

# **Biodiesel: Potential Alternatives Sources**

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**Embrapa Maize and Sorghum**





# BIODIESEL: HISTORY

- 1975 → Release of PRÓ-ÓLEO (substitution diesel by vegetal oil)
- 2004 → Release of National Program of Production and Use of Biodiesel (PNPB, 2004)
- 2006 → 2% of vegetal oil in the diesel
- 2013 → 5% - Anticipated to 2010

H-BIO → 18% of vegetal oil in the diesel

Demand for 2010 – 3 million of tons of oil

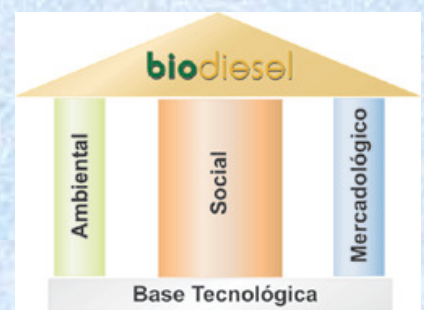


**(PNPB, 2004)**

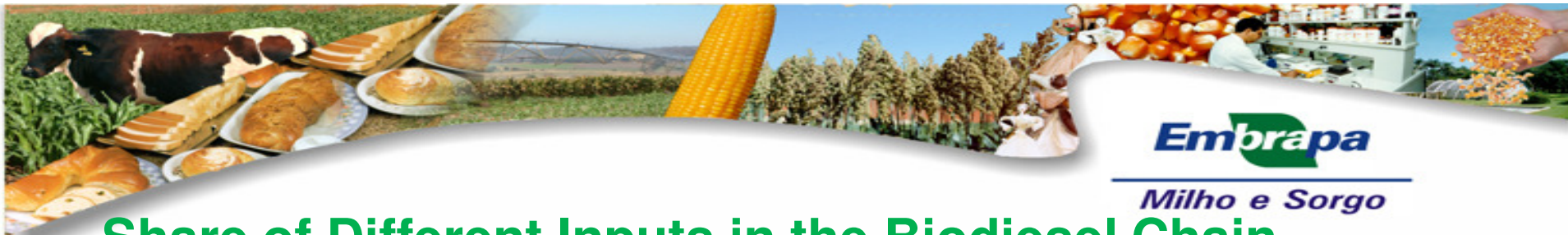
- Job and income generation in the rural area (Social)
- GHG reduction (Environmental)
- Energy garanty (Market)



Year	Blend	Demand (m <sup>3</sup> )*
2008	B2	830.000
2008 (Julho)	B3	1.245.000
2009	B4	1.660.000
2013 (2010)	B5	2.073.000
...	B10, B30, ...	...

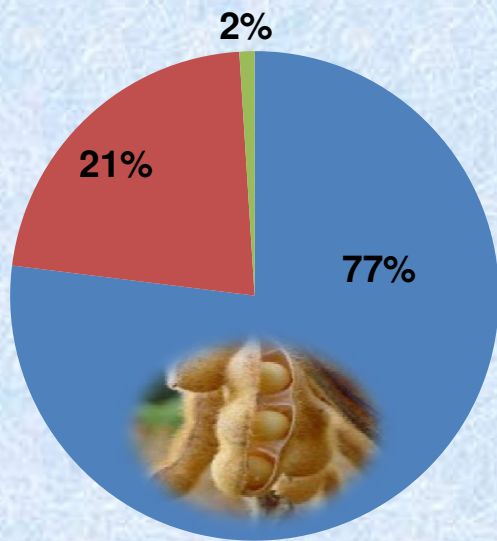


\* Estimatives of demand considering the consumption of 41.500.000 m<sup>3</sup> of Diesel oil in 2007



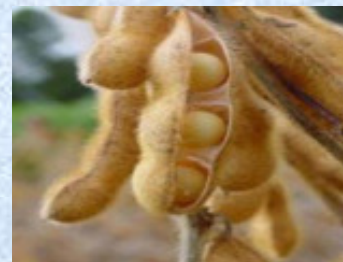
# Share of Different Inputs in the Biodiesel Chain

- Soybean
- Animal Fat
- Others oil source (cotton, sunflower, etc.)



Source: BiodieselBR, 2008

## Oil Productivity



500 kg/ha



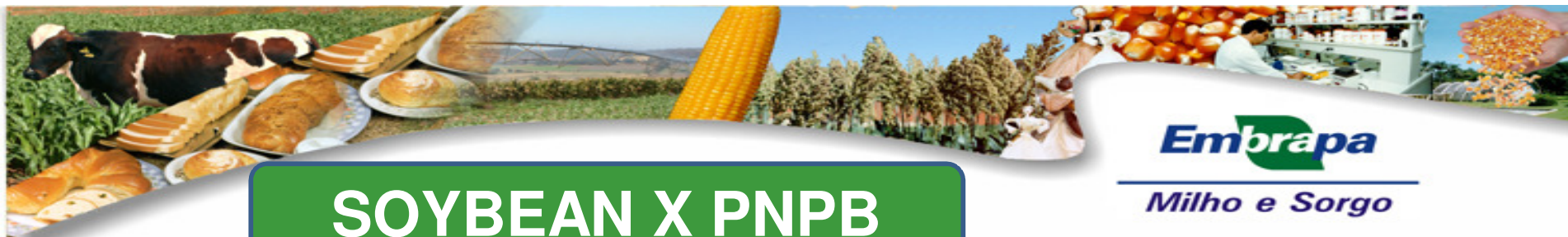
450 kg/ha



600 kg/ha



> 1.500 kg/ha



# SOYBEAN X PNPB

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- Diesel consumption: 41,5 bill of Its
- Soybean Production 2007/2008: 60.000.000 Tons of grain
- % of oil in the grain 20%
- Oil Production: 12.000.000 m<sup>3</sup> (if total soybean grain production was pressed)

Year	Blend	Demand (m <sup>3</sup> )	% of soybean production
2008	B2	830.000	6,90
2008	B3	1.245.000	10,40
2009 (julho)	B4	1.660.000	13,83
2013 (2010)	B5	2.075.000	17,30
...	B10	4.150.000	34,60
...	B30	12.450.000	103,8



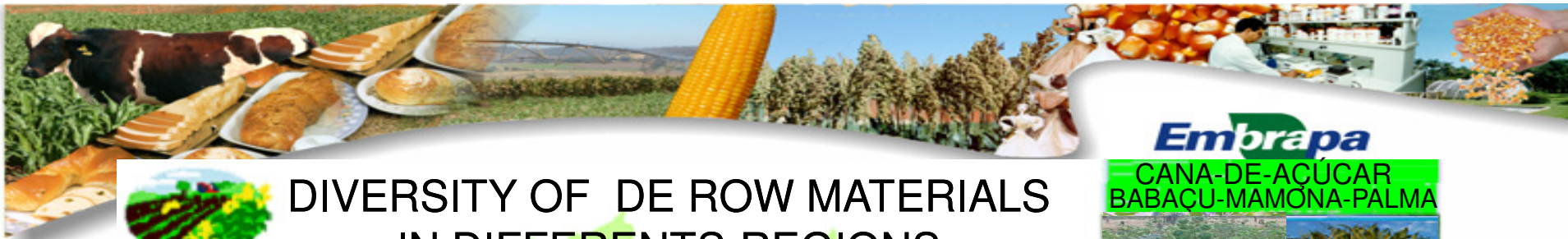
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## ALTERNATIVES RAW MATERIAL FOR BIODIESEL

- SOYBEAN;
- CASTOR OIL;
- PALM OIL;
- SUNFLOWER;
- Canola/COLZA;
- Palmist;
- Babaçu;
- PEANUT;
- Tucumã;
- COTTON SEED;
- Pequi;
- Sesame seed;
- Jatropha Curcas;
- Buriti;
- Turnip forrageiro;
- Jojoba;
- Linhaça;
- ANIMAL FAT;
- INDUSTRIAL RESIDUE.



