FEASIBILITY OF BIOENERGY FROM BIOMASS/RESIDUES IN BRAZIL

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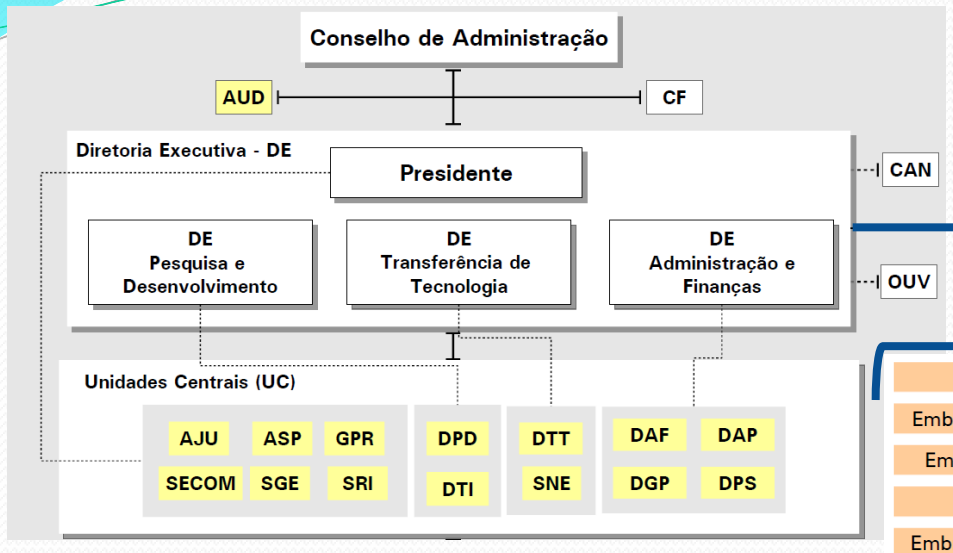
R&D Director of Embrapa Agroenergy

INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

Ministry of Mines and Energy of Brazil

Embrapa – A National RD&I Network in Agriculture



Mission: The Brazilian Agricultural Research Corporation's mission is to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer.

Thematic Units

Ecoregional Units

- Embrapa Acre
- Embrapa Agropecuária Oeste
- Embrapa Agrossilvipastoril
- Embrapa Amapá
- Embrapa Amazônia Ocidental
- Embrapa Amazônia Oriental
- Embrapa Cerrados
- Embrapa Clima Temperado
- Embrapa Cocais
- Embrapa Meio-Norte
- Embrapa Pantanal
- Embrapa Pecuária Sudeste
- Embrapa Pecuária Sul
- Embrapa Rondônia
- Embrapa Roraima
- Embrapa Semiárido
- Embrapa Tabuleiros Costeiros

Product Units

- Embrapa Algodão
- Embrapa Arroz e Feijão
- Embrapa Caprinos e Ovinos
- Embrapa Florestas
- Embrapa Gado de Corte
- Embrapa Gado de Leite
- Embrapa Hortaliças
- Embrapa Mandioca e Fruticultura
- Embrapa Milho e Sorgo
- Embrapa Pesca e Aquicultura
- Embrapa Soja
- Embrapa Suínos e Aves
- Embrapa Trigo
- Embrapa Uva e Vinho

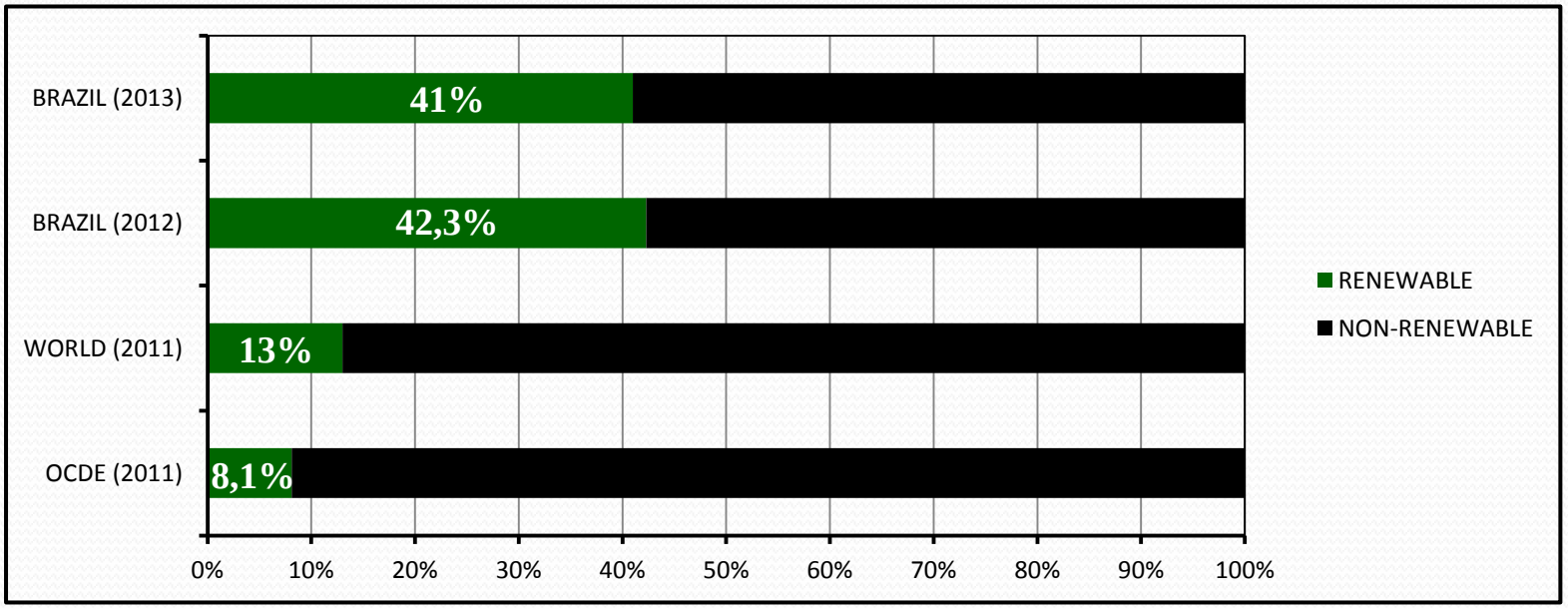
Service Units

- Embrapa Agrobiologia
- Embrapa Agroenergia
- Embrapa Agroindústria de Alimentos
- Embrapa Agroindústria Tropical
- Embrapa Estudos e Capacitação
- Embrapa Informática Agropecuária
- Embrapa Instrumentação
- Embrapa Meio Ambiente
- Embrapa Monitoramento por Satélite
- Embrapa Recursos Genéticos e Biotecnologia
- Embrapa Solos
- Embrapa Café
- Embrapa Gestão Territorial
- Embrapa Informação Tecnológica
- Embrapa Produtos e Mercado
- Embrapa Quarentena Vegetal

NATIONAL SYSTEM FOR AGRICULTURAL RESEARCH

- 17 State Agricultural Research Institute (Ex. Epamig & Epagri);
- Public Research Institute (Ex.: CTBE);
- Public Universities (Ex.: UFLA, UFV);
- Private Universities (Ex. UCB);
- Private Companies; and
- EMBRAPA

