Conservation tillage techniques for Tropical Agriculture

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Embrapa Wheat

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2/10/2010

Agriculture challenges: technology

Presentation topics

- **Background**
- **Summary**
- ***No Tillage System: 3 Phases***
- ***Agriculture Challenges: 3 Cycles***
- ***Conclusions***

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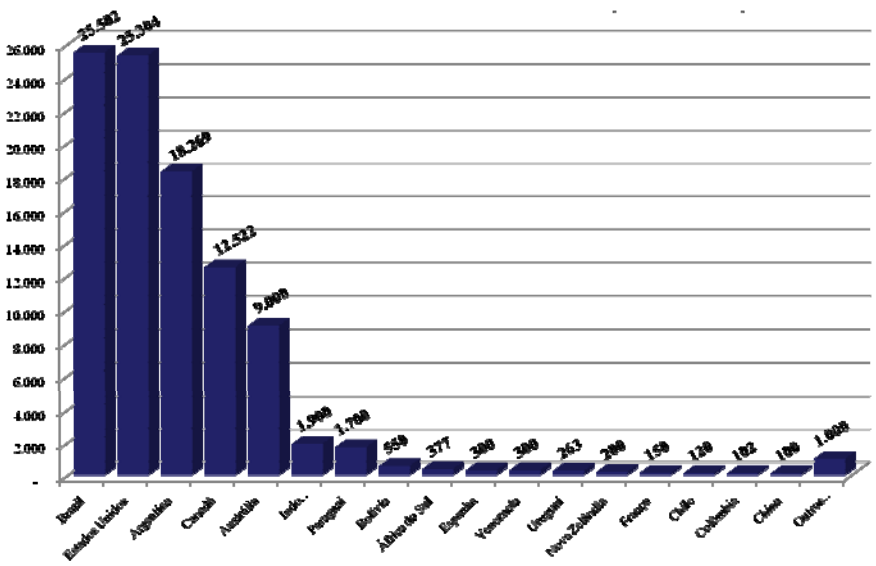
World - Evolution of Cultivated area of No Tillage



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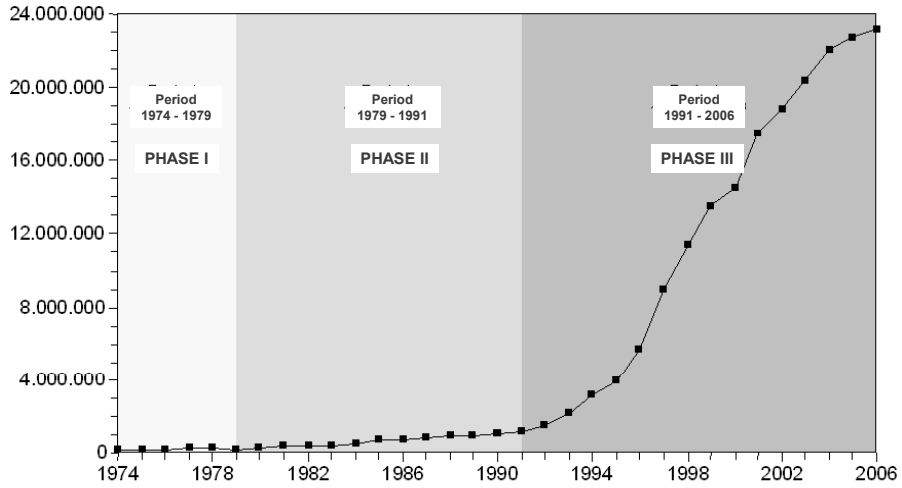
Brazil - Evolution of Cultivated Area of No Tillage 1974 to 2006



Source: Adapted from FEBRAPDP (2007) by Denardin

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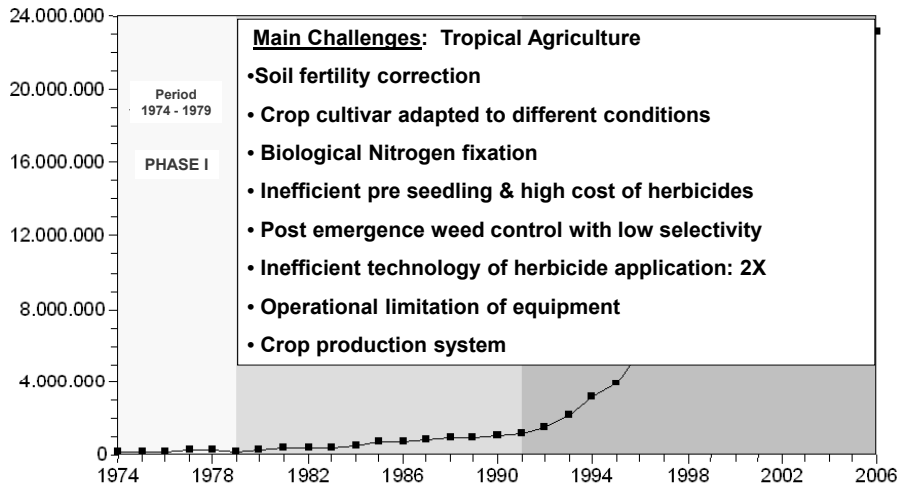
Technology challenge: soil management system



Main Challenges: Tropical Agriculture

- Soil fertility correction
- Crop cultivar adapted to different conditions
- Biological Nitrogen fixation
- Inefficient pre seedling & high cost of herbicides
- Post emergence weed control with low selectivity
- Inefficient technology of herbicide application: 2X
- Operational limitation of equipment
- Crop production system

Source: Adapted from FEBRAPDP (2007) by Denardin

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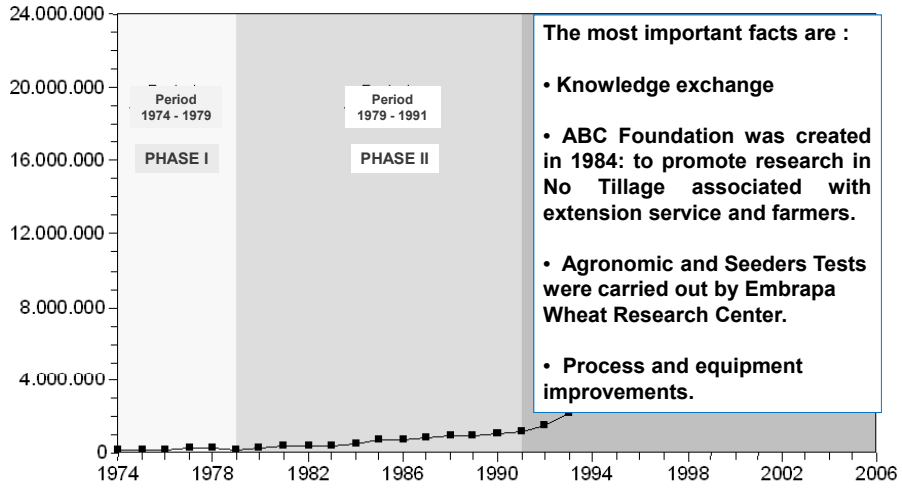

The most important facts are :

- Knowledge exchange
- ABC Foundation was created in 1984: to promote research in No Tillage associated with extension service and farmers.
- Agronomic and Seeders Tests were carried out by Embrapa Wheat Research Center.
- Process and equipment improvements.

Source: Adapted from FEBRAPDP (2007) by Denardin

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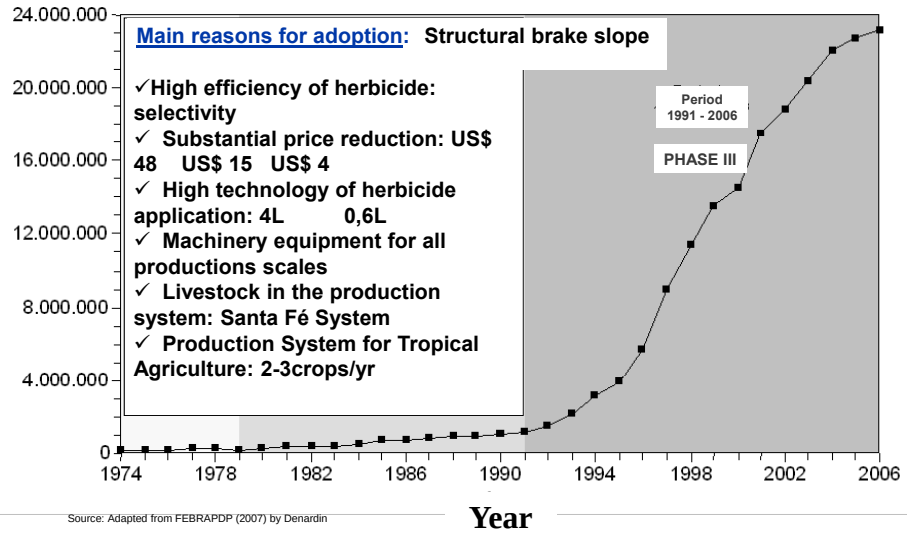
Technology challenge: soil management system



Main reasons for adoption: **Structural brake slope**

- ✓ **High efficiency of herbicide: selectivity**
- ✓ **Substantial price reduction: US$ 48 US$ 15 US$ 4**
- ✓ **High technology of herbicide application: 4L 0,6L**
- ✓ **Machinery equipment for all productions scales**
- ✓ **Livestock in the production system: Santa Fé System**
- ✓ **Production System for Tropical Agriculture: 2-3crops/yr**

Source: Adapted from FEBRAPDP (2007) by Denardin

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Equator

TROPICAL REGION

Tropic of Capricorn

SUB TROPICAL REGION

- *Brazilian territory: 8,511,965 km2*
  - *representing 20.8% of the American Continent*
  - *as well as 47.0% of Latin America.*

Source: Denardin et all 2007

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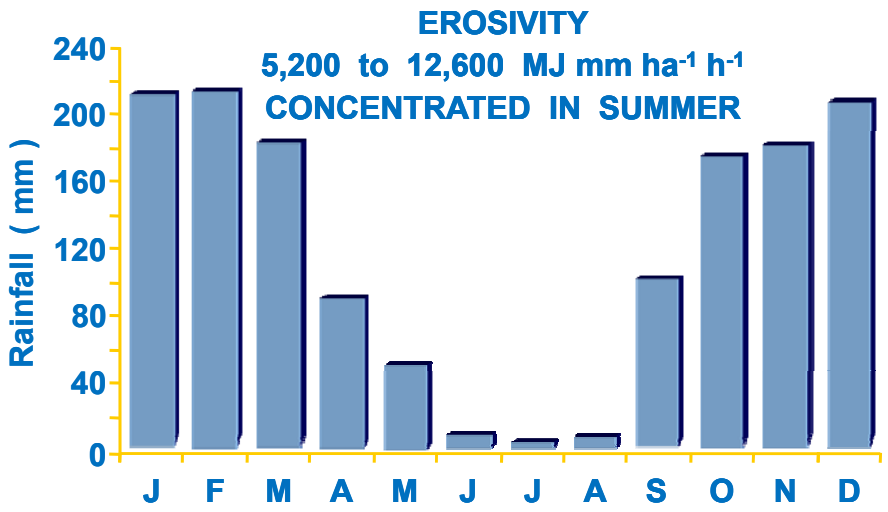
ANNUAL RAINFALL DISTRIBUTION



