



# Sustainable Agriculture in Brazil

## - Advances and Future Challenges -

**Maurício Antônio Lopes, PhD**  
Brazilian Agricultural Research Corporation – Embrapa  
Embrapa Labex Program – Suwon, Republic of Korea



**Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity**  
**Side Event - "Pathways to Sustainable Agriculture in Brazil"**  
**Nagoya, Japan – October 21st, 2010**



# There is a Brazil that most people know

Amazon forest



Soccer



Carnival



Rio de Janeiro



It keeps being successful, but there is still more to know

# The Brazil you must know



## Technology, Innovation, Competitiveness

### A strong academic base

10,000 doctors trained every year

16,000 scientific papers

Rank 13 in scientific publications

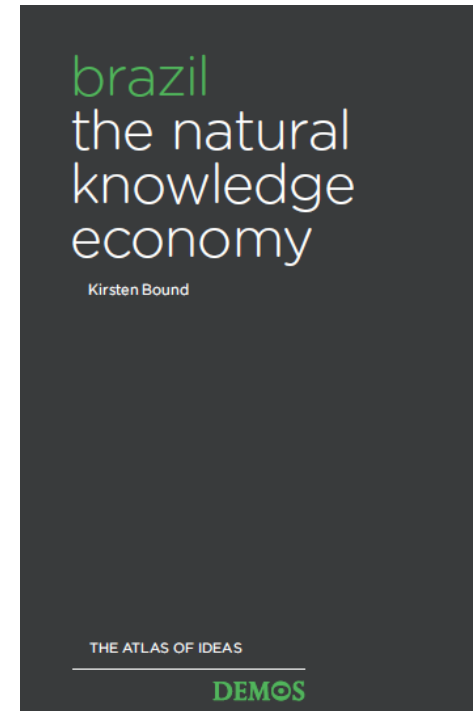
A growing intensity of industry R&D

# The Brazil you must know



## The Economist - Nov. 14-20, 2009

“A country with the world’s largest freshwater supplies, the largest tropical forests, fertile land that in some places allows up to three harvests a year, and huge mineral and hydrocarbon wealth.”



## The Atlas of Ideas – Demos Institute, 2008

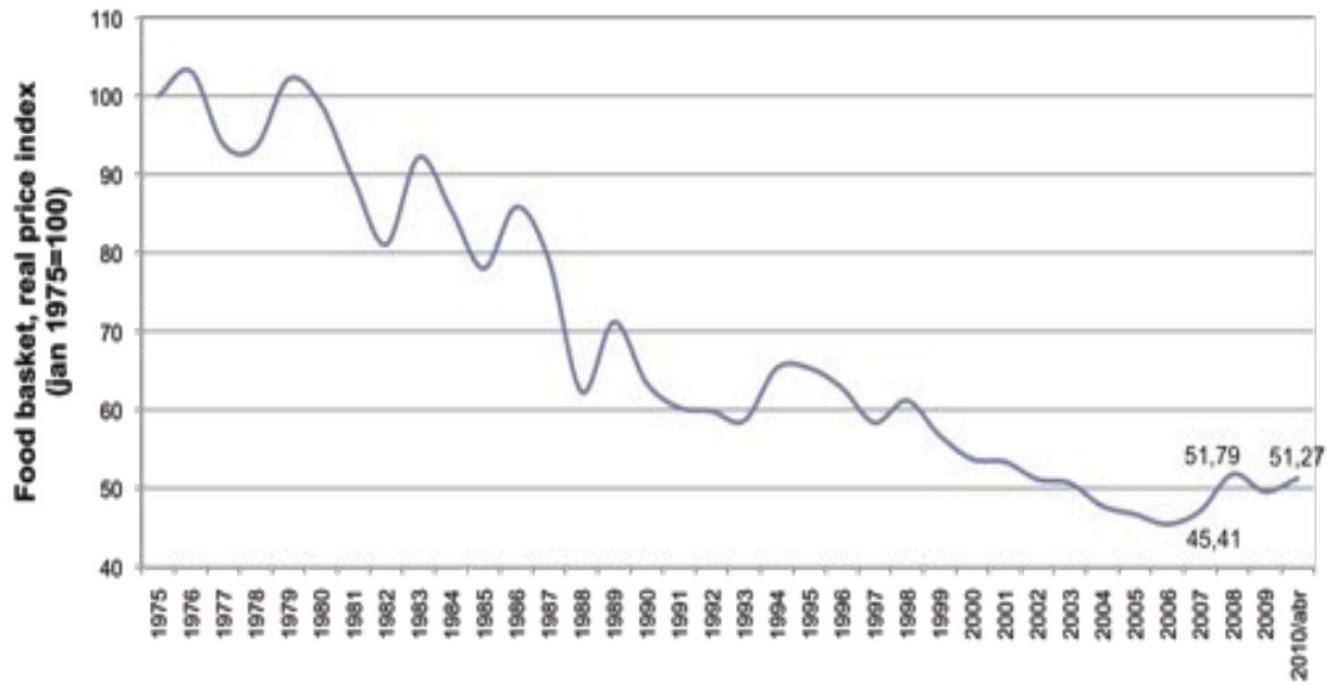
“It is helpful to think of Brazil as a ‘natural knowledge-economy’... its innovation system is in large part built upon its natural and environmental resources, endowments and assets.”

# The Brazil you must know

A Country that became Food Secure in a Short Period of Time



## Food Basket: Real Prices, Jan/1975 – Apr/2010

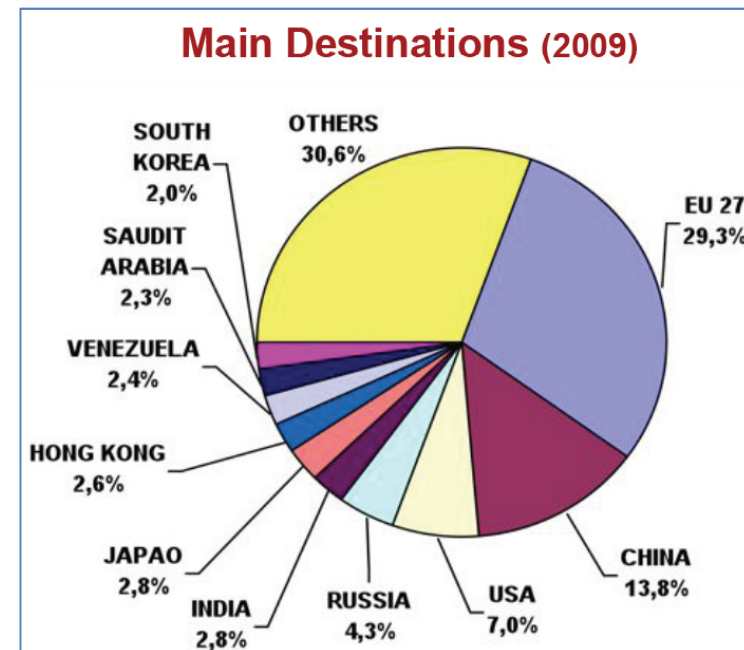
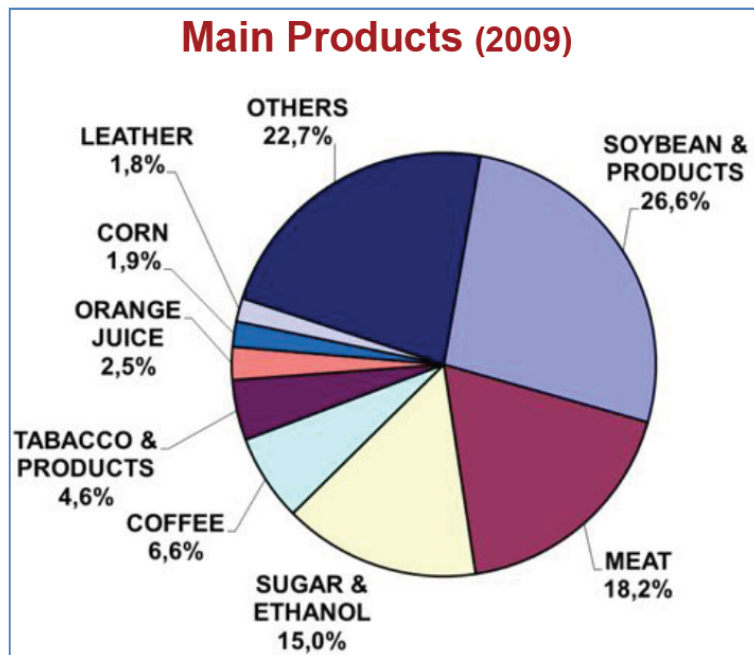


# The Brazil you must know

A Country that is becoming an important player in Food Security worldwide

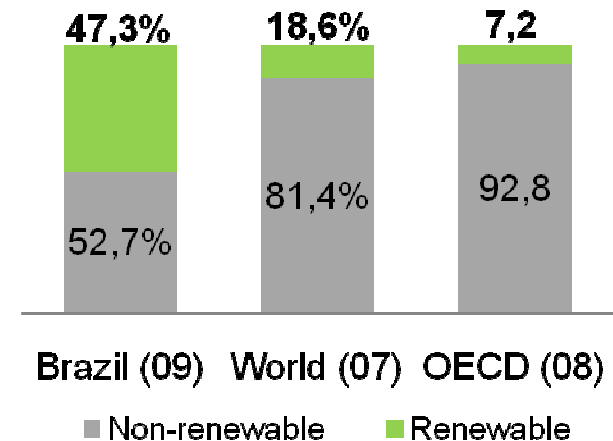
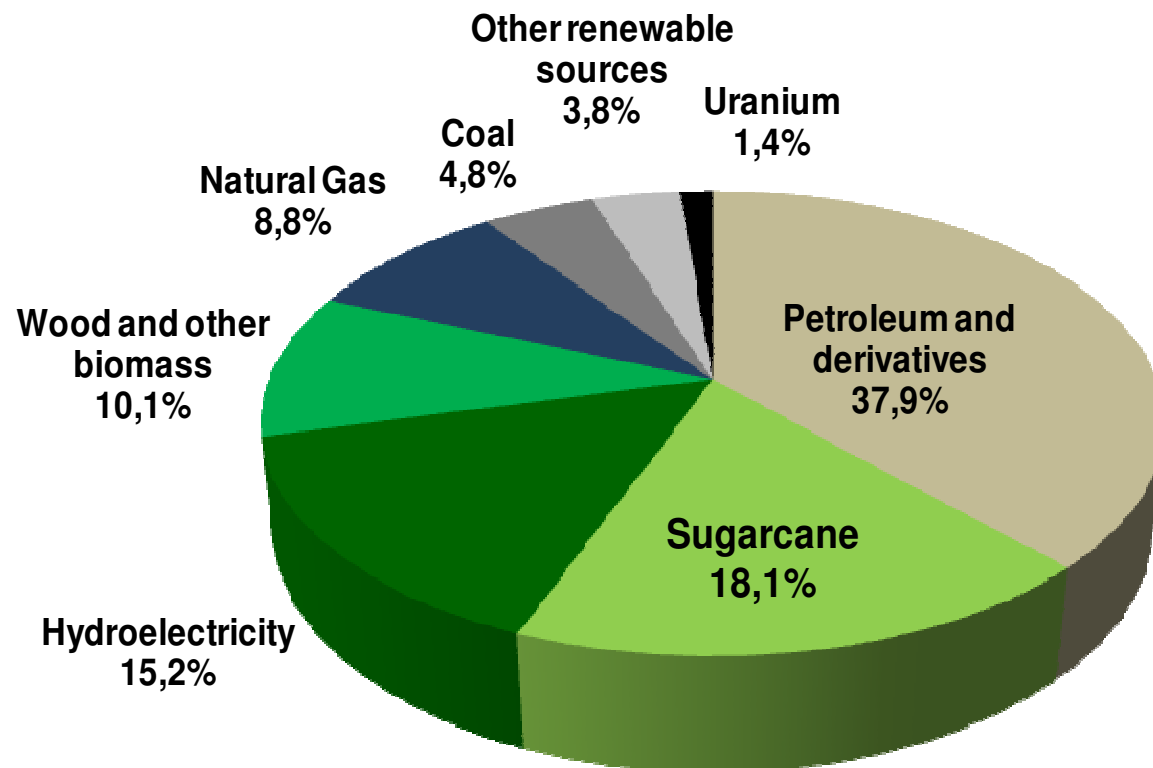
Around 79% of the Brazilian food production is consumed domestically and 21% is shipped to over 212 foreign markets

- In 2008 Brazil exported more than 1500 types of agricultural products -



# The Brazil you must know

## A Country With a Clean Energy Matrix

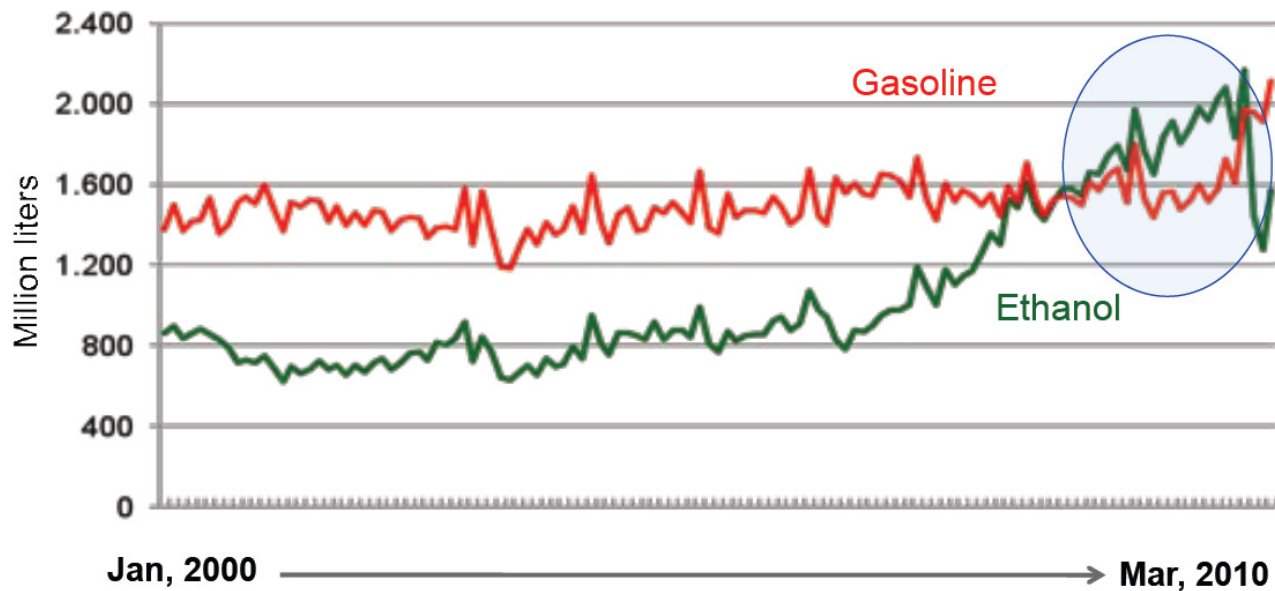


# The Brazil you must know

'In Brazil Gasoline is Becoming the Alternative Fuel'



