperation in Bioenergy



Latin America and Africa have plenty of land for 1st generation biofuels to succeed...

Technological advances will make bioenergy more widely available, even to countries with less available natural resources (especially land);

Brazil-Korea  
Good complementarities  
Innovation driven economies

# Brazil-Korea Cooperation in Bioenergy

## **Production of second generation ethanol, biodiesel and other biofuels:**

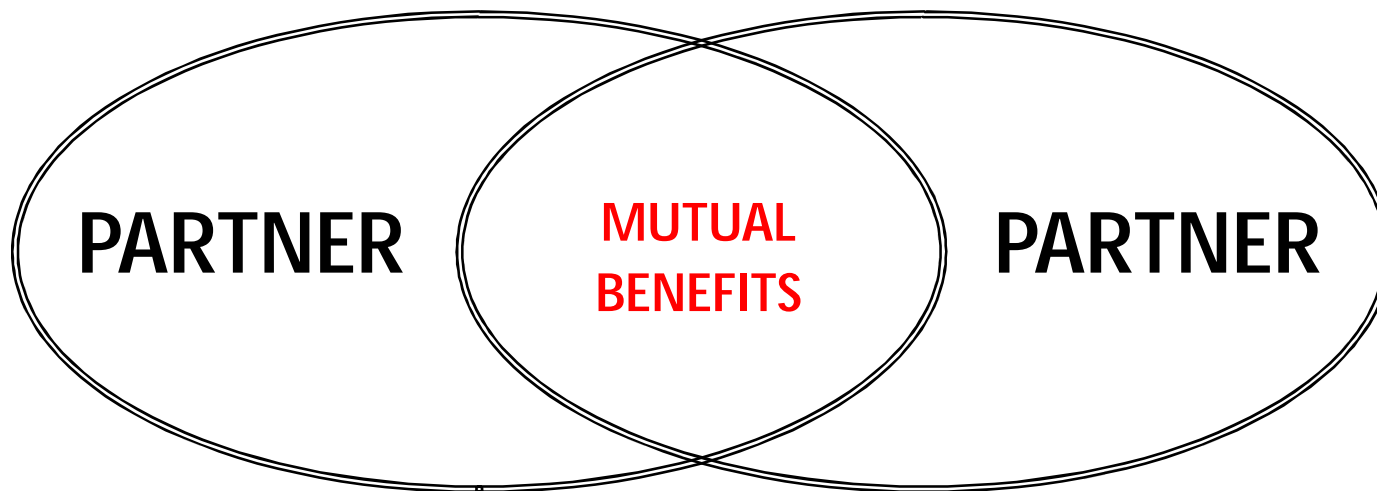
- Improving feedstock production and processing – including logistics;
- Improving processes: hydrolysis, pyrolysis, gasification, fermentation, distillation;
- Prospection of microorganisms to ferment substrates into biofuels;
- Prospection of enzymes and enzymatic processes;
- Industrial processes to convert biomass into biofuels & bioenergy;
- Promote full use of biomass: - add value to by-products and residues:
  - Innovations that enable the biorefinery concept;
  - New processes in alcohol-chemistry;
  - Development of “green chemistry”.

## **Cross-cutting studies of bioenergy production chains:**

- Assessment of social, economic and environmental impacts;
- Indicators and methods for assessing sustainability of bioenergy chains;
- Energy balances, Greenhouse Gases emission (GHG) & Life Cycle Analysis (LCA);
- Development of scenarios & prospective studies for the development of bioenergy chains.

# Challenges and Opportunities

Brazil counts on many other countries producing ethanol and biodiesel from various sources. Great interest in networking and cooperative R&D





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Thank  
You!

Embrapa