Source: Denardin et all 2007

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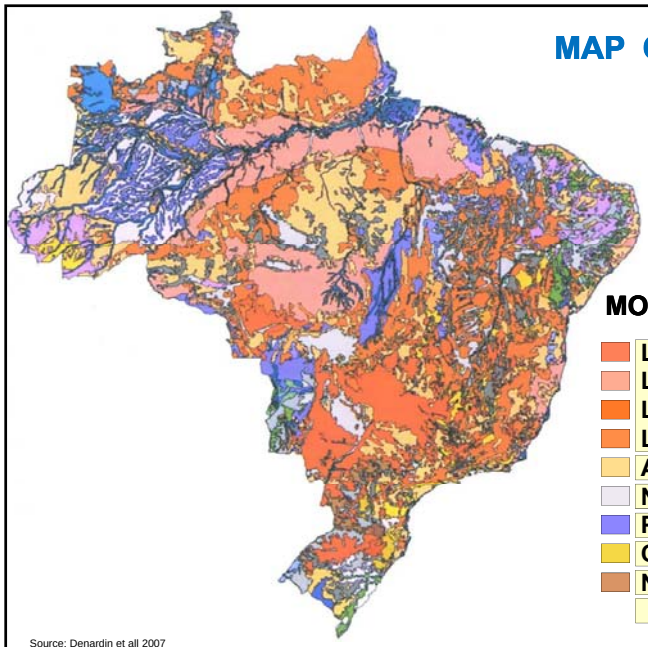
MAP OF BRAZIL SOILS



MOST FREQUENT SOILS

Latosol - Red Latosol - Yellow Latosol – Brown Latosol - Red-Yellow	38.7%
Argisol	20.0
Neosol - sand quartz	14.6
Plinthosol	6.0%
Cambisol	2.7%
Nitosol	1.4%
Other	16.6%

Source: Denardin et all 2007

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SOIL PHYSICAL PROPERTIES

Latosols, Argisols, Neosols and Nitosols

- Deep
- Well-drained
- Distributed on slightly rolling to rolling landscape

No limitations for mechanization

Source: Denardin et all 2007

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SOIL PHYSICAL PROPERTIES

Soil Organic Matter

SOIL TYPE	g/100 g
Neosols - sand quartz	< 2
Latosols	< 4
Argisols	< 4
Plinthosols	< 4
Nitosols	< 4
Cambisols	> 5

Source: Denardin et all 2007

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SOIL PHYSICAL PROPERTIES

Most frequent soils

- **Clay fraction**

1 : 1 → (caolinite)
oxides → Fe and Al

LOW WATER CLAY DISPERTION → **HIGH AGGREGATE STABILITY**

Source: Denardin et all 2007

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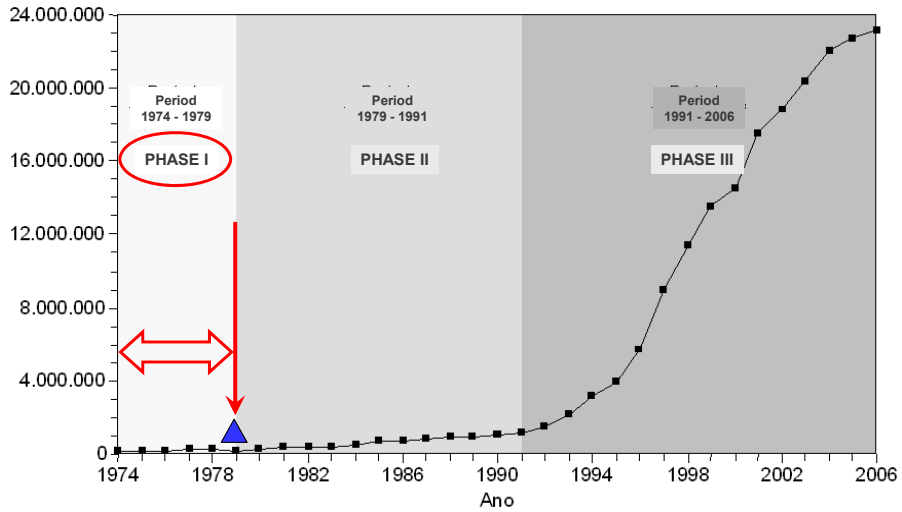
No Tillage System - PHASE I 1974-1979

$Y = 11{,}901X - 2.34x10^7$ $R^2 = 0.84$



Source: Adapted from FEBRAPDP (2007) by Denardin

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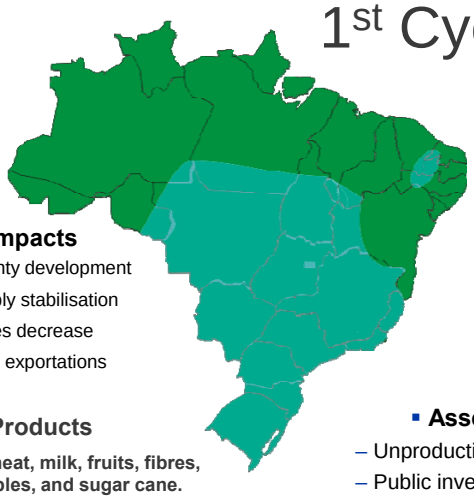
Agriculture challenges: technology

1st Cycle



- **Impacts**
  - Rural-county development
  - Food supply stabilisation
  - Food prices decrease
  - Increasing exportations
- **Products**
  - **Grains, meat, milk, fruits, fibres, vegetables, and sugar cane.**
- **Assets**:
  - Unproductive lands
  - Public investment

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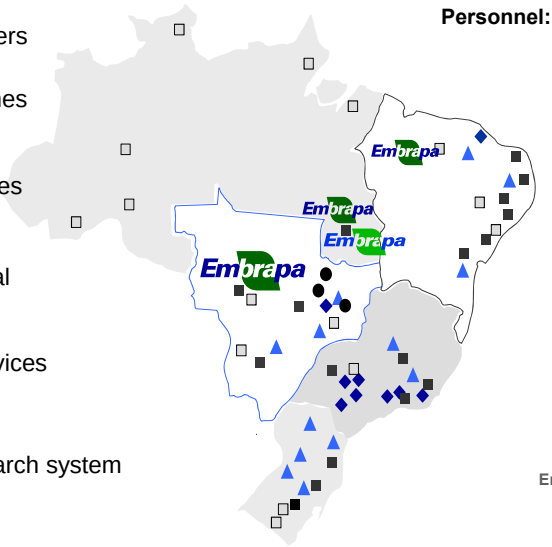
Embrapa & National Agriculture Research System

Budget 2008: US $ 1,2 billion

Personnel: 8.632

- Embrapa Headquarters
- 9 Basic themes
- 13 Commodities
- 15 Ecoregional
- 3 Special services
- 17 State research system



Labex USA

Labex Europe

Embrapa Africa

Embrapa Venezuela

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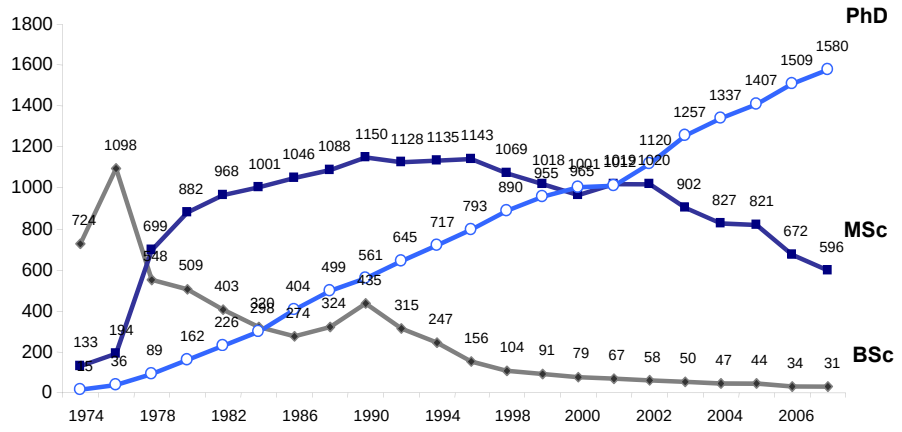
Embrapa: Building research capability



Strong training program in centers of excellence around the world.

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National Agriculture Research System

EMBRAPA + STATE RESEARCH SYSTEM + UNIVERSITIES

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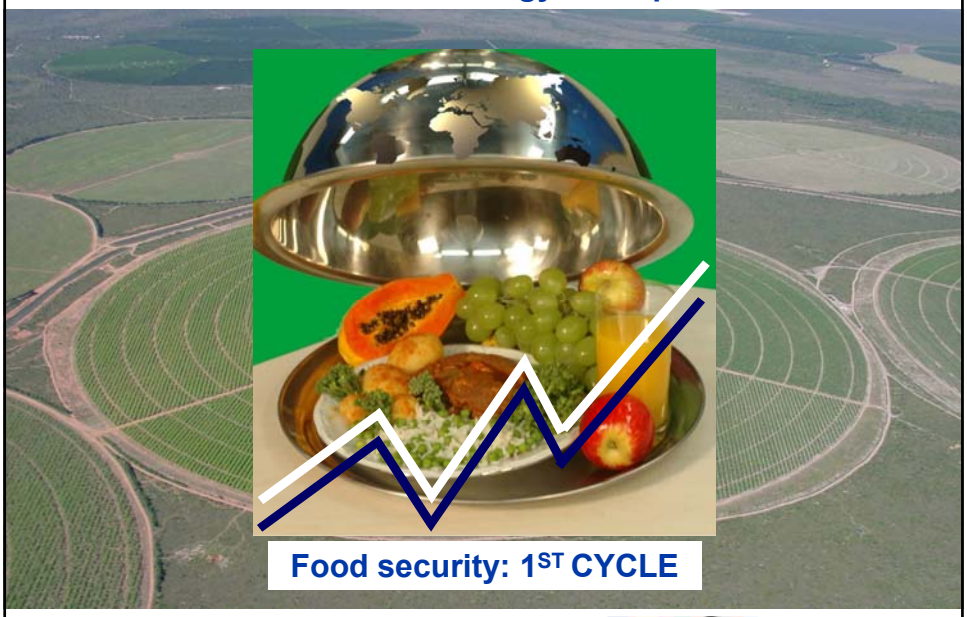
Innovation and technology: food production