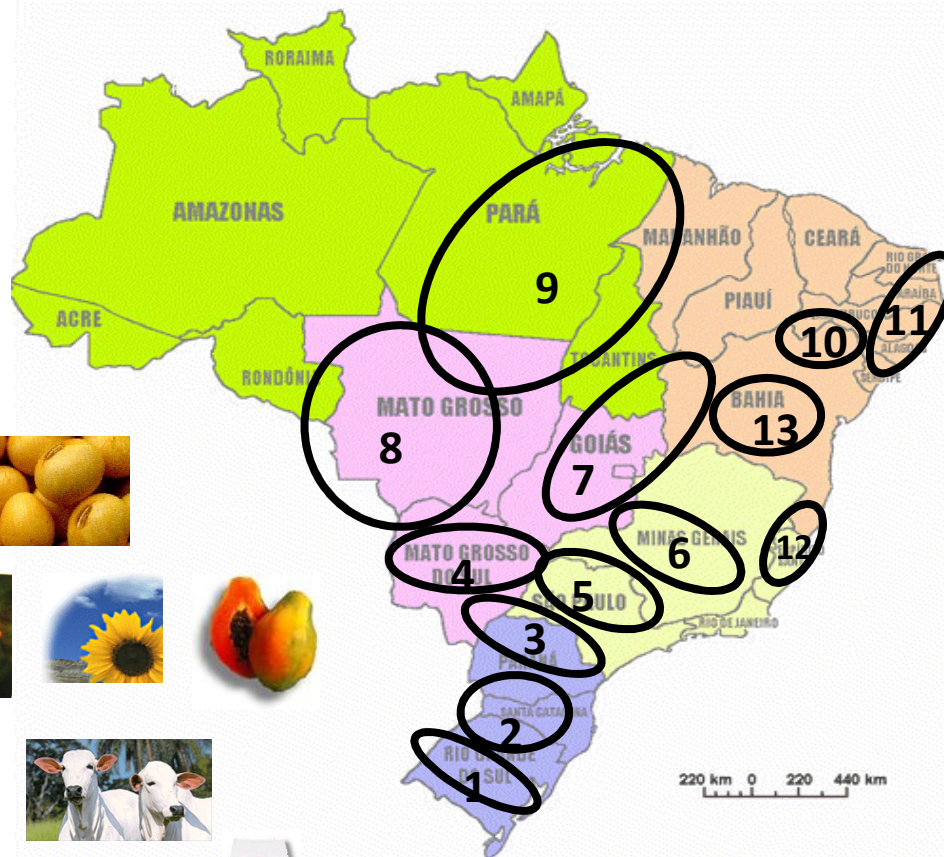
## Consumption of Gasoline and Ethanol in Brazil





# The Brazil you must know

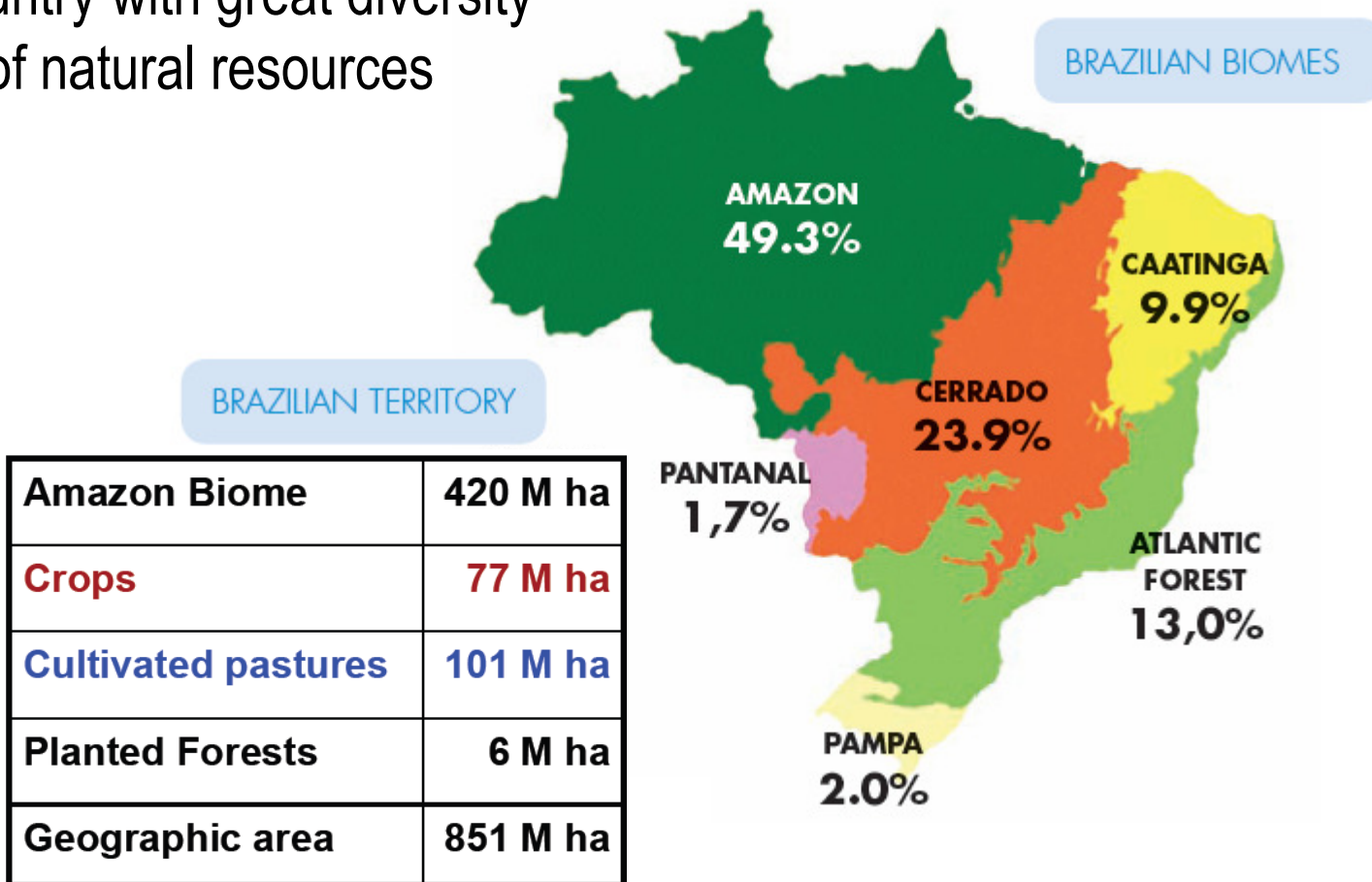
A Country with a diverse and dynamic agricultural system



AREA/ MAIN CROPS	MM HA
1- FLOODED RICE	0.95
2- SOYBEAN CORN WHEAT	3.30 1.30 0.60
3- SOYBEAN CORN WHEAT	3.20 2.40 0.90
4- SOYBEAN PASTURE	1.20 11.00
5- SUGARCANE COFFEE CITRUS	2.50 0.30 0.70
6- COFFEE	1.00
7- SOYBEAN CORN COTTON DRYBEANS PASTURE	1.80 0.80 0.10 0.20 9.00
8- SOYBEAN COTTON CORN PASTURE	3.30 0.50 0.40 12.00
9- PASTURE	10.00
10- TROPICAL FRUITS	0.07
11- SUGARCANE	0.90
12- COFFEE	0.60
13- DRYBEANS SOYBEAN	0.70 0.90

# The Brazil you must know

A country with great diversity  
of natural resources

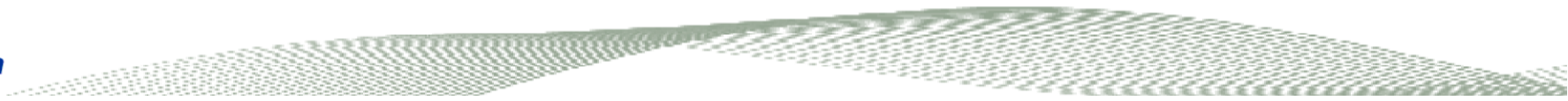
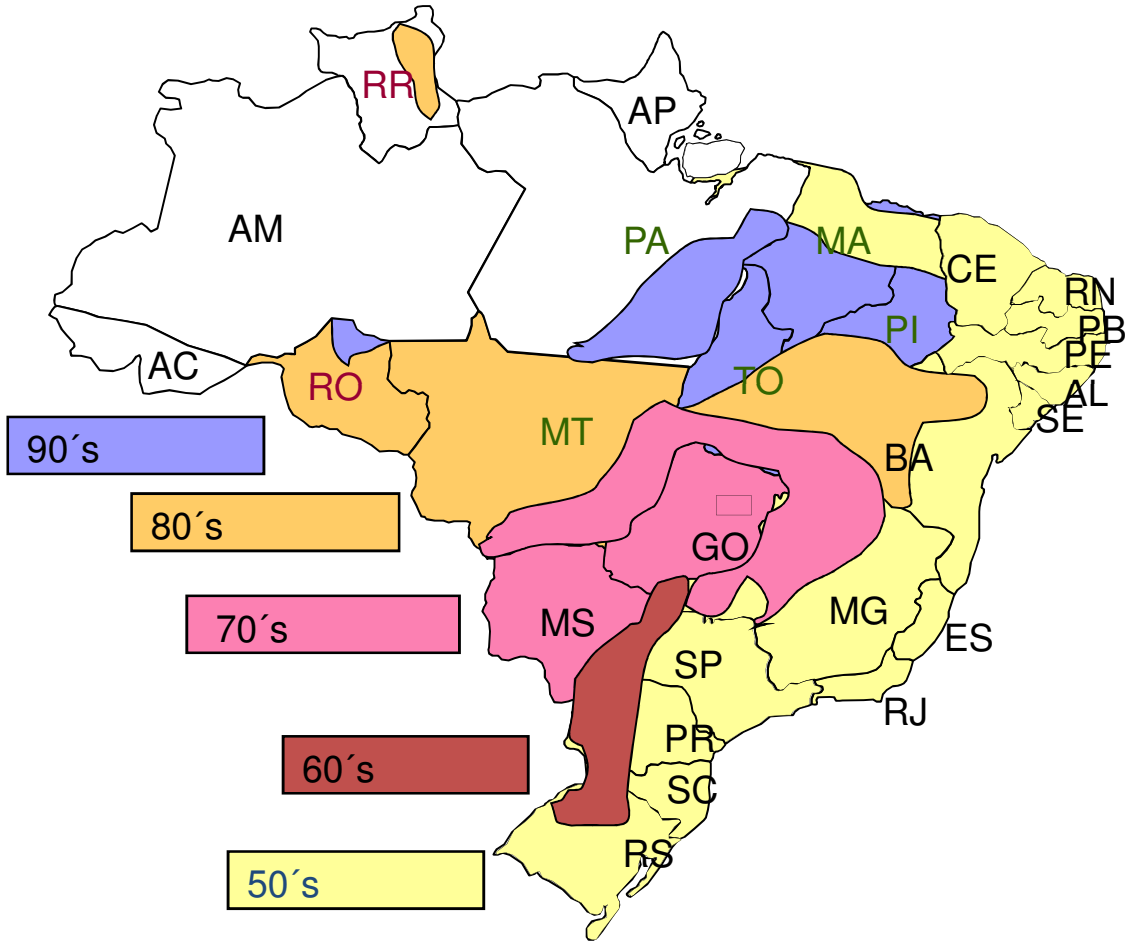


Source: MAPA / Biomes MMA 2006 / ABRAF

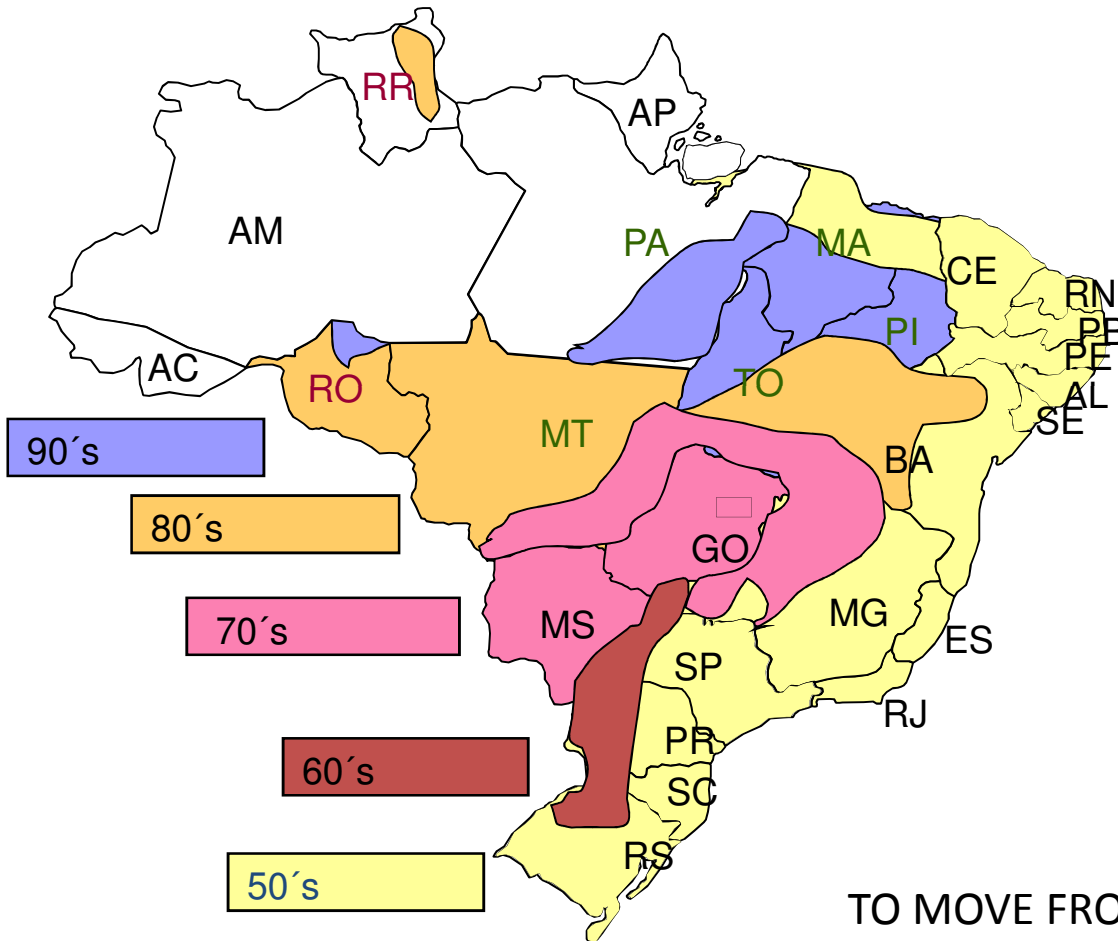
# Evolution of Agriculture in Brazil



**Brazilian Agriculture  
From the 50's to the 90's**



# Brazilian Agriculture Before the 1970's



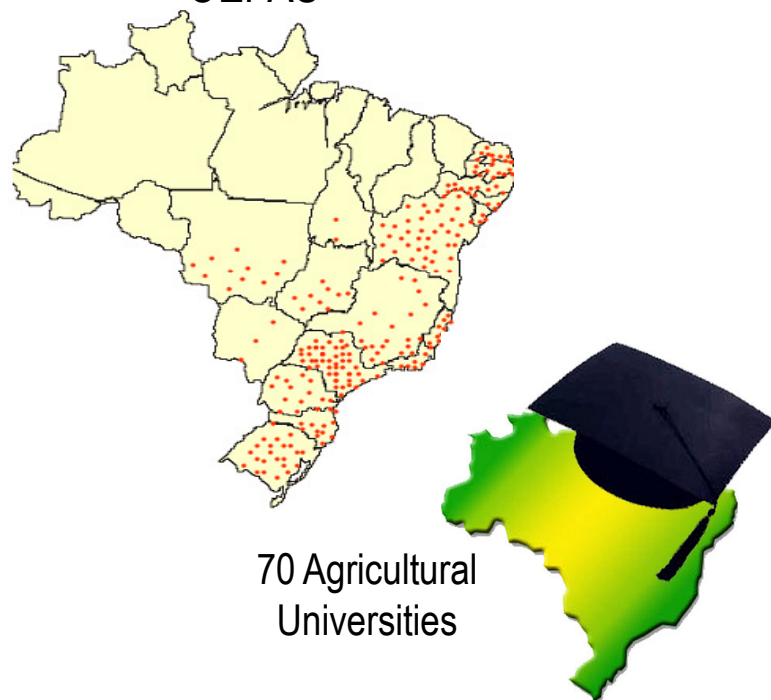
- ❖ Low agricultural production and low yields
- ❖ Production concentrated in the richer South and Southeast Regions
- ❖ Constant food supply crisis
- ❖ Rural poverty
- ❖ Lack of specific knowledge in Tropical Agriculture
- ❖ Lack of Adequate Institutional Policies (agricultural research, education, markets, media and government agencies, etc.)