PARTICIPATION OF RENEWABLE SOURCES IN THE BRAZILLIAN ENERGY MATRIX



SOURCES: Empresa de Pesquisas Energéticas
International Energy Agency

DOMESTIC ENERGY OFFER

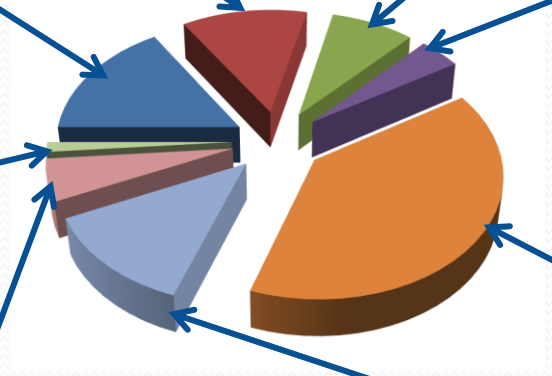
HYDROELECTRIC
12,5%

WOOD AND
CHARCOAL
8,3%

SUGARCANE
BAGASSE
16,1%

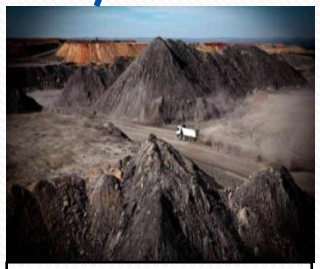
SOLAR AND WIND
4,2%

RENEWABLE
41%



URANIUM
1,3%

OIL AND
OIL PRODUCTS
39,2%



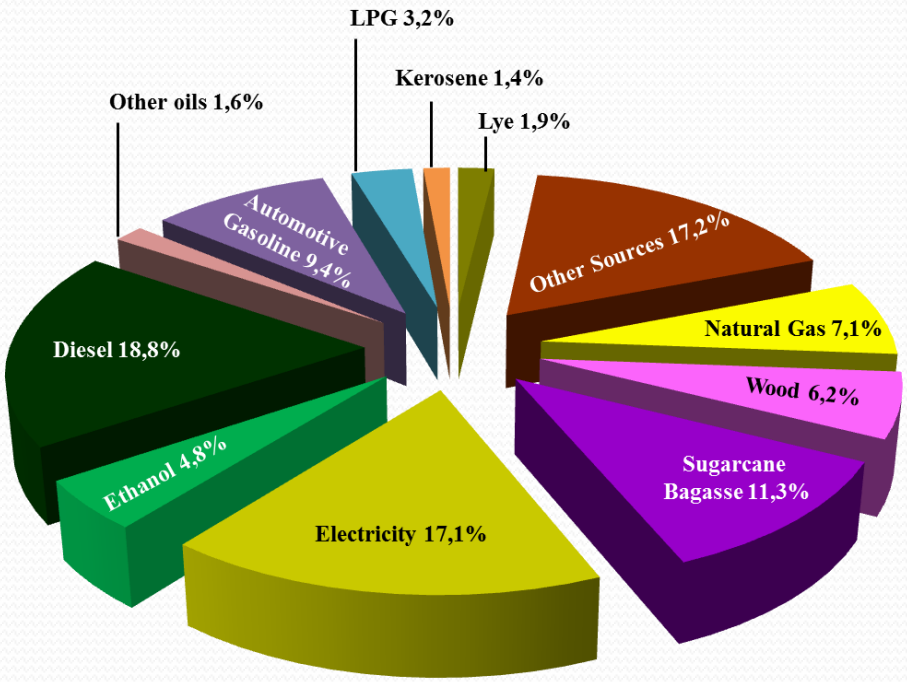
MINERAL COAL
5,6%

NATURAL GAS
12,8%

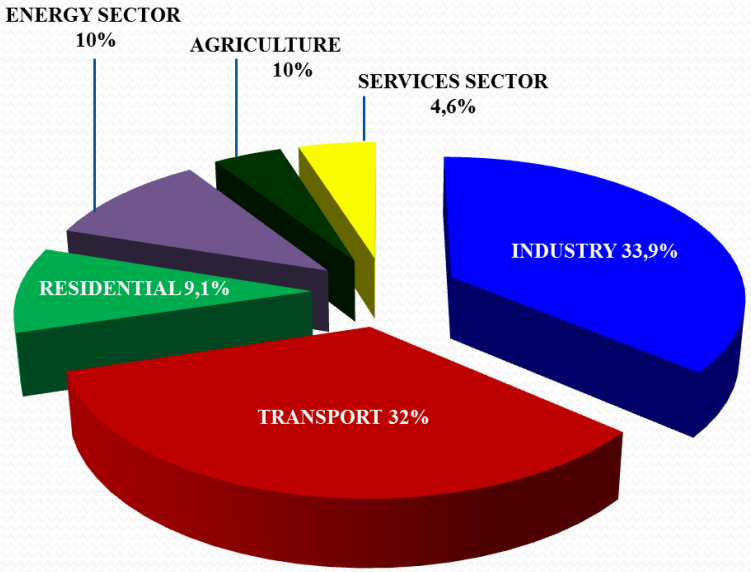
NON-RENEWABLE
59%

Source: EPE 2013

FINAL ENERGY CONSUMPTION BY SOURCE IN BRAZIL



ENERGY USE BY SECTOR



Source: EPE 2013

DATA COLLECTION

- **What is the legal basis and procedure to collect energy/agricultural data?**
  - There are many Research Institutions, Ministries, Associations, Universities raising information of different nature (Some public, some protected)

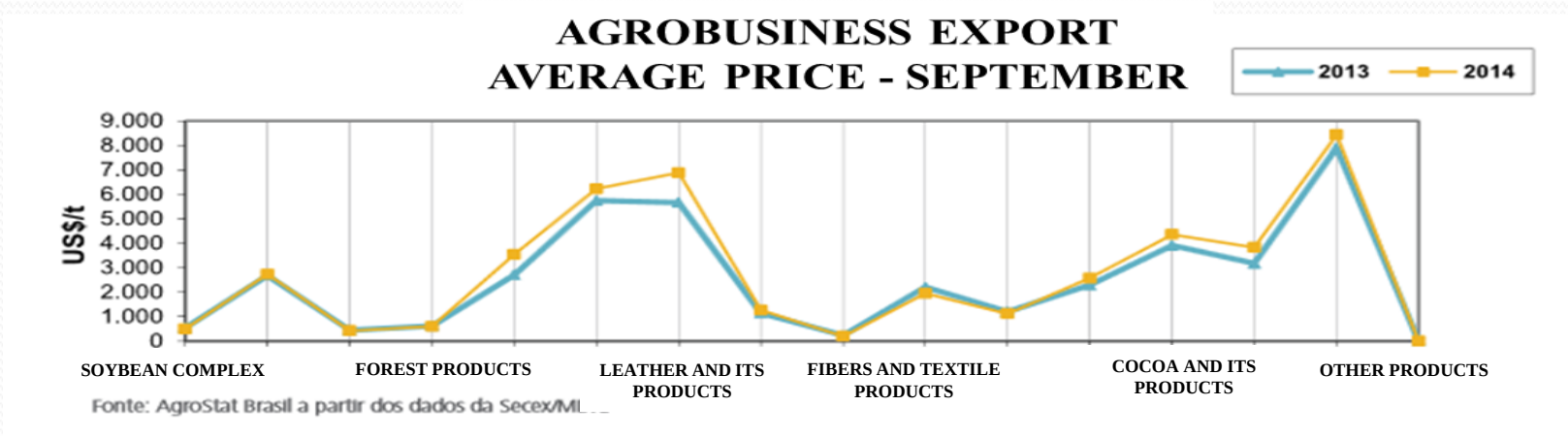
- **Who uses the data and how?**
  - For public information – anyone
  - For protected information – Who pays/ Who is partner

- **What are the main issues?**
  - Difficulty in rising information in a continental country
  - Changes in the agriculture profile (new crops, fallow areas, etc.)
  - Competition among and between sectors (energy, food, fuel, etc.)

AGRICULTURE SITUATION IN BRAZIL

- Main food crops produced
  - Vegetables, fruit, rice, beans, soybean, corn, peanuts, many others.

