USE OF BIO-FUELS IN BRAZIL

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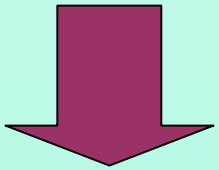
In-Session Workshop on Mitigation
SBSTA 21 / COP 10
December 9, 2004
Buenos Aires

Brazilian experience with fuel grade ethanol started in the 1920's. Variable ethanol content in gasoline depending on ethanol availability…until

1973 OIL CRISIS & LOW SUGAR PRICES



1975

PROÁLCOOL
BRAZILIAN FUEL ETHANOL PROGRAM

- **GASOHOL REGULARLY AVAILABLE SINCE 1977**

- **NEAT ETHANOL FOR ALCOHOL CARS AVAILABLE COMMERCIALLY SINCE 1979**
  (over 5 million ethanol fueled vehicles produced in Brazil)

FUEL ETHANOL TYPES

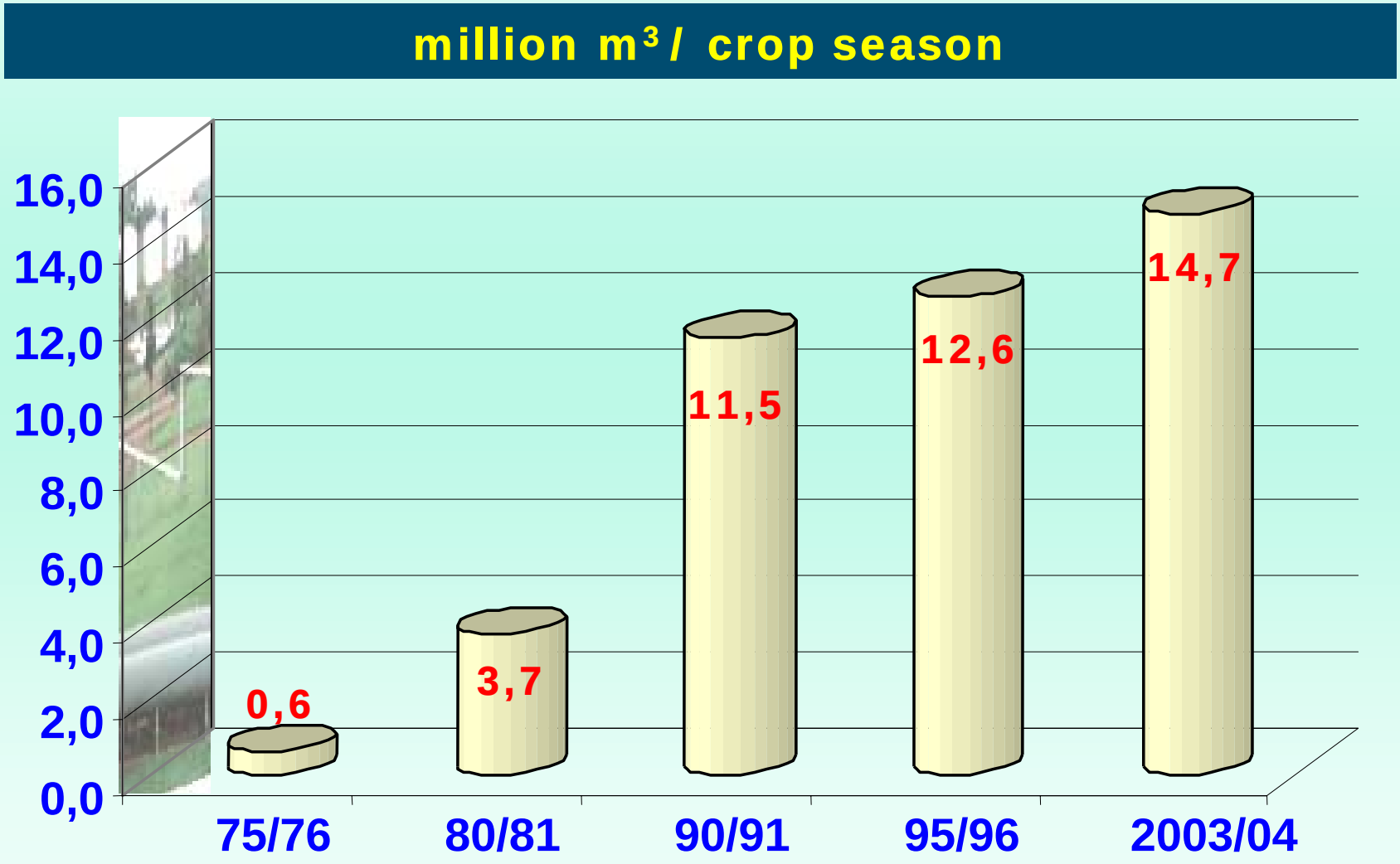
Under Brazilian regulations two types of fuel ethanol are produced:

- **Anhydrous: blended with automotive gasoline**
- **Hydrous: used as a neat fuel in vehicles or blended with gasohol by the consumer in FFV**

Type	alcohol content ºGL (at 20 ºC)
Anhydrous	99.58 minimum
Hydrous	95.13 – 95.98