## THE TASK

TO MOVE FROM A TRADITIONAL AGRICULTURE TO A SCIENCE BASED AGRICULTURE

# The Brazilian Agricultural Research System

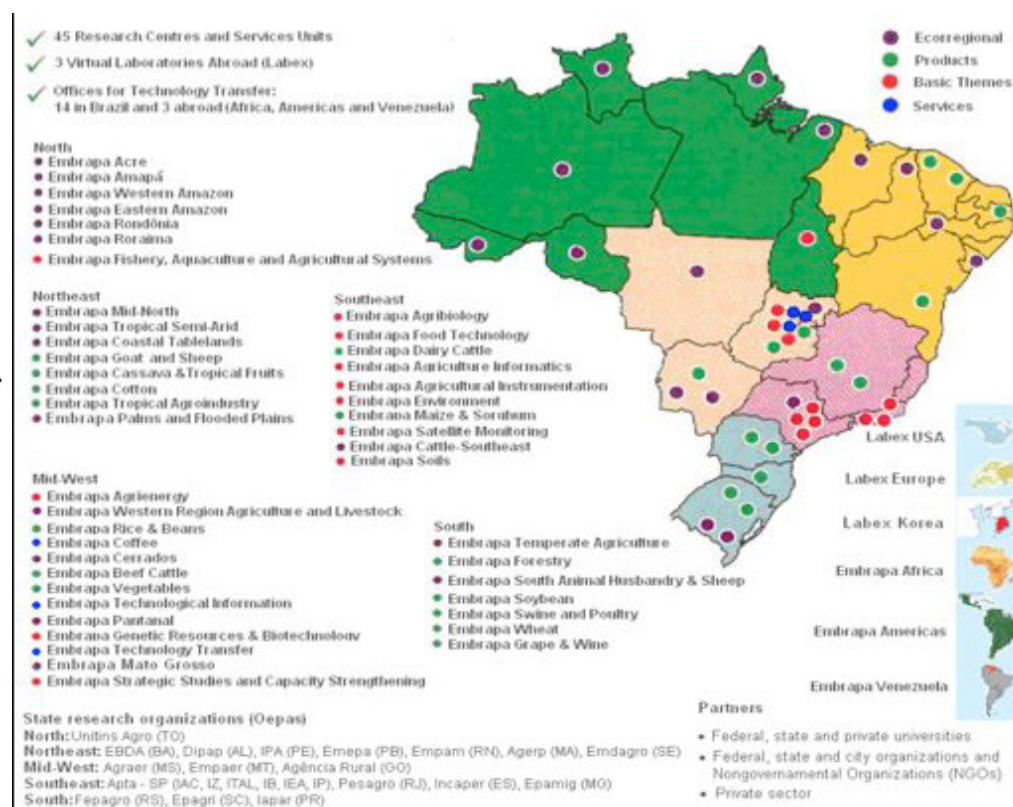
## 17 State Research Networks OEPAS



## Private Sector

An active and growing private sector, which supplies technologies and technical assistance, farm inputs, logistics, commercialization, processing...

## The Brazilian Agricultural Research Corporation A Network of 45 Research Centers



# The Brazilian Agricultural Research System



TABLE 1  
Share of world publications

	1998-2002		2008-2007		Rank	
	Count	Share(%)	Count	Share(%)	Share	Growth
Plant & Animal Science	5,857	2.62	10,006	3.91	1	1
Agricultural Sciences	2,155	3.07	3,308	3.72	2	9
Microbiology	1,438	2.2	2,192	2.86	3	8
Environment/Ecology	1,353	1.47	3,209	2.63	4	2
Pharmacology & Toxicology	1,156	1.65	2,152	2.55	5	3
Neuroscience & Behavior	2,106	1.68	3,394	2.4	6	6
Physics	8,645	2.28	10,121	2.28	7	22
Immunology	725	1.28	1,225	2.11	8	5
Space Science	1,000	1.95	1,208	2.08	9	20
Biology & Biochemistry	3,189	1.29	5,240	1.97	10	7

“Brazil clearly has very real strength in life sciences, particularly related to natural resources... the country is strong in areas related to animal and plant biology, agriculture and veterinary science.

Its greater than 5% share of world publications has underpinned key economic sectors but also gives it the knowledge base to develop its ‘natural knowledge’.”

Global Research Report – Brazil, Research and collaboration in the new geography of science  
Thomson-Reuters - <http://researchanalytics.thomsonreuters.com/grr/>

# Evolution of Agriculture in Brazil

## Key drivers of Agricultural Development in Brazil

### The development of science-based tropical agriculture

Entrepreneurship of farmers

Government commitment and public policies

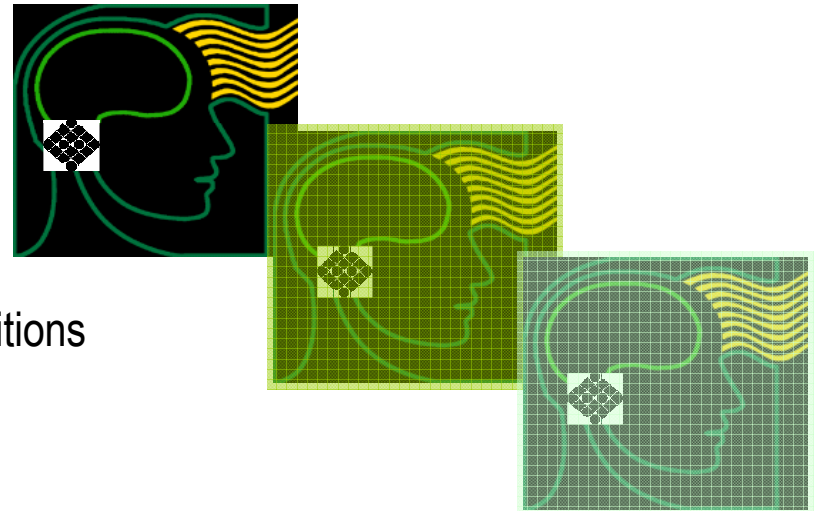
Availability of basic infrastructure

Large extension of arable land and adequate climatic conditions

Landscape suitable for mechanization

Good physical characteristics of the soils

Availability of mineral resources (limestone and phosphate)





## **Sustainable Agriculture in Brazil**

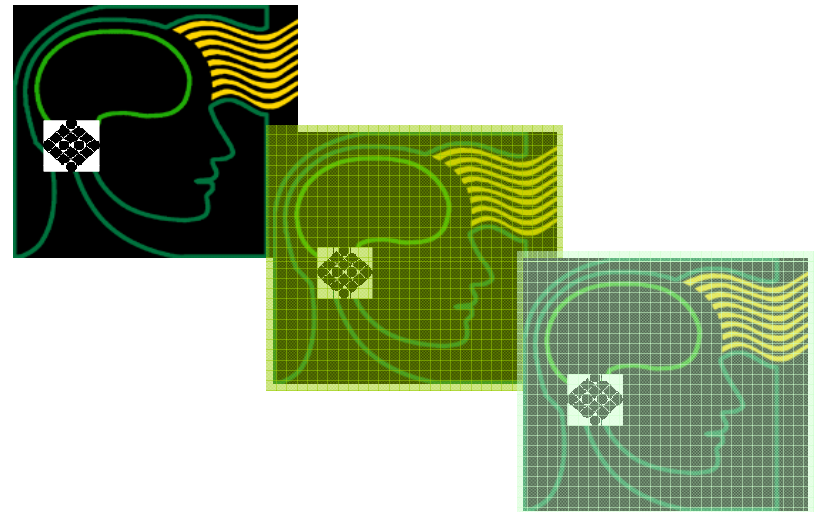
Sustainable development is one of the most challenging goals for mankind, and is vital to Brazil!



# Sustainable Agriculture

“No concise, universally acceptable definition of sustainable agriculture has yet emerged.

This is so because sustainability is often viewed as a management philosophy rather than a method or process of operation and, as such, acceptance or rejection of any definition is linked to one’s value system.”

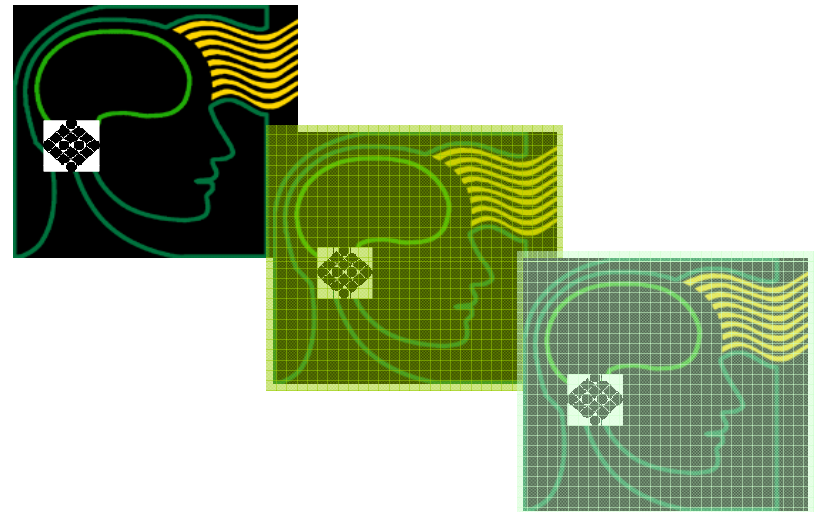


# Sustainable Agriculture

“However, it is well accepted that sustainability’s dimensions – technical, economic, social and environmental – must be always pursued.

These dimensions have strong interdependence linkages and, ideally, should be simultaneously met. “

**But we should keep in mind that it is not a trivial task to design strategies that always return win-win situations, e.g., simultaneous gains in all sustainability dimensions...**





**The Brazilian Government and the country's agricultural sector are committed to promote sustainable agricultural systems**

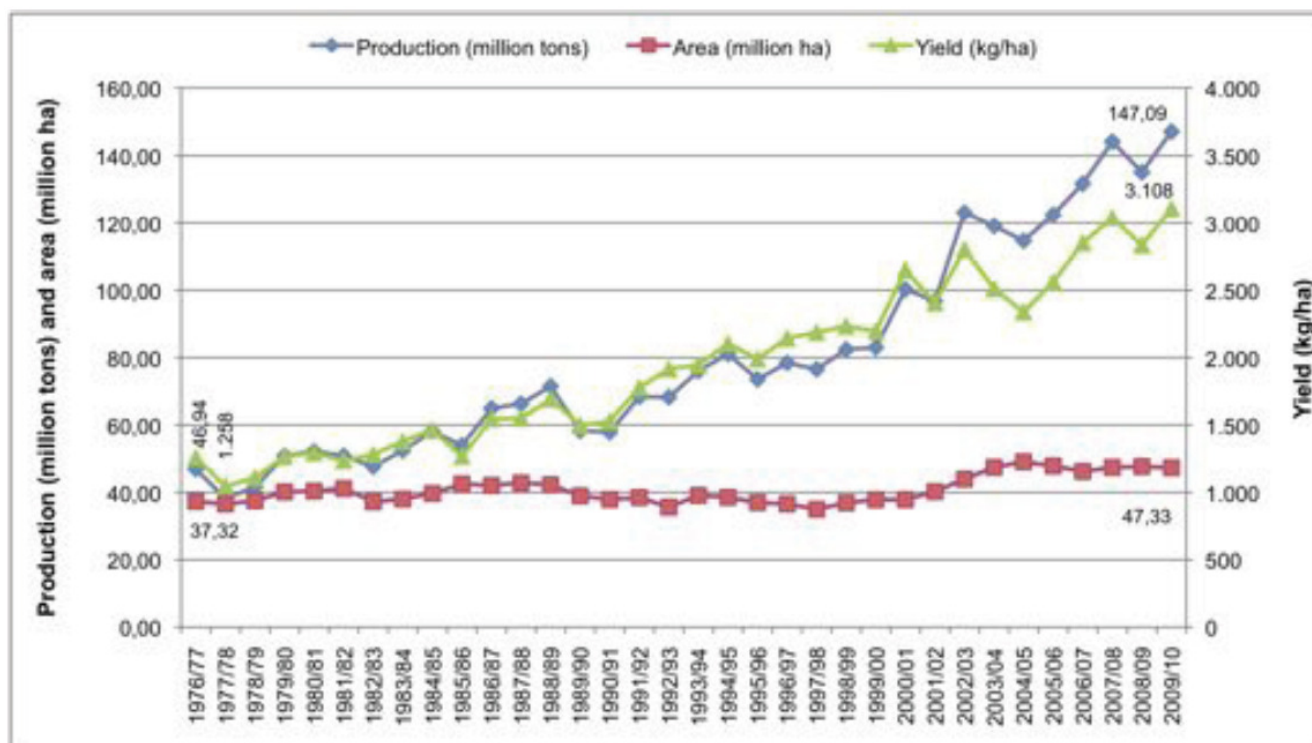


## Conservation Agriculture in Brazil

**In the last decades, farmers are steadily adopting conservation practices, such as no-till planting, and more resource-efficient processes, such as integrated crop-livestock systems**

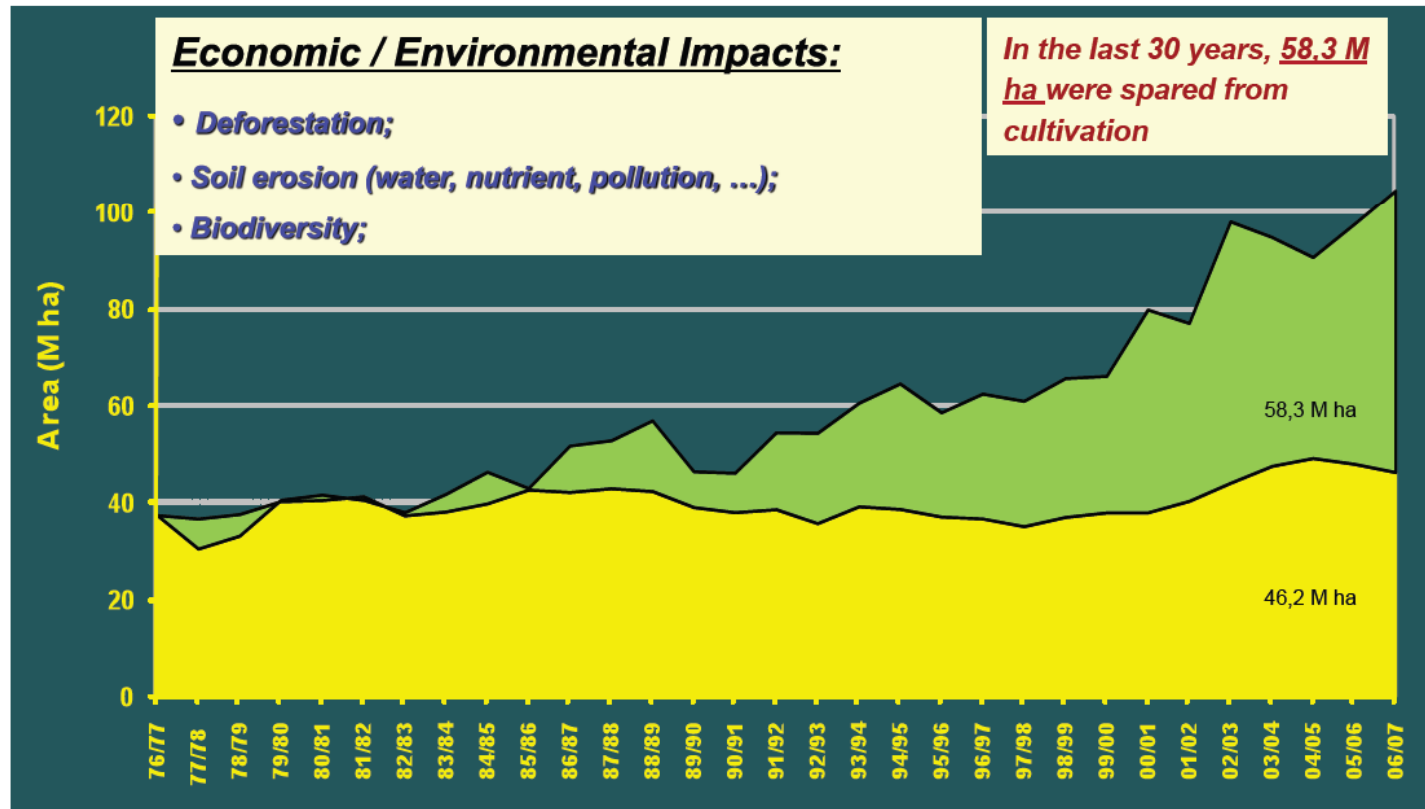
# Evolution of Agricultural Systems in Brazil

Evolution of grains and oilseeds production (million metric tons), yields (Kg/ha) and area (million hectares) in Brazil from 1975 to 2010.