- Main export staples
  - Soybean, Forest products, leather, Fibers, Cocoa, Other products



Adapted from Agrostat Brasil

CROP RESIDUES/WASTE PRODUCED IN BRAZIL

- **Types of residues**

  - Waste from agricultural activity
  - Waste from industrial activity that uses agricultural raw material
  - Waste from industrial activity that does not use agricultural raw material
  - Urban waste

- **Disposal/use of residues**

  - Use in agriculture
  - Use as raw material for by-products production
  - Use in the manufacture of building materials
  - Landfills
  - Incineration
  - Other***

URBAN RESIDUES







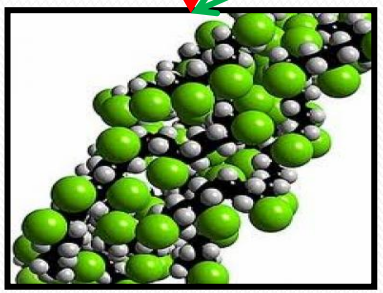


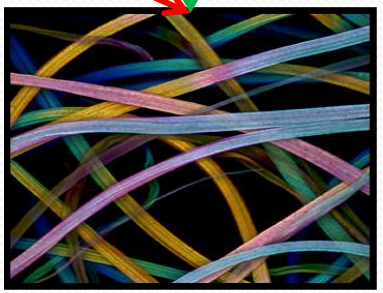


RESEARCH FOCUSED ON TRANSFORMIG RESIDUES INTO HIGH VALUE PRODUCTS

WOOD RESIDUES

ORGANIC RESIDUES





BIO-OIL

NEW BIOMATERIALS

NEW POLYMERS

CELLULOSE NANO FIBERS

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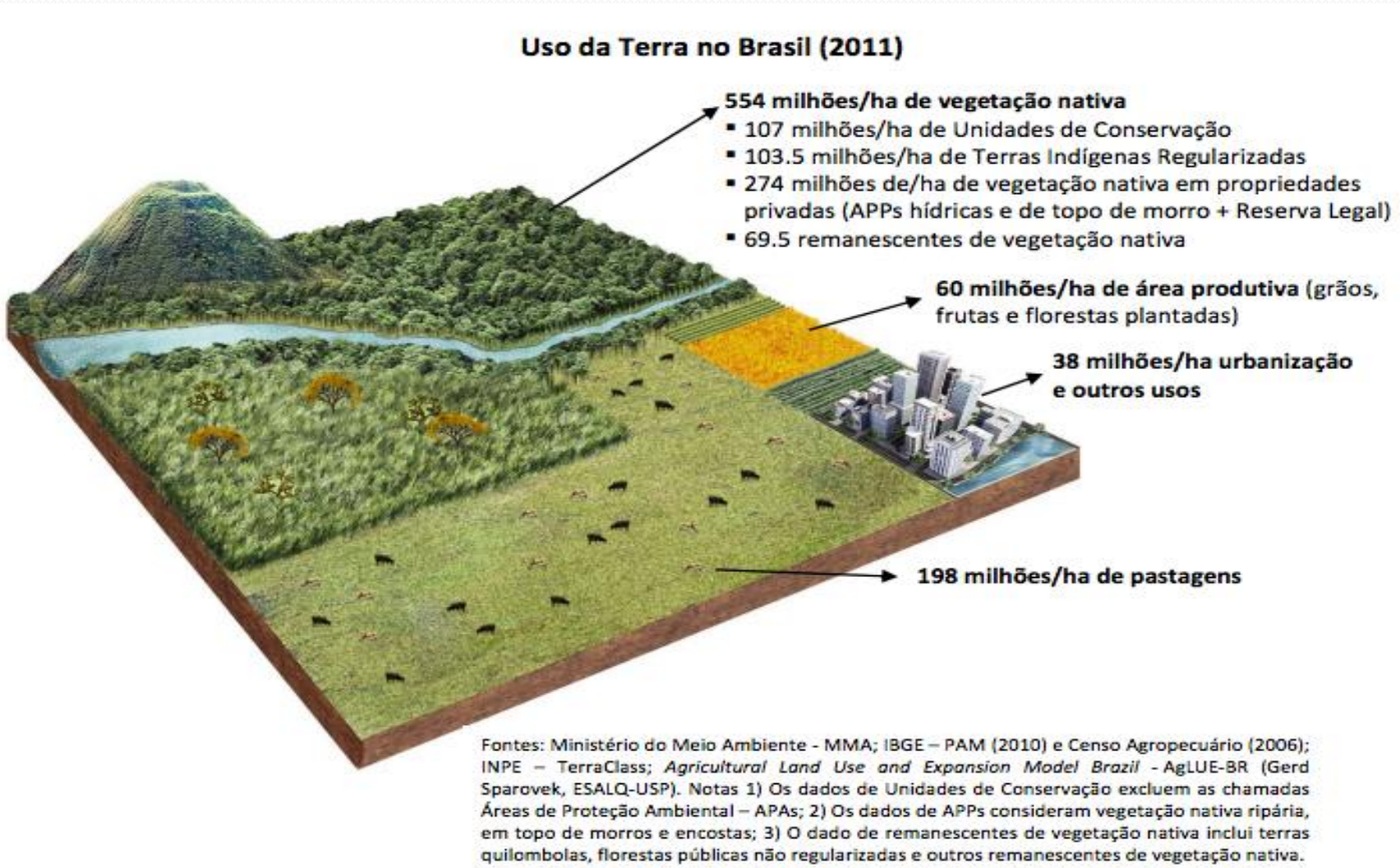
AGRICULTURE STRATEGY

LAND USE IN BRAZIL – 851 MILLION ha



Fontes: Ministério do Meio Ambiente - MMA; IBGE – PAM (2010) e Censo Agropecuário (2006); INPE – TerraClass; *Agricultural Land Use and Expansion Model Brazil* - AgLUE-BR (Gerd Sparovek, ESALQ-USP). Notas 1) Os dados de Unidades de Conservação excluem as chamadas Áreas de Proteção Ambiental – APAs; 2) Os dados de APPs consideram vegetação nativa ripária, em topo de morros e encostas; 3) O dado de remanescentes de vegetação nativa inclui terras quilombolas, florestas públicas não regularizadas e outros remanescentes de vegetação nativa.

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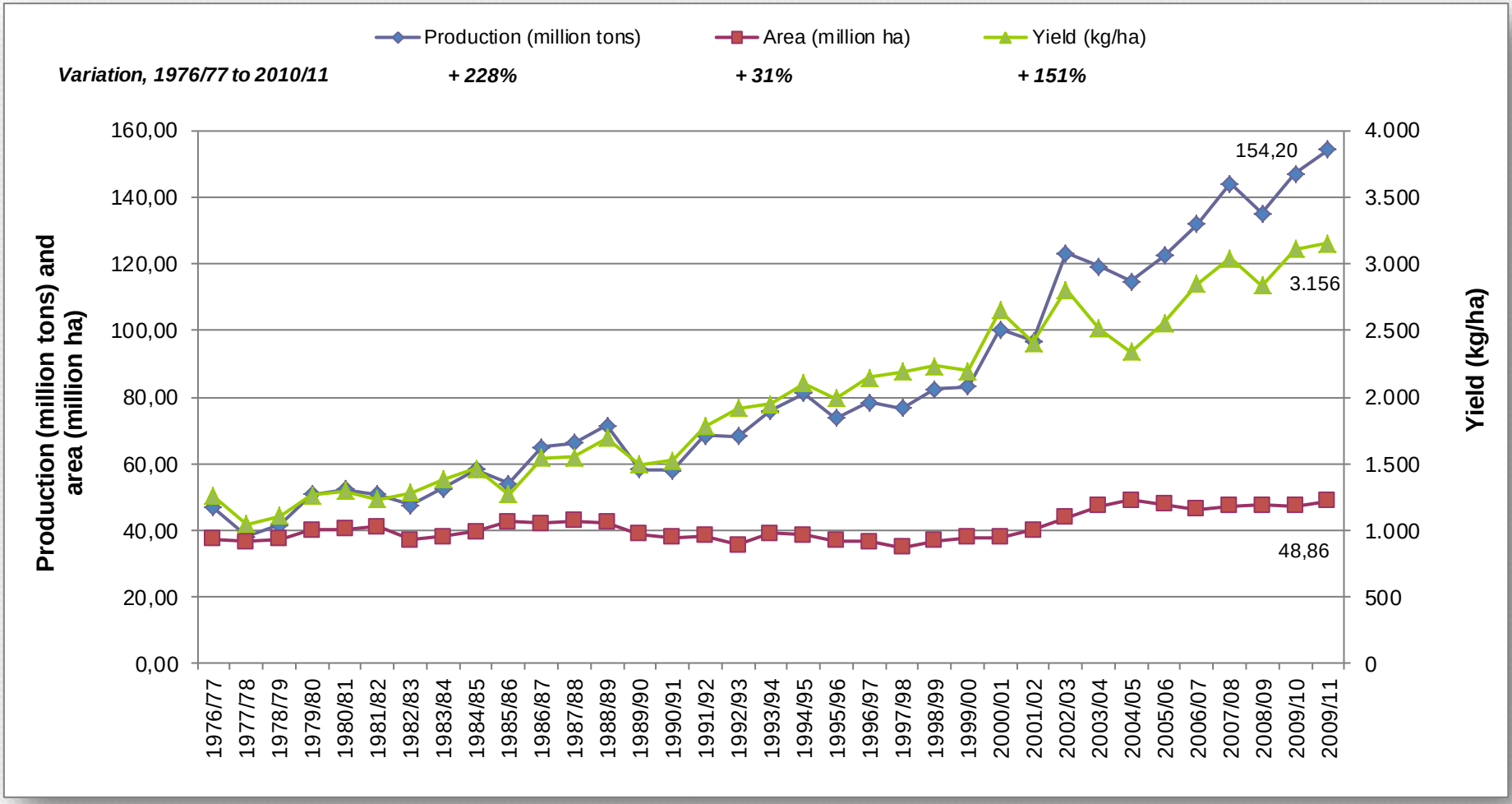
Grain and oilseed production, yields and farmed area in Brazil from 1975 to 2010.