Ramos, LP (adaptado)



**Embrapa**

CANA-DE-ACÚCAR  
BABACU-MAMONA-PALMA



## DIVERSITY OF DE ROW MATERIALS IN DIFFERENTS REGIONS

**DENDÊ**

Norte

Nordeste

Centro-Oeste

CANA-DE-ACÚCAR  
SOJA-MAMONA-  
ALGODÃO (CAROÇO)

Sudeste

CANA-DE-ACÚCAR  
SOJA-ALGODÃO-GIRASSOL



SOJA-ALGODÃO-GIRASSOL-CANOLA

Sul



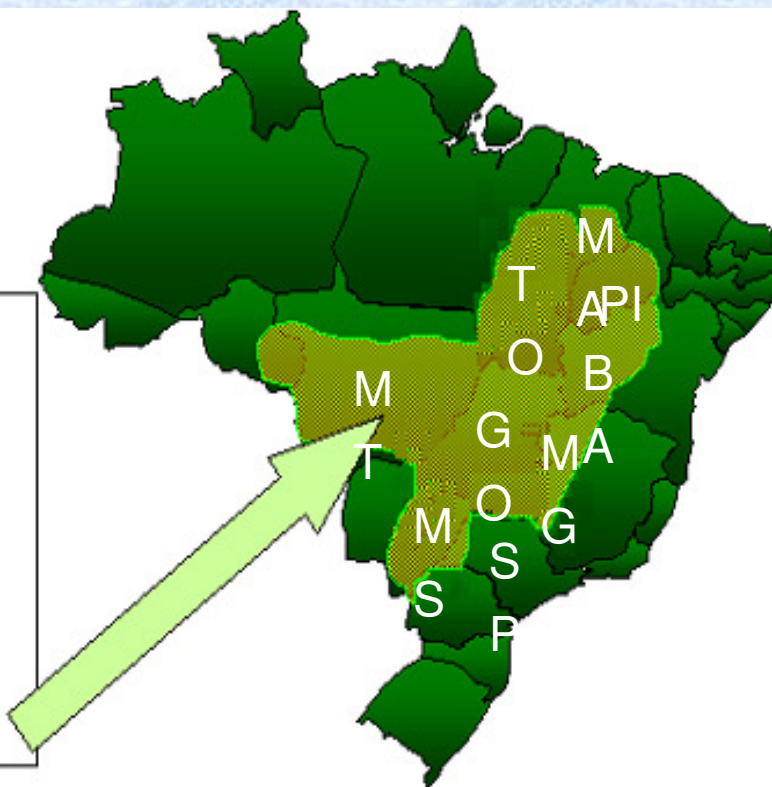


## Brazilian Potential Agricultural Expansion

### Área de Expansão do Cerrado Brasileiro

(milhões hectares)

- Área Total .....	204
- Área Agricultável .....	137
- Pastagem .....	(35)
- Culturas Anuais .....	(10)
- Culturas Perenes e Florestas .....	(2)
- <b>Área Disponível .....</b>	<b>90</b>







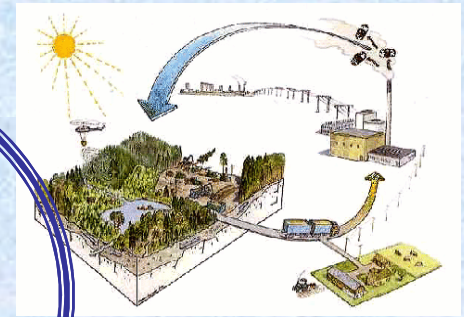
## BRAZILIAN POTENTIAL

- Palm tree - 30 mill. ha;
- Native babacu - 17 mill. ha;
- Native buriti - 2 mill. ha;
- Agriculture/Pasture Integration - 20 mill. ha;
- Uncultivated Arable area - 100 mill. ha;

