

Challenges and Perspectives for R,D&I for Brazilian Agroenergy

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Why are biofuels attractive?

- ***Energy security***
- ***Climate change mitigation***
- ***Lower emissions of pollutants***
- ***Liquid – use of existing infrastructure***

Fonte: Esmap, 2005

Biofuel production in Different Countries

Ethanol:

- sugarcane (Australia, Brazil, China, Colombia, Ethiopia, India, Thailand)
- sugar beets (EU)
- maize (US, China)
- wheat (Canada, EU)
- cassava (Thailand)
- biomass wastes: forest products (Canada), wood wastes, agriculture residues, maize stover, sugar cane trash
- energy crops switch grass, hybrid poplar, willow

Biodiesel:

- rapeseed (EU)
- soybeans (US, Brazil)
- Palm oil (Philippines)
- coconut (Philippines)
- plants growing on marginal land – Jatropha, karanja (India)

Fonte: Esmap, 2005

Prospects for biofuels

● **Near term:**

- **ethanol from sugarcane: best overall commercial chance**
- **biofuel trade liberalization**
- **biodiesel remains expensive relative to world oil prices**

● **Medium term:**

- **fall in production costs**
- **new feedstocks**
- **growing trade**

● **Long term:**

- **increase in commercialization of cellulosic ethanol**
- **higher oil prices favoring biofuel economics**

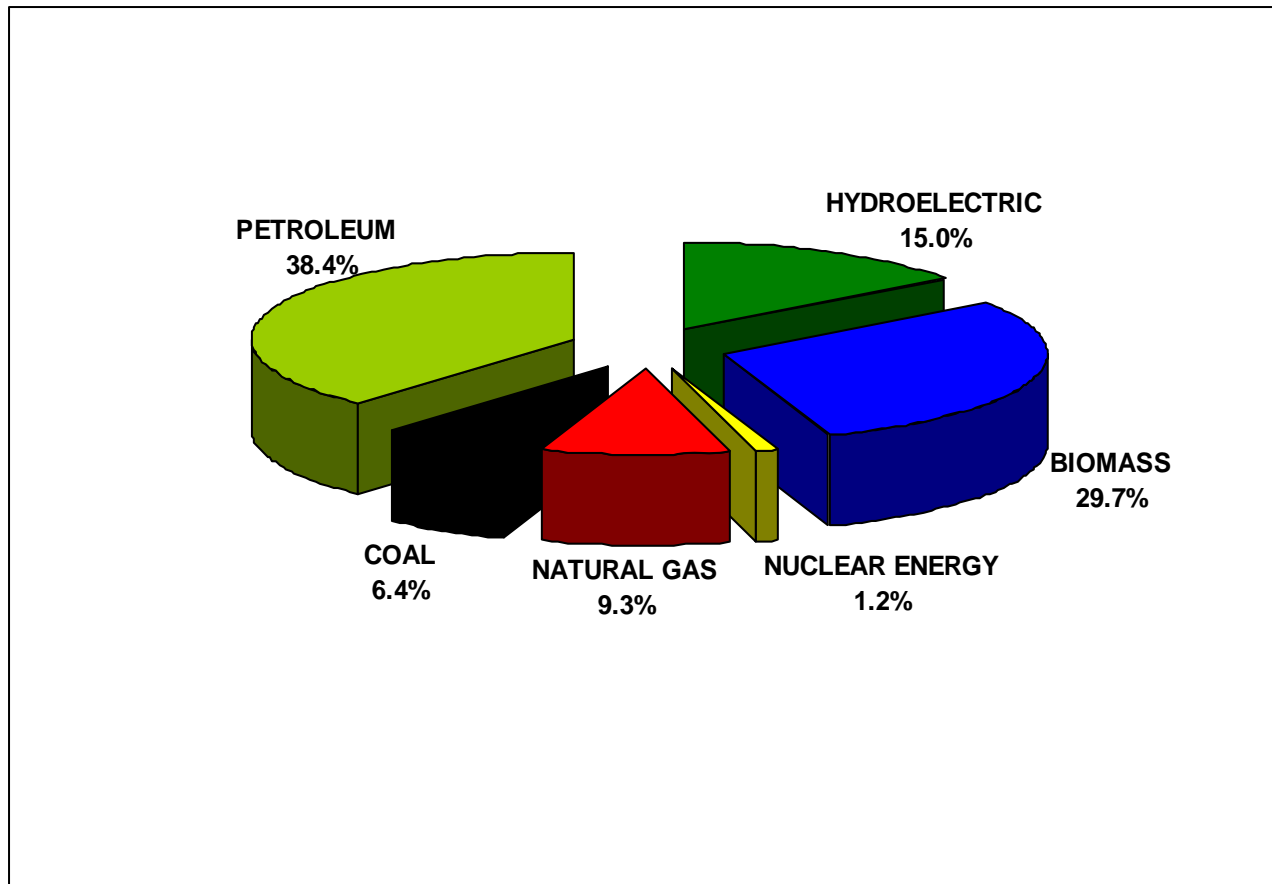
Fonte: Esmap, 2005



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Brazilian Energetic Matrix



**WOOD/
VEGETAL COAL**
13.1%

SUGAR CANE
13.9%

OTHERS
2.7%

SOURCE: MME, 2006.