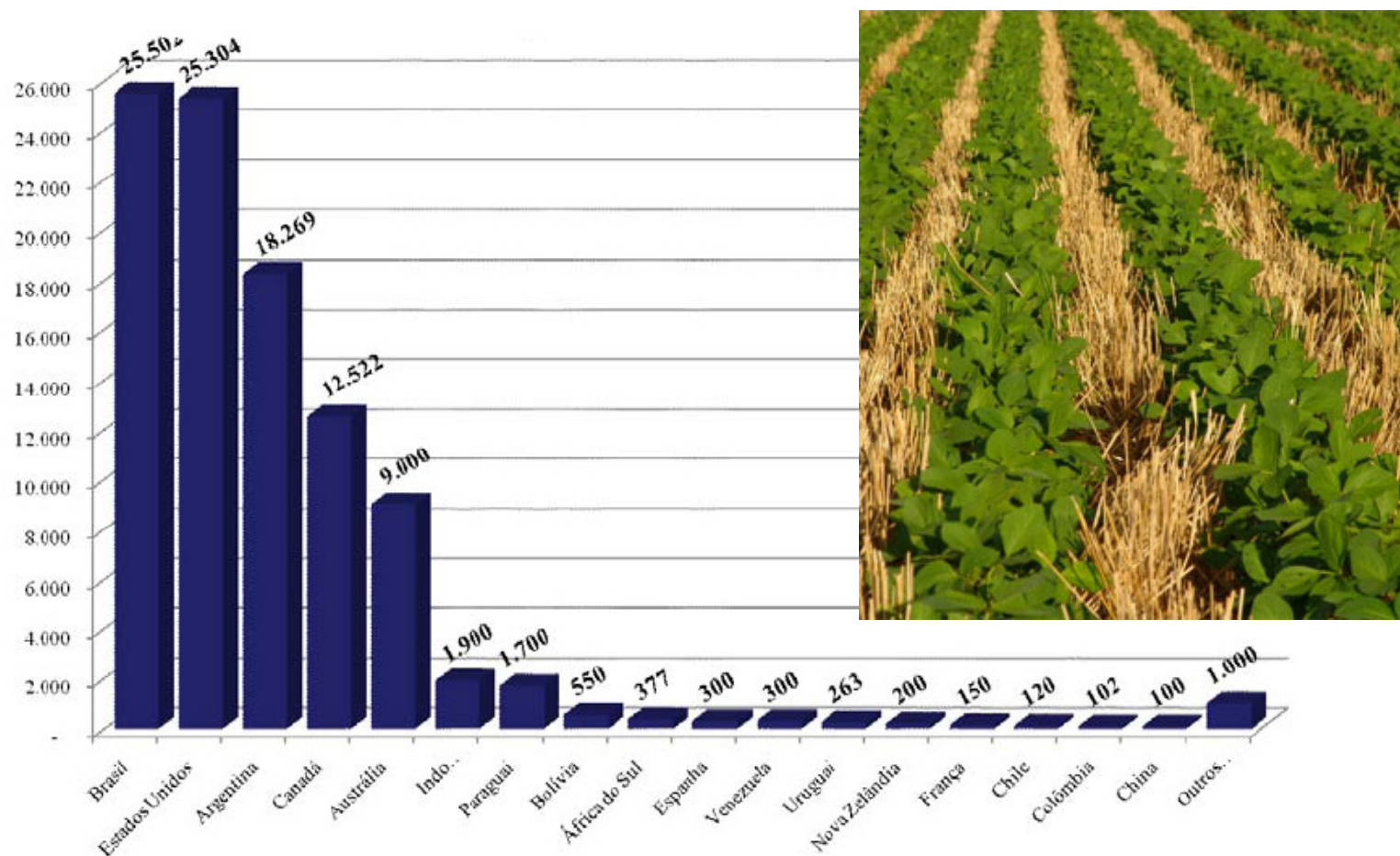
# Evolution of Agricultural Systems in Brazil

Without advances in crop productivity and increased agricultural system's efficiency, additional 58 million ha would have been necessary to reach today's production



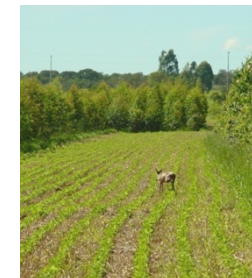
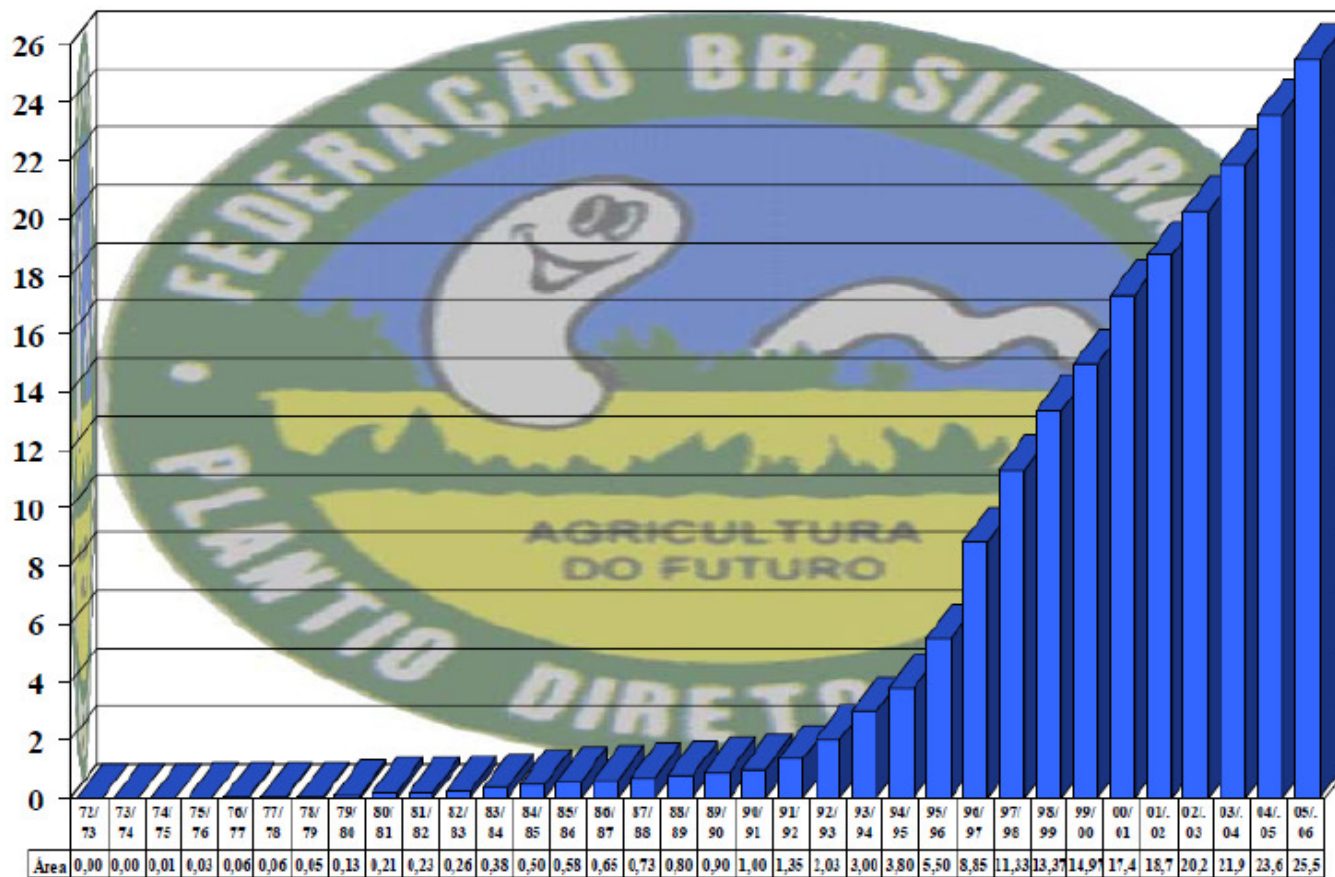
# Conservation Agriculture in Brazil

Cultivated area under no-tillage systems around the world (1000 ha)



# Conservation Agriculture in Brazil

Cultivated area under no-tillage systems in Brazil – over 25 million ha





# Conservation Agriculture in Brazil

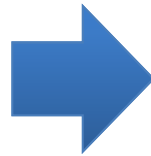
Drastic reduction in soil erosion – improved chemical, physical and biological properties  
Reduction in energy use - Agriculture is becoming a major “producer” of clean water



# Conservation Agriculture in Brazil

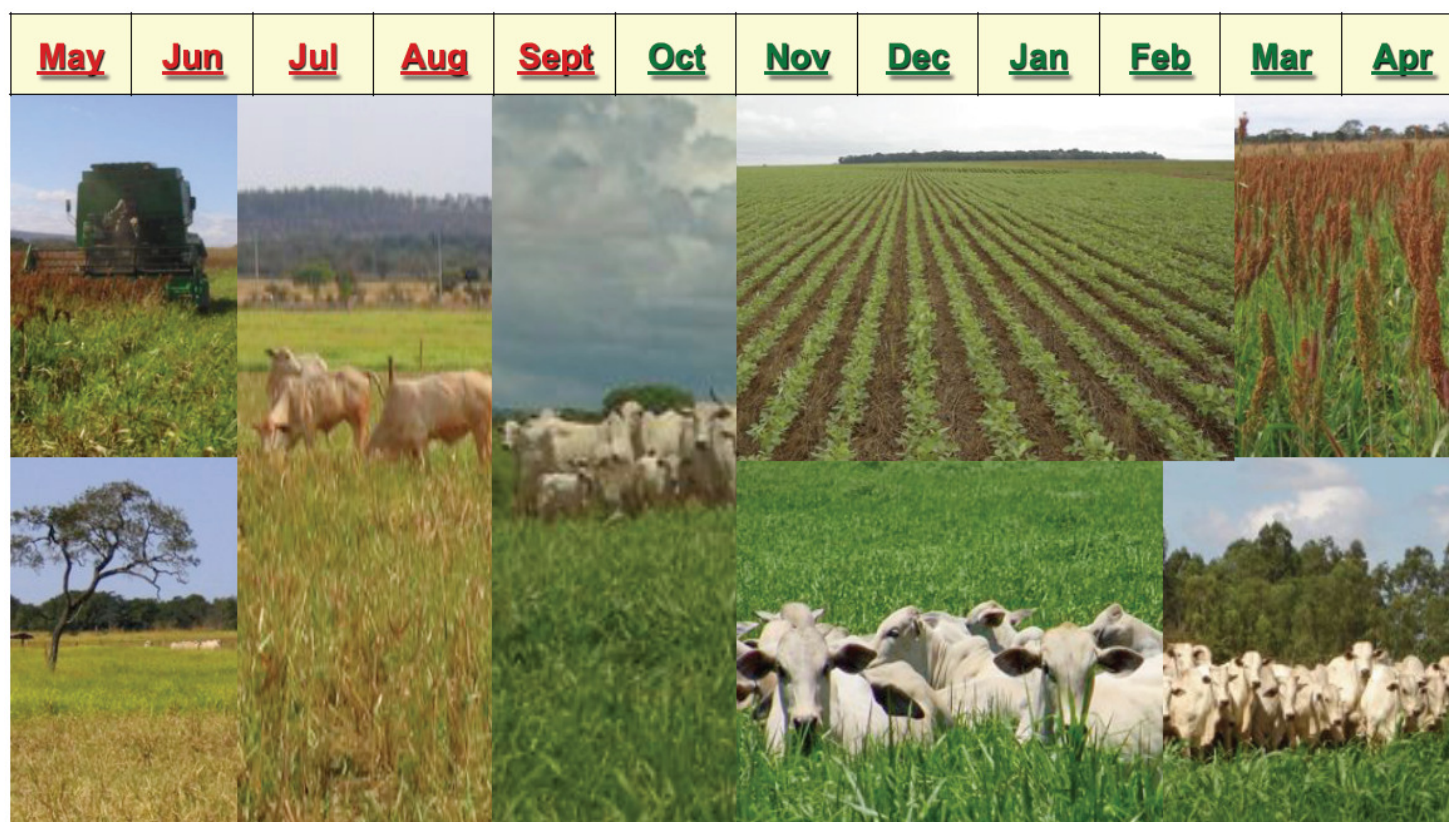
Avoiding deforestation by intensification of use of areas already opened

Under the Brazilian Climate Change Law, from December 2009, 15 million hectares of degraded land (mostly pastures) will be recovered.



# Conservation Agriculture in Brazil

## Integrated Crop-Livestock Systems



# Conservation Agriculture in Brazil

Intensification of land use with integrated crop-livestock-forest systems  
Large Scale Operations



# Conservation Agriculture in Brazil

Intensification of land use with integrated crop-livestock-forest systems  
Technologies Adapted to Small Scale Farming Systems

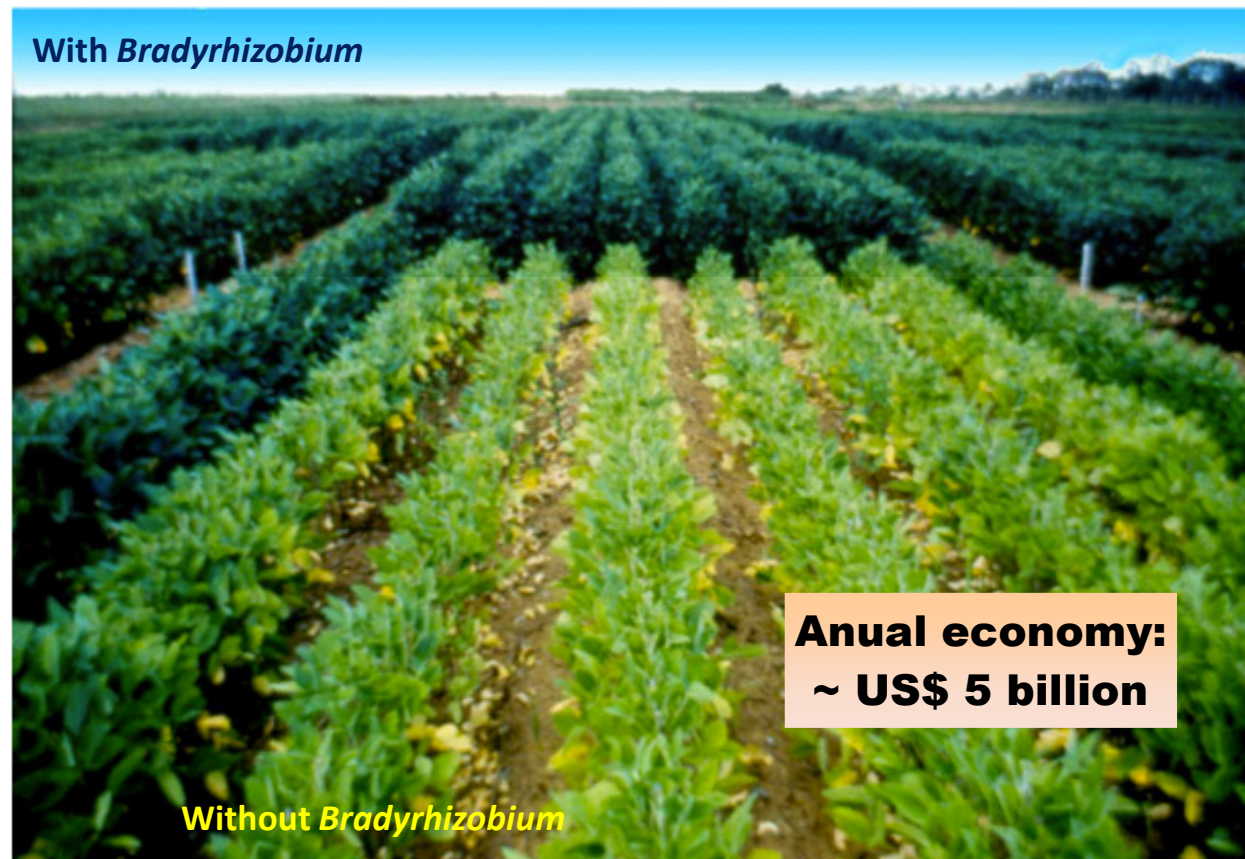


# Biological Nitrogen Fixation

Brazil has become the world leader in replacing N fertilizers by biological N<sub>2</sub> fixation (BNF).