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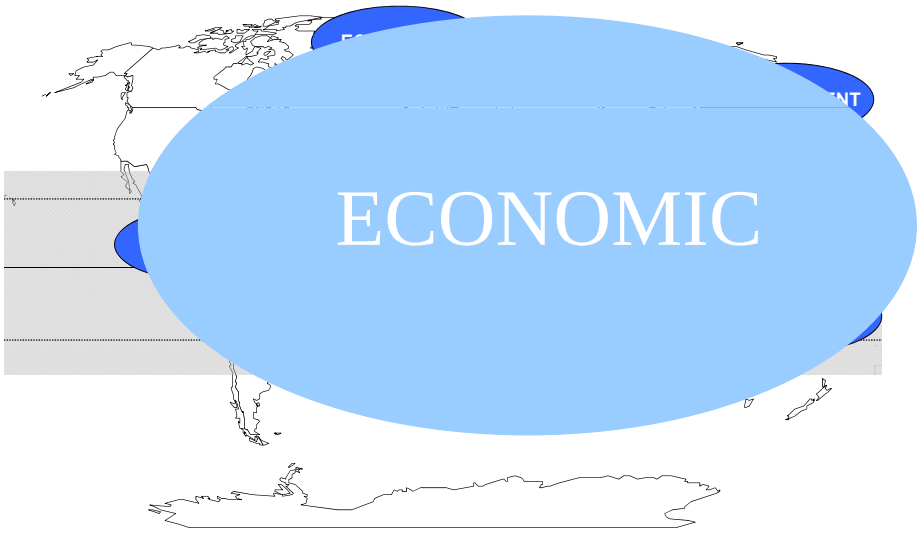
Agriculture challenges: Food Production



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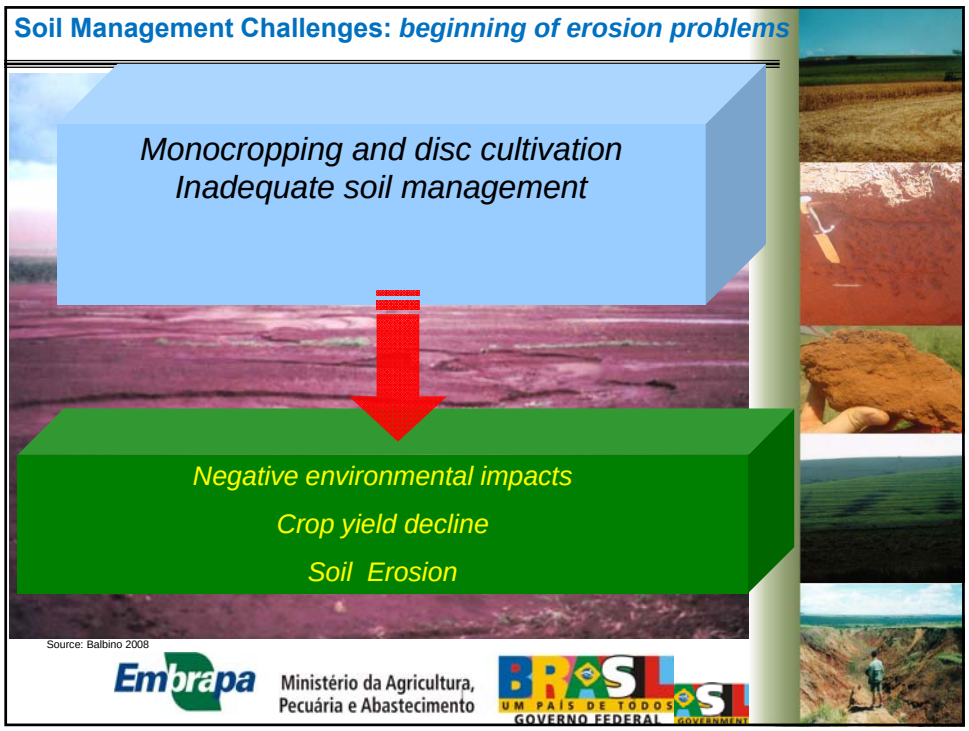
Soil Management Challenges: beginning of erosion problems
Monocropping and disc cultivation
Inadequate soil management
Negative environmental impacts
Crop yield decline
Soil Erosion
Source: Balbino 2008
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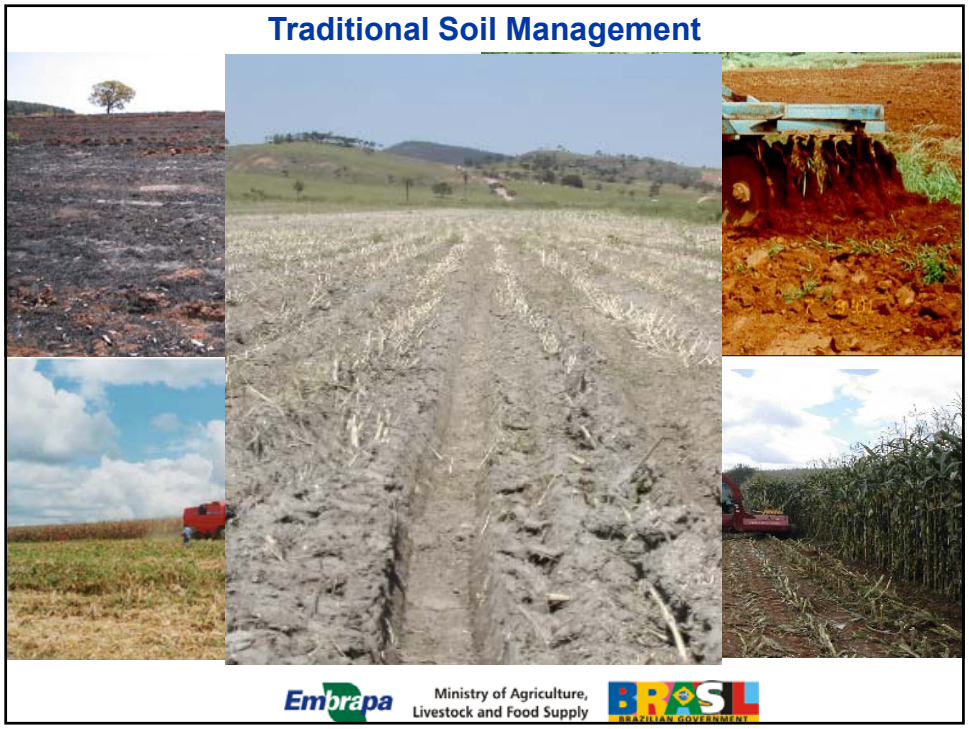
Ministério da Agricultura, Pecuária e Abastecimento
BRASIL
UM PAÍS DE TODOS
GOVERNO FEDERAL


Traditional Soil Management
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Traditional and Conservation Soil Management

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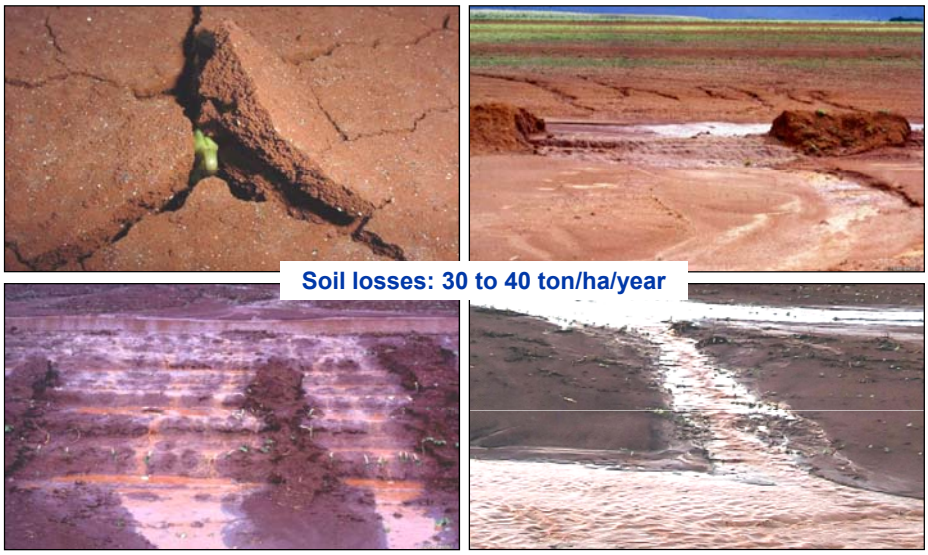
Technology challenge: soil management system



Soil losses: 30 to 40 ton/ha/year

Consequences: Erosion problem

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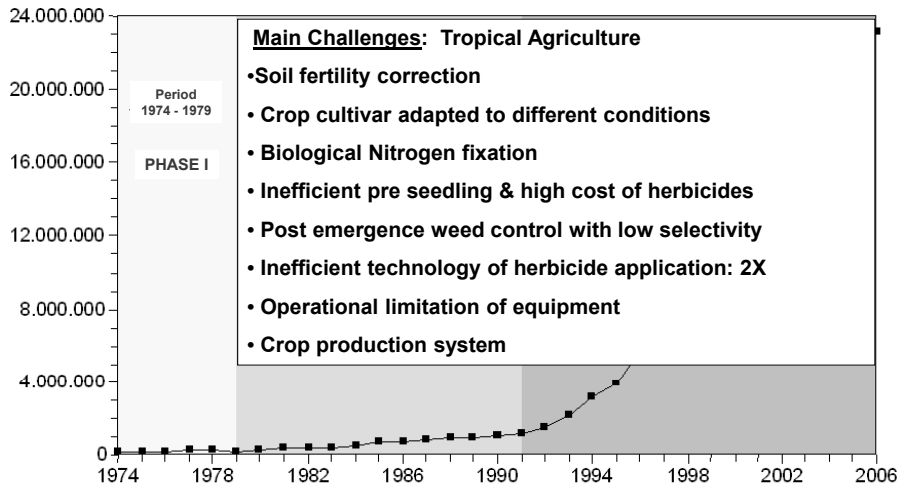
Technology challenge: soil management system



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Source: Adapted from FEBRAPDP (2007) by Denardin