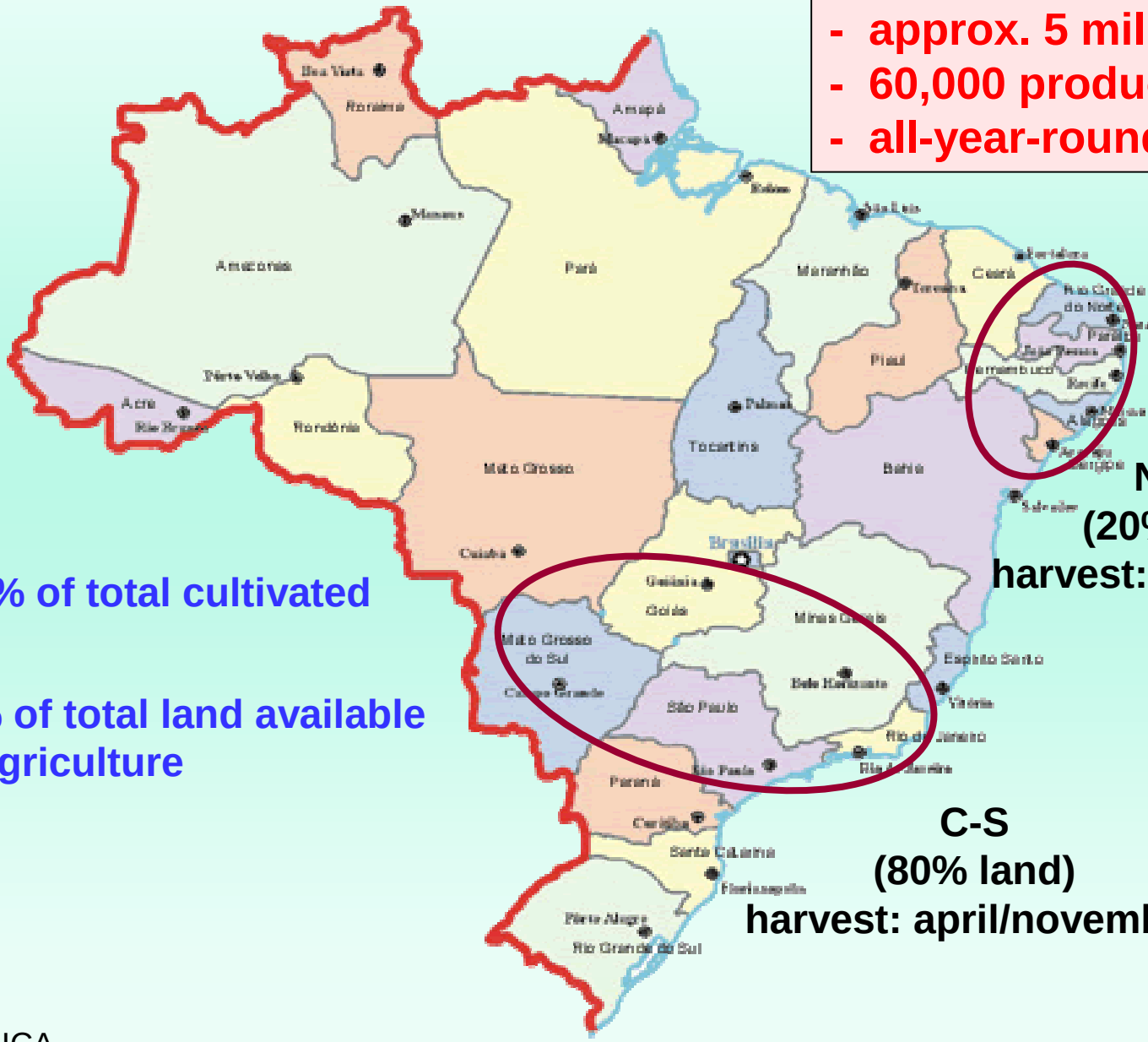
Source: Portaria ANP Nº 126 de 08/08/2002

Brazil: Ethanol production milestones (anhydrous + hydrous)



Brazil

SUGAR CANE
- **approx. 5 million ha**
- **60,000 producers**
- **all-year-round harvest**