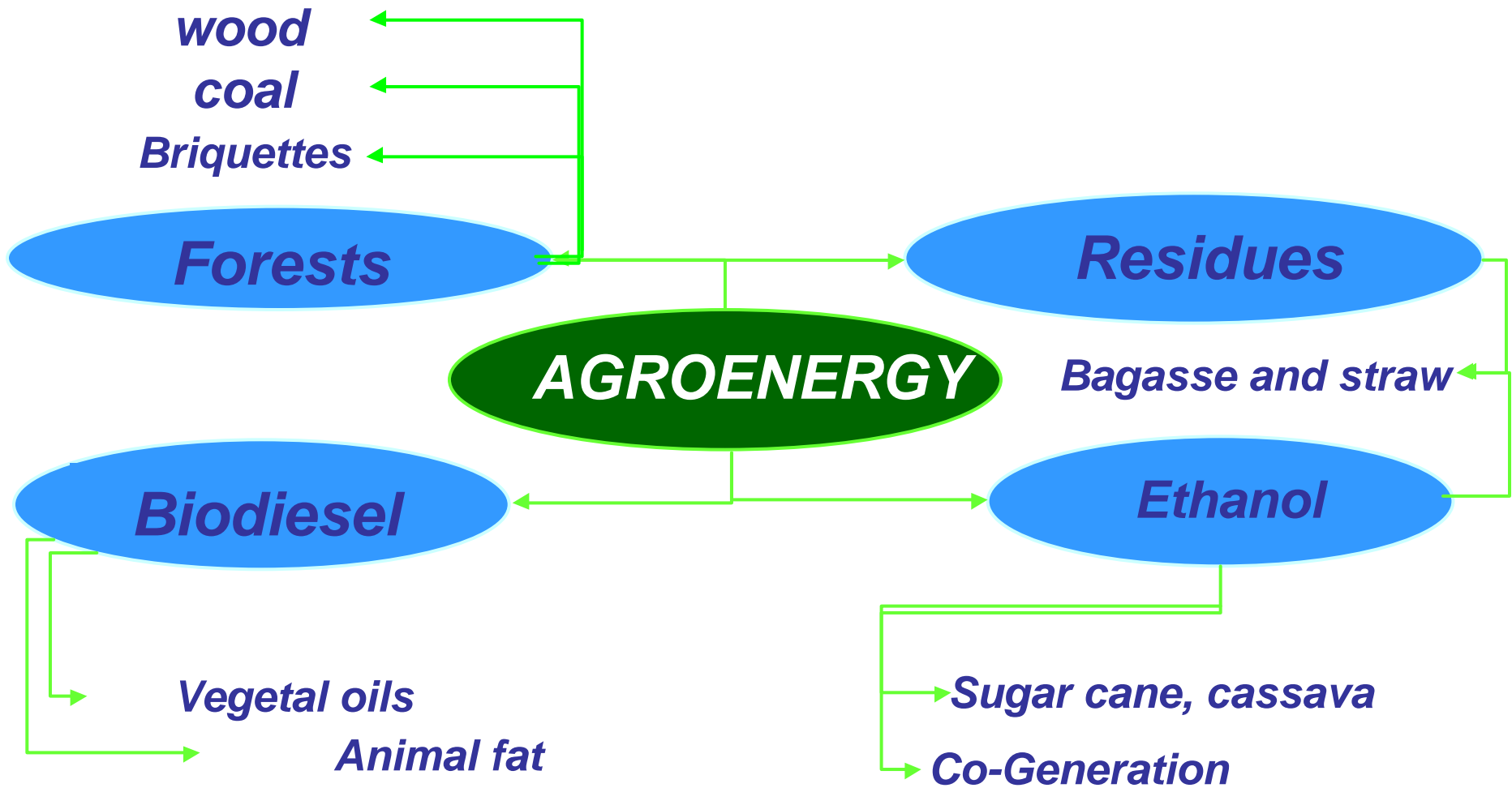
BRAZILIAN AGROENERGY PLAN

Its an instrument, which orients actions of Ministry of Agriculture and the agroenergy supply chains according to the Agroenergy policy of Federal Government.

It is based on five dimensions:

***Economics, Social, Environmental,
Regional differences, International insertion***

Brazilian Agroenergy Production Matrix



Ethanol in Brazil

- *1912: First Experiences with alcohol-fueled automobiles*
- *1931: Anhydrous-gasoline mixture (up to 5%)*
- *1938: Mixing compulsory*
- *1966: Mixture gap increases to 5-10% (voluntary)*
- *1975: Government launches the National Alcohol Program (**Proalcool**), based on two pillars:*
 - *increasing anhydrous-alcohol mixture in gasoline*
 - *launching the hydrated-alcohol-fueled car*
- *1979 – 2002: Mixture increases from 15 to 25%*

BRAZILIAN SUGAR – ALCOHOL STATISTICS

Variables	CROP YEAR				
	2000/01	2002/03	2004/05	2005/2006	2006/07³
Sugarcane production (million tons)¹	326.1	364.4	416.3	431.4	469.8
Harvest area (million ha)¹	4.8	5.1	5.6	5.8	6.2
Productivity (ton/ha)¹	67.9	71.3	73.9	73.9	75.8
Sugar production (million ton)²	16.0	22.4	26.6	26.7	29.2
Alcohol production (million liters)²	10.5	12.5	15.2	17.0	17.8