FAMILY FARMING IN BRAZIL

Photo: Cláudio Morões

- Farming area: **106.8** million hectares
- **12** million producers (1/3 of them are women)
- **24%** of agricultural area
- **84%** of land owners in Brazil

Cassava	**87%**
Milk	**58%**
Bean	**70%**
Cattle	**30%**
Poultry	**50%**
Corn	**46%**
Pork	**59%**
Rice	**34%**

Source: Ministry of Agrarian Development

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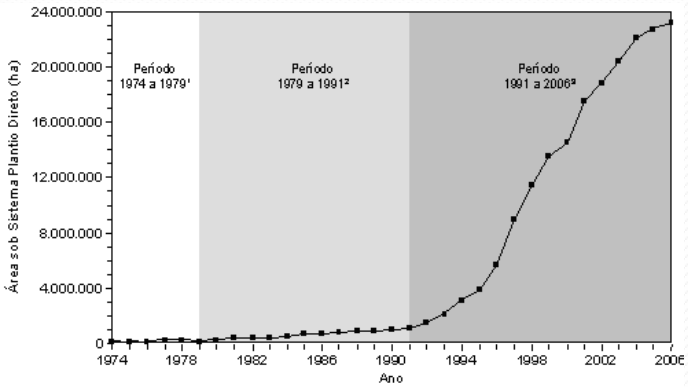
CROPPING SYSTEM – NO TILL FARMING

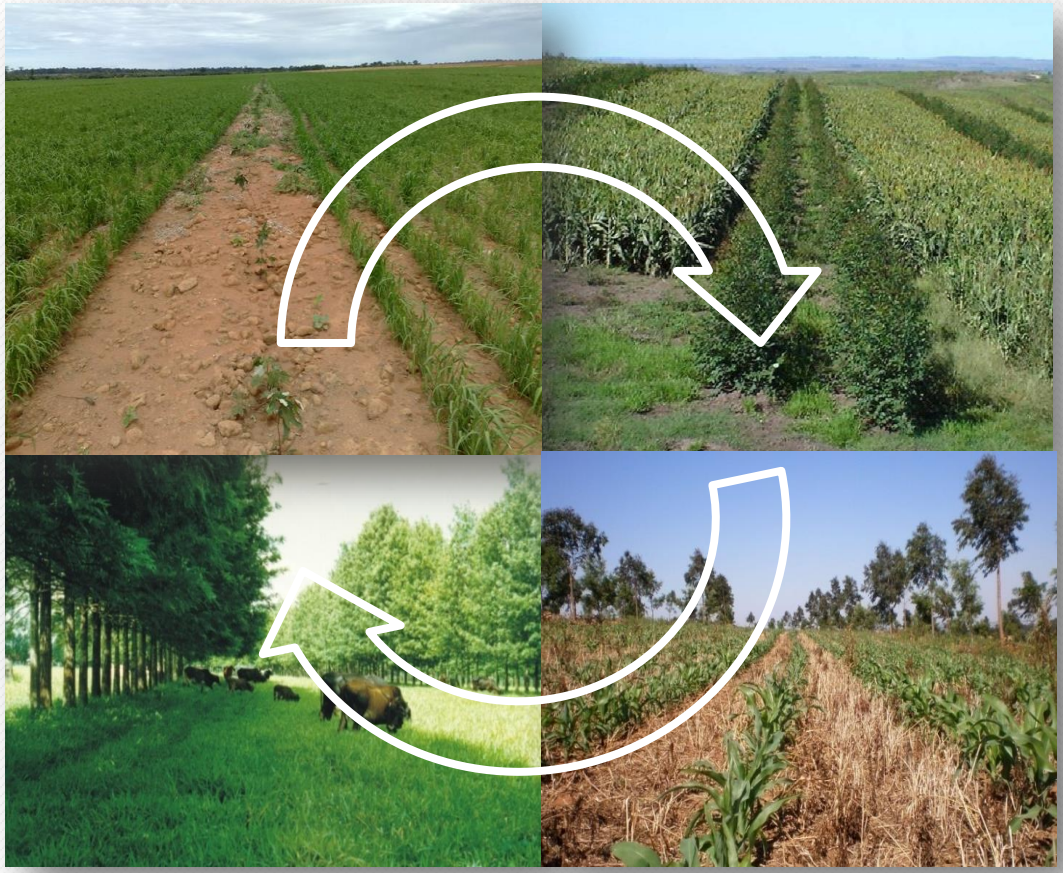
- 75% reduction in soil erosion.
- 69% reduction in nutrient lixiviation
- Reduction in CO_2 emission.
- Reduction diesel consumption.
- More efficient use of inputs.
- Better water retention.