N-NE
(20% land)
harvest: sept/march

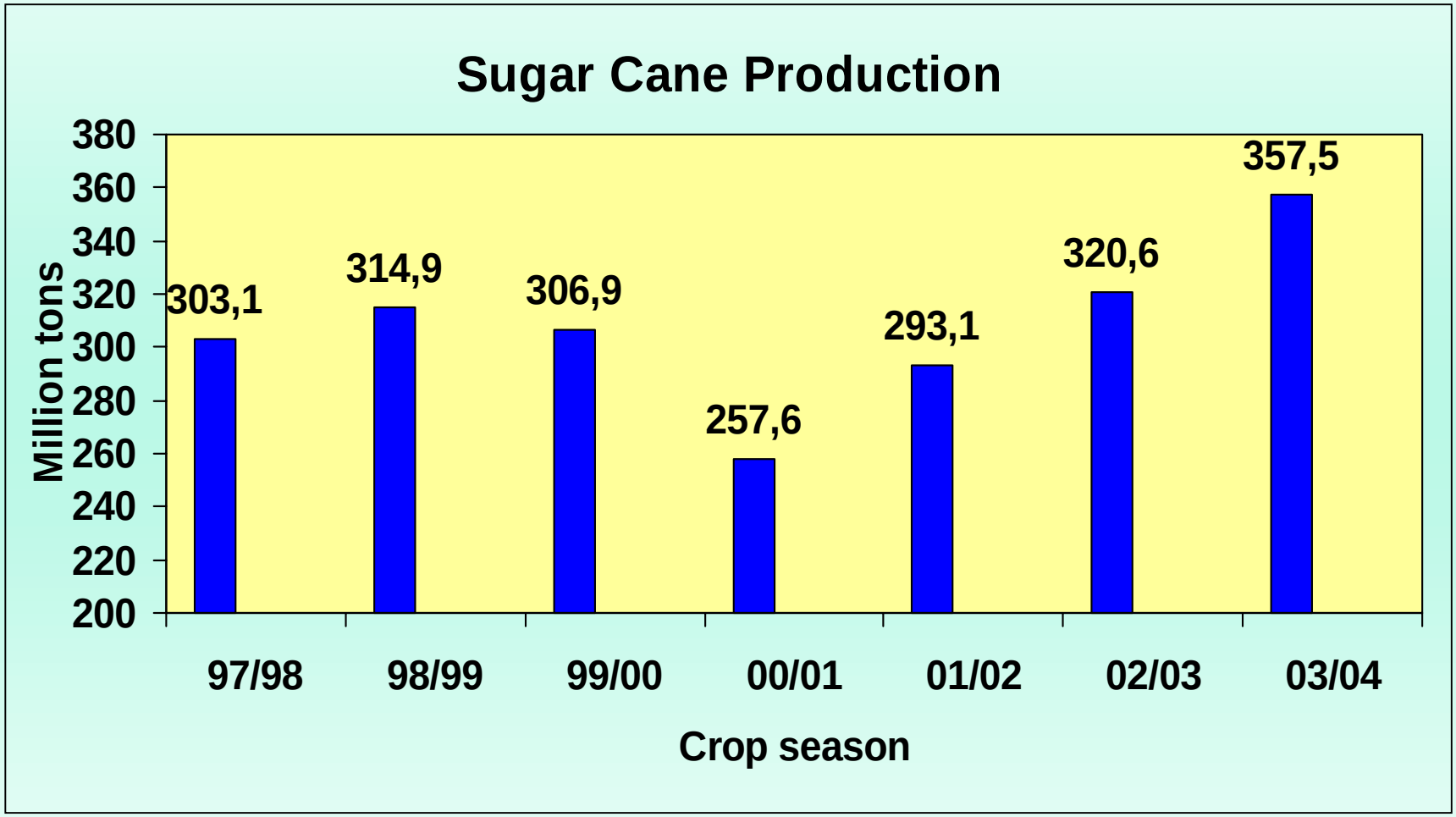
~ 10% of total cultivated land

~ 1% of total land available for agriculture

C-S
(80% land)
harvest: april/november

Source: UNICA

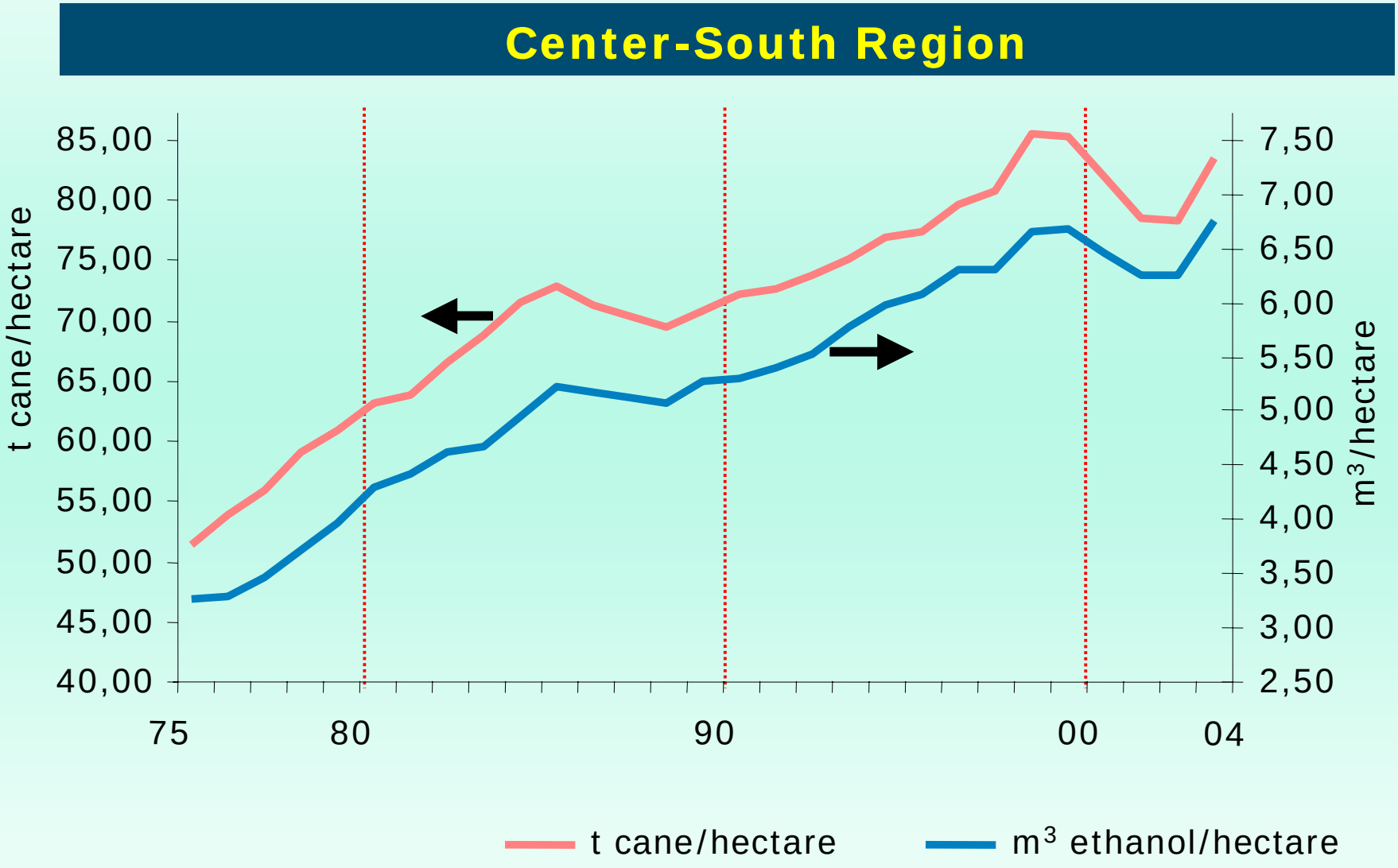
Brazil: 1997/98 - 2003/04



About 50% of sugar cane is used for ethanol production

Source: UNICA

Productivity Gains



Source: UNICA

FERTI-IRRIGATION WITH STILLAGE

ferti-irrigation with stillage helps to reduce use of water & chemical fertilizers and recovers soil fertility

Autonomous Energy

bagasse