# RD&I EMBRAPA PROGRAM



*Biodiesel*



*Energetic Forest*



*Ethanol*

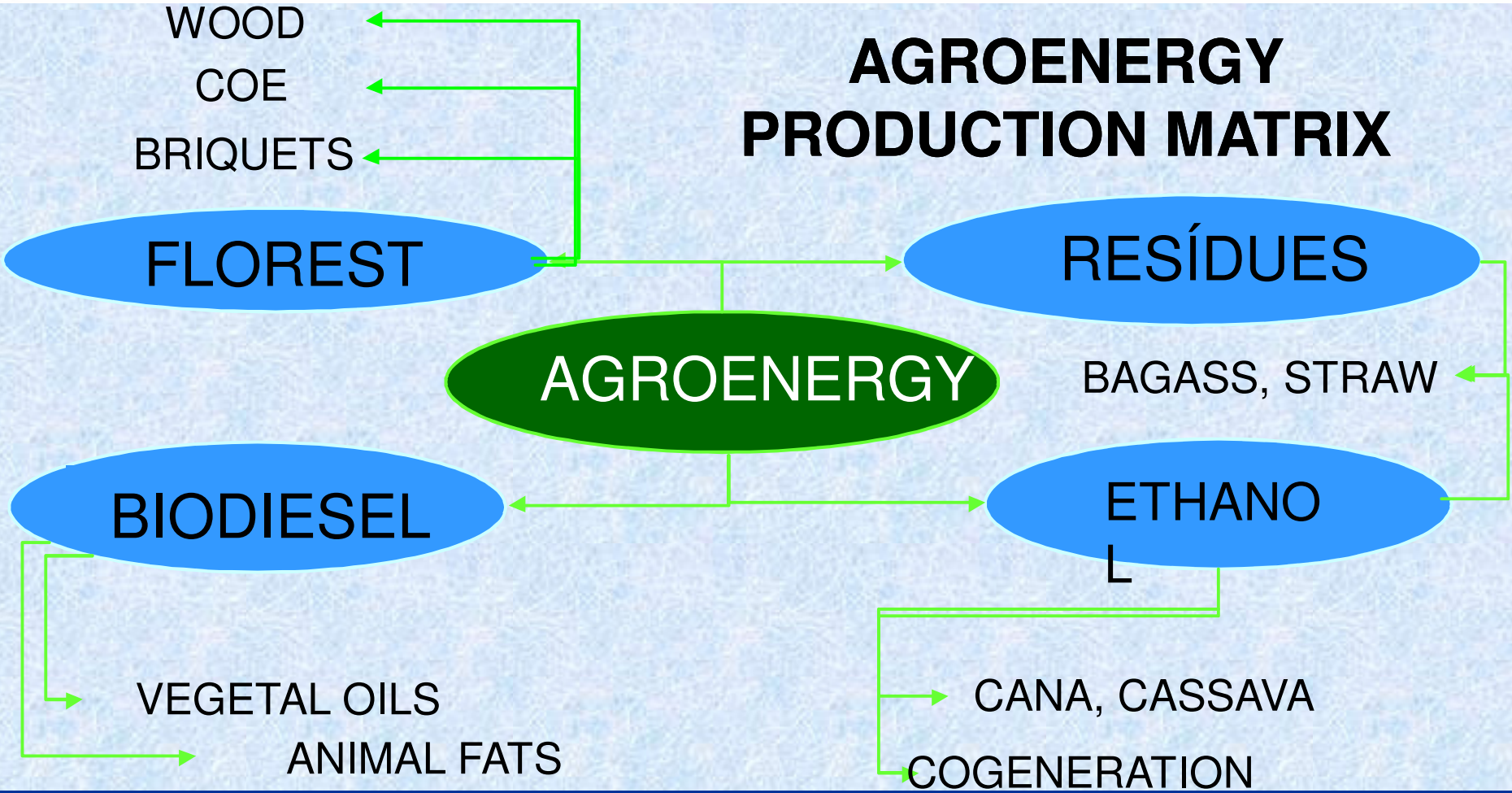


*Residue*





# AGROENERGY PRODUCTION MATRIX

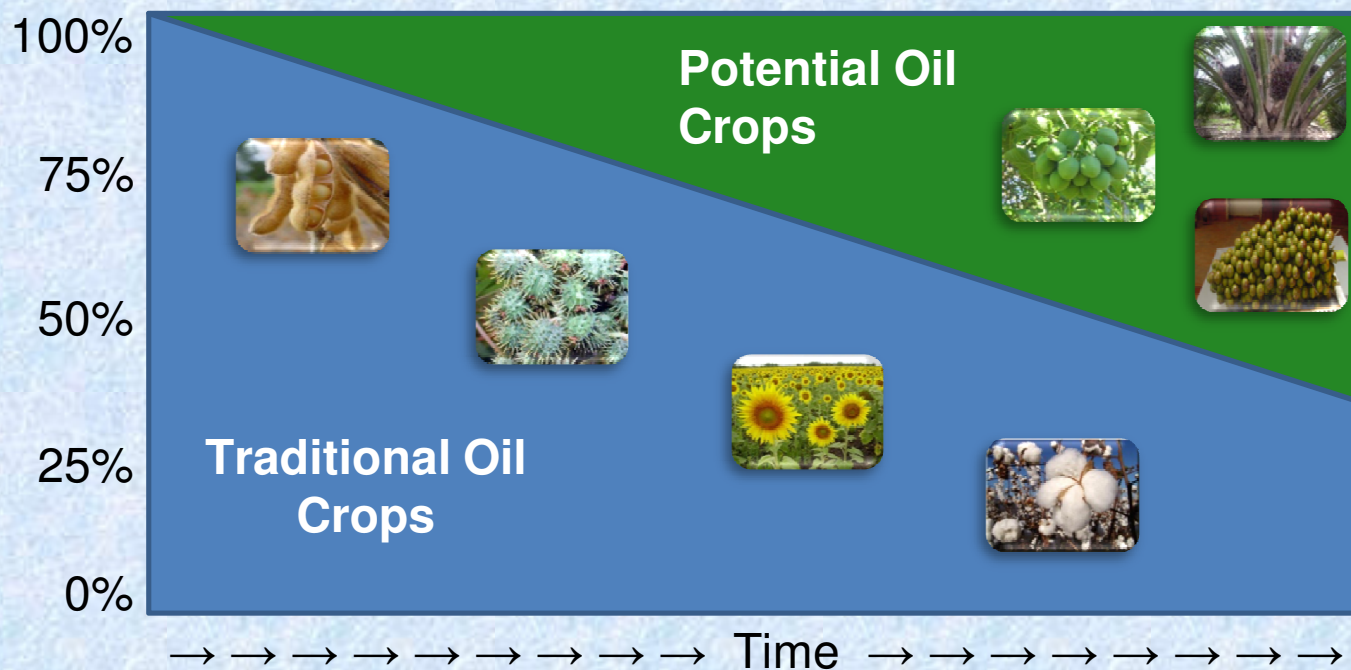




# PLANO NACIONAL DE AGROENERGIA

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“According with Brazilian Agroenergy Plan 2006-2011 (2006), the research should seek more oil crops species, with better oil yields, passing from the level from 600 kg/ha to nearly 5.000 (?) kg/ha.”



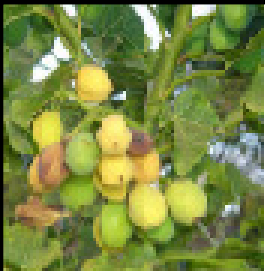

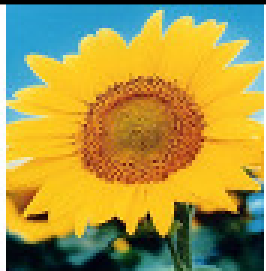



Brazilian  
**Agroenergy**  
Plan  
2006 – 2011

# BIODIESEL PRODUCTION



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## Row Material Diversity for biodiesel

					
<i>Jatropha curcas</i>	Castor	Sunflower	Soybean	Oil Palm Tree	Cotton
<b>Average Agricultural Productivity (kg/ha )</b>					
<b>5.000</b>	<b>1.500</b>	<b>1.500</b>	<b>3.000</b>	<b>20.000</b>	<b>3.000</b>
<b>Vegetal Oil Level (%)</b>					
<b>35</b>	<b>47</b>	<b>42</b>	<b>18</b>	<b>20</b>	<b>15</b>
<b>Vegetal Oil Production (kg/ha)</b>					
<b>1750</b>	<b>705</b>	<b>630</b>	<b>540</b>	<b>4.000</b>	<b>450</b>



## Main Objective

To Identify and to select high productivity oil species, to generate technologies and knowledgement that allow the sustainable and integrated productions of those new sources of vegetal oil suppliers for biodiesel. This has to integrated with the cattle production and others food crops, avoiding the competition with the food and the use of new areas for food production leaving place to bioenergy production.



## Main Potential Crops for Biodiesel Production

### 1. Well known potential species

- Dendê (*Elaeis guineensis*) no Cerrado e Semi-árido
- Pinhão-manso (*Jatropha curcas*)
- Macaúba (*Acrocomia aculeata* e *A. totai*)
- Pequi (*Caryocar* spp.)
- Tucumã (*Astrocaryum vulgare* e *A. aculeatum*)



## Main Potential Crops for Biodiesel Production

### 2. Potential Species Little known

- Inajá (*maximiliana maripa*)
- Andiroba (*Carapa guianensis*)
- Muru-muru (*Astrocaryum murumuru*)
- Tucum (*Astrocaryum cf.vulgare.*)
- Buriti (*Mauritia flexuosa*)
- Babaçú (*orbigynia spp.*)
- Barú (*Dipterix alata*)
- Cucurbitáceas (Fevilha, bucha vegetal)





# Cerrado Irrigated Palm





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# Intercrops Palm x Banana

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## Intercrops Palm x Cassava (manioc)





Intercrops Palm x Pineapple

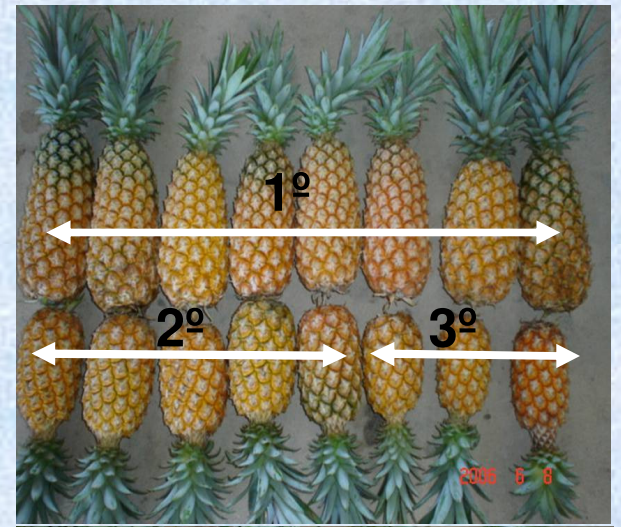


## Intercrops Palm x Passion Fruit





# Data collect for intercrops productions



# Macaúba (*Acrocomia aculeata*)



**High productivity Macaúba genetic sources**







Estimatives of yield comparing two macaúba species, in function of plant for area density.