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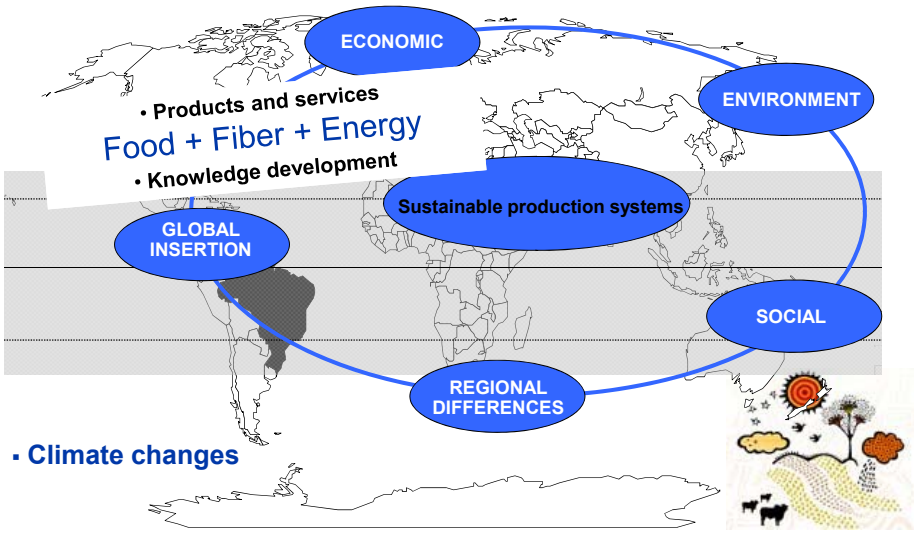
Agriculture challenges: Sustainable Agriculture



- Climate changes

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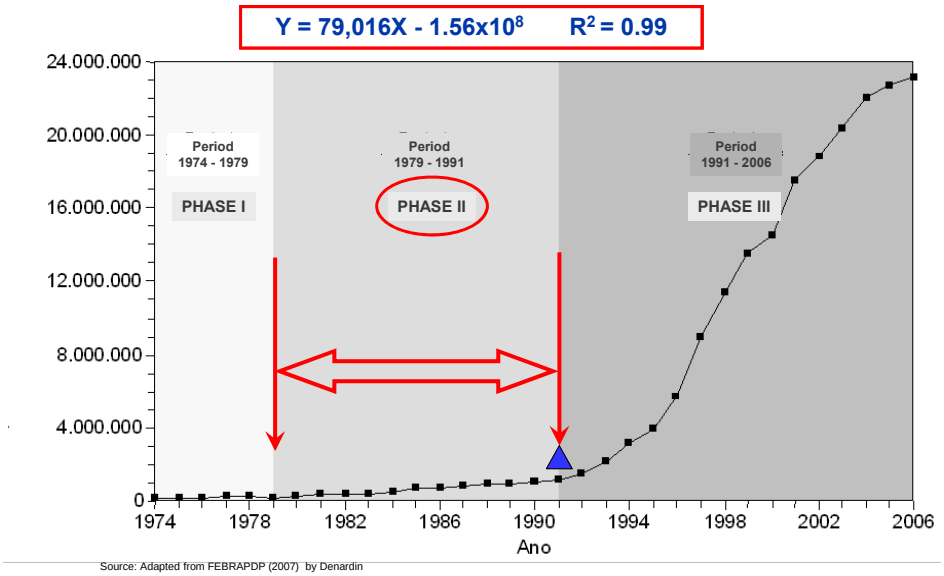
No Tillage System: PHASE II 1979-1991



Source: Adapted from FEBRAPDP (2007) by Denardin

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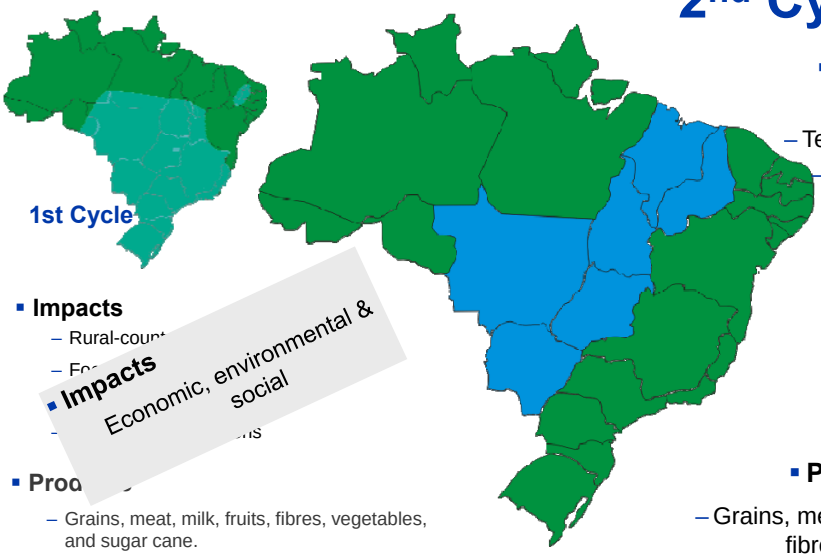
Agriculture challenges: Sustainable Agriculture

2nd Cycle



- **Assets**
  - Land
  - Technology
  - Logistics

- **Impacts**
  - Rural-coun
  - Fo
  - ns

- **Impacts**
  Economic, environmental & social

- **Prod**
  - Grains, meat, milk, fruits, fibres, vegetables, and sugar cane.

- **Products**
  - Grains, meat, fruits, fibre, biofuel.

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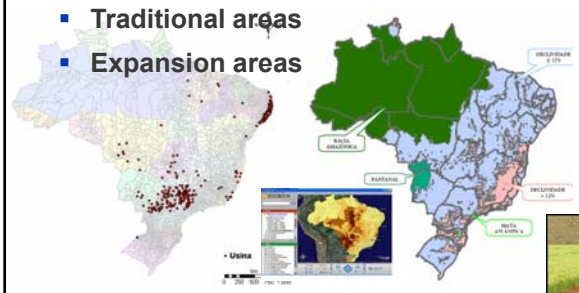
Innovation and technology: production systems

Soil **Plant** **Climate**

- Traditional areas
- Expansion areas



- Arrangements
  - Food
  - Energetic fiber
  - Forestry
    - Perennial crops

Sustainability criteria

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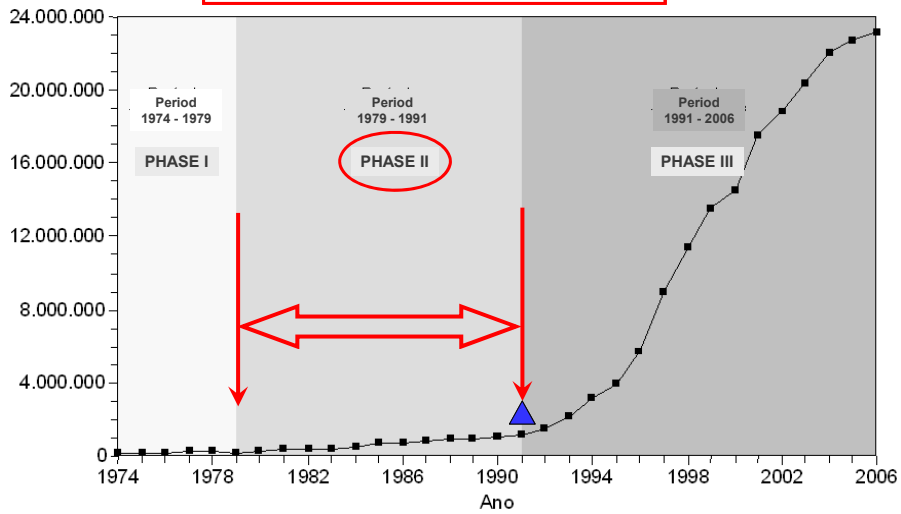
No Tillage System: PHASE II 1979-1991

$Y = 79{,}016X - 1.56x10^8$ $R^2 = 0.99$



Source: Adapted from FEBRAPDP (2007) by Denardin

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Knowledge exchange

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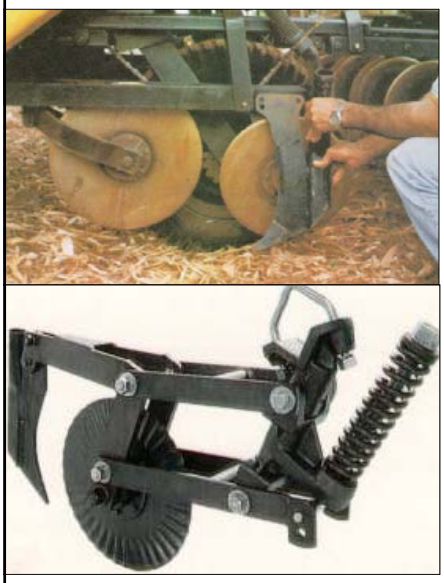
Process and equipment improvements



Mechanisms for opening furrows seedlings

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Southern Region: erosion control no tillage system

Efficiency - post emergence herbicides for weed management

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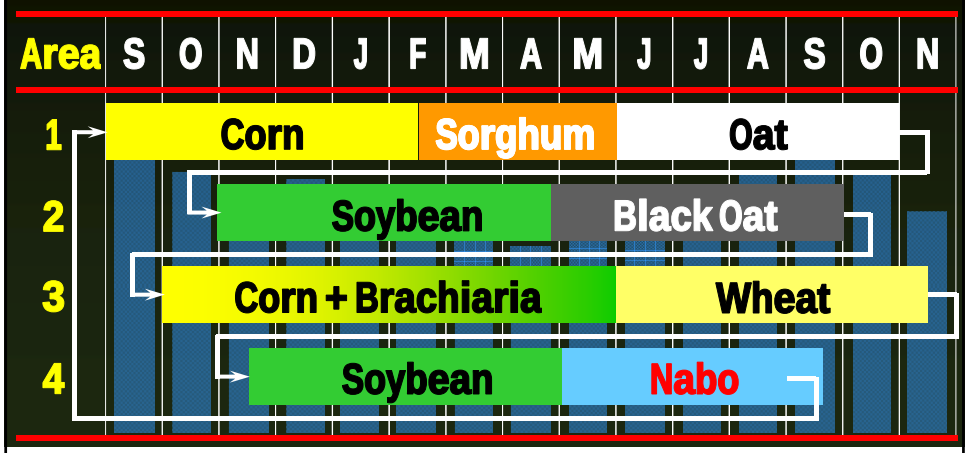
NO TILLAGE SYSTEM: SUBTROPICAL REGION