The sugarcane industry produces its own thermal & electric energy using bagasse as a fuel in co-generation systems and it sells the excess electricity to the public grid (presently 600 MW)

electricity

Source: UNICA

SUGAR & ETHANOL PLANT IN BRAZIL

The Brazilian Ethanol Experience

- Brazilian ethanol, gasohol & Flex-Fuel vehicles

- Imported gasohol vehicles and engines

- energy security & diversification
- technology development
- environmental benefits
- balance of payments
- jobs

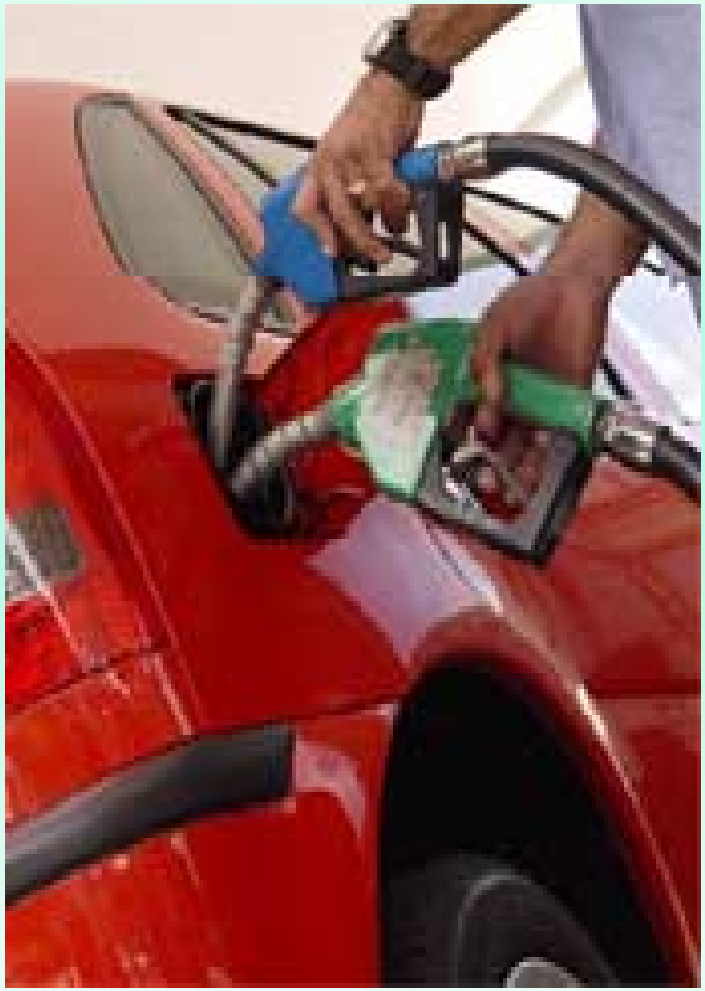
% Ethanol in Gasoline (gasohol)

1977: 4.5%
1979: 15%
1981: 20%
1985: 22%
1998: 24%
1999: 20 to 24%
SINCE 2002
20% to 25%