Nitrogen fixation occurs in nodules on legume roots (Source: FAO, Rome)



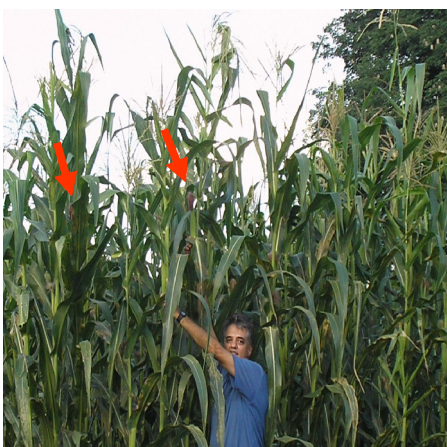
# Genetic Resources, Breeding and Crop Adaptation



**Despite of its rich biological diversity, Brazil is very dependent on exotic diversity for food and agriculture.**

# Genetic Resources, Breeding and Crop Adaptation

Tropical corn had poor agronomic performance 30 yrs ago



New materials



Source: Parentoni & Teixeira, 2006



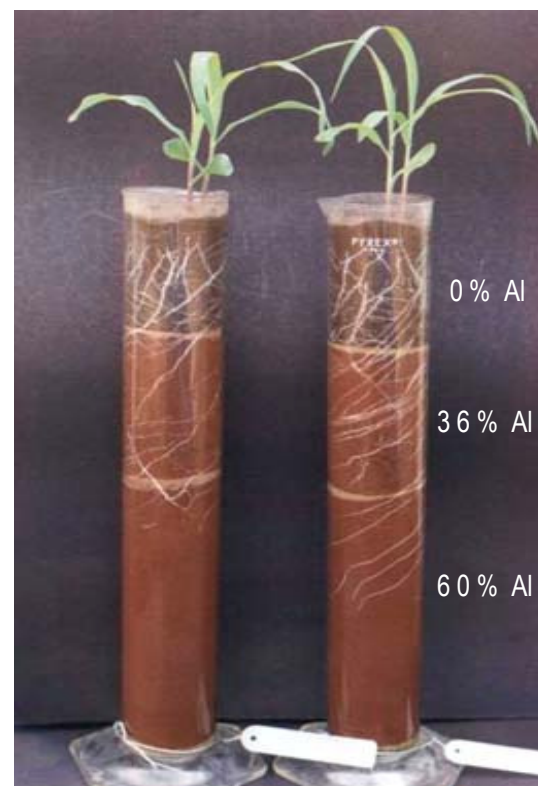


# Genetic Resources, Breeding and Crop Adaptation

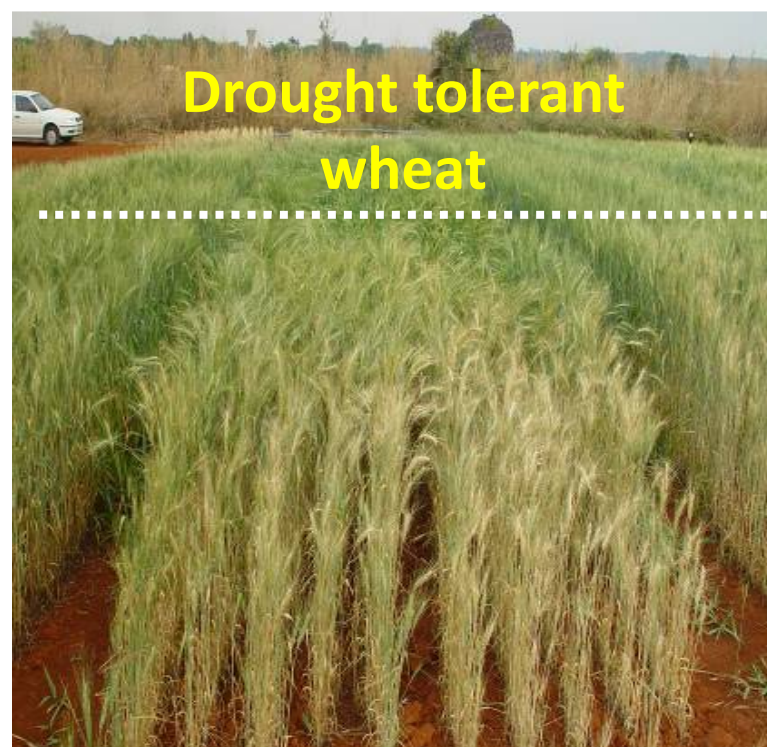
Aluminum tolerance and phosphorus use efficiency – Adapting corn to the Brazilian Savannahs



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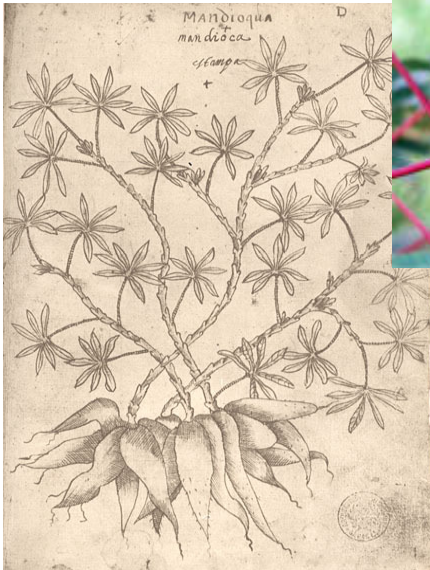


# Genetic Resources, Breeding and Crop Adaptation



# Conservation and Sustainable Use of Agrobiodiversity in Brazil

## Agrobiodiversity



### Celebrating Cassava Diversity

(A Contribution from Embrapa/LBB)

Luiz J. C. B. Carvalho, PhD



**Embrapa**

Genetic Resources and  
Biotechnology

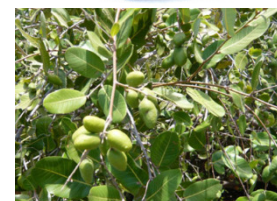
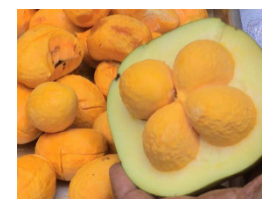


Source: Embrapa Genetic Resources and Biotechnology

# Conservation and Sustainable Use of Agrobiodiversity in Brazil

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

<i>Acrocomia aculeata</i> (macauba palm)	<i>Licania rigida</i> (oiticica)
<i>Astrocaryum murumuru</i> (murumuru)	<i>Mauritia flexuosa</i> (buriti palm)
<i>Astrocaryum vulgare</i> (tucumã)	<i>Maximiliana maripa</i> (inaja palm)
<i>Attalea geraensis</i> (indaiá-rateiro)	<i>Oenocarpus bacaba</i> (bacaba-do-azeite)
<i>Attalea humillis</i> (pindoba)	<i>Oenocarpus bataua</i> (patauá)
<i>Attalea oleifera</i> (andaiá)	<i>Oenocarpus distichus</i> (bacaba-de-leque)
<i>Attalea phalerata</i> (uricuri)	<i>Paraqueiba paraensis</i> (mari)
<i>Caryocar brasiliense</i> (pequi)	<i>Sesamum indicum</i> (benneseed)
<i>Cucumis melo</i> (melon)	<i>Theobroma grandiflorum</i> (cupuassu)
<i>Jatropha curcas</i> (pinhão-manso)	<i>Trithrinax brasiliensis</i> (carandai)
<i>Joannesia princeps</i> (cutieira)	



Source: Nass et al. (2007)

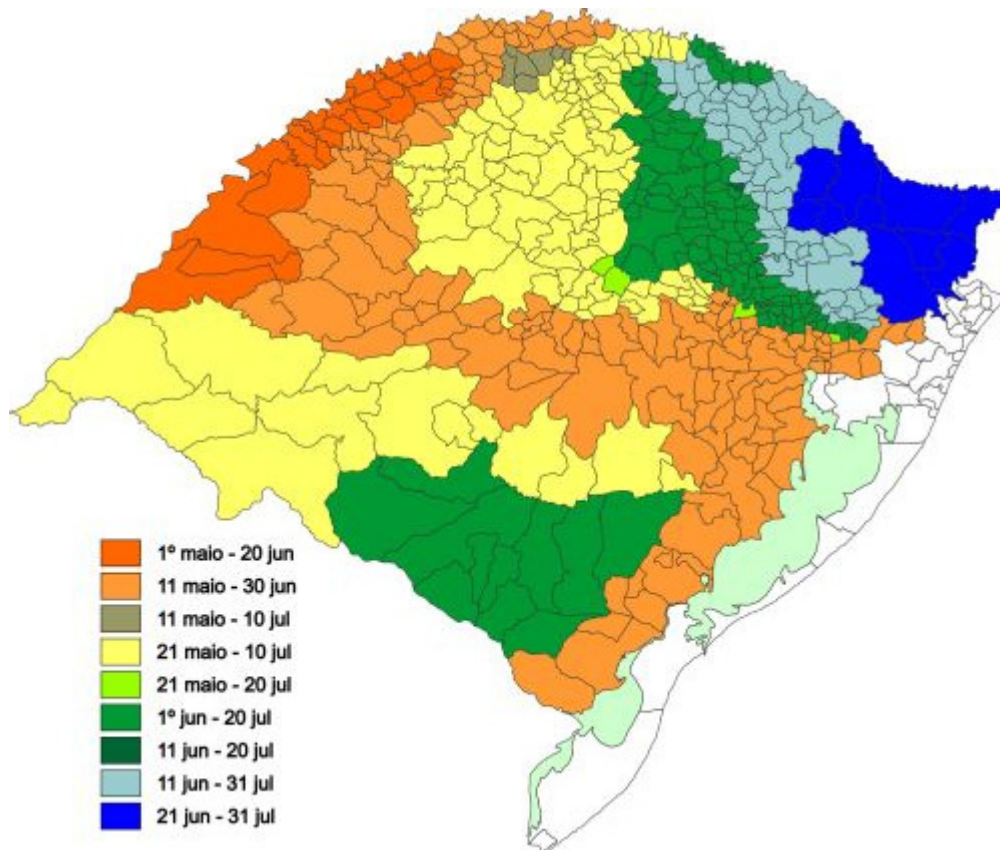
# Conservation and Sustainable Use of Agrobiodiversity in Brazil

## Etnobiology (Biodiversity and Social Diversity)



Source: Embrapa Genetic Resources and Biotechnology

# Agricultural Zoning Program



To reduce climatic risks, Brazil has implemented in 1996 its Agricultural Zoning Program.

It analyzes the parameters related to soil, climate and plants, using mathematical and statistical models to determine the probability of occurrence of adverse climatic events that may cause crop losses.

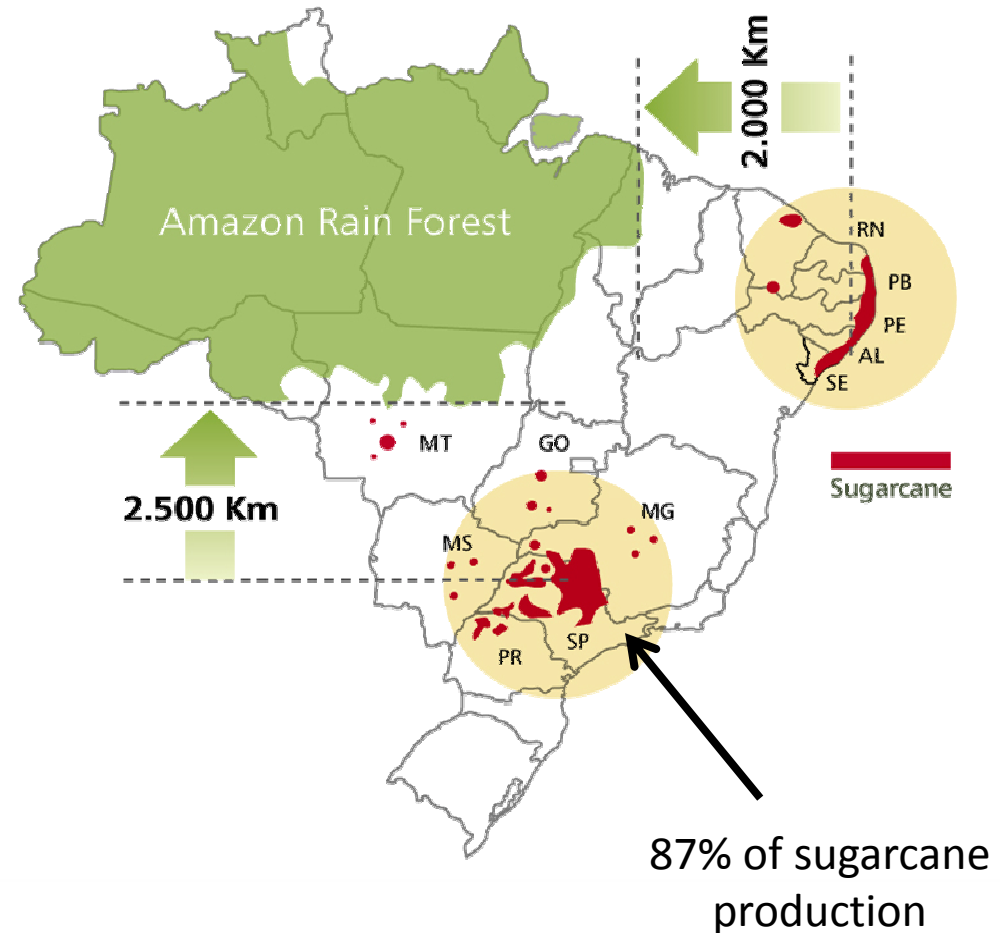
It allows definition of planting calendars to guarantee at least 80% probability of having an adequate water supply for a diverse group of crops without artificial irrigation.

<http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Trigo/CultivodeTrigo/zoneamento.htm>

# Agroecological Zoning Plan for Sugarcane Expansion

## Brazil is using Zoning Technology to Manage Sugarcane Expansion

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



# Sugarcane Zoning in Brazil

## Brazil is using Zoning Technology to Manage Sugarcane Expansion

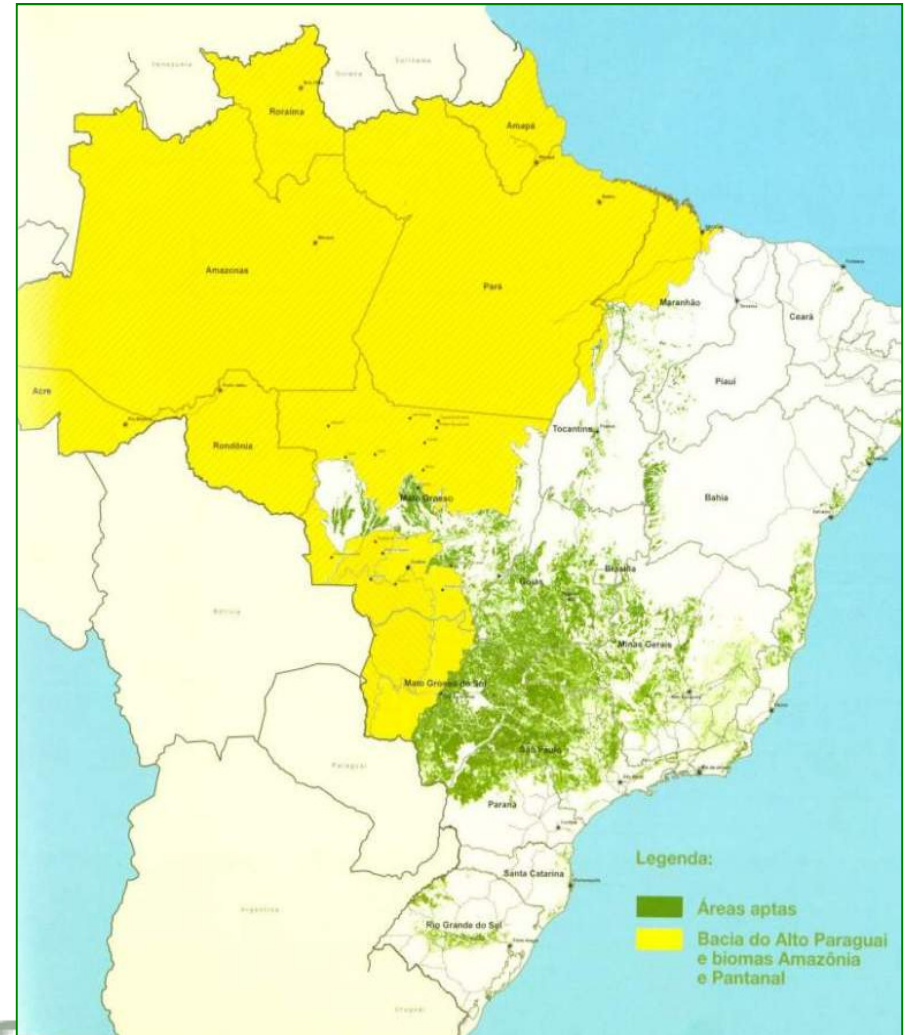
### Brazilian regulations...