Sources:¹ IBGE; ²DAA/SPC – MAPA

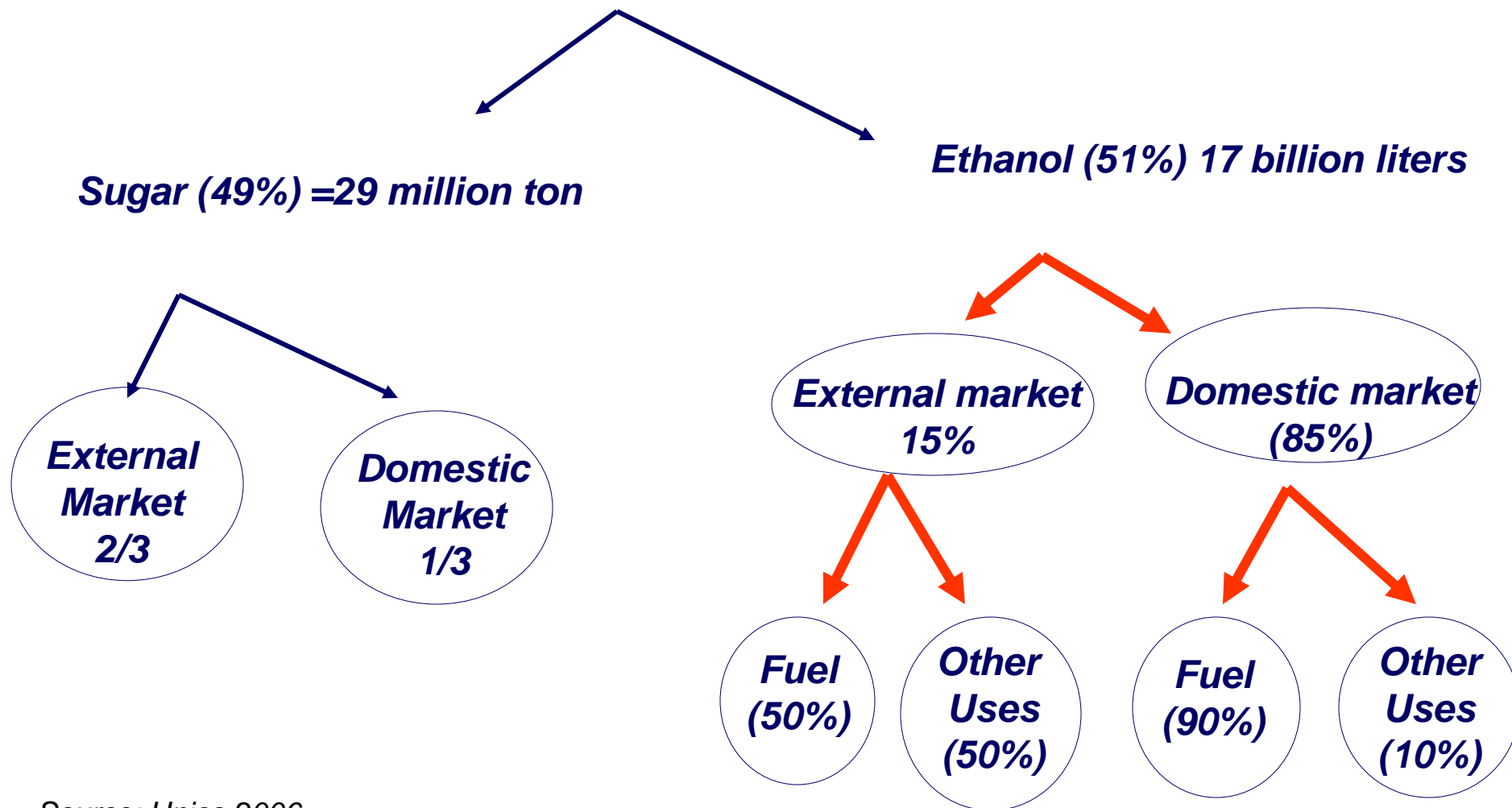
³ Estimate: CONAB, May 2006



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Sugarcane = 430 millions of ton (2006)



Source: Unica 2006

Perspectives



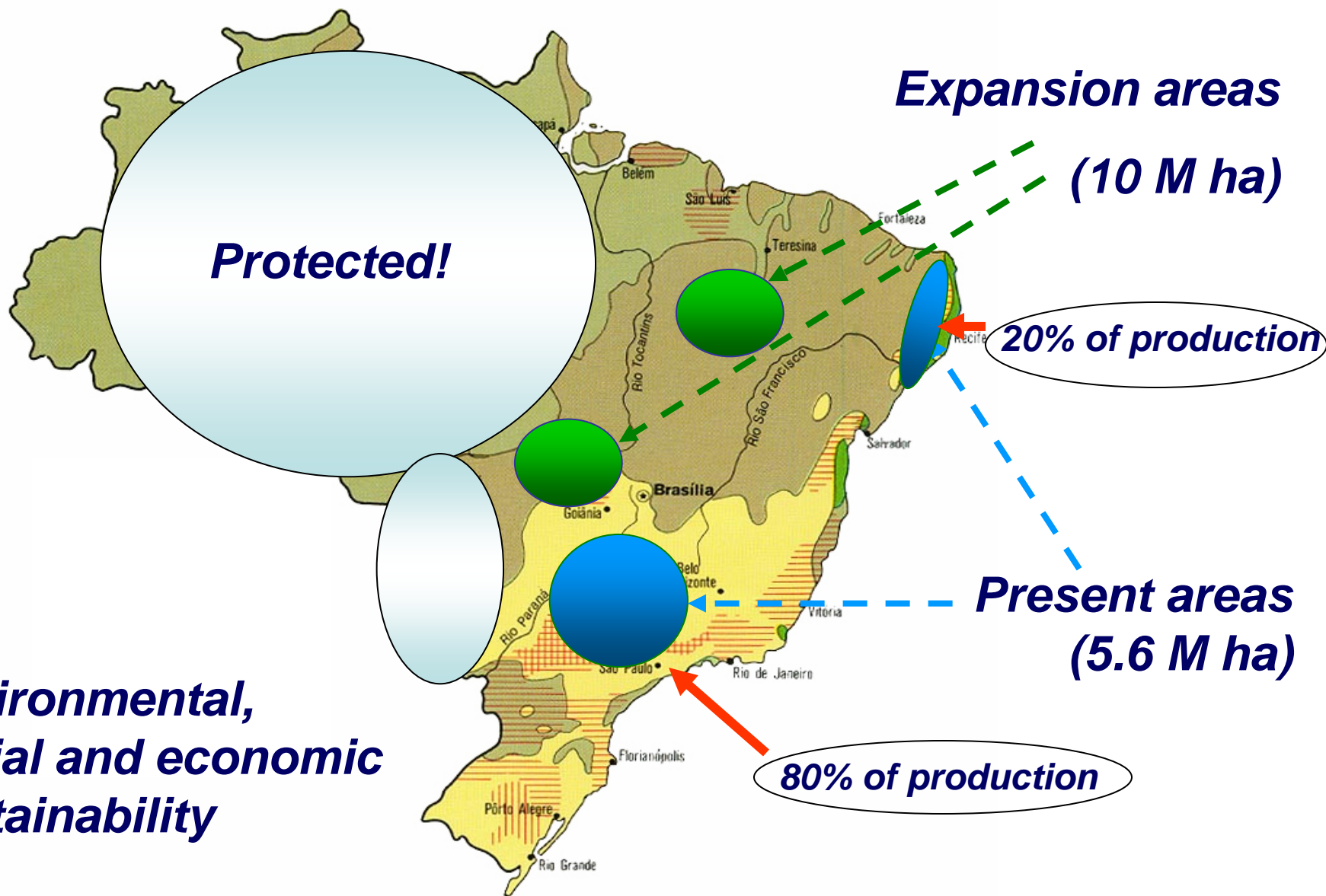
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Short term scenarios for ethanol in Brazil

	2005	2013
Sugarcane production	420 Mt	620 Mt
Ethanol	16,7 GL	25 GL
Sugar	29 Mt	37 Mt
Energy (co-generation)	3 GWh	5 GWh