“FLEX FUEL” Vehicles

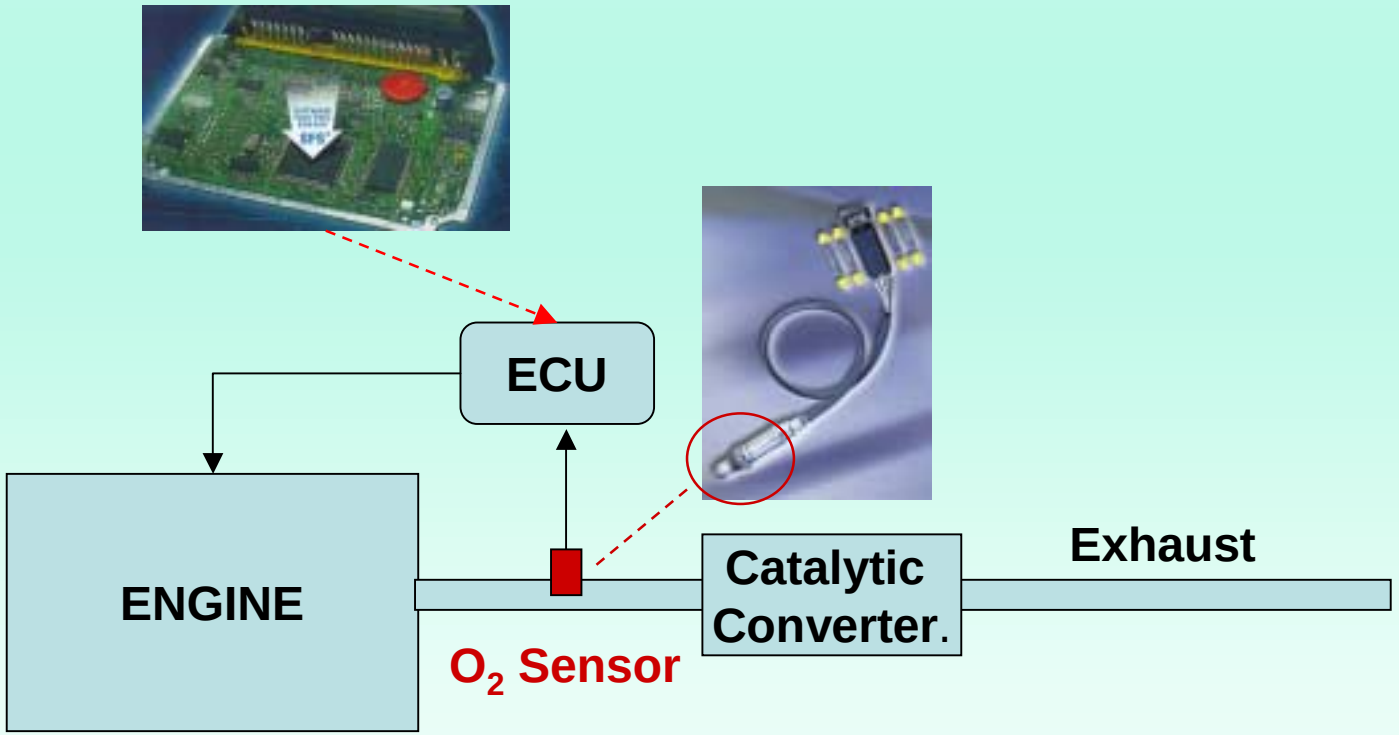
- **Vehicle can operate on gasoline or ethanol or any ethanol-gasoline blend without any special requirement**

- **Consumers’ good acceptance: 2004 sales projections → 300,000 Flex Fuel units**