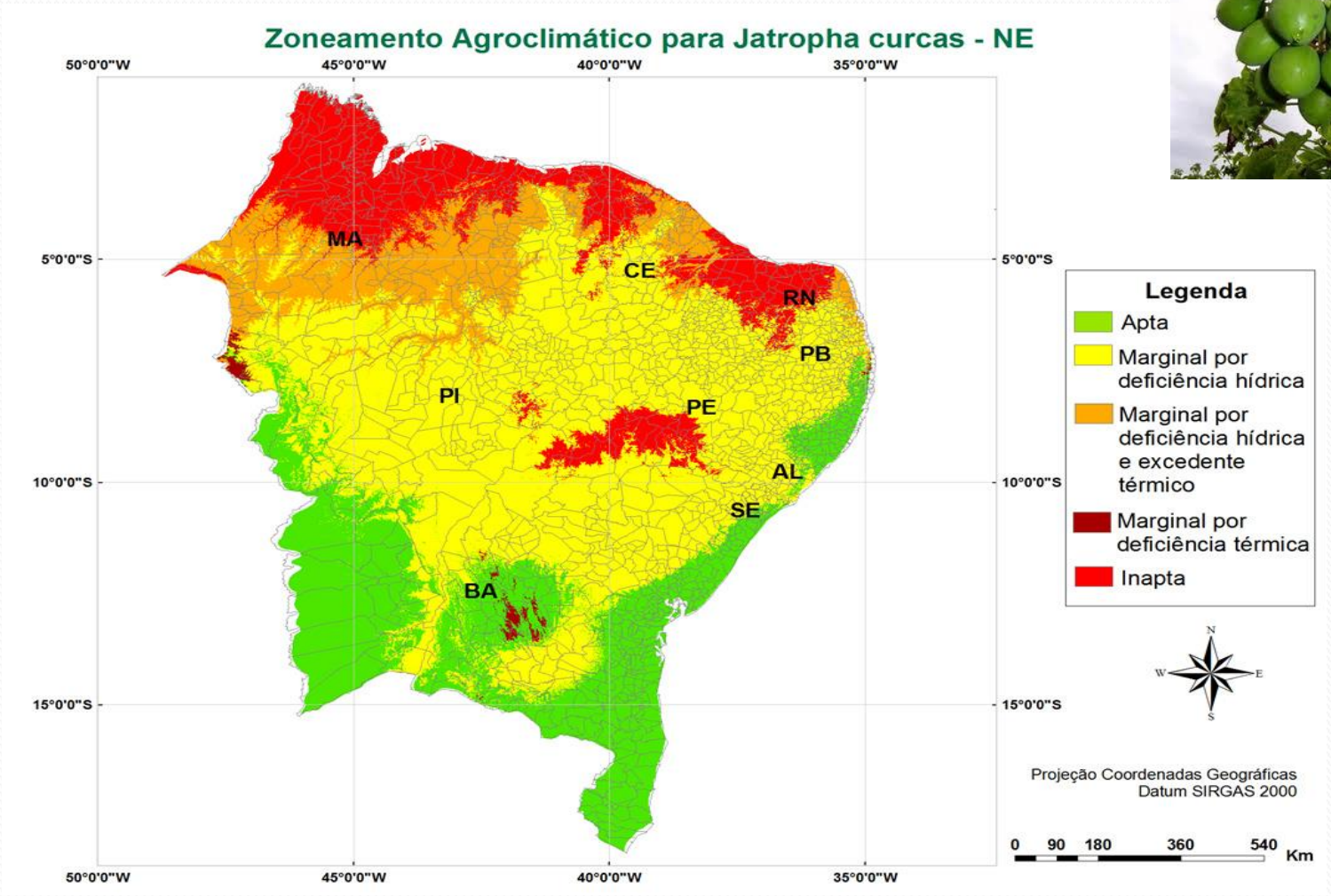
Embrapa

CROP – LIVESTOCK - FOREST INTEGRATION - CLFI

"Agricultural intensification and expansion with mitigation of environmental impact"



AGROCLIMATIC ZONING FOR *Jatropha curcas*

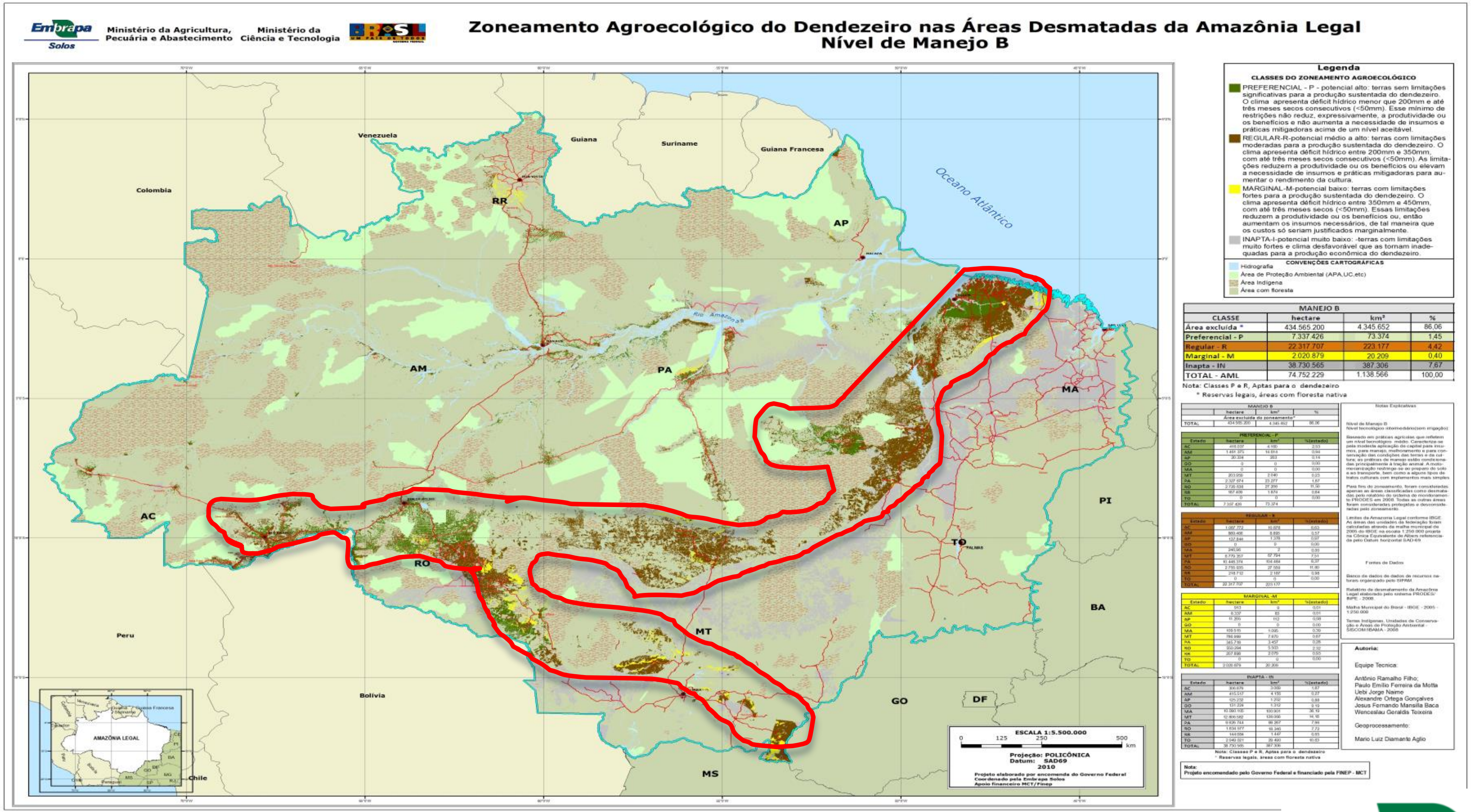


ESALQ (USP)