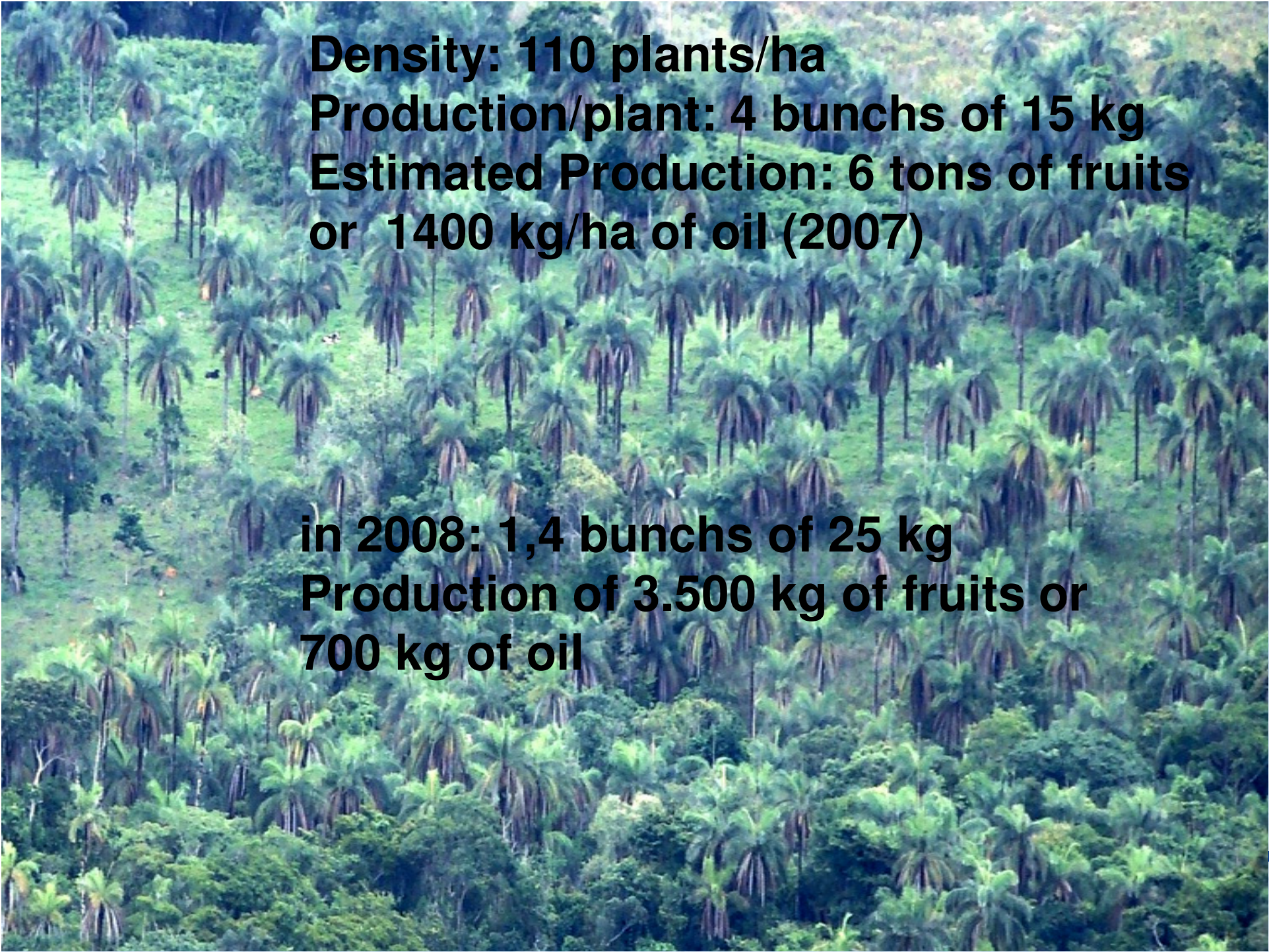
Plants/ha	Space	Oil yield (kg ha <sup>-1</sup> )	
		<i>A. aculeata</i> <sup>1</sup>	<i>A. totai</i> <sup>2</sup>
100	5 m x 20 m	1.840 – 2.300	1.440
123	-	2.264 – 2.829	1.771
156	-	2.879 – 3.588	2.246
216	5 m x 10 m	3.974 – 4.968	3.110
400	5 m x 5 m	5.600 – 9.000	

<sup>1</sup> 5 bunches/plants, 400-500 fruits/bunch. Source: (FUNDAÇÃO..., 1983a);

<sup>2</sup> 6 bunches/plants, 12 kg bunches/plants, 20% dof oil in the fresh fruit. Source: (Roscoe, unpublished data).





An aerial photograph of a vast palm oil plantation. The trees are densely packed and cover a significant portion of a hillside. The foliage is a mix of vibrant green and dark brown, indicating the presence of mature fruit bunches. The perspective is from a high angle, looking down on the plantation.

**Density: 110 plants/ha**  
**Production/plant: 4 bunchs of 15 kg**  
**Estimated Production: 6 tons of fruits**  
**or 1400 kg/ha of oil (2007)**