#### 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)





# Monitoring Crop Expansion in Sensitive Areas



"Soybean is no longer an issue for the Amazon Biome deforestation".  
Minister of Environment of Brazil

Since the "moratorium",  
soybean area  
decreased to 0.27%  
of the Amazon Biome.

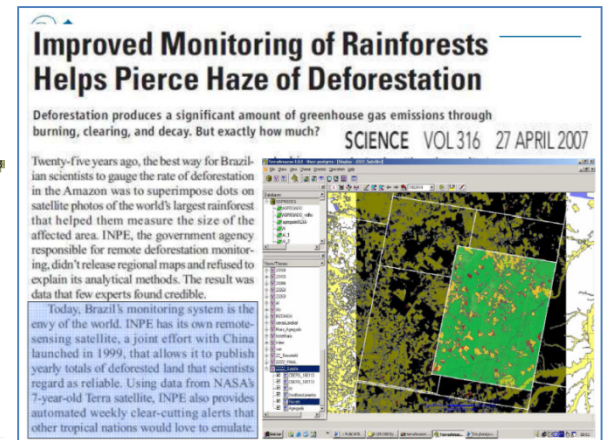
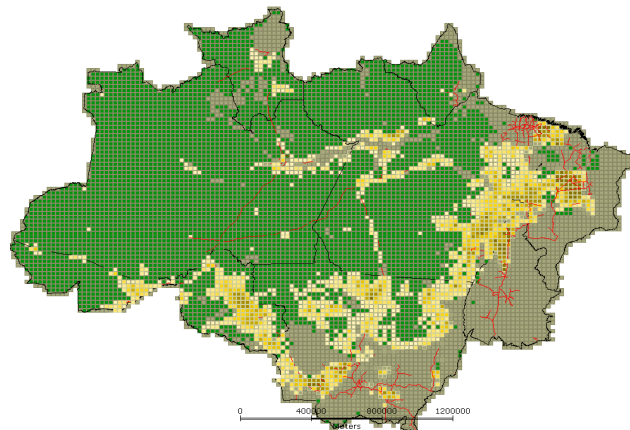
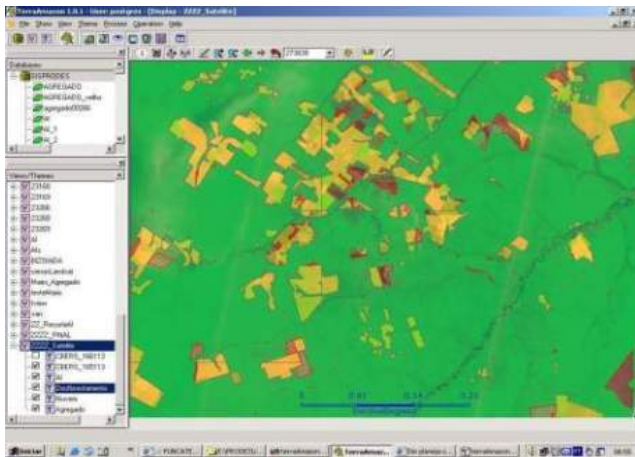
Since 2006, private representatives of the soybean segment declared a "moratorium" to the soybean produced in the Amazon Biome - a comprehensive commitment prohibiting to buy or sell grain produced in the region.

Satellite monitoring controls the origin of the product helping ensure rain forest protection.

Sources: Ministry of Agriculture, Brazilian Institute of Geography and Statistics

# Monitoring and Reducing Deforestation

## Monitoring Amazon deforestation: PRODES

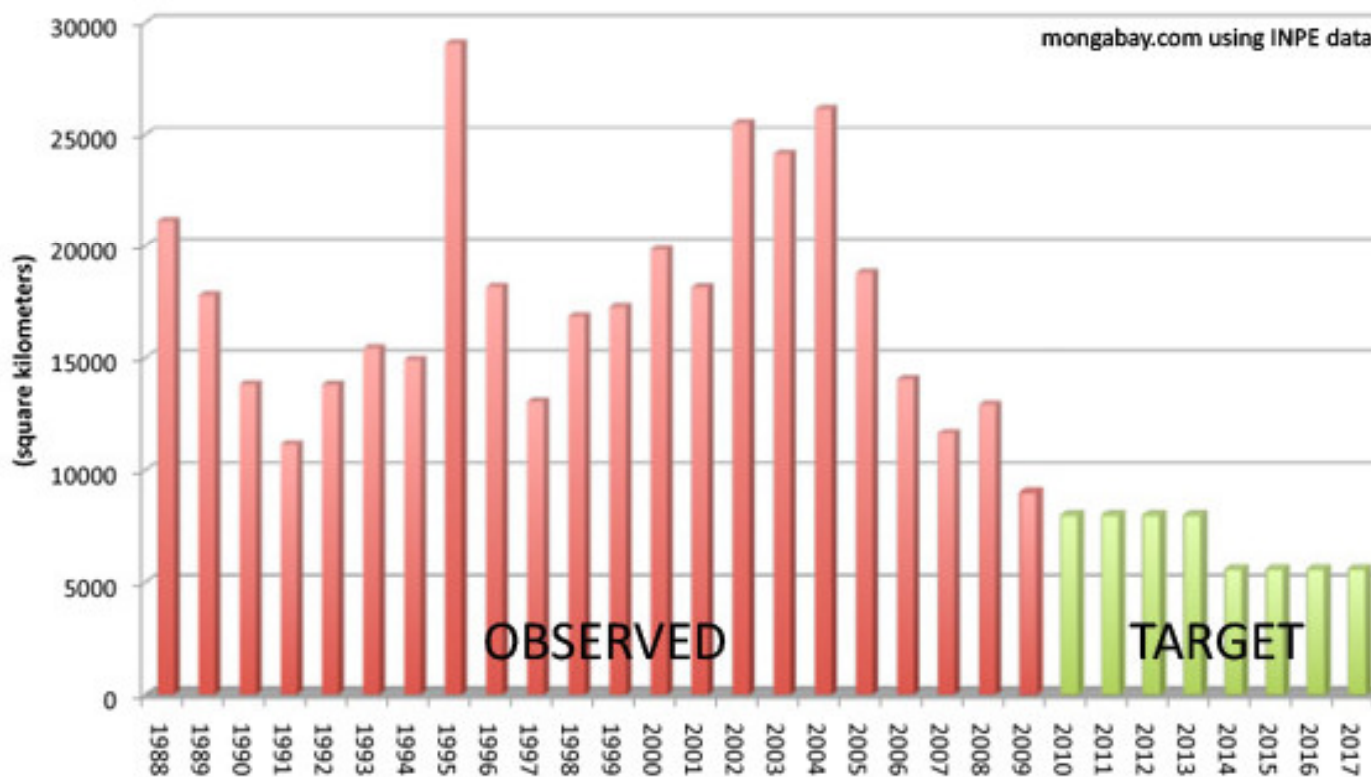


Brazil is the world leader in use of satellite images to monitor deforestation in the tropics

# Monitoring and Reducing Deforestation

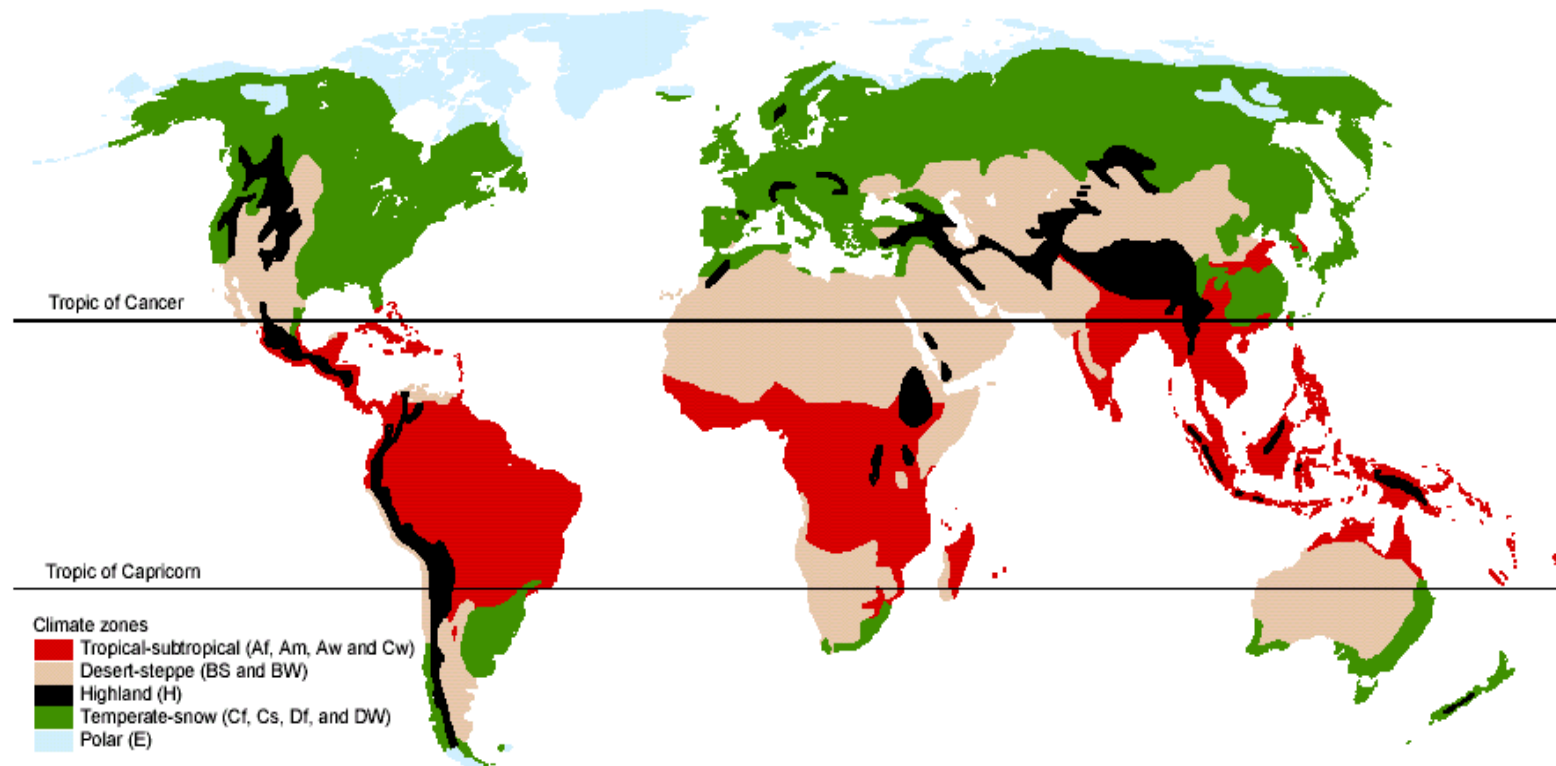
## Deforestation in the Brazilian Amazon

observed 1988-2009, target for 2010-2017

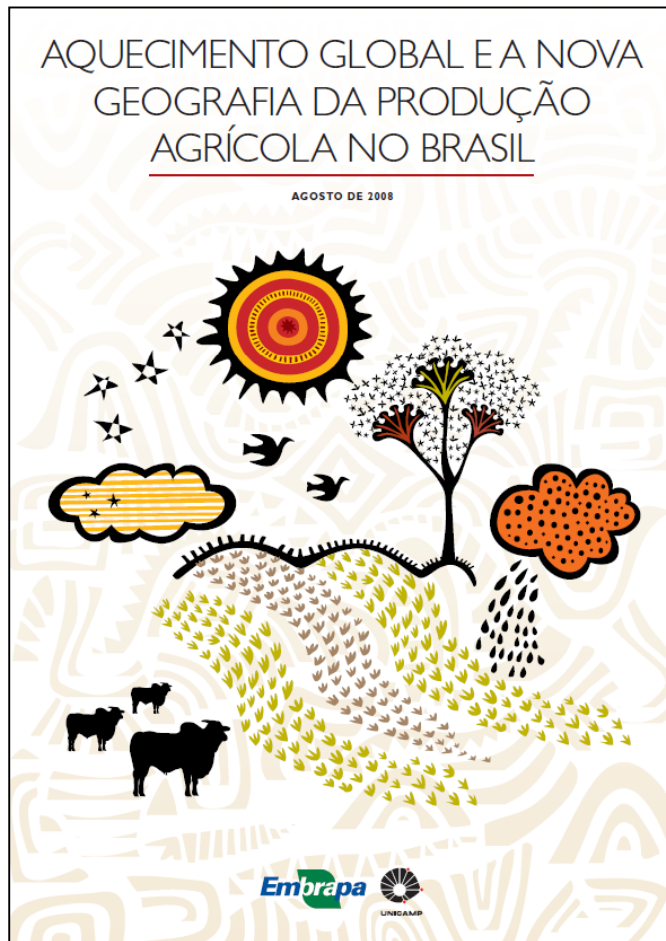


# Agroecological Zoning and Climate Change

Climate change will impose additional stresses to many delicately balanced agroecosystems, especially in tropical areas, where significant intensification of biotic and abiotic stresses is expected in the next decades.