**Environmental,
social and economic
sustainability**



Source: Arraes, 2007

AGRI-INDUSTRY OF SUGAR CANE

Investments for Ethanol Production

2005

- **Number of sugar mills/ distilleries: 313**
- **Production: 16 million m³**
- **Sugar cane production: 430 millions ton**
- **Cropped area for ethanol production: 2.9 million ha**
- **Energy (co-generation): 3 GWh**

by 2010

- **Investments: US\$ 10 billion in 89 plants**
- **Sugar cane production: 600 millions ton**
- **Increase in ethanol production : 8 million m³**
- **Cropped area increase for ethanol production: 2 million ha**
- **Energy (co-generation): 5 GWh**

Source: Arraes, 2007

Source: Ministry of Mines and Energy;
DEDINI S/A Base Industries - 2005



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Ethanol Overview - United States and Brazil

	USA	BRAZIL
Mills in operation	97	335
Feedstock	Corn	Sugar cane
Cultivated area (million tons)	78.2	15.9
<i>Amount designated for ethanol</i>	15.6	7.6
FEEDSTOCK production (million tons)	267	426
<i>Percent of feedstock for ethanol</i>	20%	48%
<i>Yield (tons/acre)</i>	3.4	31.5
ETHANOL production (million gallons)	4900	4600
Ethanol productivity (gallons/acre)	321	727
Fuel ethanol as a percent of consumption	2%	40%
ETHANOL trade (million gallons)		
<i>Imports</i>	741	-
<i>Exports</i>	-	800
Cost of production (US\$/gallon)	1.14	0.83
Import duty	39%	0%

Notes: 2006/07 data for Brazil end 2005/06 data for US. 2004 data for production costs. US Import duty presented is the ad valorem equivalent (2004-2005 average) for non denaturized ethanol (54 cents/gallon + 2.5%).

Sources: UNICA, USDA, USITC, MME, World Watch Institute, RFA.

Elaboration: ICONE



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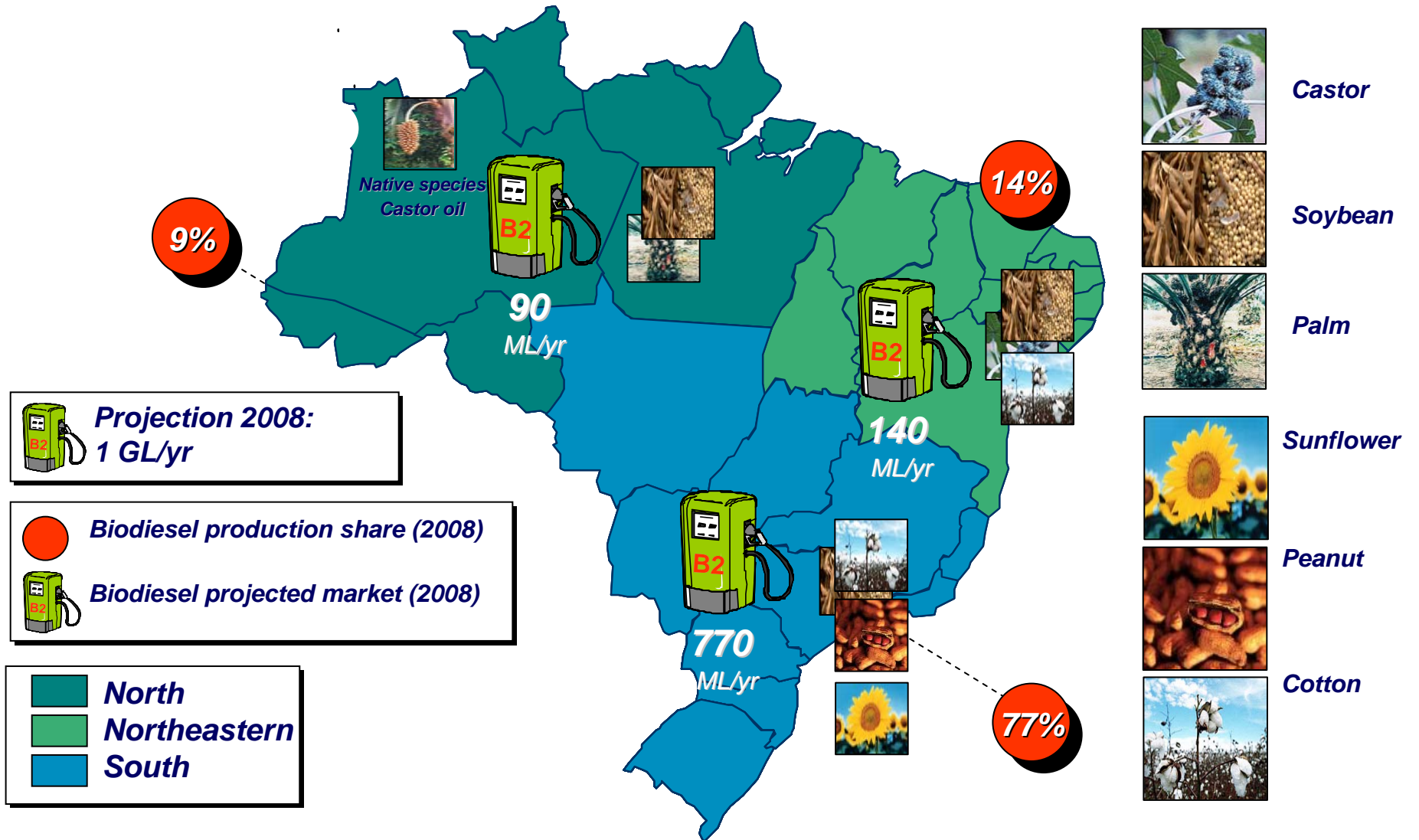
Biodiesel in Brazil

- ***1970: First experiences (high vegetable oil prices)***
- ***1980: First biodiesel patent in the world***
- ***2003: Federal Government Working Group***
- ***Dec/2003: Inter-ministerial Executive Committee***
- ***Dec/2004: Program launching***
- ***2005: Started organization of research nets***
- ***May/2006: Creation of Embrapa Agroenergia***

Biodiesel versus Alcohol: different reasons

- ***Alcohol (1975): basically economics.***
- ***Reasons for biodiesel (today):***
 - ***economic: high crude oil prices again, but Brazilian dependence is now very low***
 - ***social: needs for jobs and permanent settlement of families in countryside***
 - ***environmental: to introduce another renewable and friendly fuel***