**in 2008: 1,4 bunchs of 25 kg**  
**Production of 3.500 kg of fruits or**  
**700 kg of oil**













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Abastecimento

GOVERNO FEDERAL

# *Pequi* (*Caryocar* spp.)



Pequizeiro-anão





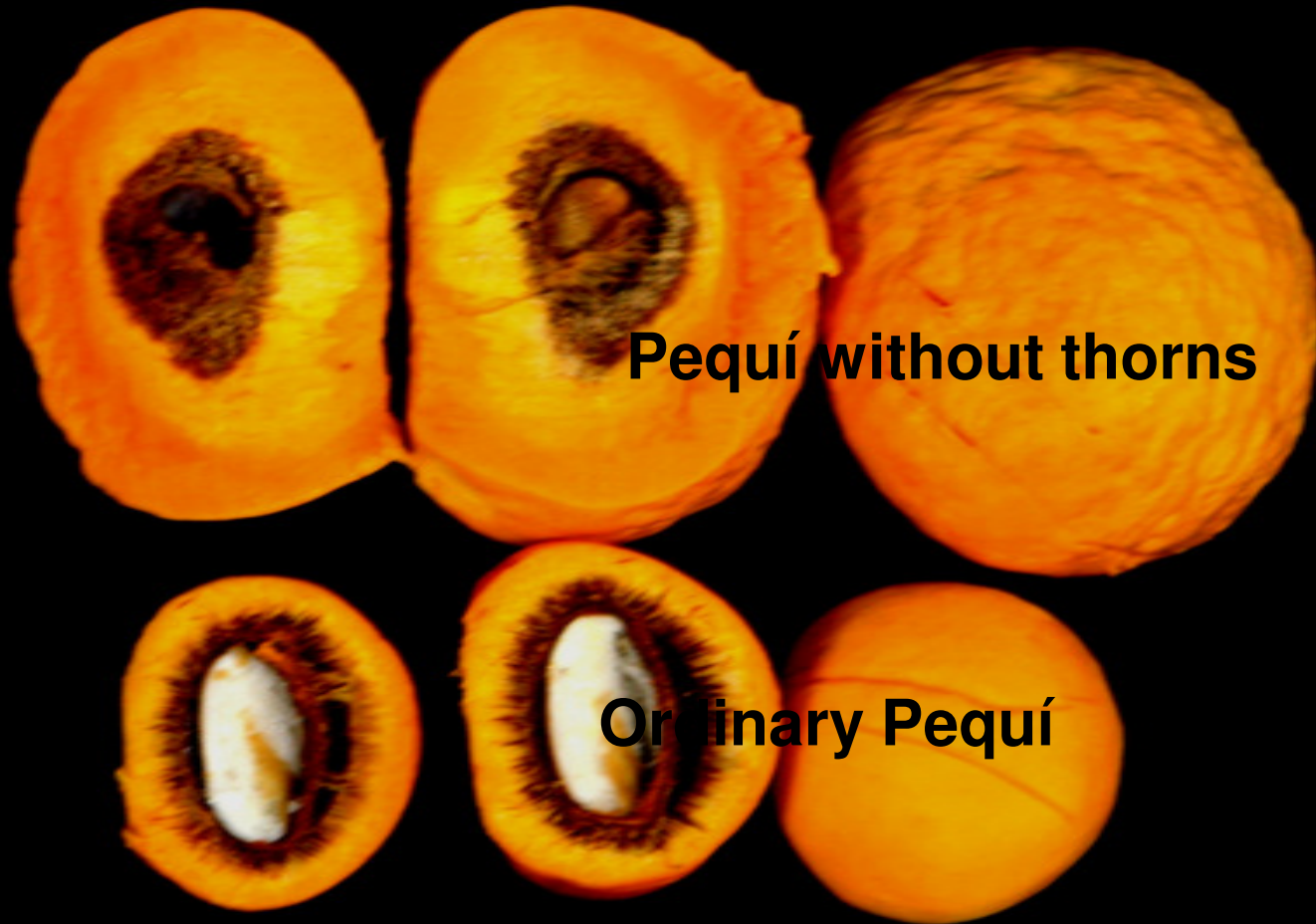








## Selection of Pequí without thorns at Embrapa



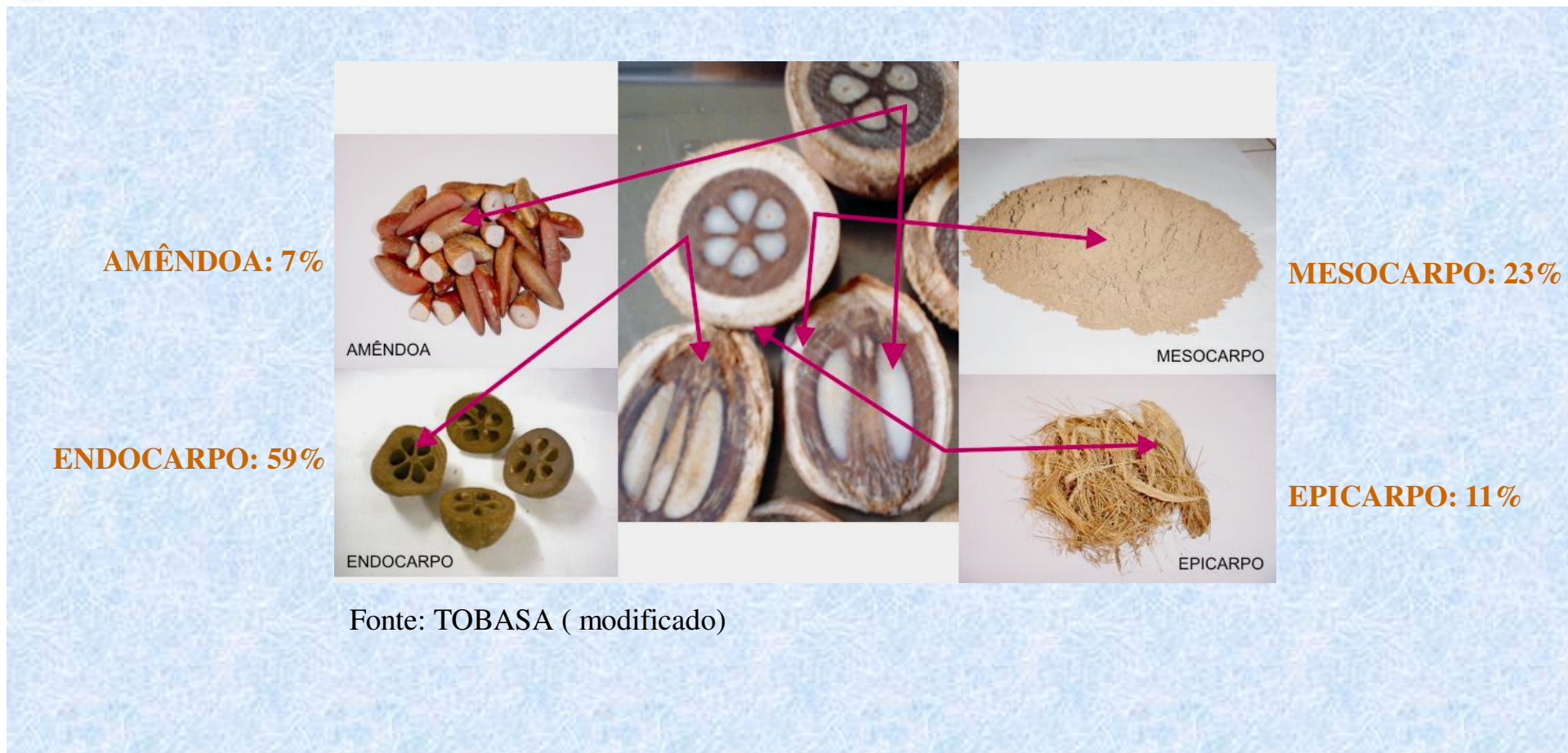
Pequí without thorns

Ordinary Pequí



**Babaçú**

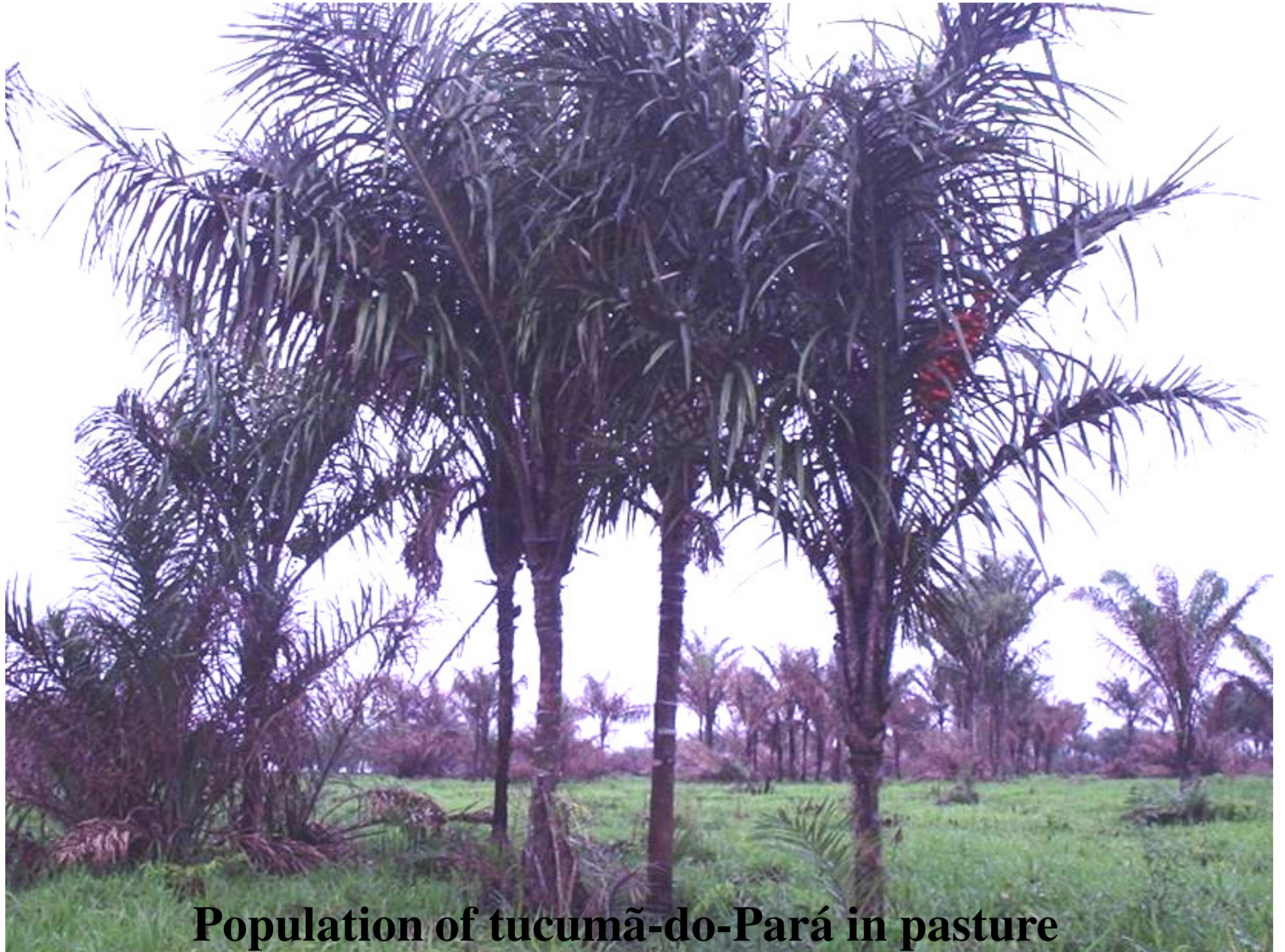




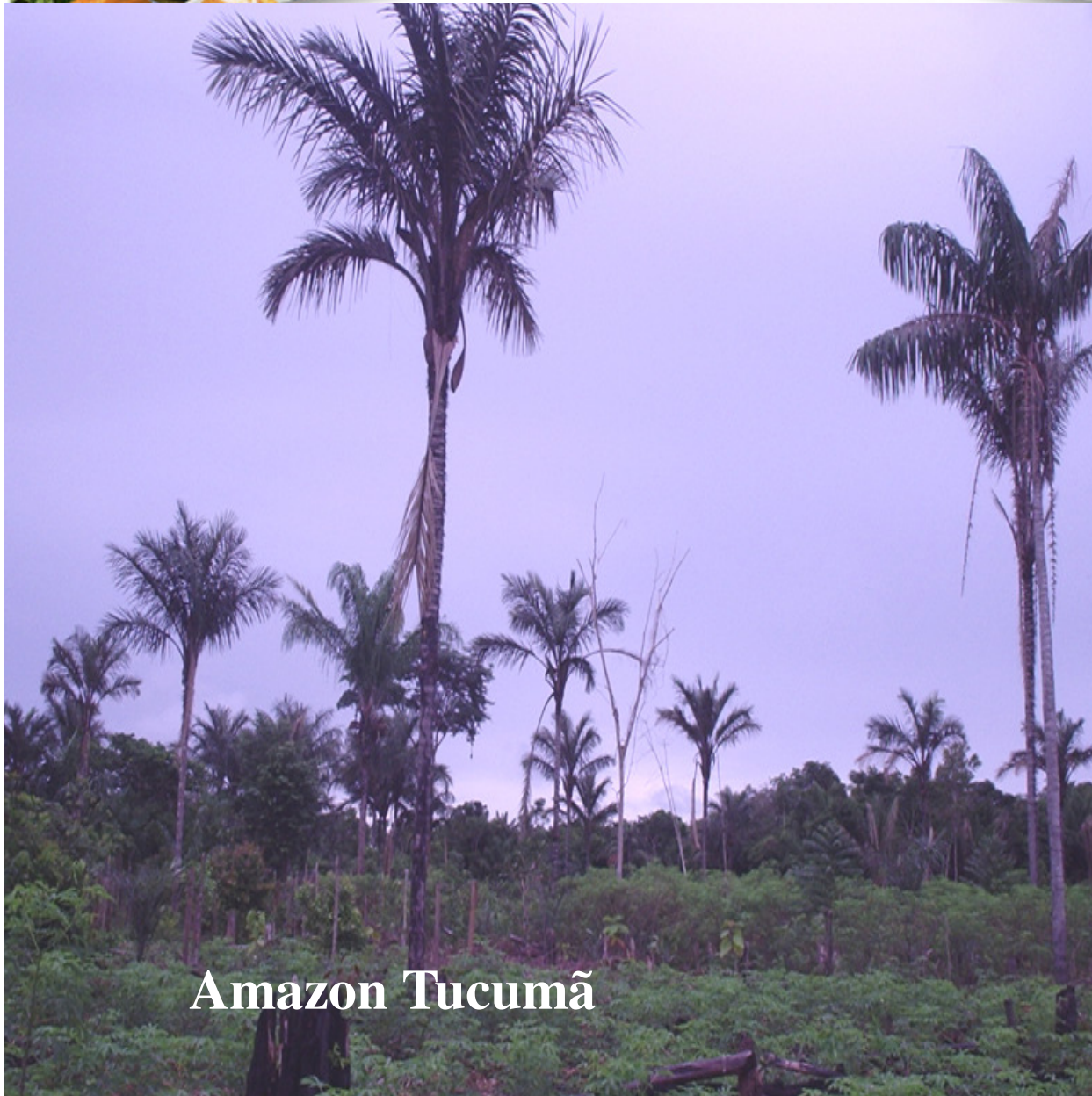
# Tucumã



Socorro Pádilha Embrapa CPAE-U



**Population of tucumã-do-Pará in pasture**



Amazon Tucumã



**Meaddle North Tucum or tucumã**



**Photo by Eugênio E. Araújo – Embrapa Meio Norte**





Photos by Otoniel R. Duarte - Embrapa



Inajá



Photos: Otoniel R. Duarte  
Valéria Saldanha



**Photos by Otoniel R. Duarte**



**Photos by Otoniel R. Duarte**





## Nhandiroba (*Fevillea* spp.)

Large distribution in the Brazil

High oil level in the seeds

High possibility to be cultivated in integrated agro-forest systems