IDEAL PRODUCTION MODEL



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Harvest-planting Process
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Harvest-planting Process
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ORGANIC MATTER → STRAW
In the Subtropical region, mere coverage of the soil with straw doesn´t have a strong impact on soil structure .
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Millet
Maize
Sorghum
Mucuna
Soybean
Barley
Wheat
Vica
ROOT ACTIVITY
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BIOLOGIC ACTIVITY
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MECHANIC ACTION
1 cm
>15 cm
Embrapa
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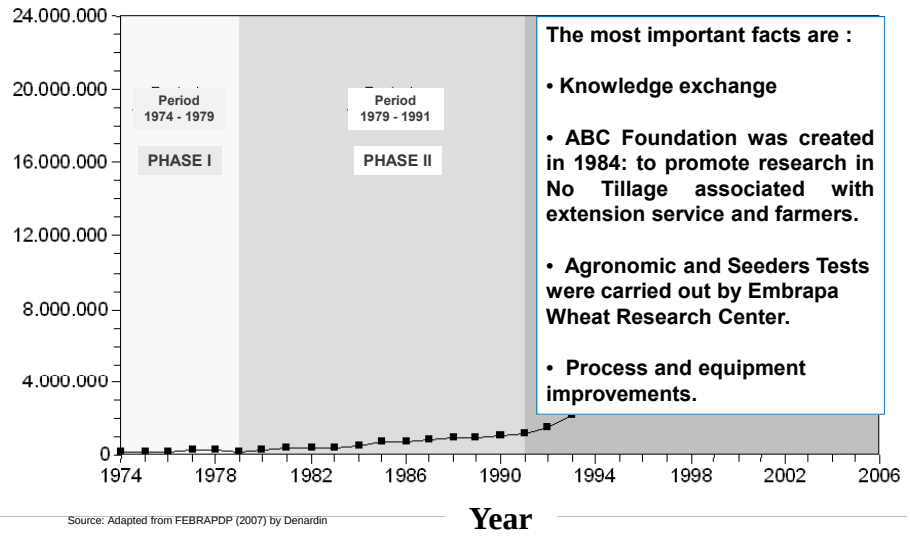
Technology challenge: soil management system



Source: Adapted from FEBRAPDP (2007) by Denardin

The most important facts are :

- **Knowledge exchange**
- **ABC Foundation was created in 1984: to promote research in No Tillage associated with extension service and farmers.**
- **Agronomic and Seeders Tests were carried out by Embrapa Wheat Research Center.**
- **Process and equipment improvements.**

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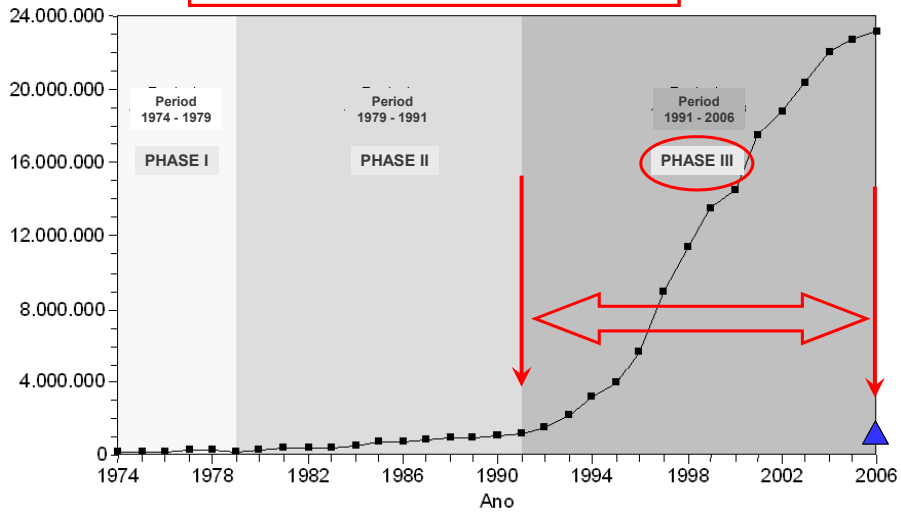
No Tillage System : PHASE III - 1991-2006

$Y = 1{,}709{,}957X - 3.40x10^9 \qquad R^2 = 0.98$



Source: Adapted from FEBRAPDP (2007) by Denardin

R&D and TT: sustainable technologies

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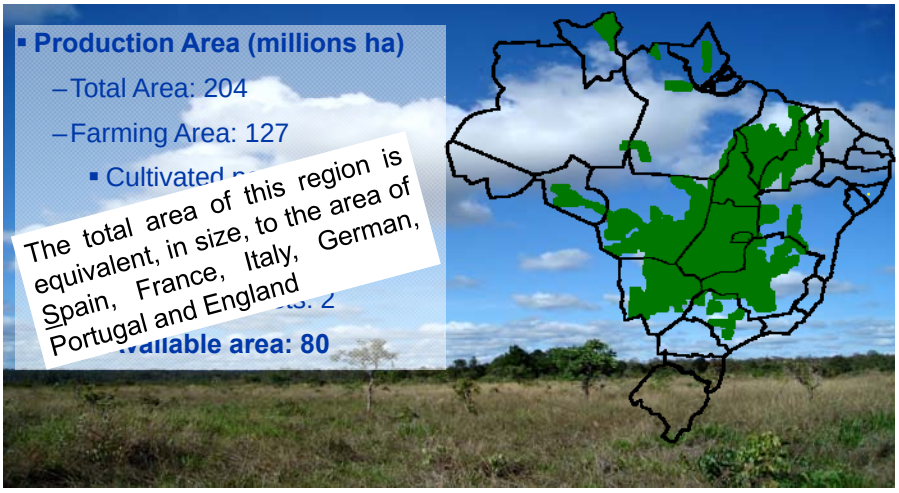
"The challenge of latosol management in the Cerrados was met using technology transfer from the Southern experience"



Innovation and technology: agriculture of the Cerrados.

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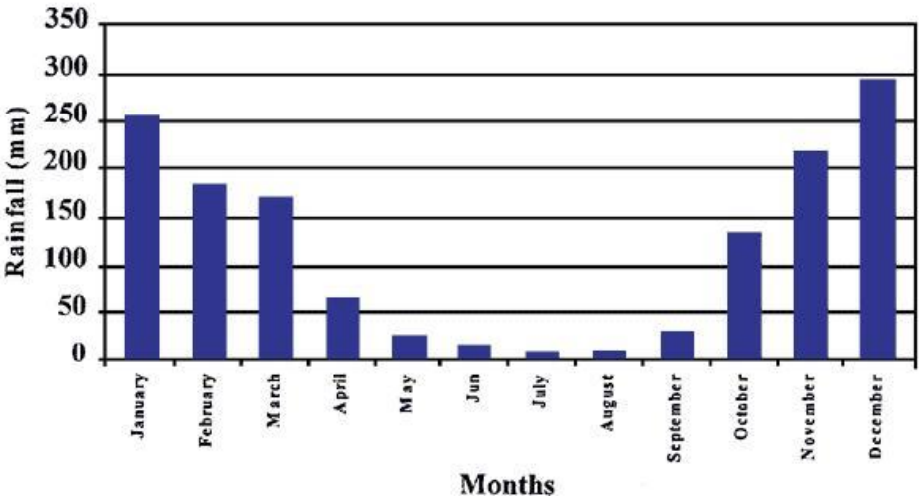
Typical Rainfall for the Cerrados



Source:http://www.fao.org/docrep/004/Y2638E/y2638e08.htm#

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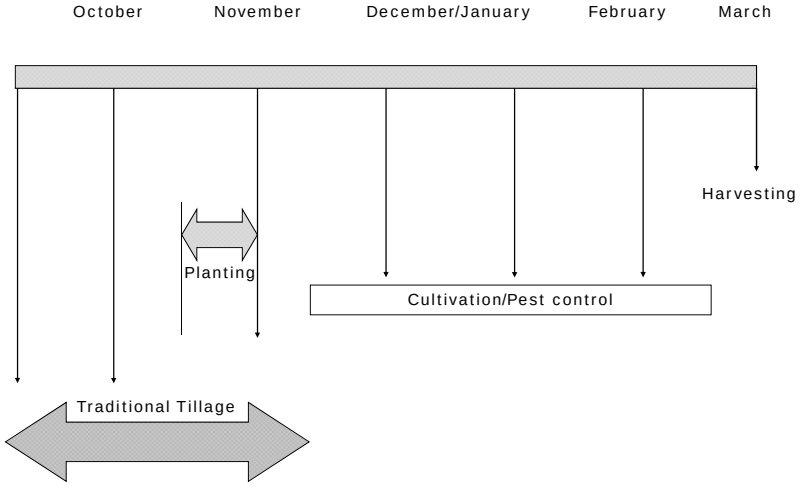
Summer Crop Schedule

Decades 70 & 80



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Traditional Soil Management

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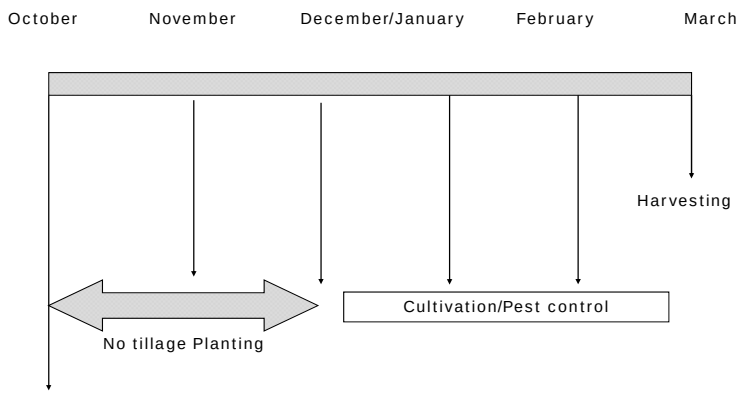
Vilela, 2005

Summer Crop Schedule

Decades 90 & 00



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Summer Crop Schedule

- **Grain crop production using No Tillage**

No Tillage: sowing without previous ploughing or harrowing.

Source: Balbino 2008

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Technology transfer: mechanization for the Cerrados

- Agronomy Technology
- Soil Management
- Machinery Technology

Figura 4 - Semeadoras SDA 2 Especial da MARCHESAN e PHM da MORGENSTERN.

Figura 5 - Semeadoras PC 7/4 da PLANTI CENTER e SMT 6414 da VENCE TUDO.

PAR 2800/3000/3600

PH3 - PH5E

SOL MASTER 7 - 9

Figura 6 - Semeadora MAGNUM 2800, usada, adaptada pelo produtor Paulo Rohr.