OILSEED PRODUCTION IN BRAZIL



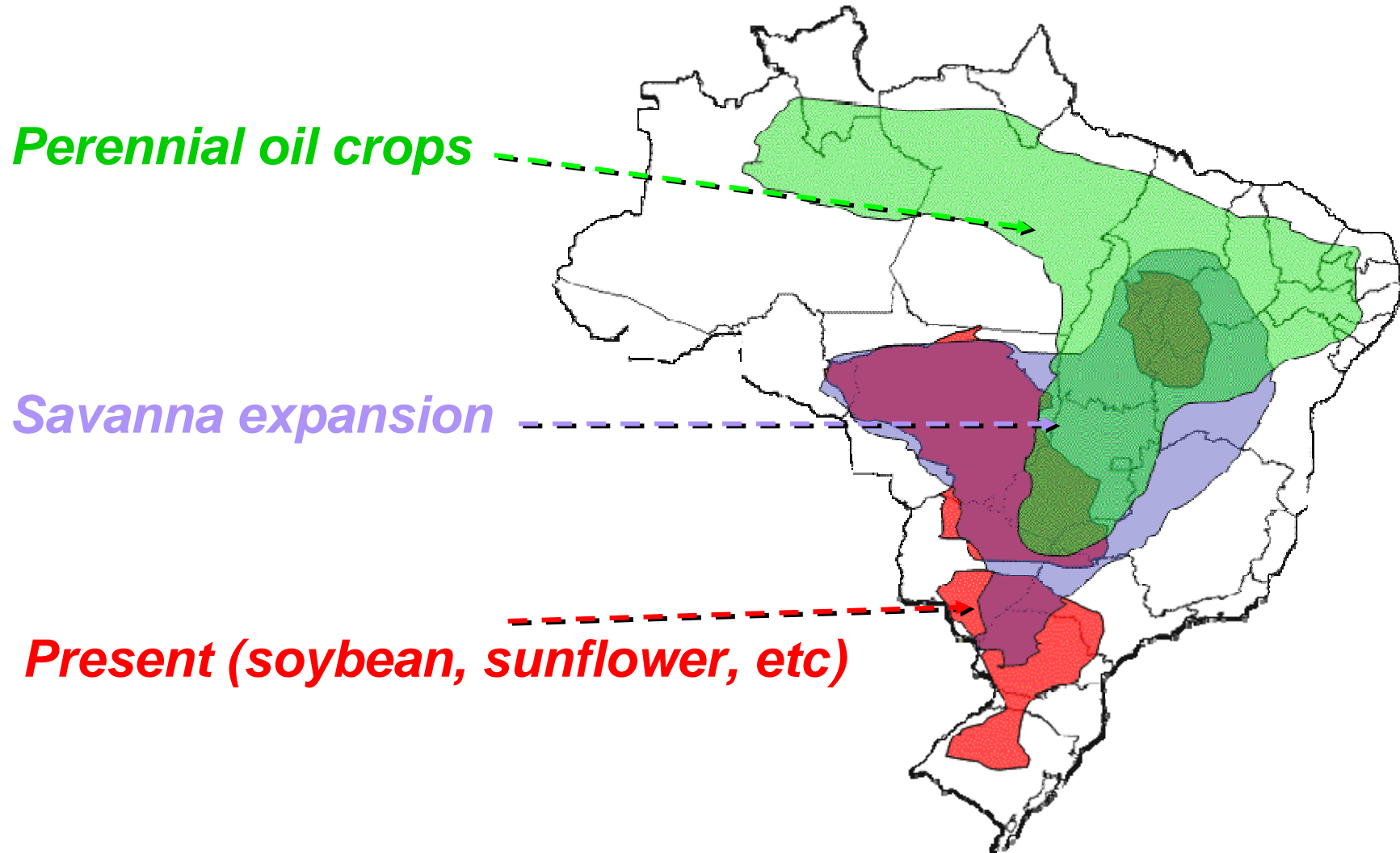
Brazilian Potential

- ***Area appropriated to Palm tree – 30 millions of ha.***
- ***Area appropriated to Babaçu – 17 millions of ha.***
- ***Area appropriated to Buriti – 2 millions of ha.***
- ***Area appropriated to agropastoral systems – 20 millions of ha.***
- ***Area arable not explored - 100 millions of ha.***