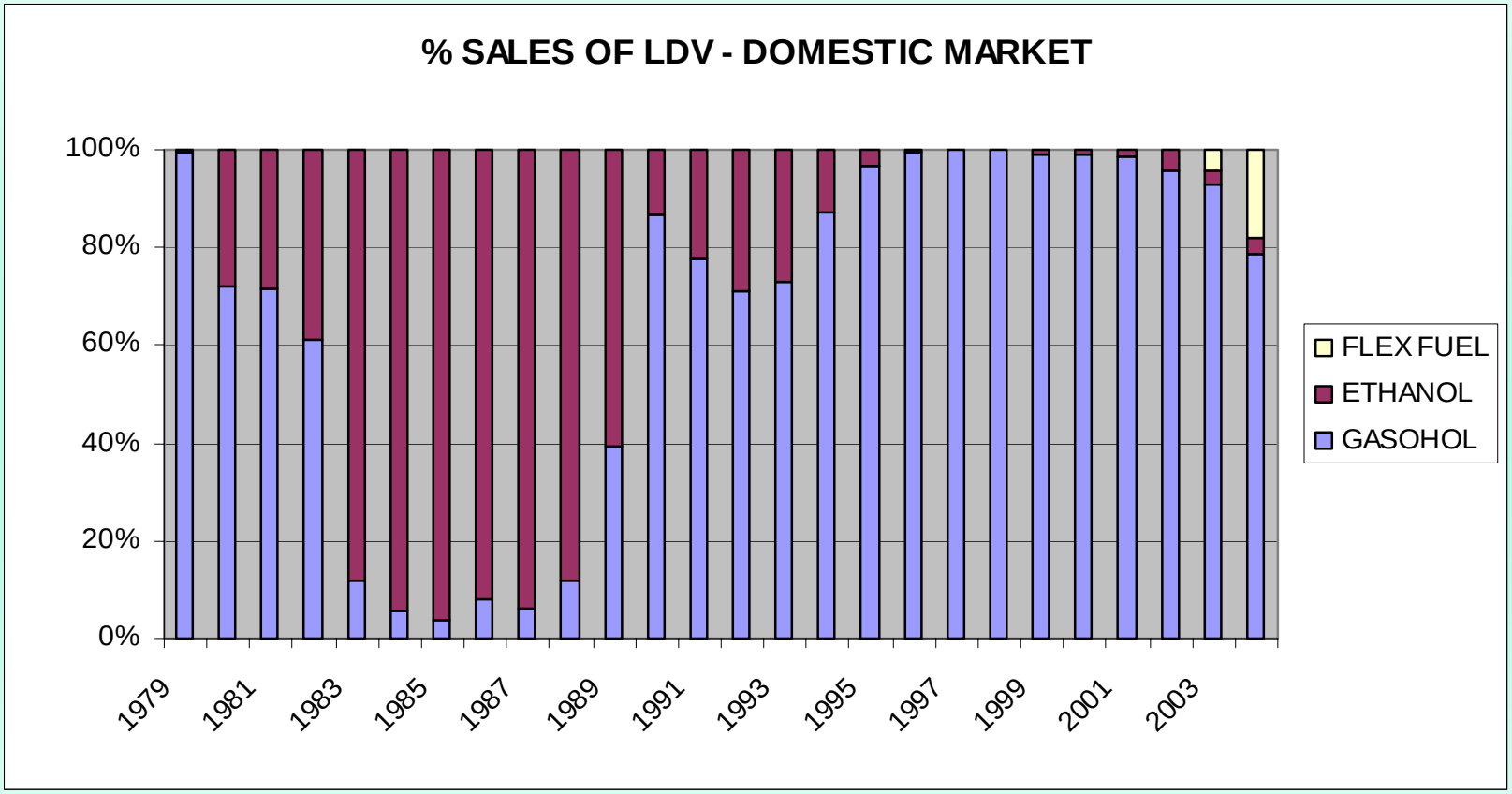


The FLEX FUEL Concept

Sensor originally used for emission control measures O_2 content in exhaust gas and sends a signal to the Engine Control Unit (ECU) indicating the level of ethanol in the fuel line → ECU automatically recalibrates spark timing and fuel injection.



Vehicle Market Share in Brazil



Sales Jan/Sept 2004: 35,497 Ethanol 218,320 Flex Fuel 942,993 Gasohol

Source: ANFAVEA / Prepared by ÚNICA

Diesel vehicles are not included

Vehicle Emission Reductions Related to Fuel Ethanol Use in Brazil

Lead additives banned since 1990

Reduction of SOx

Reduction of PM (carbon and sulfate particles)

VOC´s with lower toxicity & photochemical reactivity

CO: Higher reduction in older E100 (up to 70%) and gasohol (up to 40%) vehicles in comparison with ethnaol-free gasoline

Source: CETESB

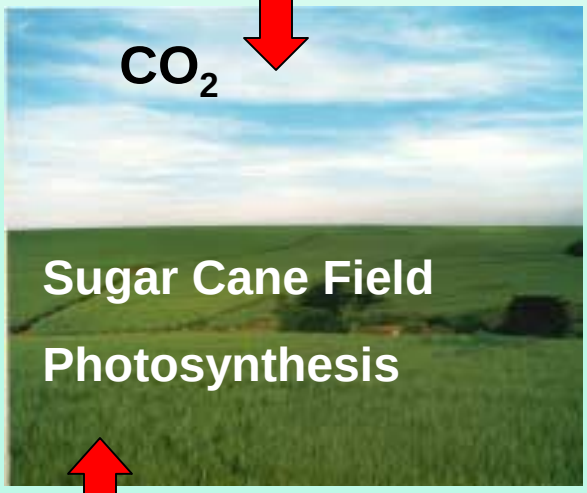
Ethanol Production & Energy Balance by Feedstock

Feedstock	Energy Output/Energy Input
Wheat	1.2
Corn (USA)	1.3 – 1.8
Sugar Beet (EU)	1.9
Sugar Cane (Brazil)	8.3