# PINHÃO MANSO (*Jatropha Curcas*) Best Practices and Production systems.

# RAW MATERIAL

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Raw Material	Cultivated Area (mil ha)	Production (mil ton)	Oil Level	Oil Production (mil m3)*
Soybean	21.313	60.018	18 %	10.803,2
Sunflower	111,3	147,1	42 %	61,78
Cotton	1.077,4	2.504,7	15 %	375,70
Castor	162,7	123,4	47 %	57,99
Jatropha	(20) ?	?	35 %	?

\* Potential of production

source: Conab, safra 2007/2008

The production of 3 oil crops (sunflower, cotton and castor) is equivalent to 495 mill. liters of vegetal oil. That could supply about 50% of the demand of the B2.

We do not know the size of planted area with Jatropha in the Brazil. There is no information about total jatropha production.



# PINHÃO MANSO (*Jatropha curcas* L.)



## WHY PINHÃO MANSO?

- HIGH potential of yield of grain/oil
- Adaptability, Precocity and Longevity
- Perennial Crop, not necessary annual renovation
- It is good for familiar agriculture (need of workperson, Diversification)
- Excellent quality of Oil for biodiesel production
- Non food specie – do not compete with food production



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Which is the miracle he did today?



Non, for while, but he promises a lot!!!