Potential Palm Trees

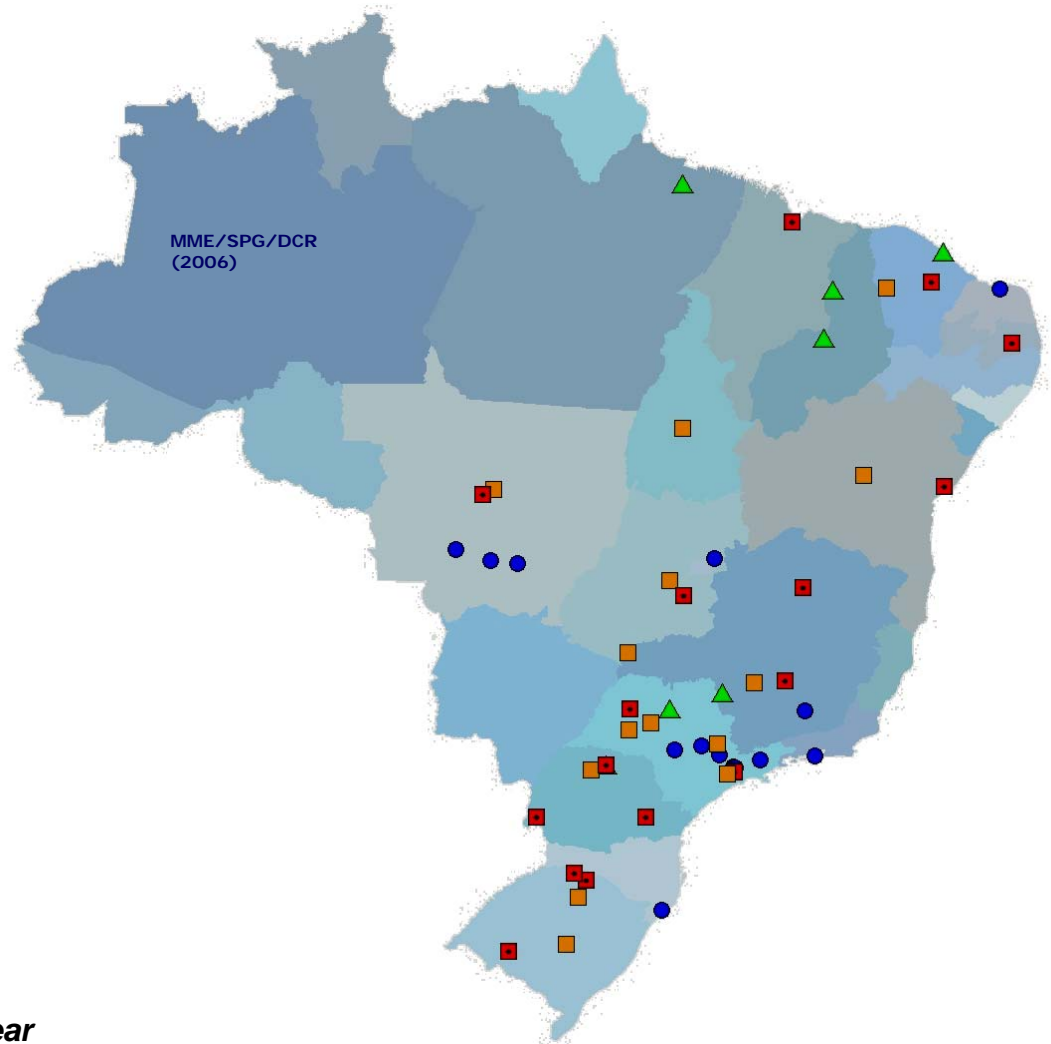
<i>Scientific name</i>	<i>Region of origin in Brazil</i>	<i>Common name</i>
<i>Acrocomia intumescens D.</i>	<i>Northeast</i>	<i>Macaúba</i>
<i>Sayagrus Coronata M.</i>	<i>Northeast</i>	<i>Ouricuri</i>
<i>Oenocarpus bacaba M,</i>	<i>North</i>	<i>Bacaba-do-azeite</i>
<i>Oenocarpus distichus M.</i>	<i>North, Northeast</i>	<i>Bacaba-de- leque</i>
<i>Trithrinax brasiliensis M.</i>	<i>South</i>	<i>Carandai</i>
<i>Attalea Humilis M.</i>	<i>Southeast</i>	<i>Pindoba</i>
<i>Acrocomia Aculeata Lodd.</i>	<i>Midwest, Southeast</i>	<i>Macaúba</i>
<i>Astrocarym vulgare M.</i>	<i>Northeast, Midwest</i>	<i>Tucumã</i>
<i>Attalea oleifera B. R.</i>	<i>Northeast, Midwest</i>	<i>Indaiá</i>

Potential for expansion of oil crops area in Brazil



NATIONAL PROGRAM OF BIODIESEL

Biodiesel plants	Number of units	Capacity MML/year
Under commercial operation	7 	91
Under Licensing process	15 	366
Under construction	15 	813
New projects	15 	687
Total	52	1957



by 2008: B2 Mandatory Demand: 840 million liters/year

by 2013: B5 Mandatory Demand: 2,400 million liters/year

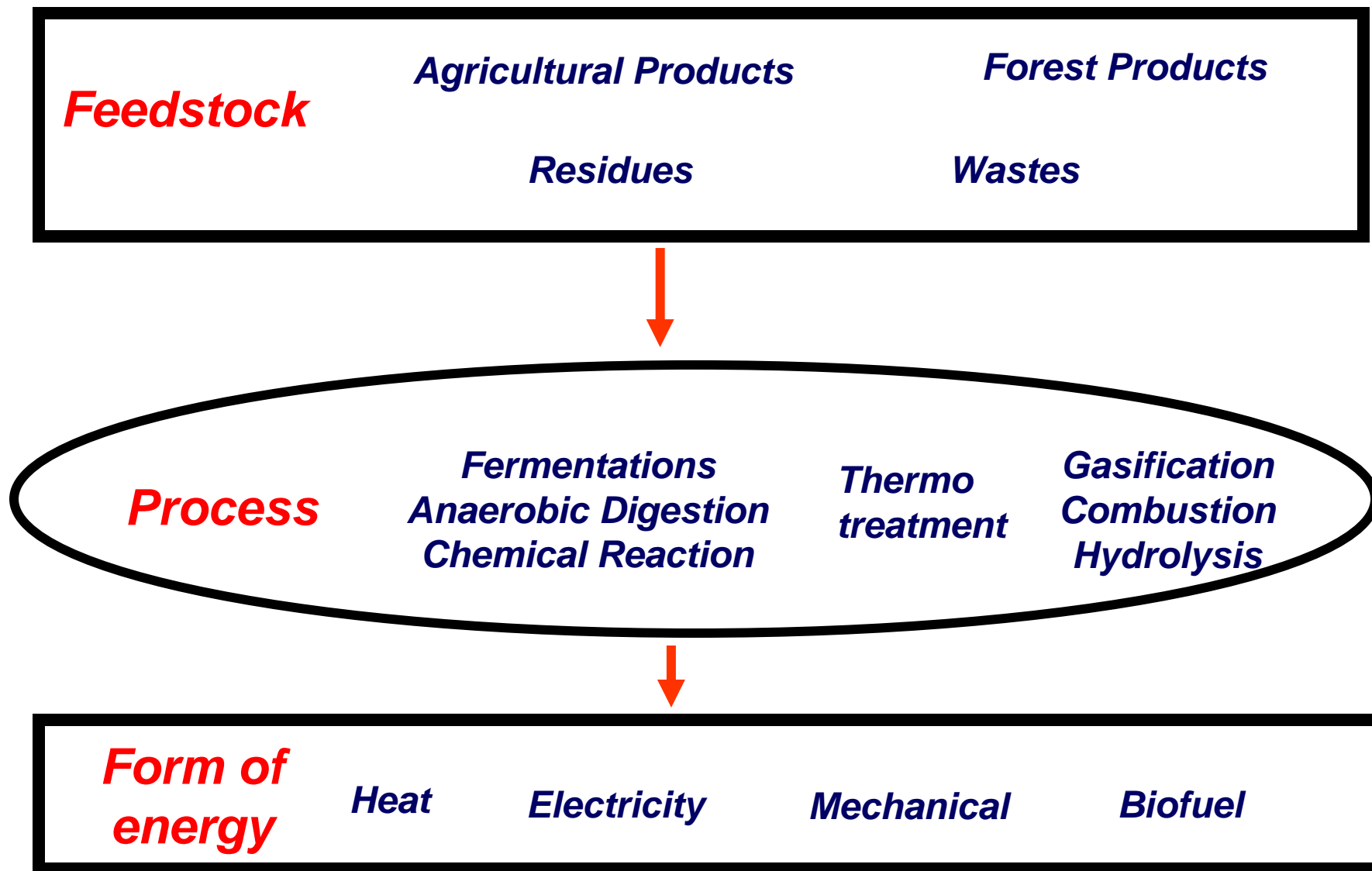
Source: Ministry of Mines and Energy -
National Petroleum Agency - 2006