Gasoline	0.83

Source: F.O. Licht, Macedo, I et alii 2004 NREL 2002

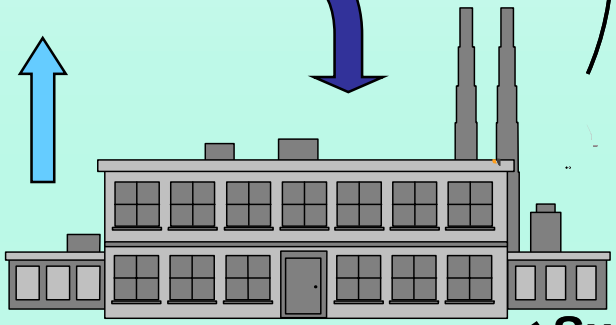
Sugar Cane and the CO_2 Cycle



Bagasse

CO_2

Cogeneration



Sugar

CO_2

Neat Ethanol or Blends

Ethanol

Electric Energy

SOURCE: ADS

Greenhouse Effect Mitigation

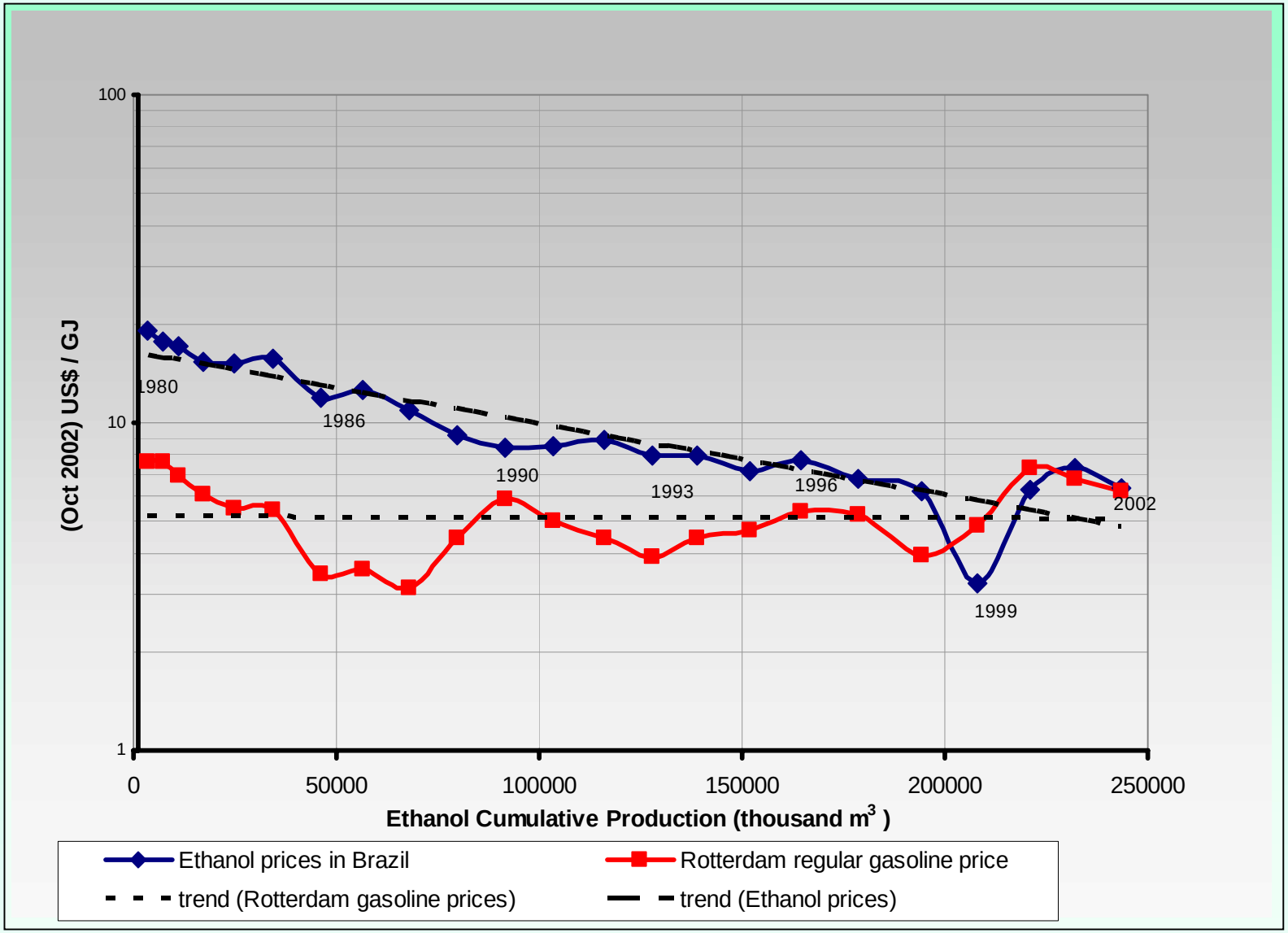
Under Brazilian production conditions the substitution of ethanol for gasoline & bagasse for fuel oil avoids the emission of:

2.6 t of CO_2 equivalent/m^3 anhydrous ethanol

1.7 t of CO2 equivalent/m^3 hydrous ethanol

Source: Macedo, I et alii, 2004

Gasoline X Ethanol Prices



Source: Goldenberg, J. et alii, Biomass and Bioenergy, 26, 2004

New Uses for Ethanol

AVIATION FUEL
(100% ethanol airplane by Embraer. Already certified → production will start in 2005

INDUSTRIAL FUEL
100% ethanol boiler
(boiler can operate also on CNG or LPG)

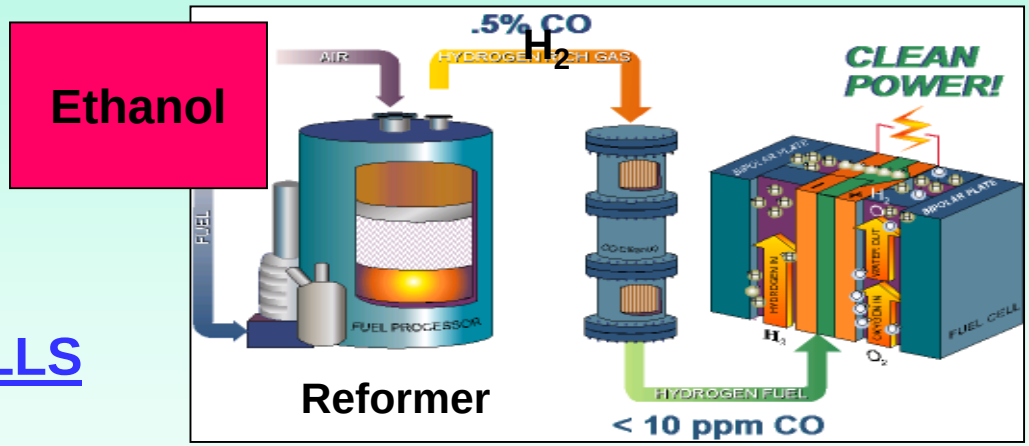
Ethanol Vaporizer

New Uses for Ethanol

DIESEL-ETHANOL BLENDS
(Pilot Tests)

Truck operating with diesel + 7% ethanol

SOURCE TO PRODUCE HYDROGEN FOR FUEL CELLS
(Research Level)