**biodieselbr.com**

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# JATROPHA CROP DEVELOPMENT



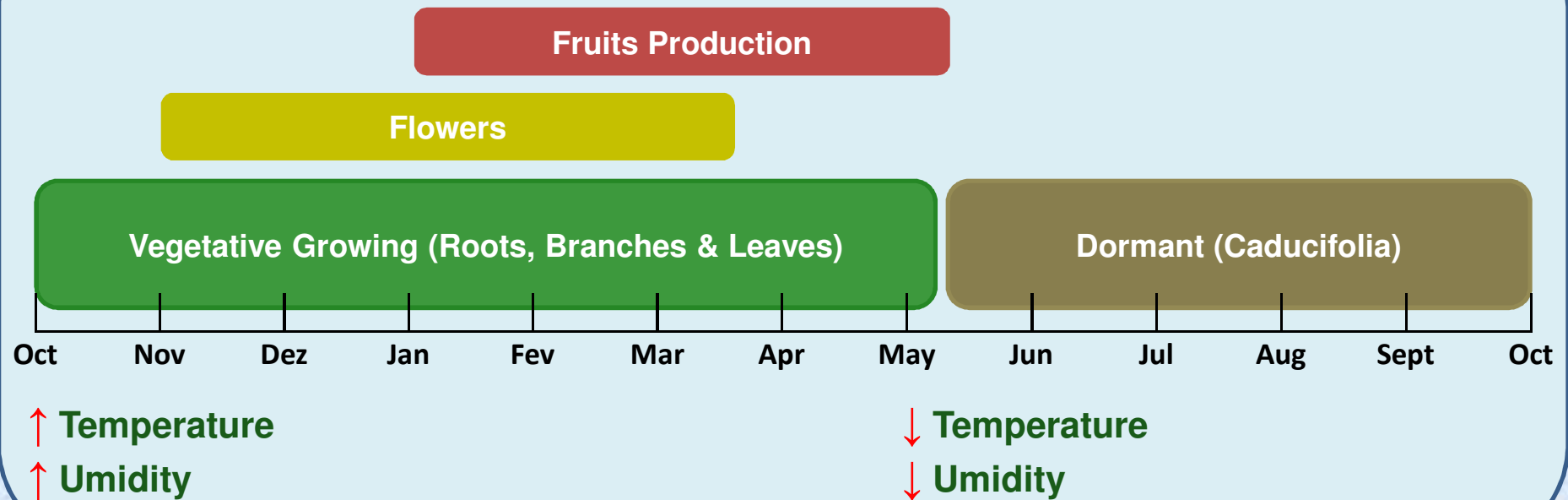
**Embrapa**  
Milho e Sorgo



→ → → **Stresses** → → →  
(biotics & abiotics)



## Phenologic Cycle of Jatropha in Brazil





Pinhão-manso





# Pinhão-manso (*Jatropha curcas*)

## Eminent Risks:

- High incidency of rotten roots in some places;
- High incidency of pests like empoasca, ácaros and tripes;
- Manual Harvest economicly unprofitable;
- No cultivars;
- No Adequated production system;
- No production chain;
- Co-produt with low commercial value (organic fertilizer)









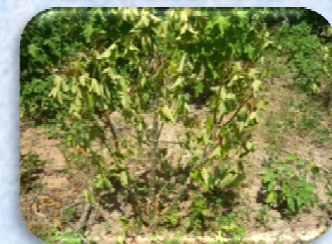




# JATROPHA

## RESEARCHES CHALLENGERS

- Lack of scientific knowledge and technological control about production system
- Lack of cultivars (genetic diversity unknown)
- Susceptible to a lot of pests and diseases
- No uniform harvest x oil quality x production cost
- Toxicity Factor (Use of the meal for animal feed)





# JATROPHA RD&I STRATEGIES

PROCESS



GENETIC

CROP SYSTEM





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## PROJETOS DE PD&I EM PINHÃO MANSO

PROJECTO	FOCUS	PERIOD	FOUNDINGS
RD&I in Jatropha Curcas for biodiesel production	<ul style="list-style-type: none"> <li>- Genetics Resources</li> <li>- Genetic breeding</li> <li>- Production systems</li> <li>- industrial Process</li> <li>- Transversals studies</li> </ul>	2009-2011	R\$ 7.000.000,00
Detoxification of Jatropha meal for animal feeding	<ul style="list-style-type: none"> <li>- Detoxification of Jatropha meal</li> <li>- Animal feeding</li> </ul>	2009-2010	R\$ 328.000,00
Jatropha curcas: Applied and technological researcher on plant traits	<ul style="list-style-type: none"> <li>- Melhoramento Genético</li> <li>- Genômica</li> <li>- Sistema de produção</li> </ul>	2009-2012	€ 260.693,67 (Embrapa)



# PD&I EM PINHÃO MANSO: *Germoplasm Bank*

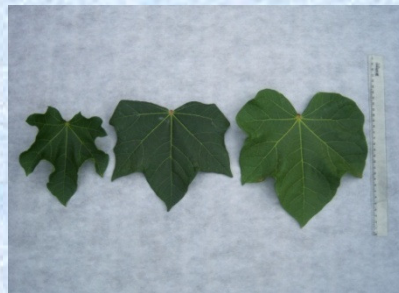
**Germoplasm Bank  
(204 accesses)**



**Characterization  
26 botanics describers  
Moleculars Markers**



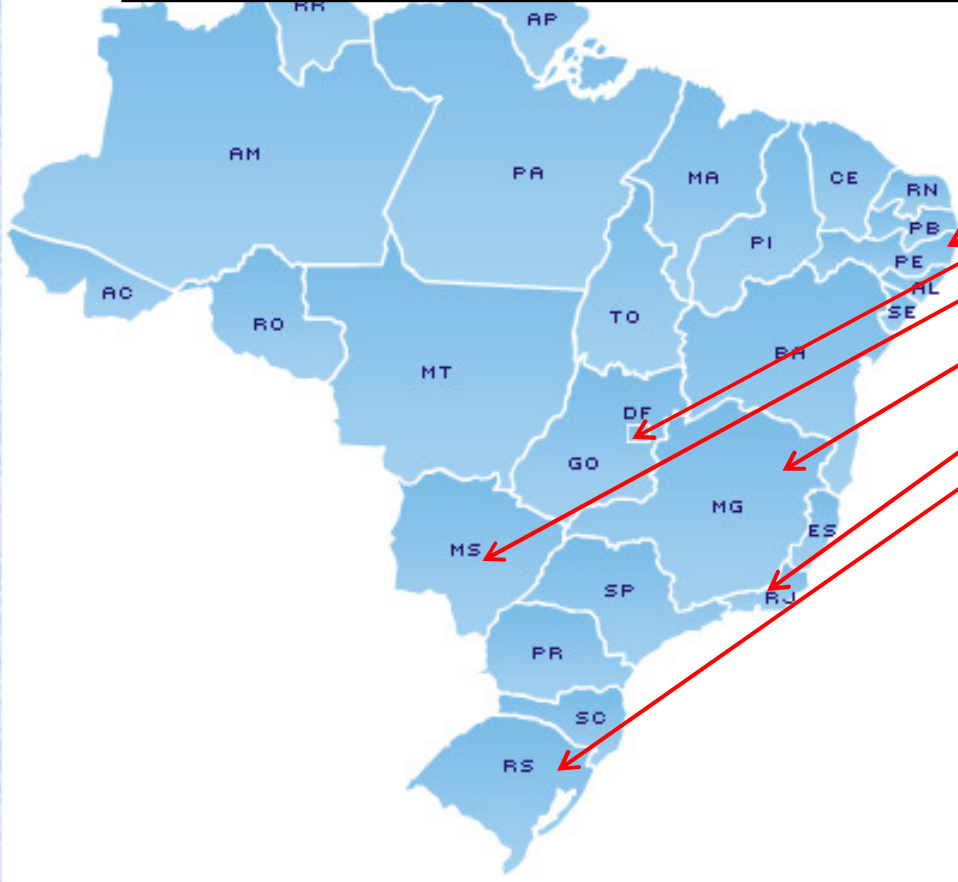
**Breeding Programs**





# RD&I EM PINHÃO MANSO: *Cultivars Selection*

**Cultivars Selections Adapted to Different Regions**



**Avaliação net of  
Potential Genotypes  
RS, RJ, MG, DF, MS PE**



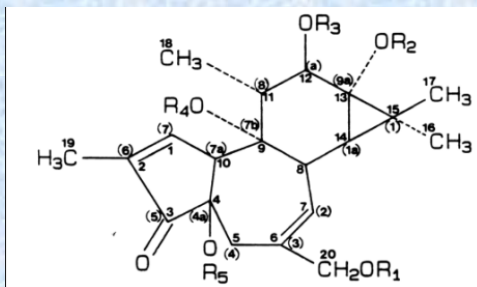
**Cultivar BRS  
(2011/2012)**



# PD&I EM PINHÃO MANSO: *Torta*

## USO POTENCIAL

- Adubo orgânico
- Rica em N
- Impacto na microbiota do solo (?)
  