No Tillage Seeders technology: 27 manufactures

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Chemical application technology

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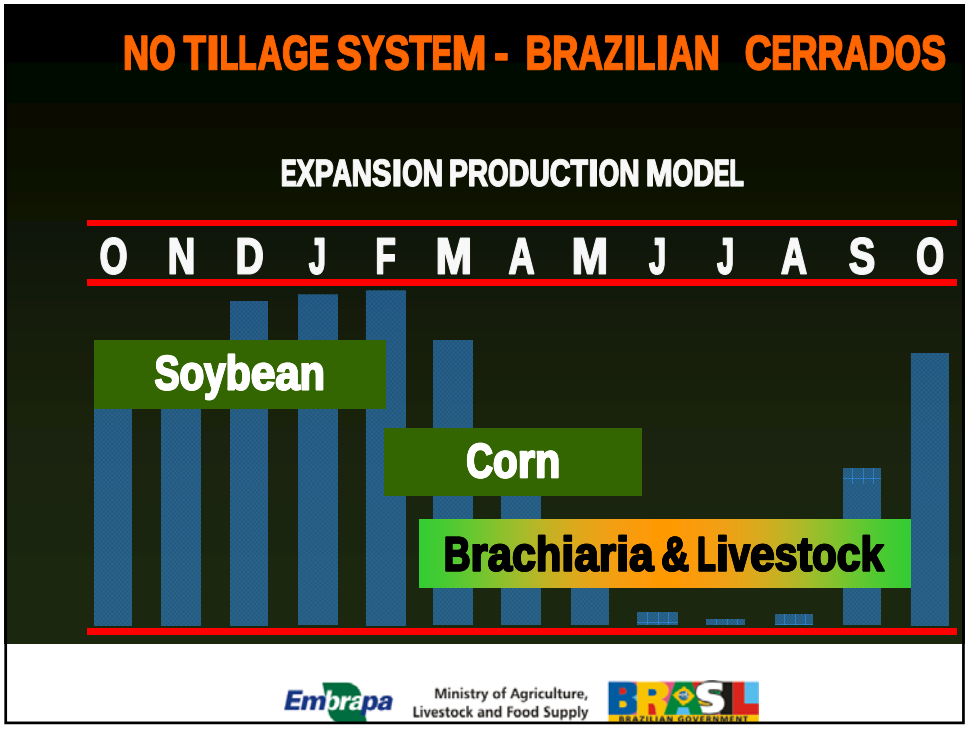
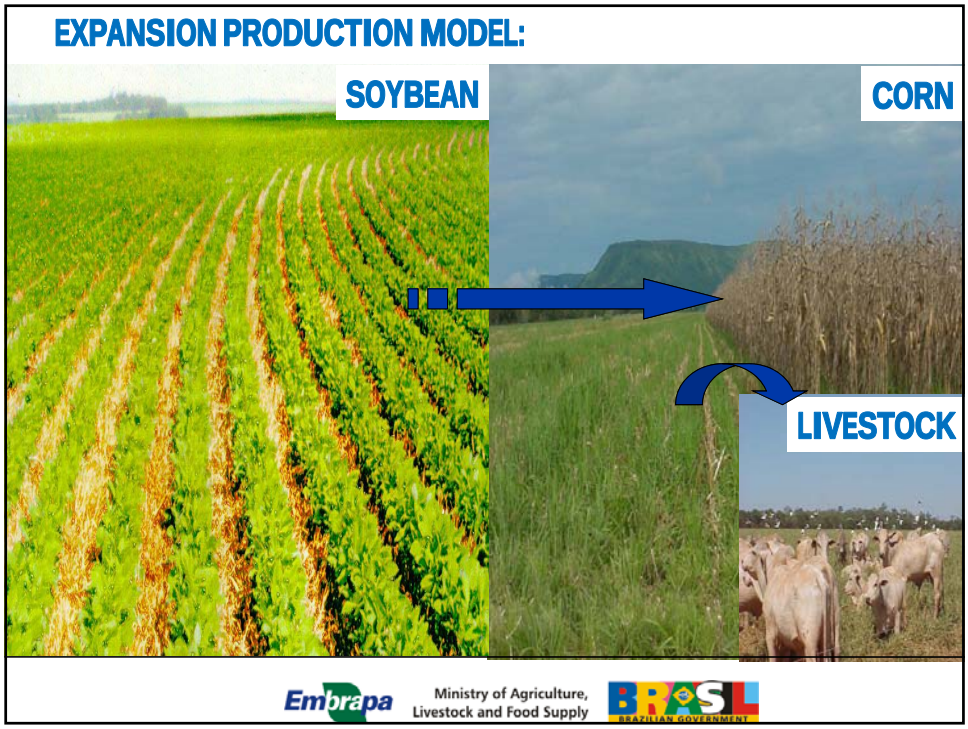

NO TILLAGE SYSTEM - BRAZILIAN CERRADOS
EXPANSION PRODUCTION MODEL
O N D J F M A M J J A S O
Soybean
Corn
Brachiaria & Livestock
Embrapa
Ministry of Agriculture, Livestock and Food Supply
BRASIL


EXPANSION PRODUCTION MODEL:
SOYBEAN
CORN
LIVESTOCK
Embrapa
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BRASIL

CONSERVATION TILLAGE SYSTEM

HARVESTING-SOWING PROCESS
CROP ROTATION - FERTILE SOIL

- **Flows of organic matter in productive agricultural systems are similar to the ones observed in ecosystems.**
- **Permanent and simultaneous flow : mineralization and nutrient absorption.**
- **The use of intensive rotation with high residue cover from crop production, under No Tillage, improves soil productivity.**

Innovation and technology: Tropical No Tillage System

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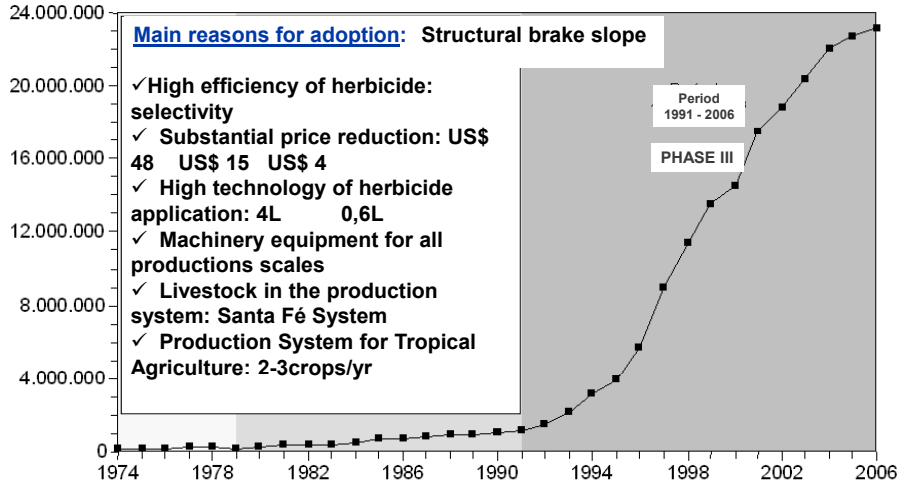
Technology challenge: soil management system



Source: Adapted from FEBRAPDP (2007) by Denardin

Year

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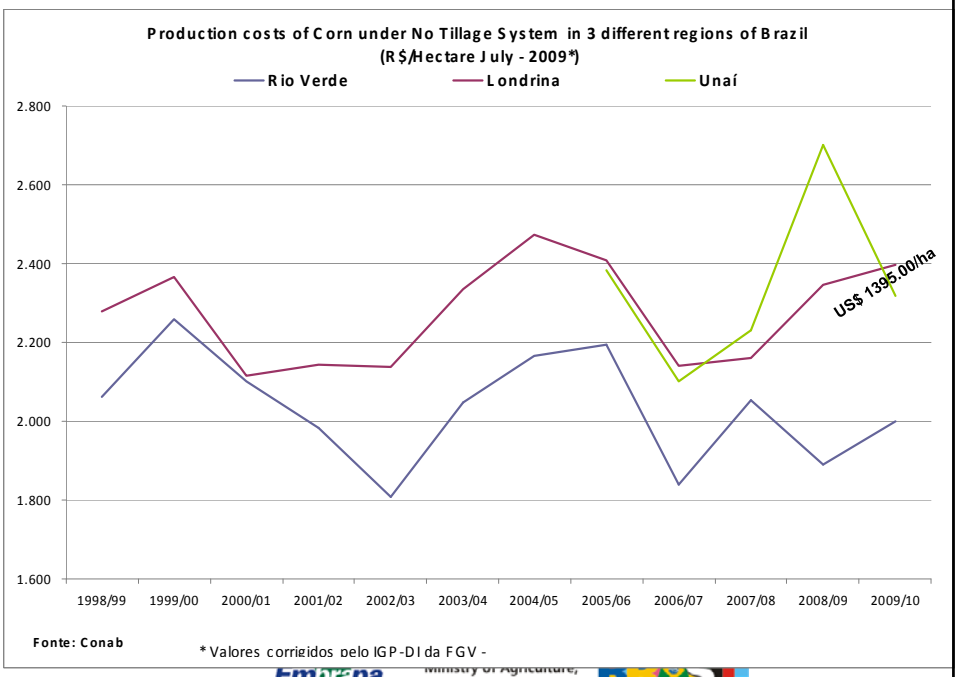

Fertilizers Consumption in the Cerrados - 1986 e 2007

Region	Consumption (thousand tons)		Increment 1986-2007 (%)
	1986	2007	
Cerrados Region	2.650	10.866	310,0
Other Regions	6.520	10.116	55,1
Total: Brazil	9.170	20.982	128,8

Source: ANDA -Anuário Estatístico Setor de Fertilizantes, 1986 e 2007.

Fleet & sales of Tractors in the Cerrados Region

Region	Frota			Sales 2007
	1975	2006	Increment % (1975-2006)	
Cerrados Region	52.459	228.832	336.21	7.494
Other Regions	270.654	559.221	106.62	24.241
Total: Brazil	323.113	788.053	143.89	31.735

Fonte: IBGE e Anfavea.

Fleet & sales of Combines in the Cerrados Region

Region	Frota			Sales 2007
	1975	2006	Increment % (1975-2006)	
Cerrados Region	15.784	52.782	234.40	787
Other Regions	68.923	106.636	54.72	1.590
Total: Brazil	84.707	159.418	88.20	2.377

Source: IBGE e Anfavea, 2006.