# Agroecological Zoning and Climate Change

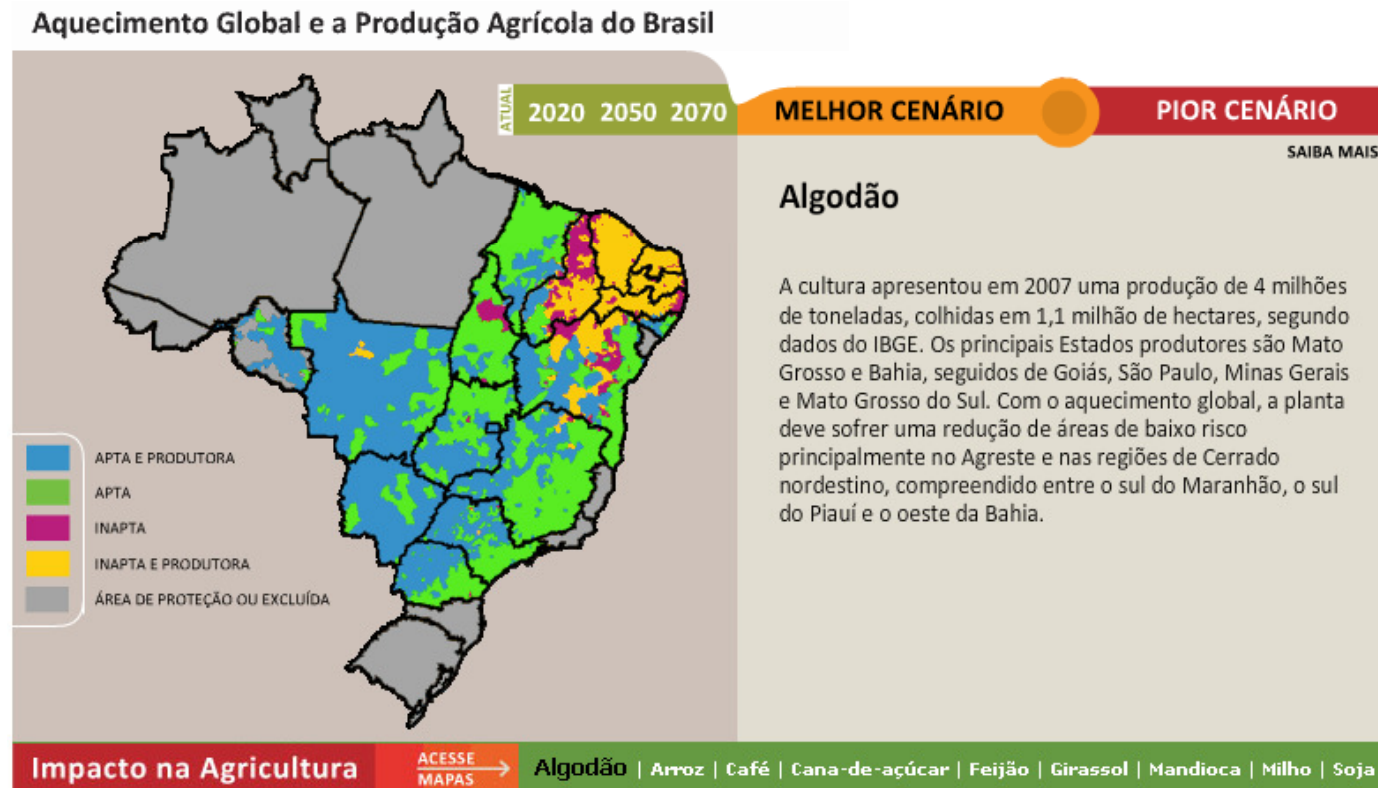


Climate Change and the new geography  
of agricultural production in Brazil



# Agroecological Zoning and Climate Change

## Climate Change and the new geography of agricultural production in Brazil



Anticipating  
potential  
challenges for  
**cotton**

# Agroecological Zoning and Climate Change

## Climate Change and the new geography of agricultural production in Brazil

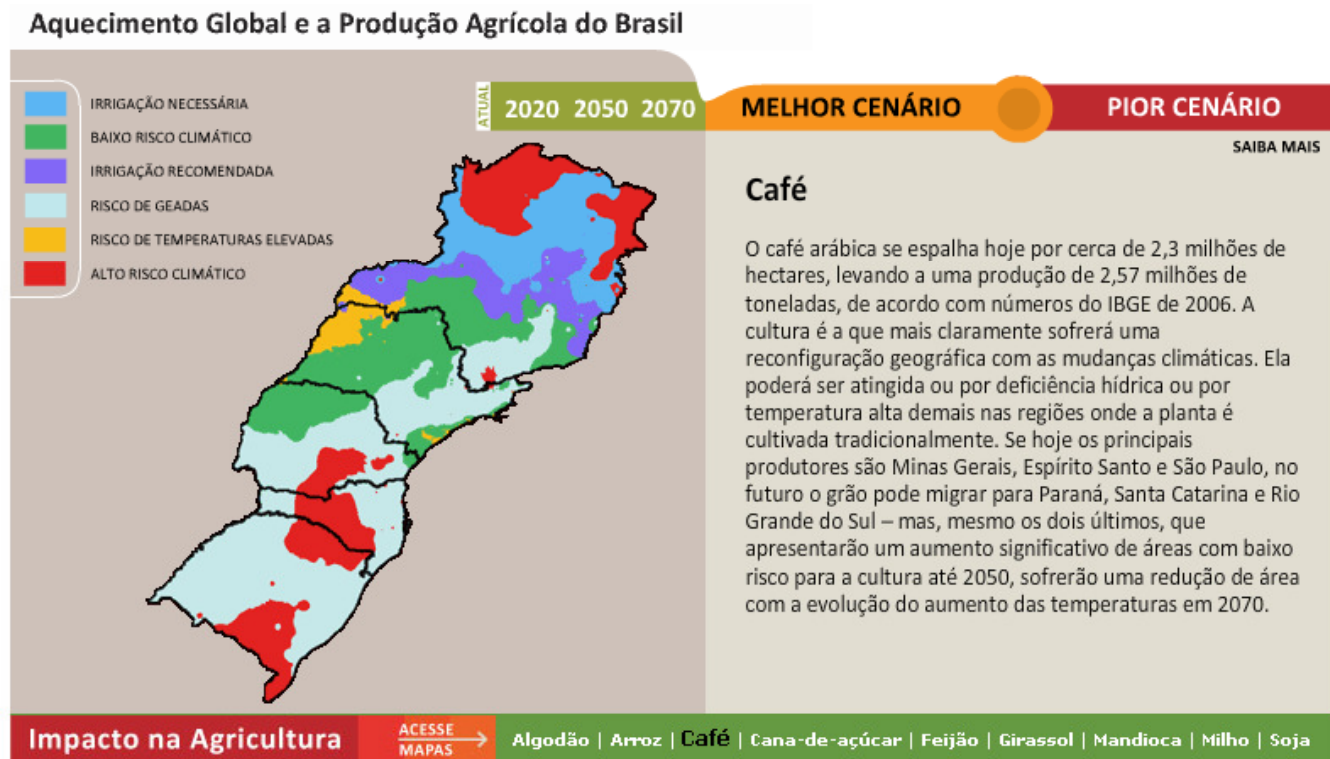
### Aquecimento Global e a Produção Agrícola do Brasil



**Anticipating potential challenges for rice**

# Agroecological Zoning and Climate Change

## Climate Change and the new geography of agricultural production in Brazil

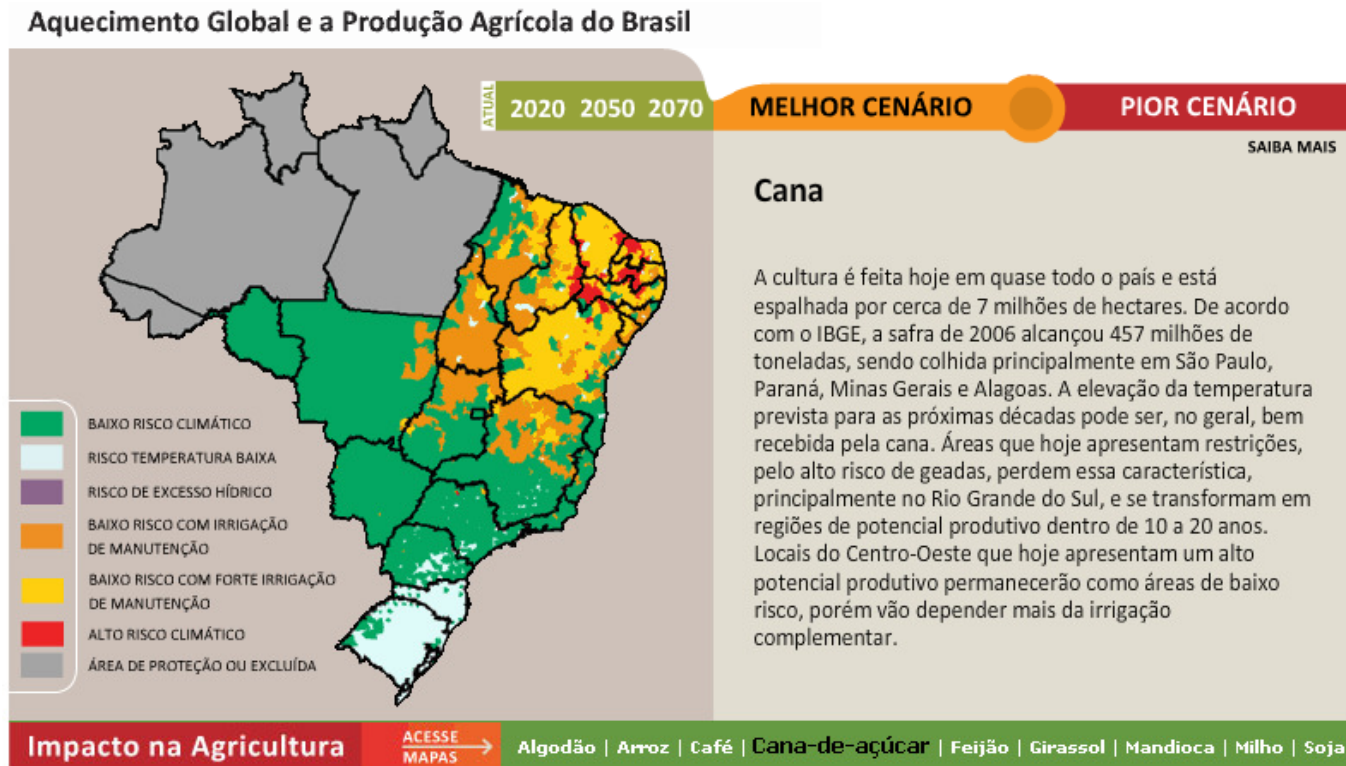


**Anticipating  
potential  
challenges for  
coffee**



# Agroecological Zoning and Climate Change

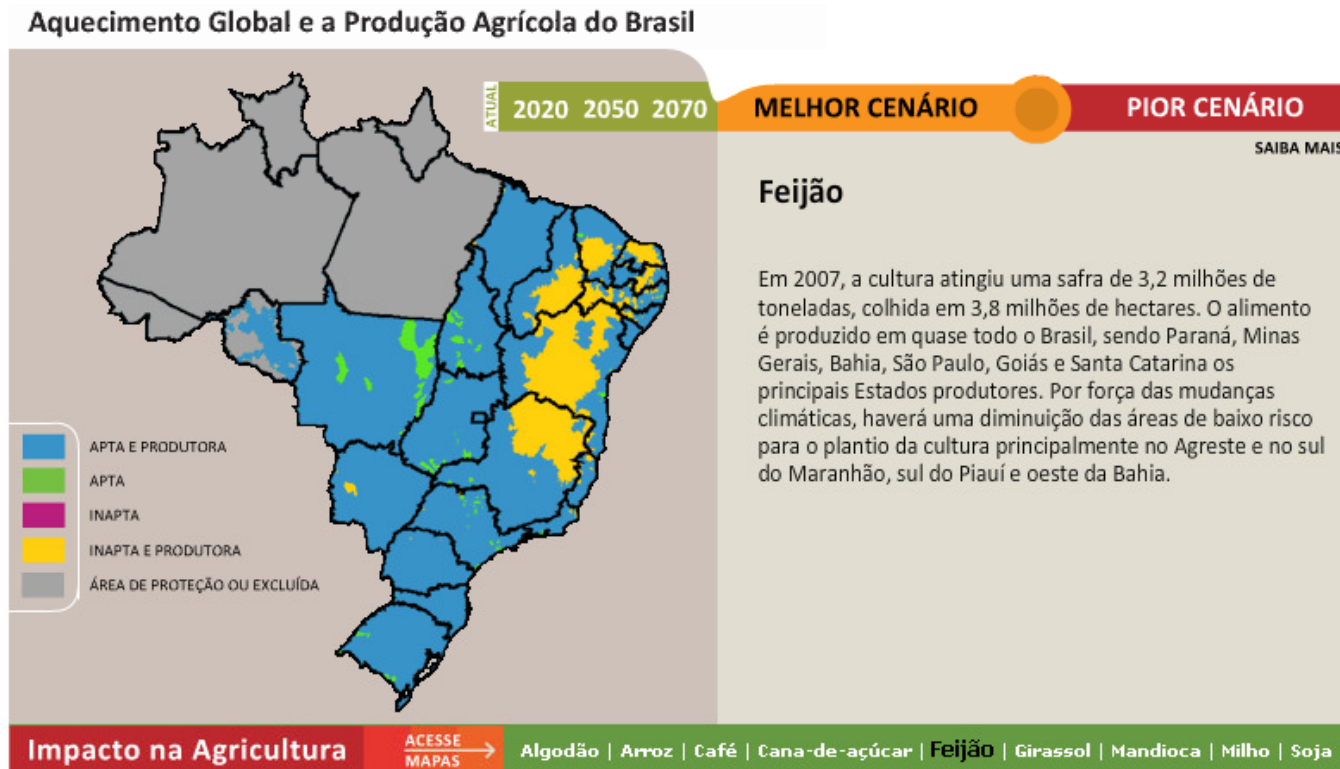
## Climate Change and the new geography of agricultural production in Brazil



Anticipating potential challenges for sugarcane

# Agroecological Zoning and Climate Change

## Climate Change and the new geography of agricultural production in Brazil

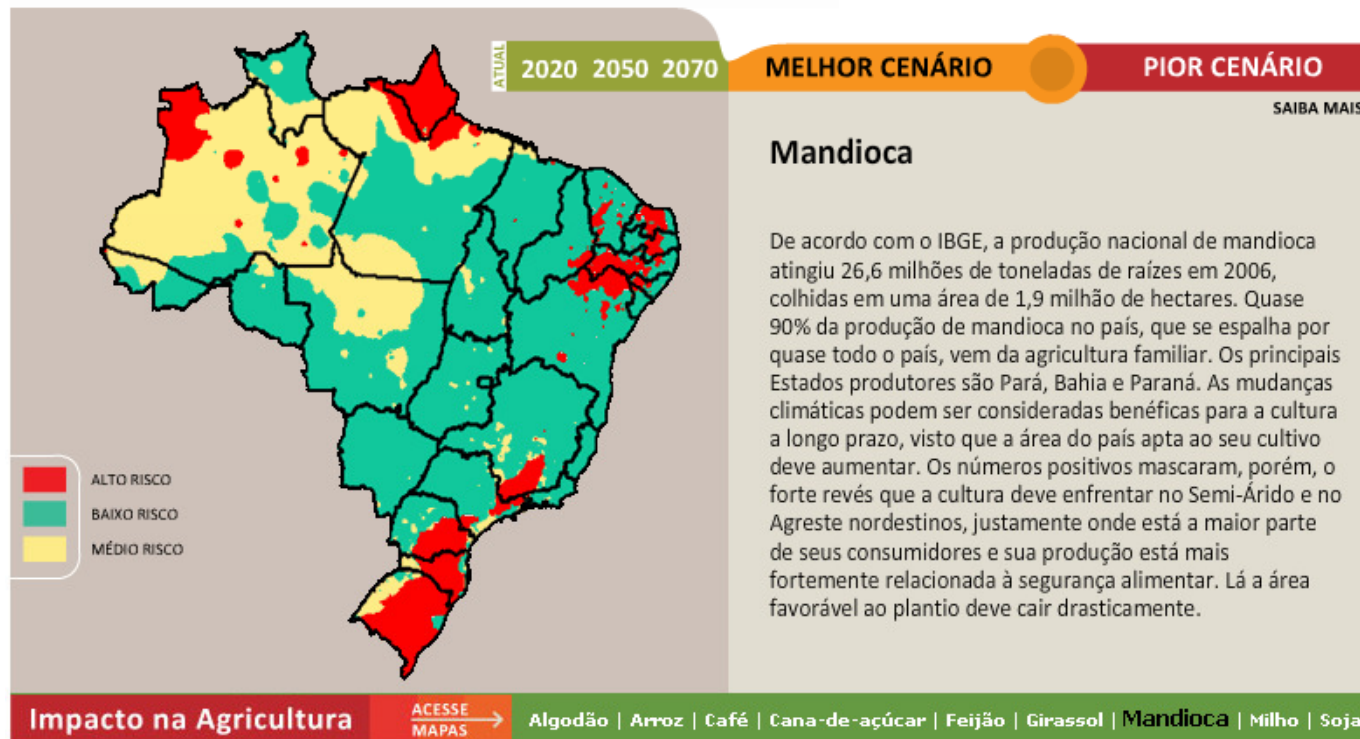


**Anticipating  
potential  
challenges for  
common beans**

# Agroecological Zoning and Climate Change

## Climate Change and the new geography of agricultural production in Brazil

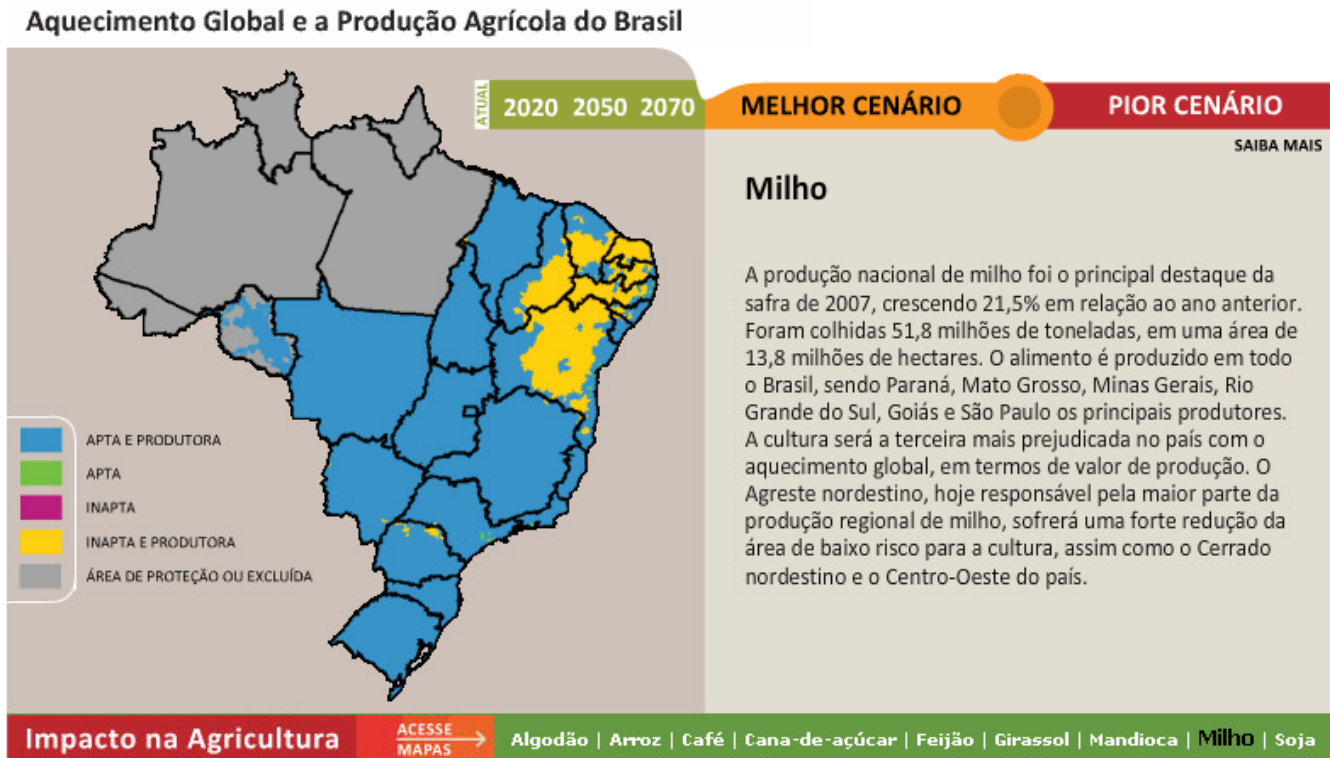
### Aquecimento Global e a Produção Agrícola do Brasil