Embrapa

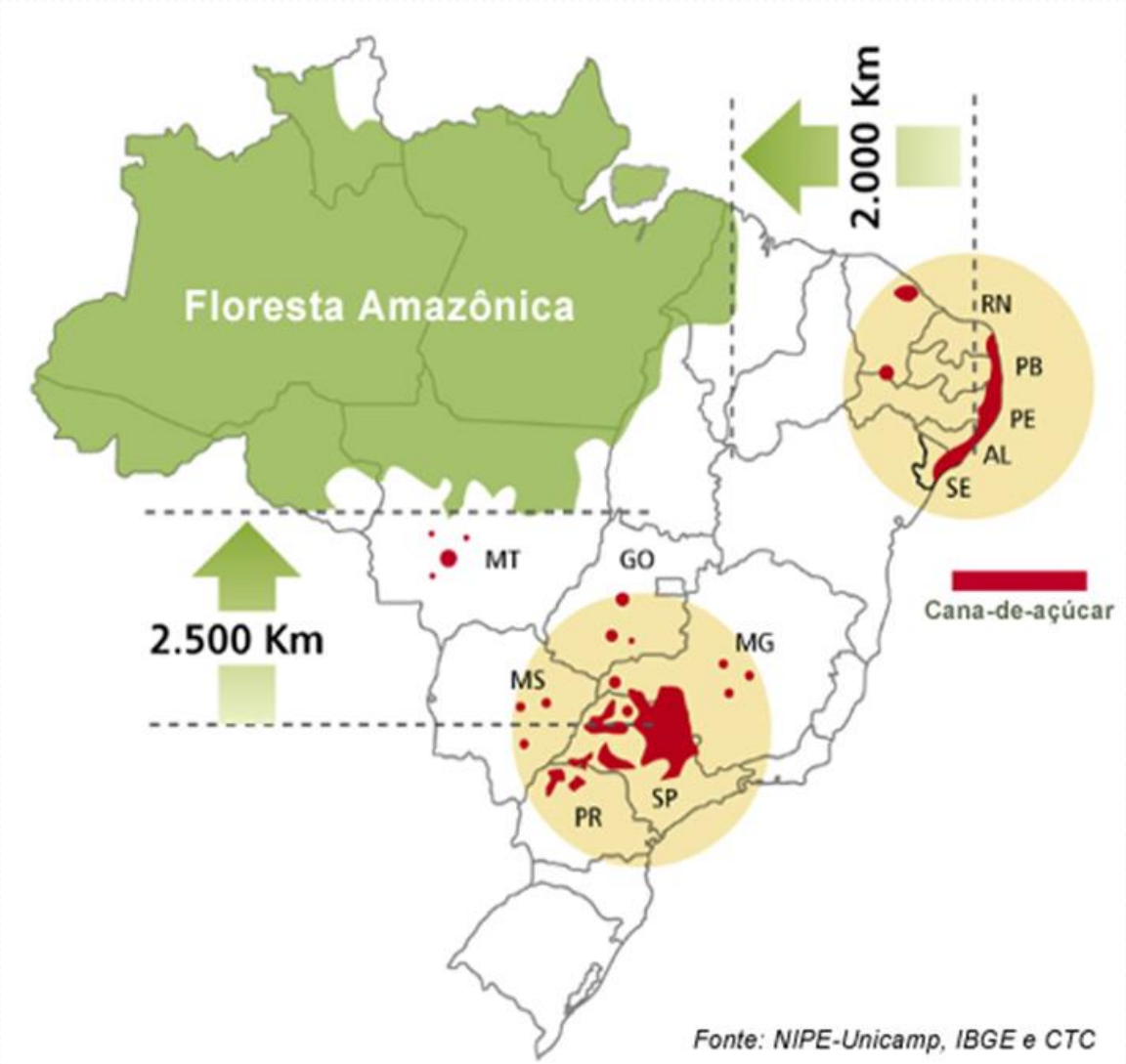
AGROCLIMATIC ZONING FOR OIL PALM

316.760 Km^2 (Tech level B)
31.676.012 ha
(AC, AP, AM, PA, RO, RR, RD, MT)

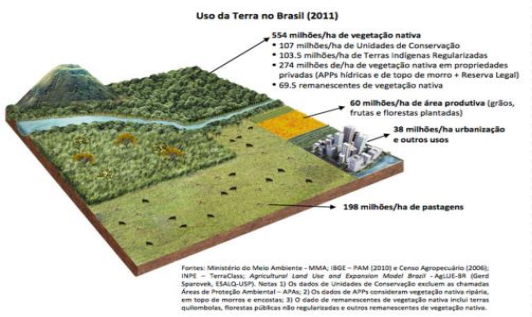


Embrapa

AGROCLIMATIC ZONING FOR SUGAR CANE



WHAT ARE THE MAIN ISSUES? (LAND, WATER, PRODUCTION, STORAGE, EXPORT, POLICY…)

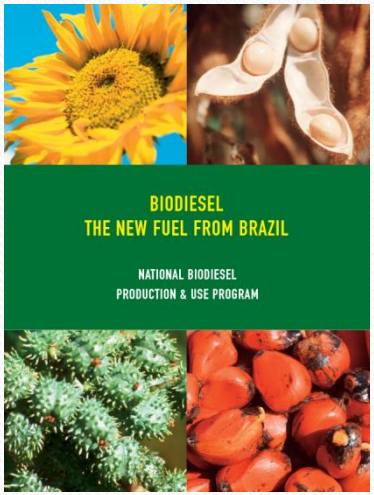


- **Whater is an issue anyware**
- **Land for food crops and for energy crops is not an issue**
  - No conflict food x energy
- **Sotrage is an issue mostly for food crops**
  - As we increase the use of residues storage becomes an issue
- **Export has constraints**
  - Nontariff barriers
  - Phytosanitary barriers
  - No conflict between food and energy production in Brazil
- **Policy**
  - Uncertainty regarding public policies for different sectors (Biodiesel, Sugar cane industry, etc.)

POLICY FRAMEWORK

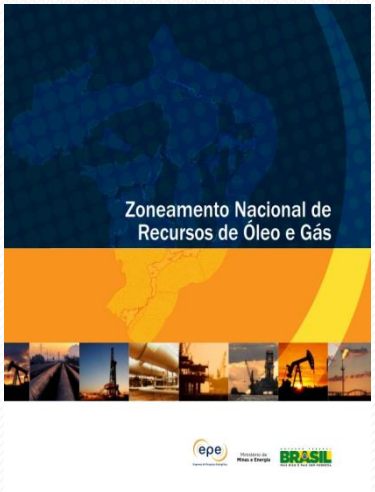
PNA

PNPB

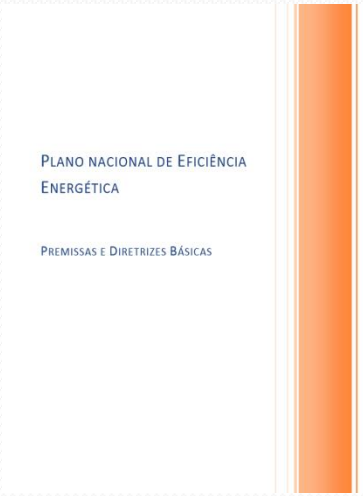


PNE

ZNROG

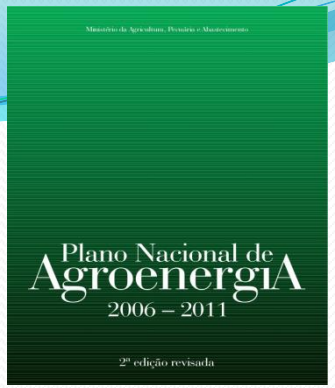


PNEE



Embrapa

BRAZILIAN AGROENERGY PLAN 2006-2011



KEY ELEMENTS OF THE POLICY FRAMEWORK

Development of bioenergy - Expansion of the ethanol sector, implementation of the biodiesel production chain, waste recovery and expansion cultivated energy forests, with nationwide coverage, focusing on efficiency and productivity and favoring less developed regions.

Agro-energy and food production - The expansion of agroenergy will not affect food production for internal consumption, specially the standard food basket. Rather, co-product of biodiesel, such as soybean cake and sunflower seeds, tend to complement the supply of products for human consumption and animal.

Technological development - Research and development of agricultural and industrial technologies suitable for bioenergy production chains that provide greater competitiveness, adding value to products and reduction of environmental impacts. Concomitantly, should contribute to the economic and social integration, including the development of appropriate technologies to use energy biomass on a small scale.

Community Energy Autonomy - The idea is to provide isolated communities, to individual farmers, cooperatives or associates, and agrarian reform settlements, means to generate their own power, especially in remote regions of the country.

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BRAZILIAN AGROENERGY PLAN 2006-2011

KEY ELEMENTS OF THE POLICY FRAMEWORK

Generating employment and income - The Agroenergy policy should be a vector for internal development, social inclusion, reducing regional disparities and settlement of populations in their natural habitat, especially by adding value to the supply chain and integration of different dimensions of the agribusiness.

Optimizing the use of disturbed areas - Energy crops should be produced respecting the sustainability of productive systems, and to discourage unwarranted expansion of the agricultural frontier or the progress toward sensitive or protected systems, such as the Amazon Rainforest, the Pantanal region, among others. May also contribute to the recovery of degraded areas.

Optimization of regional vocations - Encouraging installation of bioenergy projects in regions with abundant supply of soil, sunlight and manpower, providing benefits for work and capital, considering private and social points of view, considering yet crops with greater potential.

Leadership in international trade in biofuels - Brazil brings comparative advantages that allow it to aspire to the leadership in the international market for biofuels and to implement actions to promote energy products derived from bioenergy. The expansion of exports, and the generation of foreign exchange, consolidate the sector and boost the country's development.