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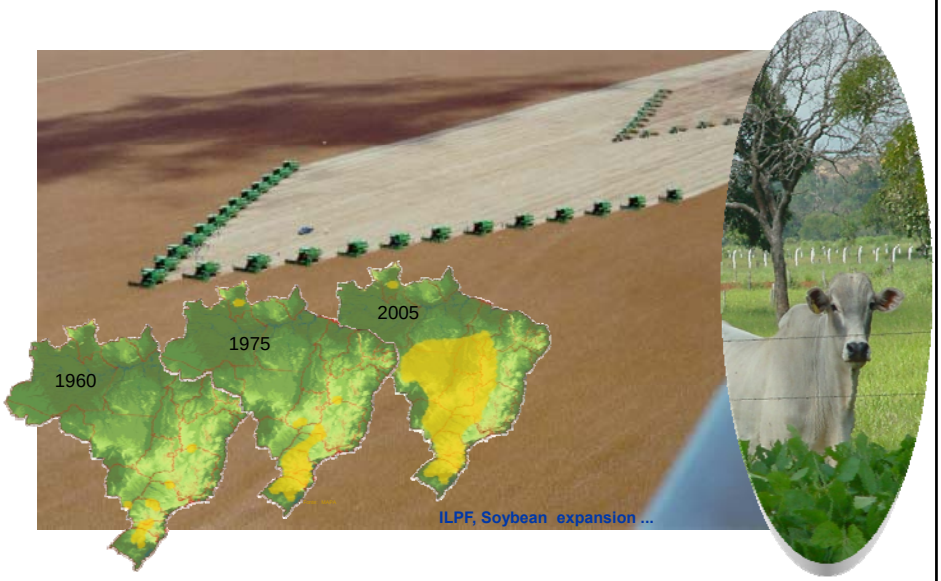
Innovation and technology: Tropical Agriculture



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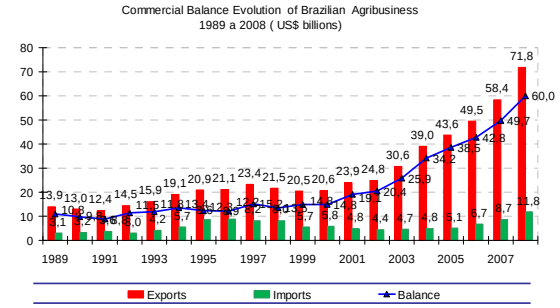
The Agribusiness in Brazil

One of the most dynamic sectors of the economy.

- 5 million rural properties - 18 million people.
- 23% GNP 2007 and 37 % employment In the country.

Main source of International income

- Commercial balance: US$ 60 billions in 2008.
- 37% of Brazilian exports.



Source: AgroStat Brazil/ SECEX/MDIC

PRODUCTS	PRODUCTION	EXPORTS
Coffee	1º	1º
Sugar	1º	1º
Orange juice	1º	1º
Cattle meat	2º	1º
Tobacco	2º	1º
Alcohol	2º	1º
Soybean	2º	2º
Poultry meat	3º	1º
Mayze	4º	2º
Pork meat	4º	4º

Source: MAPA e USDA

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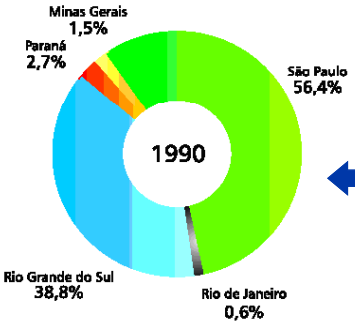
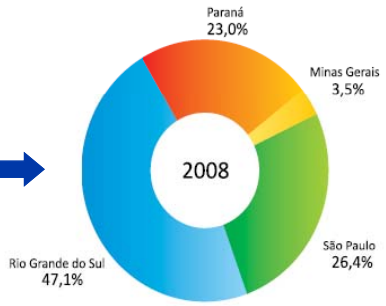
Production Growth of Agriculture Machinery





Estados/*States*	Empresas/*Companies*
Rio Grande do Sul	Agrale, Ideal, Maxion, SLC
Paraná	Ford New Holland
São Paulo	Caterpillar, CBT, Engesa, Ford New Holland, JI Case, Komatsu, Kubota, Valmet, Yanmar
Rio de Janeiro	Muller
Minas Gerais	Fiatallis

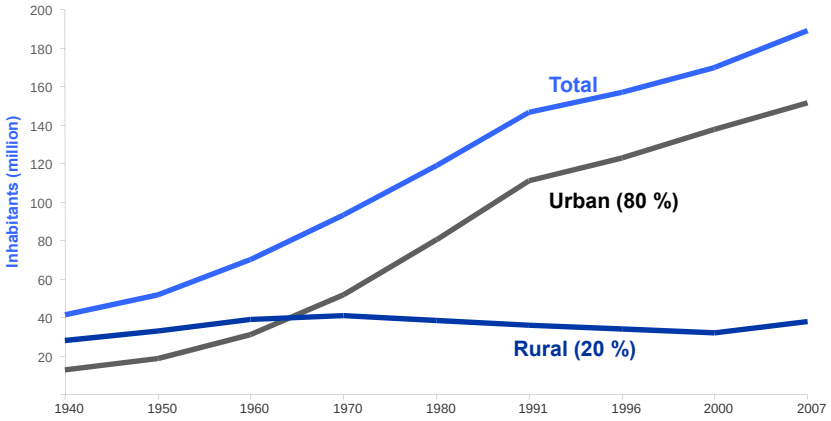
Máquinas agrícolas automotrizes produzidas
Agricultural machinery assembled:
33.114
unidades/*units*

Estados/*States*	Empresas/*Companies*
Rio Grande do Sul	AGCO, Agrale, John Deere
Paraná	CNH Case, CNH New Holland
Minas Gerais	CNH Case, CNH New Holland
São Paulo	CNH Case, Caterpillar, Komatsu, Valtra

Máquinas agrícolas automotrizes produzidas
Agricultural machinery assembled
84.992
unidades/*units*

Innovation and technology : agriculture expansion

3rd Cycle



Source: IBGE

Urban and rural population

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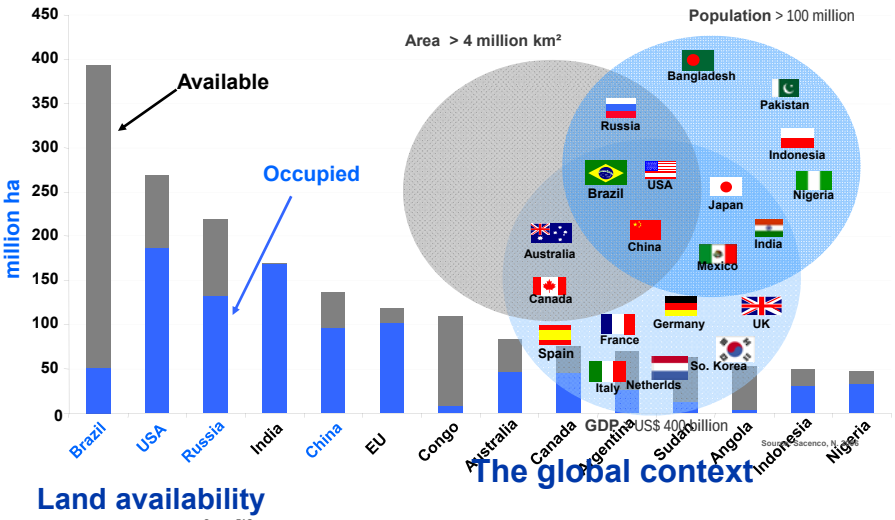
Innovation and technology: agriculture expansion



The global context

Land availability

Source: FAO

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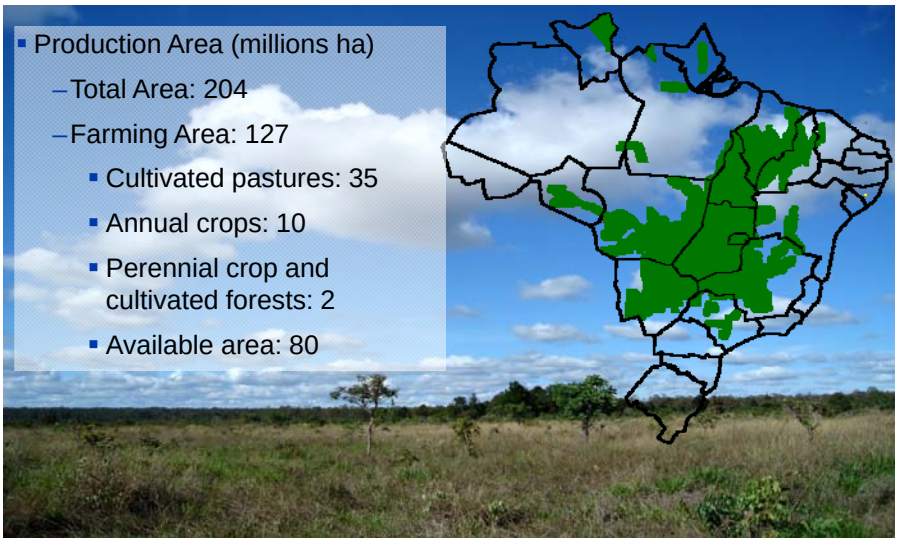
Innovation and technology: agriculture expansion



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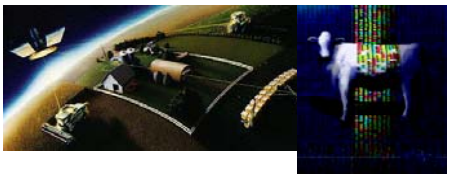
Innovation and agriculture challenges: 3rd cycle

From small-scale agriculture... **to precision agriculture…**



nanotechnology, system biology…

Summary :

- Institutional and RD&I challenges
- Partnerships: national and international
- Knowledge frontier: nanotechnology, integration functional genomics .....
- Growth Acceleration Program (PAC): budget and modernization
- V Strategic Master Plan-2008-20011-2023: New Mission, Objectives, ...