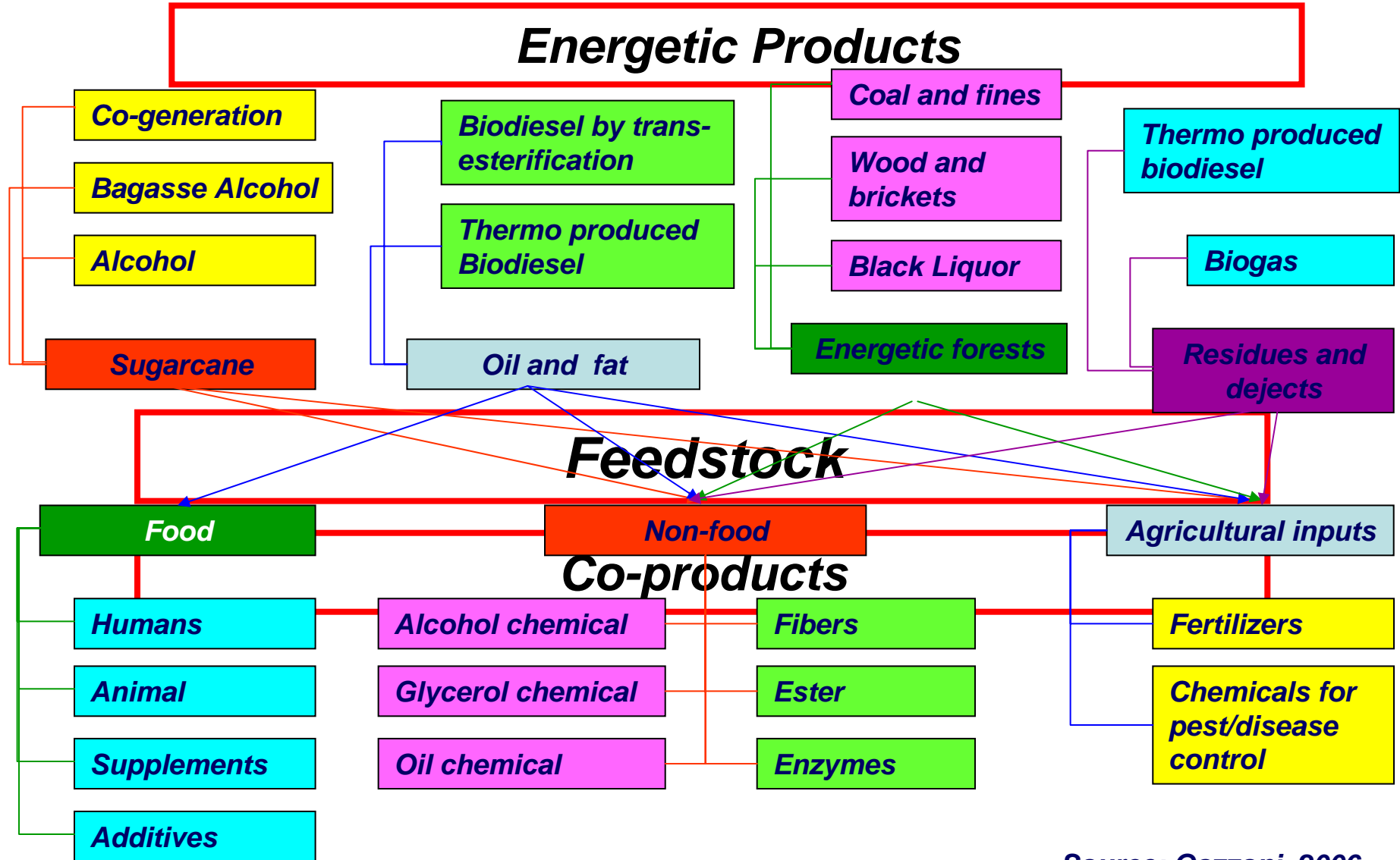
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Focus of Embrapa RD&I and TT Programs