Adherence to environmental policy - bioenergy programs should be adherent to the Brazilian environmental policy, besides being in perfect harmony with the provisions of the Clean Development Mechanism (CDM) of the Kyoto Protocol, increasing the use of renewable energy sources with lower emissions of greenhouse gas emissions.

HAS THE **BIOMASS RESOURCE AVAILABILITY** BEEN ASSESSED AT NATIONAL/LOCAL LEVEL? IF NOT, WHAT IS THE LIMITING FACTOR?

WHAT IS NEEDED TO USE A BIOMASS/RESIDUES IN THE CONTEXT OF BIOENERGY?

1) **TECHNOLOGICAL DOMAIN**
   - **Production system adapted to different environment**
   - **Conversion processes available**

2) **PRODUCTION SCALE**
   - **Cultivars (seed)**
   - **Productivity**

3) **LOGISTICS**
   - **Transport, proximity to market, etc.**

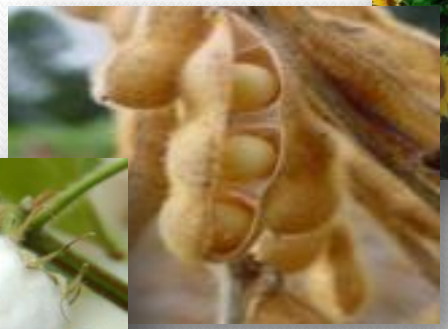
TRADITIONAL BIOMASSES

- **Raw materials (requirements):**
  - **Technological domain**
  - **Production scale**
  - **Logistics**

Oil Palm
4.000 kg/ha

Castor Bean
700 kg/ha

Sun Flower
600 kg/ha



Soy Bean
500 kg/ha

Cotton
450 kg/ha

Oil Productivity

POTENTIAL BIOMASSES

In use

- Soy Bean
- Castor Bean
- Sun Flower
- Cotton

Under evaluation

- Oil Palm *(Elaeis guineensis)*
- Macaúba (*Acrocomia aculeata*)
- Tucumã (*Astrocaryum sp.)*
- Babaçu *(Orbignya phalerata)*
- Inajá (*Maximiliana maripa*
- Physic nuts (*Jatropha curcas*)
- Peanuts
- Canola
- Buriti
- Residual Oils
- Wild radish
- Crambe
- Sesame
- Linseed (seed)
- Pequi
- Industrial waste
- Tung

Source: Bruno Laviola (Embrapa Agroenergia)

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Technical Coefficients

- **Technical coefficients of traditional oilseeds**

Biomass	% Oil	Productivity (Kg/ha)	Oil Production (Kg/ha)
Soybean	18	3.000	540
Cotton	20	1.900	360
Sunflower	42	1.500	630
Peanuts	45	1.800	800
Castor bean	47	1.500	705
Canola	40	1.300	500
Oil Palm	20	20.000	4.000

Souce: Laviola e Alves (2011)

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Technical Coefficients

- **Technical coefficients of potential oilseeds**

Biomass	% oil	Potential productivity (Kg/ha)	Oil production (Kg/ha)
Macaúba	20	20.000	4.000
Inajá	20	17.500	3.500
Tucumã	20	12.000	2.400
Babaçu*	5	10.000	500
Soybean	18	3.000	540

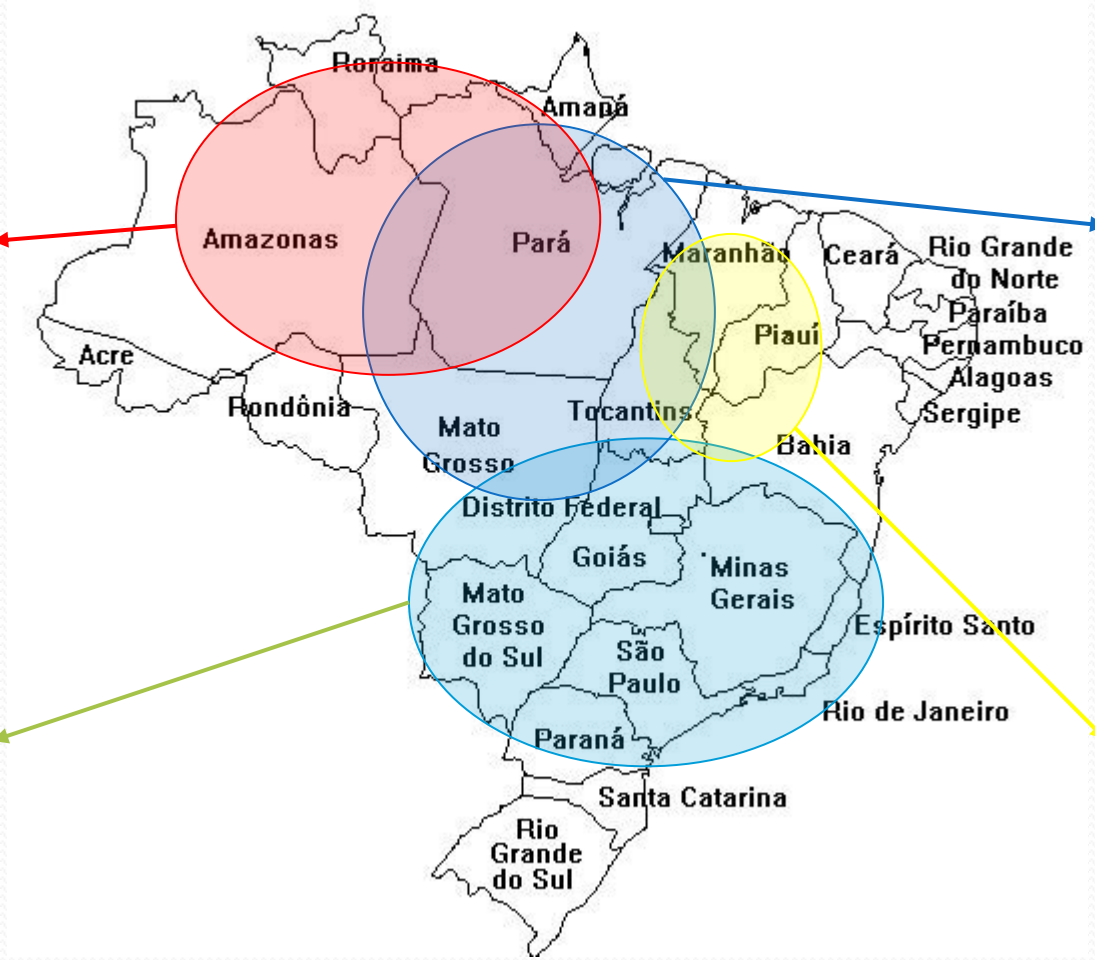


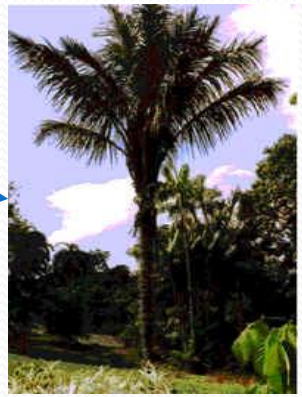

Source: Laviola e Alves (2011)

Geographical Distribution

Inajá

Macaúba





Tucumã

Babaçu

Source: Laviola e Alves (2011)

JATROPHA CURCAS

- **PERENIAL OIL PRODUCER PLANT WITH HIGH POTENTIAL FOR THE PRODUCTION OF AVIATION BUIOFUELS, BIODIESEL AND OTHER PRODUCTS**

Crop Potentialities

High yield of grains
(> 4.500 kg/ha – 9.000 Kg/ha)

High yield of oil
(> 2.000 kg/ha – 3.000 kg/ha)

High oil quality for Biodiesel
Palmitic 12,4%; Oleic 44,8%
Linoleic 34%; Stearic 7,8%
(C16 to C18) – (C10-C14)