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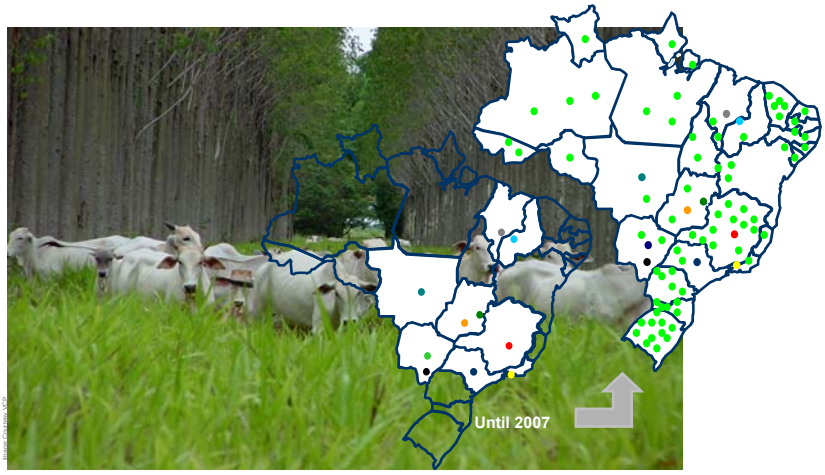
Innovation and technology: new production systems



- Recuperation of degraded pasture: 50 Million hectares

Source: Balbino 2008

Integrated crop-livestock-forestry

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GOALS FOR DEGRADED AREAS WITH ICroPASTURE :

- 2006 - 3 million ha
- 2010 - 5 million ha (Public Policies)
- 2015 - 18 million ha
- 2020 – 25 million ha
- 2030 – 36 million ha

Source: Balbino 2008

CONCLUSIONS

1. Conservation Tillage in Sub Tropical and Tropical regions was implemented by the No Tillage system which showed to be the most appropriate technique for soil management for erosion control.

2. As a whole, No Tillage systems were responsible for most of the improvement of agriculture equipment, development of new short cycle cultivars, low price and efficiency of herbicide, their application technology, etc.

3. The change in concept was very significant and, at present, the No Tillage System comprehends a complex of technologies .

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CONCLUSIONS

4 The use of No Tillage in the Cerrados allowed farmers to produce two or three crops per year, increasing planting efficiency by establishing proper seasonality for the sequence of crops.

5 The use of No Tillage showed favorable impact on nitrogen fixation, and biological(integrated) pest control associated to precision farming allowed for better natural resources management.

6 The magnitude and rate of adoption of the No Tillage System by farmers in all regions is considered, today, a great revolution in Brazilian Tropical Agriculture.

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Thank you!
Grazie
Gracias
Dankeschön
Obrigado

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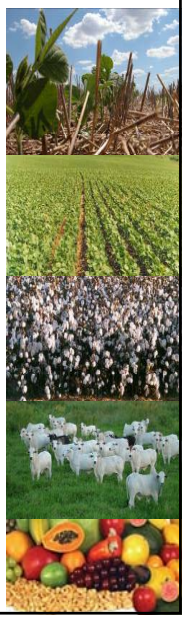
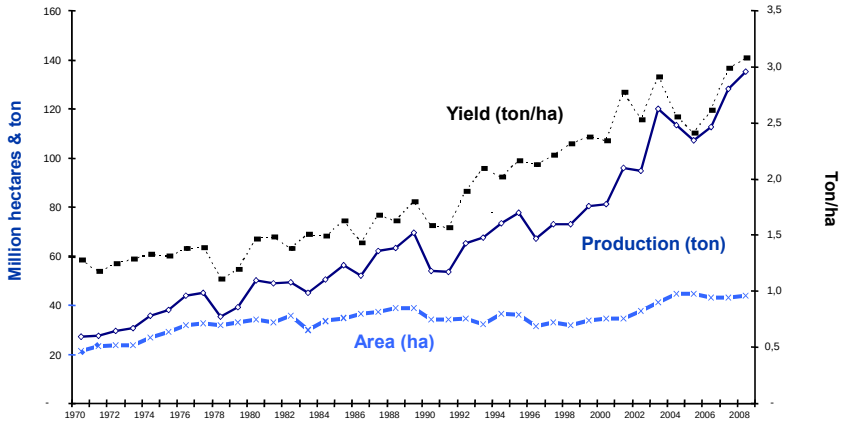
55-xx-61-34484306

Innovation and technology: tropical agriculture knowledge

- Tropical plants and animals:
  - Soybean (photoperiodism)
  - Tropical and temperate-adapted fruits
  - Zebu cattle, swine, poultry etc.
- Improved forrages and pastures quality
  - Meat & milk, *Brachiaria spp.*
- Fibers and wood (cotton, *Eucalyptus*)
- N fixation
- Biological control of pests and diseases
- No Tillage system
- Integrated crop-livestock-forestry (ILPF)
- Post-harvesting losses reduction
- Mechanization in agriculture – precision agriculture
- Agro-ecological zoning
- Integrated production systems



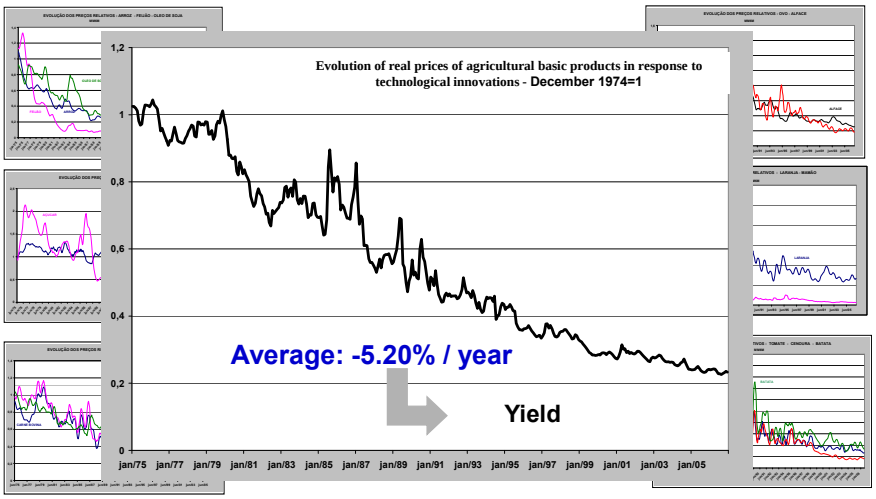
Innovation and technology: food production



Grains: Rice, beans, maize, soybean, wheat

Source: IBGE
2007 & 2008: estimate on March, 2008.

Innovation and technology: food cost



Real food price in the last 30 years.

Mendonça de Barros et al., 2008.

International Investments

John Deere Brasil Ltda Horizontina (RS)
- Products: Tractors, Combines and Planters

AGCO do Brasil Canoas and Santa Rosa (RS)
- Products: Tractors & Combines
-

New Holland do Brasil Curitiba (PR)
- Products: Tractors & Combines
-

Brazilian Wheel Tractors Fleet 1960-2007

ANO *YEAR*	TRATORES DE RODAS unidades *WHEEL TRACTOR units*	ÁREA CULTIVADA *CULTIVATED AREA* 1.000 ha	ÍNDICE DE MECANIZAÇÃO AGRÍCOLA *MECHANIZATION LEVEL* ha/trator de rodas *ha/wheel tractors*
1960	62.684	25.672	410
1965	76.691	31.637	413
1970	97.160	34.912	359
1975	273.852	41.811	153
1980	480.340	47.641	99
1985	551.036	49.529	90
1990	515.815	47.666	92
1995	481.316	50.022	104
2000	450.000	53.300	118
2005	354.722	59.339	167
2007	361.453 *	57.882	160

(*) Estimativa. / *Estimate*
Fontes/*Sources*: Anfavea, IBGE.

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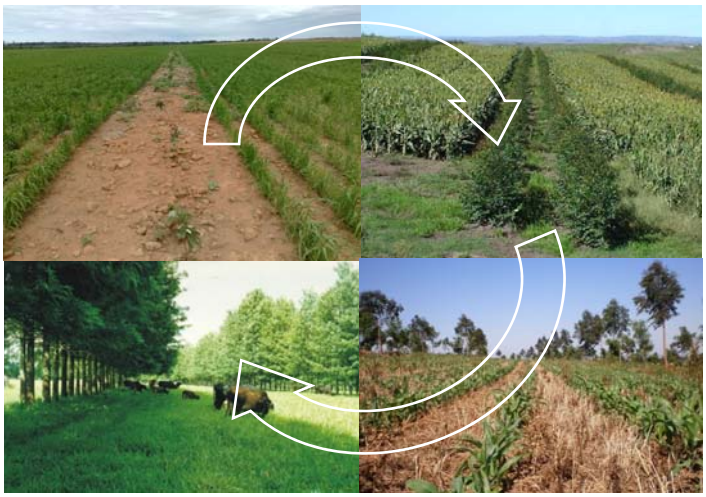
Crop-Pasture-Forest Program



Source: Balbino 2008

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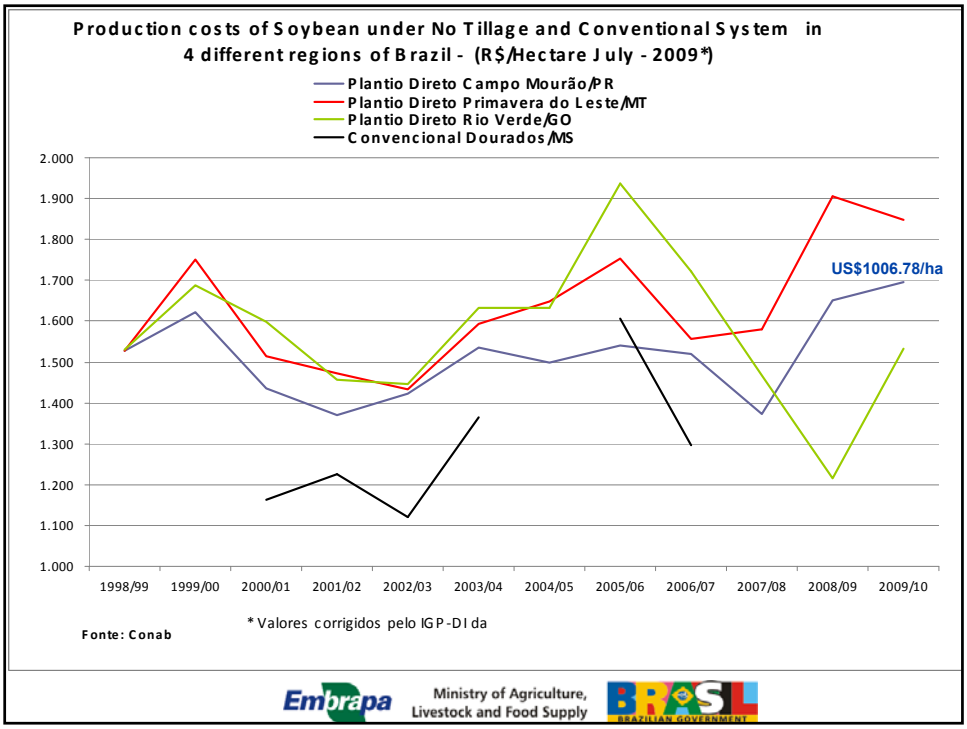

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