PD&I Platform on Agroenergy



Source: Gazzoni, 2006

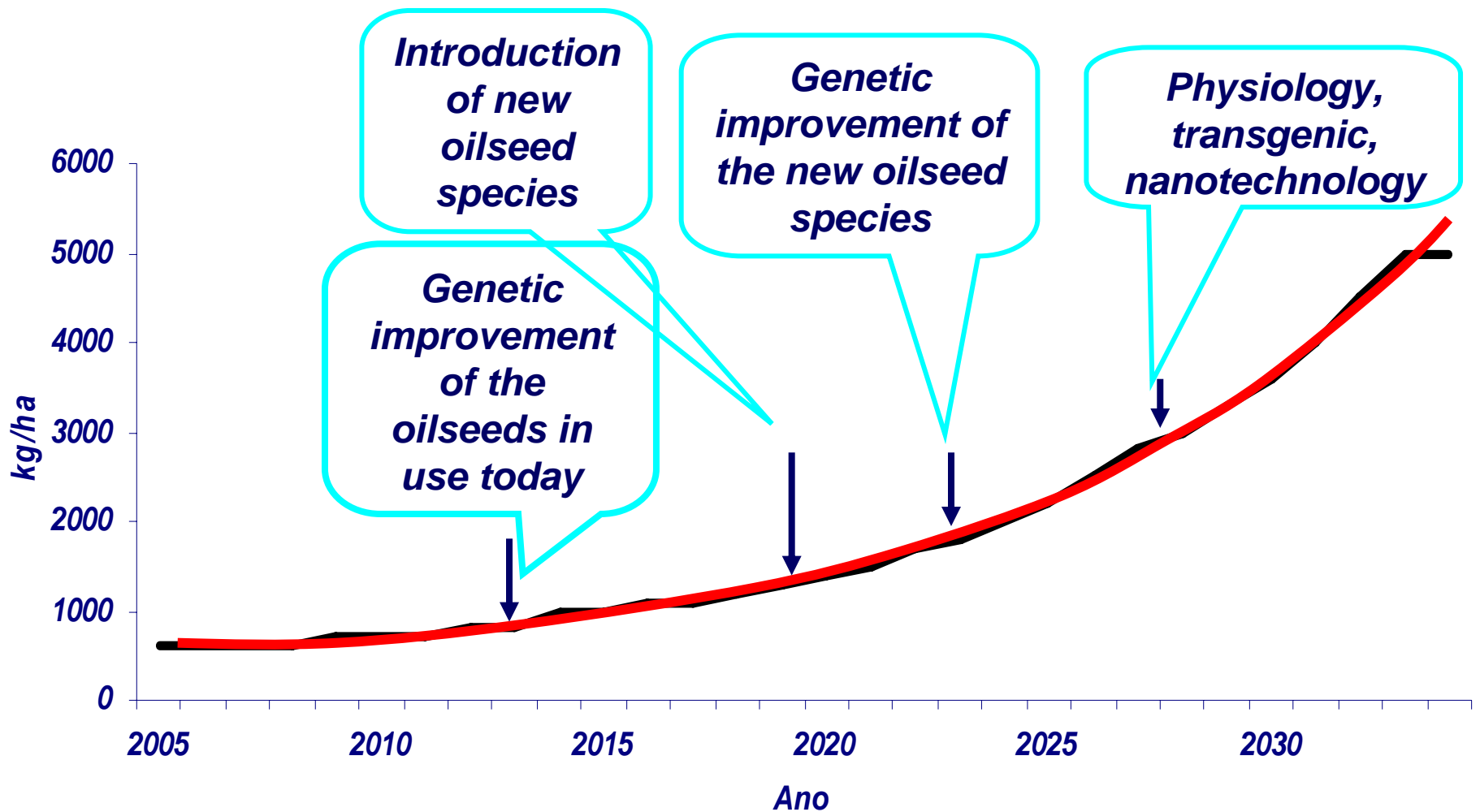
Main Research Challenges: Ethanol

- ***Promoting agro-ecological zoning for sugarcane in the new expansion areas***
- ***Developing technologies that promote symbiotic nitrogen fixation***
- ***Developing technologies that use sugarcane styles and green leaves***
- ***Developing new products and processes based on alcohol chemistry and the use of sugarcane biomass.***

Main Research Challenges: Biodiesel

- ***Prospecting new species with increased energy density and broad edafoclimatic adaptation.***
- ***Promoting agro-ecological zoning of conventional and potential oleaginous species.***
- ***Developing cultivars, varieties and hybrid of conventional and potential oleaginous species.***
- ***Developing systems aiming the improvement of oil extraction activities and the use of co-products and residues.***
- ***Using biotechnology techniques to introduce new characteristics***

Oil Production per Hectare



Fonte: Gazzoni, 2006

Main Research Challenges: Forest

- ***Developing technologies, which will enable the establishment of energy forest in areas unsuitable for agriculture and in areas degraded due to Improper agricultural management.***
- ***Developing agro-forest arrangement appropriated for small farmers.***
- ***Encouraging the use of geographic information system technology in planning the use of energy from forest biomass.***

Main Research Challenges: Residues and Wastes

- ***Generating technologies that use agricultural residues and forest residues to produce energy***
- ***Developing technologies that use residues from energy production for other purposes, such as correcting soil acidity or increasing soil fertility.***

Main Research Challenges: Industrial Technologies

- ***Improving oil extraction methods, especially from small and medium-sized plants.***
- ***Developing and improving the technological paths of biodiesel production.***
- ***Developing studies on the catalysts and reagents used in industrial processes.***

General Research Challenges

- **Traditional/biotechnology techniques to introduce new characteristics:**
 - **pest resistance**
 - **draught resistance**
 - **soil acidity and salinity tolerance**
 - **increase nutrient uptake efficiency**
- **Energetic efficiency**
- **Energetic density**
- **Input saver**
- **Integrated systems**

Some accomplishments



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Sugar Cane Breeding Programs

- ***Sugar cane varieties***
 - ***550 sugarcane varieties grown in Brazil***
 - ***last 10 years - 51 new varieties***
 - ***20 main varieties account for 70% of the planted area***
- ***Main Breeding Programs***
 - ***Copersucar - SP varieties***
 - ***Ridesa (universities network) RB varieties.***
 - ***Agronomic Institute of São Paulo State - IAC varieties***
- ***Germplasm Bank: 3000 entries***
- ***Two hybridizations stations: each of the main programs carried on 1.420.000 seedlings /year***

Selection of Genotypes with Higher Capacity of Biological Nitrogen Fixation

- ***RB 72454 - sugarcane selected cultivar.***
 - ***average yield 81 tons ha⁻¹***
 - ***BFN - more than 60% total plant N.***
- ***Pennisetum purpureum Schum. :***
 - ***Cultivars BAG-02, Cameroon e Gramafante***
 - ***BFN - more than 60% total plant N.***

Source: *Embrapa Agrobiology*

Diazotrophic endophytic bacteria's as vectors for genes with endophatogenic activity

Patent nº PI1101128-9

- ***S76 - strain of *Bacillus thuringiensis* (Bt) - activity 10 X higher biocide activity than the commercial product against *Diatraea saccharalis*, larvae.***
- ***Sequencing Plasmids pBt44 e pBT 110 underway identification of cry genes***
(partnership CNPAB, CENARGEN, UnB)
- ***Transgenic bacteria***
 - ***BNF / Insect control***

Source: Embrapa Agrobiology



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Genoma and Proteoma

- **Target bacteria: *Gluconacetobacter diazotrophicus*, strain PAL5 isolated from sugar cane.**
genome size - 4,24 Mb, 99% sequence done
- **Main metabolic pathways (nitrogen phyto-hormones, sugars, osmotic tolerance, amino-acids, sulphur)**
- **Functional Genome – genes functions.**
- **Proteomic network - *G. diazotrophicus***
- **Protein identification - BNF /sugarcane**

Partnership - CNPAB, UENF, UFRRJ, UFRJ

Source: Embrapa Agrobiology



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Thanks

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