Diversification of agriculture

Environment adaptation

Research Challenges

Need to broaden the genetic diversity

Lack of cultivars adapted to different areas

Lack of a production system

Uneven fruit ripening

Toxicity of the biomass residuals

Production cost

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OIL PALM

(E. guineensis; E. oleifera)

Crop Potentialities

High yield of Bunchs
(20 ton/ha/year)

High yield of oil
(4 a 6.000 kg/ha)

High oil quality
Palmitic 44%; Oleic 39%
Linoleic 11%; Stearic 4%
(C16 to C18) – (C10-C14)

Diversification of agriculture

Environment adaptation

Research Challenges

Strengthening breeding program

Resistance to Bud Rot

High efficiency cloning system

Increase seed production

Reduced production cost

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MACAÚBA
(*Acrocomia aculeata; A. intumescens*)

CROP POTENTIALITIES

- Potential for high yield of oil (4.000 kg/ha)
- Rusticity and adaptability to different climes
- Drough Tolerance (?)
- Evolution in dense areas (Resistance)
- Chance of sustainable harvesting
- Can be used in agroforestry systems
- Residues free of toxic compounds

RESEARCH CHALLENGES

- Lack of cultivars (Unknown genetic diversity)
- Lack of agronomic technology
- Germination problems
- Fruit production only after 4 to 5 years
- Tall plants (Dificulty of harvest)
- Harvest point x Uneven maturation
- Need for fast processing of fruits

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BABAÇU
Orbignya spp.

CROP POTENTIALITIES

- Potential for high yield of oil (4.000 kg/ha)
- Rusticity and adaptability to different climes
- Drough Tolerance (?)
- Evolution in dense areas (Resistance)
- Chance of sustainable harvesting
- Can be used in agroforestry systems
- Residues free of toxic compounds

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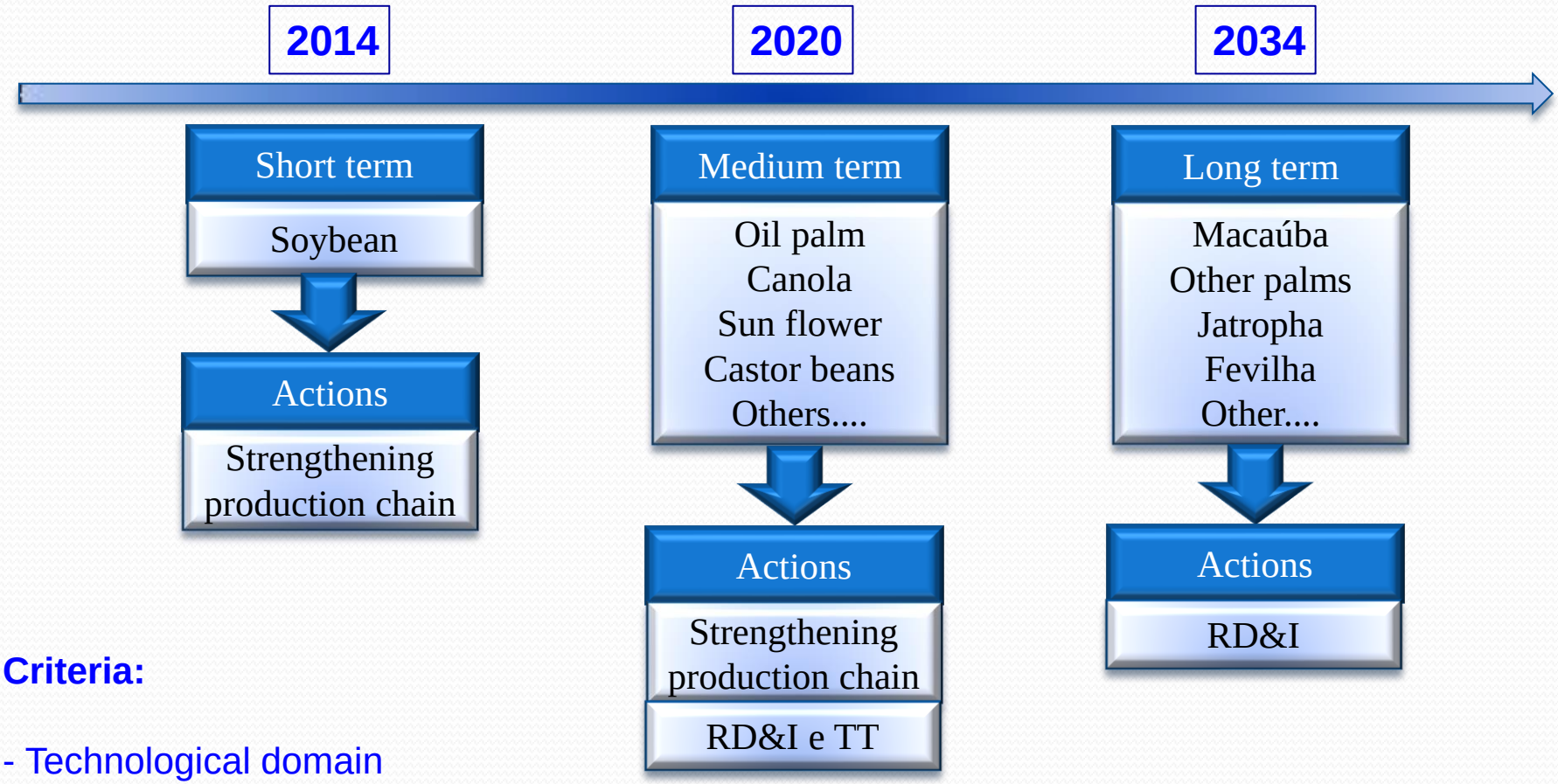
FEVILHA
Fevillea cordifolia

CROP POTENTIALITIES

- Potential for high yield of oil (4.000 kg/ha)
- Rusticity/adaptation to different climates
- Drough Tolerance (?)
- Evolution in dense areas (Resistance)
- Chance of sustainable harvesting
- Can be used in agroforestry systems
- Residues free of toxic compounds

FEEDSTOCK AVAILABILITY

INCREASE IN THE OFFER OF SUSTANABLE BIOFUELS AND BIOMASS



Criteria:

- Technological domain
- Production Scale
- Logistics

CONCLUDING REMARKS

1) SOYBEAN AND SUGAR CANE ALONE WILL NOT RESPOND TO THE DEMANDS OF ALL SECTORS

2) THERE ARE MANY ALTERNATIVE FEEDSTOCKS FOR BIOENERGY

3) INDUSTRIAL PROCESSES ARE AVAILABLE FOR TRANSFORMING FEEDSTOCK AND RESIDUES

4) RESEARCH MUST CONTINUE TO ENSURE AVAILABILITY OF FEEDSTOCK WHEN DEMANDED

5) URBAN RESIDUES ARE AN ENORMOUS SOURCE OF ENERGY AND OTHER VALUE PRODUCTS

6) SUSTAINABILITY IN THE PRODUCTION OF ENERGY IS REACHED WITH DIVERSIFICATION (FOSSIL OIL, HIDROELETRIC, WIND, BIOFUELS, ETC…)

7) MORE DIVERSIFYED PRODUCTION = INCREASE IN SOCIAL INCLUSION

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EMBRAPA AGROENERGY

THANK YOU !

Guy de Capdeville
chpd.cnpae@embrapa.br

Recommendations

- What are the solutions to the challenges identified on the previous slides?
- What needs to change and how?
- What is the timeframe for these changes?
- Who is responsible for making the changes?
- What assistance (if any) is required?

NOTE: the presenter can use more than one slide to present these topics if needed

- Have you identified the **market potential and economic impact** of bioenergy production? If not, what is the limiting factor?
  - Market potential and economic impact includes: current and future market size of bioenergy, bioenergy supply costs (incl. feedstock costs, production/generation costs, and distribution); impact on public budget (in case of financial incentives); employment benefits

- Are the **technology, infrastructure and required skills** available in your country sufficient to meet plans for bioenergy deployment? If not, what is the limiting factor?
  - Technology includes: feedstock production (incl. harvesting and transportation), conversion to final energy, and distribution