**Anticipating potential challenges for cassava**

# Agroecological Zoning and Climate Change

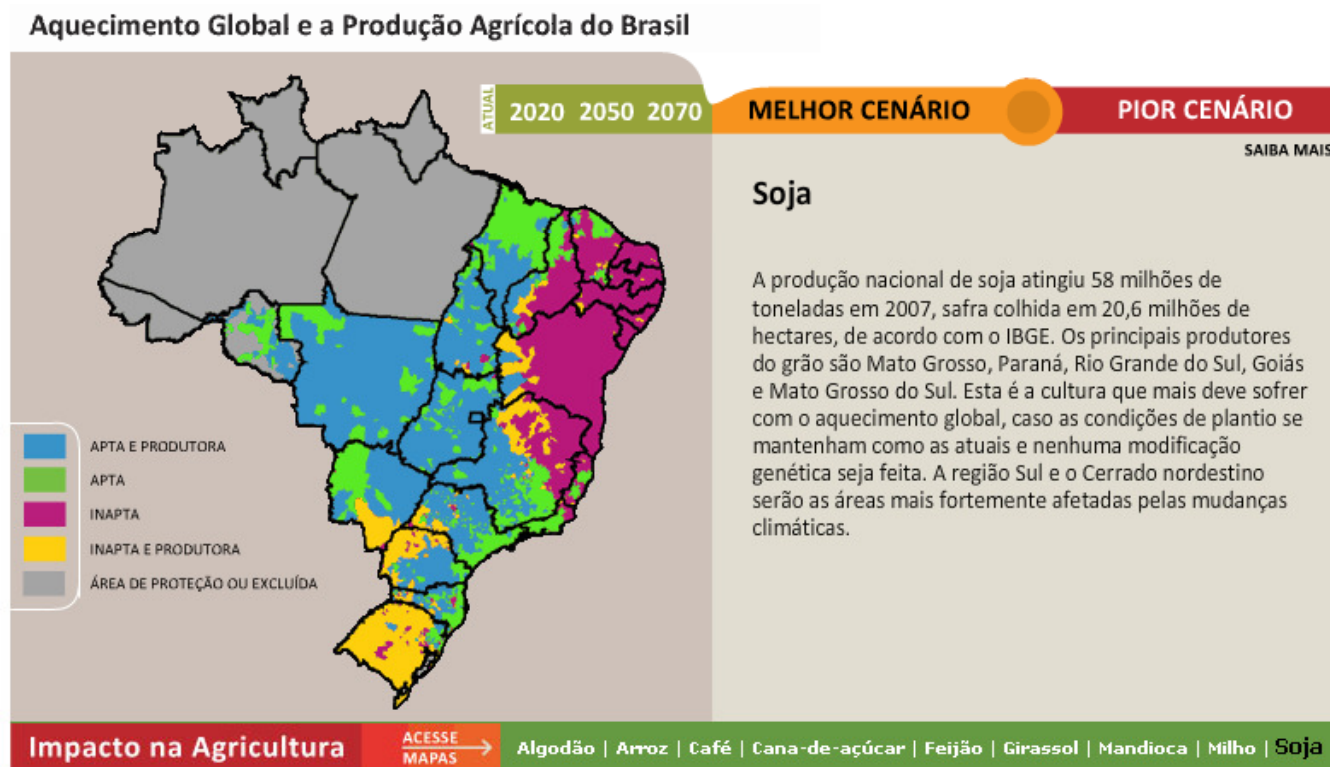
## Climate Change and the new geography of agricultural production in Brazil



Anticipating  
potential  
challenges for  
**maize**

# Agroecological Zoning and Climate Change

## Climate Change and the new geography of agricultural production in Brazil



**Anticipating potential challenges for soybeans**



## **Agriculture and Global Change**

**The Brazilian Government and the country's agricultural sector are engaged in GHG emission reduction**



# Brazilian Mitigation Actions

## Nationally appropriate mitigation actions (NAMAs)

Mitigation Actions NAMAs	2020-trend (M t CO <sub>2</sub> -e)	Emission reduction range		Reduction relative to trend		Reduction	
		(M t CO <sub>2</sub> -e)	(M t CO <sub>2</sub> -e)	%	%	% total reduction	
<b>Land-use</b>	1084	669	669	24,70%	24,70%	68,42%	63,50%
Reduced deforestation-Amazonia		564	564	20,90%	20,90%	57,89%	53,73%
Reduced deforestation-Cerrado		104	104	3,90%	3,90%	10,80%	10,03%
<b>Agricultural sector</b>	627	133	166	4,90%	6,10%	13,57%	15,68%
Pasture recovery		83	104	3,10%	3,80%	8,59%	9,77%
Crop-livestock systems		18	22	0,70%	0,80%	1,94%	2,06%
No-till planting		16	20	0,60%	0,70%	1,66%	1,80%
Biological N-fixation		16	20	0,60%	0,70%	1,66%	1,80%
<b>Energy sector</b>	901	166	207	6,10%	7,70%	16,90%	19,79%
Energy efficiency		12	15	0,40%	0,60%	1,11%	1,54%
Increased biofuel use		48	60	1,80%	2,20%	4,99%	5,66%
Increased hydroelectrical power		79	99	2,90%	3,70%	8,03%	9,51%
Increased alternatives sources		26	33	1,00%	1,20%	2,77%	3,08%
<b>Others</b>	92	8	10	0,30%	0,40%	0,83%	1,03%
Siderurgy (mineral x vegetal coal)		8	10	0,30%	0,40%	0,83%	1,03%
<b>Total</b>	2703	975	1052	36,10%	38,90%	100,00%	100,00%

# Brazilian Climate Change Law

**For the next decade, from December 2009...**

15 million hectares of degraded land (mostly pastures) will be recovered,

4 million hectares of integrated crop-livestock systems implemented,

8 million hectares of no-till planting implemented,

5.5 million hectares of biological nitrogen fixation implemented, and

Three million hectares of planted forests will be implemented.

**Overall, the Government estimates that these actions in the agricultural sector will allow for 166 million tons of CO<sub>2</sub>-equivalent reduction per year in the 2010-2020 period.**



# Low-Carbon Agriculture Program

## News

### Brazil to Launch Low-carbon Agriculture Program

Brasilia, June 8 (RHC)-- The Brazilian government will launch an one-billion-U.S.-dollar program to reduce greenhouse gas emissions in the agriculture sector, Agriculture Minister Wagner Rossi said on Monday.

In comments to reporters, Minister Rossi said that under the newly-released Agricultural and Livestock Plan 2010-2011, Brasilia will invest two billion reais (some 1.08 billion dollars) in the Low Carbon Agriculture Program during the 2010-2011 harvest season.

As noted by the Brazilian official, for the next harvest season, some 3.15 billion reais (about 1.7 billion dollars) will be earmarked for agricultural practices that help environmental preservation and productivity enhancement.

Government loans are also available for other low-carbon programs such as the Sustainable Production Agribusiness Incentive and the Commercial Plantation to Recover Forests, according to the minister.

Brazil has set a target to reduce the agriculture sector's carbon dioxide emissions by 4.9-6.1 percent by 2020.

[http://www.radiohc.cu/ingles/a\\_american/10/junio/8/lati13.htm](http://www.radiohc.cu/ingles/a_american/10/junio/8/lati13.htm)

The Government is providing credit and financing to allow farmers to continue the path of the last decades, steadily adopting conservation practices such as no-till planting, and more resource-efficient systems, such as integrated crop-livestock systems.

The newly-launched ABC program (an acronym for low-carbon agriculture, in Portuguese), provides over US\$ 1 billion to be lent at low interest rate in the 2010/2011 season.



# Pathways to Sustainable Agriculture

## Challenge and Opportunities

# Pathways to Sustainable Agriculture

Considering the challenges ahead, a complex mix of capacities and processes will be needed

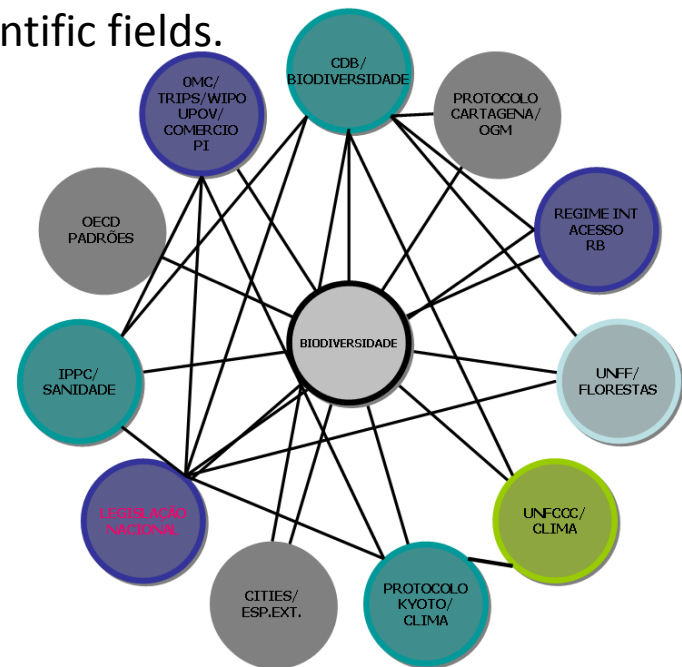
Critical mass and scientific capacity are important...

...but effective gains towards sustainability will be achieved only through multidimensional strategies



# Pathways to Sustainable Agriculture

Research on policy formulation coordination and implementation will have to receive increasing attention, as agriculture faces trans-boundary challenges and interfaces with new and rapidly developing scientific fields.



International policy dialogue, formulation and implementation, identifying opportunities and bottlenecks and defining strategies that best meet the needs for sustainable development in all its dimensions.

# Pathways to Sustainable Agriculture

## Institutional Timing x Speed of Changes

Global Order?



Strategic Intelligence  
& continuous foresight

Informed &  
Demanding Society

Social nets



“Languages” & methods  
Communication

Trans boundary  
Challenges



<http://www.gcric.org/USGCRP/forum/gifs/wheel55.gif>

Effective approaches  
to networking

# Pathways to Sustainable Agriculture

## The Changing Nature of Science

### Impacts of Convergence in the Innovation System



<http://www.internetttime.com/images/binc3.jpg>

Organizations dedicated to ST&I and to development will need to rethink their institutional structures and processes to motivate their professionals to venture across dissolving disciplinary barriers...

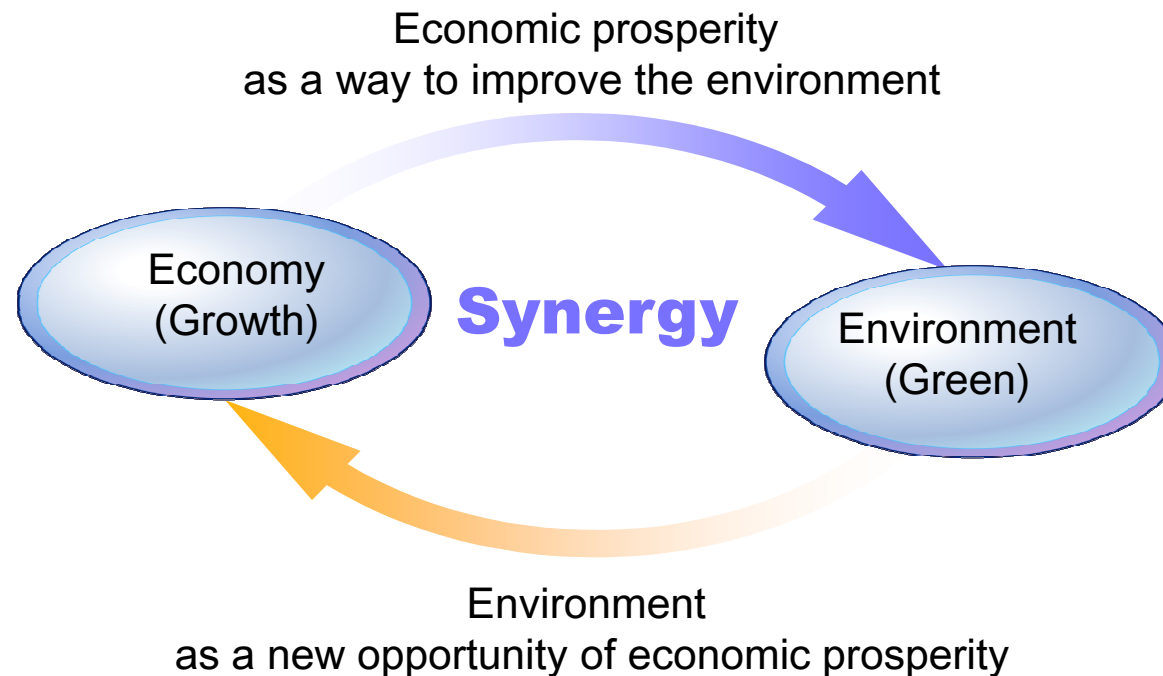
Leaders?

Thinkers?

Scientists?

# Pathways to Sustainable Agriculture

“Green” & Growth not as substitutes but  
as complements in development



# Pathways to Sustainable Agriculture



**“Chemicals”**

**“Environmental Services”**

**“Fiber”**

**“Food”**

Natural resources must be seen as the basis for a revolution in the frontier of science...

**“Biomass”**

**“Carbon Sink”**

... as well as a unique opportunity to build harmony between development and environmental conservation.

**“Energy”**

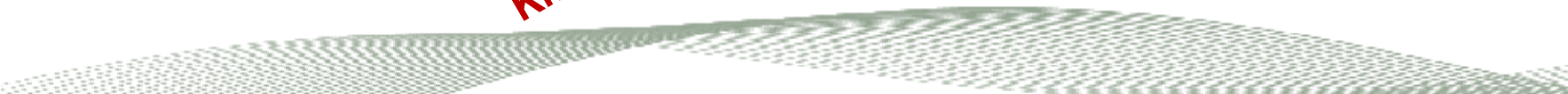
**“Pharma”**

**“Water”**

**“Traditional Knowledge”**

**“Genetic Resources”**

**“Forests”**





# Final Words...



*Agriculture must not be seen as a problem but as a solution and key component in the path towards a more sustainable future.*



Mauricio Antonio Lopes, PhD  
Embrapa Labex Korea  
Suwon - Republic of Korea  
<http://www.embrapa.br>  
<http://labexkorea.wordpress.com/>  
[labex.korea@gmail.com](mailto:labex.korea@gmail.com)

Thank  
You!

Embrapa