- Nutrição Animal
- Maior valoração
- Rica em proteína (22 a 60%)
  - Toxidez (éster de forbol, curcina e fatores antinutricionais)



**“O éster de forbol, componente mais tóxico e letal, deve ser o foco da destoxificação”. Sua presença na semente requer cuidados na limpeza das instalações de moagem após o esmagamento do material.**



## RD&I EM PINHÃO MANSO: *Detoxification Strategy*

### GENETIC BREEDING

- Non-toxic accesses Prospection
- Genetic Breeding
- Non-toxic Cultivars (without éster of forbol)



### PROCESS

- Solvent Extration
- Extrusion associated to chemical additions (NaOH, H<sub>2</sub>O<sub>2</sub>, CaO)
- Fermentation



# SADA

- 500 ha planted
  - 350 ha own area
  - 220 to 230 ha under contract with small farmers. Areas of 2 to 5 ha (Some famers abandoned their crops)
- Space between lines
  - 4 X 2,5 meters in the own areas
  - 5 X 2, 4 X 2,5, 3 X 2,5 meters in the partners areas
  - 1000 Plants/ha
- Fertilization
  - 300kg (6-30-24) NPK
  - 2 bags (100kg) of ureia
  - 3 liters of poultry manure by plant in the sow time
  - No chemical control for pests and diseases

# SADA



# TOMINAGA-KAKIDa

- Área
  - 54 há planted in 2004
    - 4 X 3; 8 X 2; 6 X 2
  - 50 ha recently planted
    - 6 X 3 X 2 – double line
  - About 833 plants/ha
- Fertilization
  - 200 kg supersimple (36 kg de P<sub>2</sub>O<sub>5</sub>)
  - Cover 10 kg de N/ha; 10 kg de P/ha; 10 kg de K/ha => when starts to produce
  - 2000 kg/ha of cattle manure

# TOMINAGA-KAKIDA

- Harvest
  - 6 bags (30kg) of fruits/mam/day =>
  - 5 to 6 kg of grain per bag =>
  - 30 a 36 kg of grains per day

**•Cost of Harvest = US\$ 1,500.00**

Cost of 1 Workman day = US\$ 15

Productivity of 1 ha = 3 a 3.6 tons

Use about 100 Workman day to harvest 1 ha

**Price of 1kg of Jatropha grain  
= US\$ 0.15**

**If one produces 3.6 tons  
Revenue = US\$ 540.00**

**Negative Profit of US\$ 960.00,  
just considering the harvest cost**

# Tominaga/ Kakida



# Tominaga/ Kakida

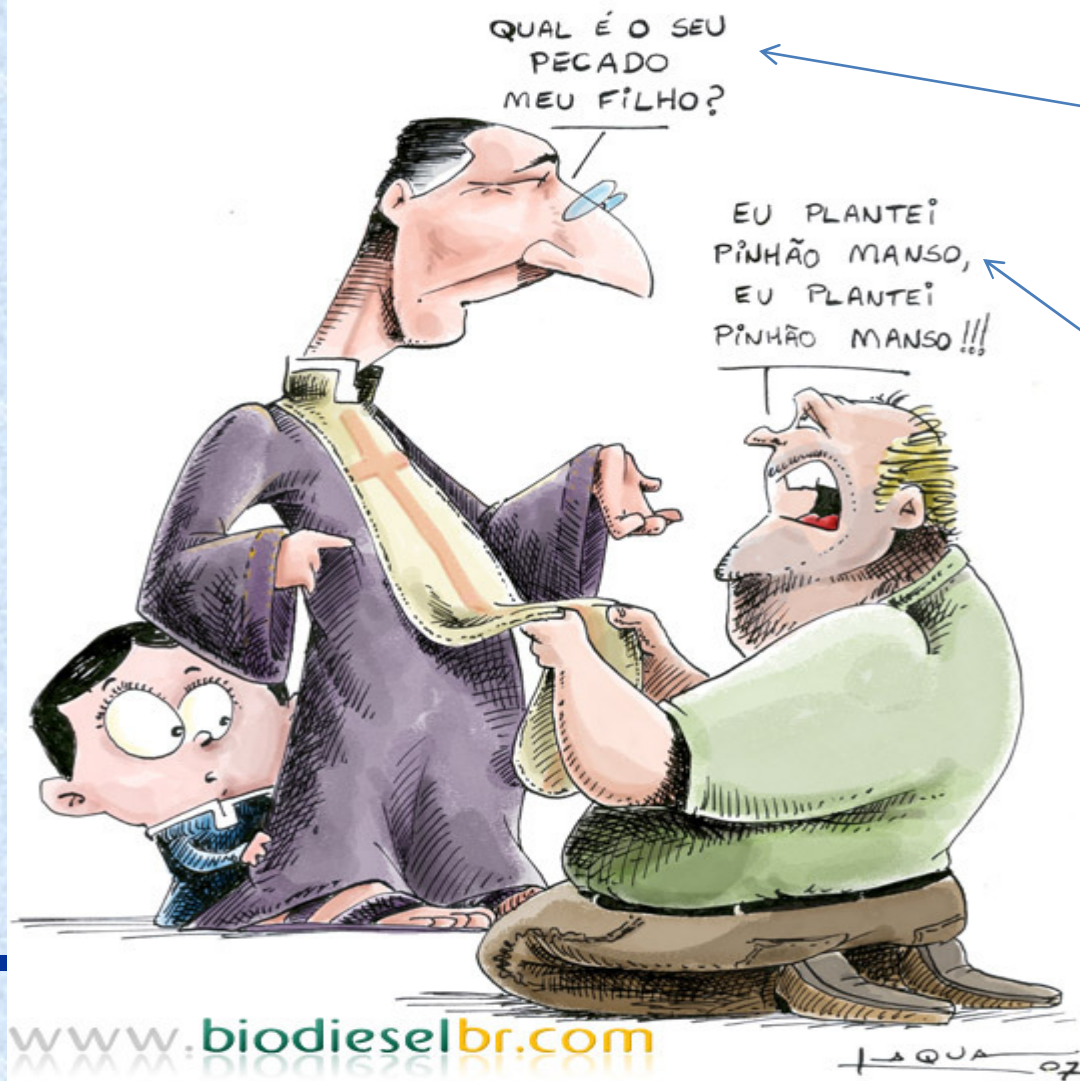


# Tominaga/ Kakida





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[www.biodieselbr.com](http://www.biodieselbr.com)

Which is your sin, my son?

I planted Jatropha,  
I planted Jatropha!!!

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***THANK YOU =  
MUITO OBRIGADO***

**Embrapa**  
Milho e Sorgo

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