New Uses for Ethanol: 100% Renewable Biodiesel

Vegetable Oils + **Anhydrous Ethanol** = **Renewable Biodiesel**

transesterification

ETHYL ESTER

SOY BEAN

+

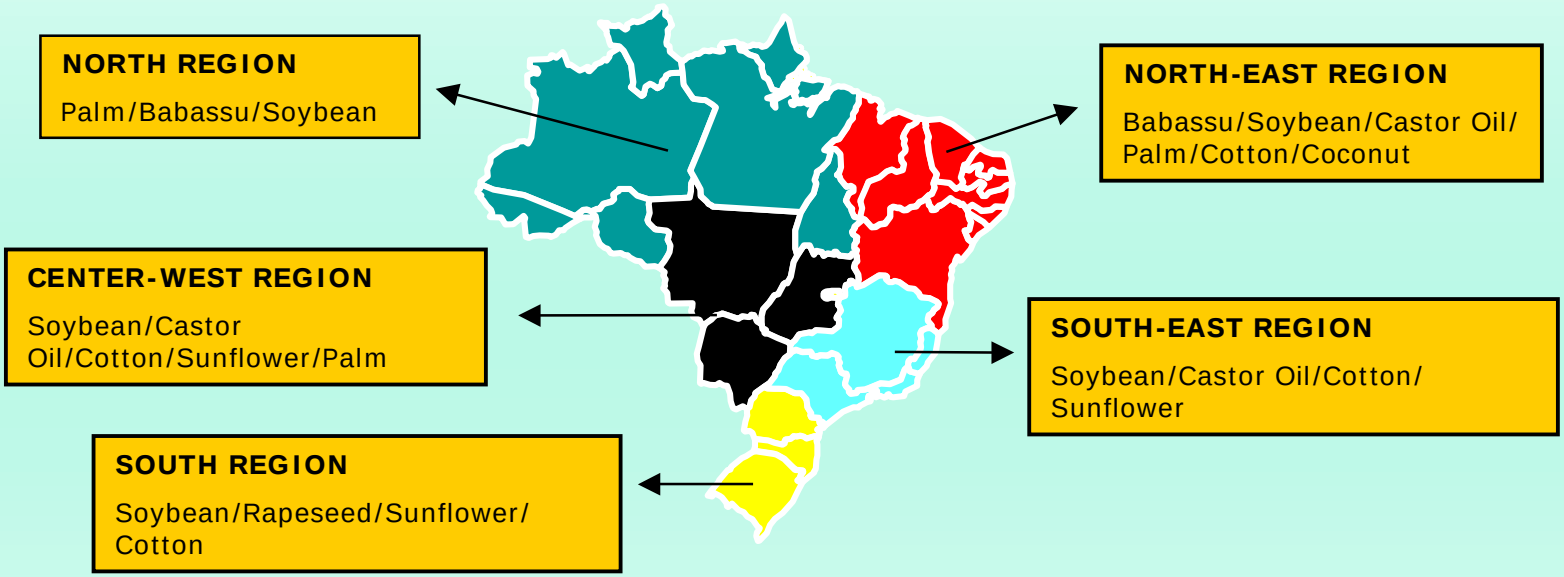
SUGAR CANE

OR → PEANUTS, SUNFLOWER, CORN, COTTON, PALM TREE.....ETC.

Biodiesel in Brazil

- Since the 1920's → initiatives to promote use of vegetable oils in Brazil
- During the 1980's: Pró-óleo and OVEG Programs → limited results
- In 2002 MCT implemented the Research & Technology Development PROBIODIESEL National Network
- 2003 Interministerial Commision evaluated feasibility of Biodiesel in Brazil and set recommendations for a program
- 2003: first Biodiesel specification (ANP 255/03)
- 2004: permission to use 2% biodiesel + 98% diesel blends (B2)
- December 6 2004: announcement of National Biodiesel Program

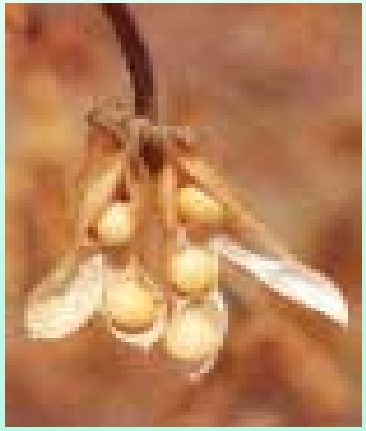
Vegetable Oil Sources in Brazil



soybean oil represents over 95% of present vegetable oil production

Source: ABIOVE

Vegetable Oil Productivity in Brazil



Soybean oil
(18-21%)
400Kg/ha

Sunflower oil
(45-55%)
800Kg/ha

Peanut oil
(40-50%)
900Kg/ha

Castor oil
(45-55%)
1200Kg/ha

Palm oil (Dendê)

(35-45%)

5900 Kg/ha

Note: values in % indicate oil content of each feedstock

Source: LADETEL/USP - ABIOVE

BIODIESEL – Environmental Aspects

- Biodegradable
- Reduces emission of:
  - Particulates
  - Carbon Monoxide
  - Sulphur oxides
  - Hydrocarbons
  - CO_2

Benefit is proportional to the amount of biodiesel used

Soybean biodiesel energy balance
3.2 output energy/input fossil energy
For diesel oil the ratio is 0.83

On a well-to-wheel basis it is estimated that:

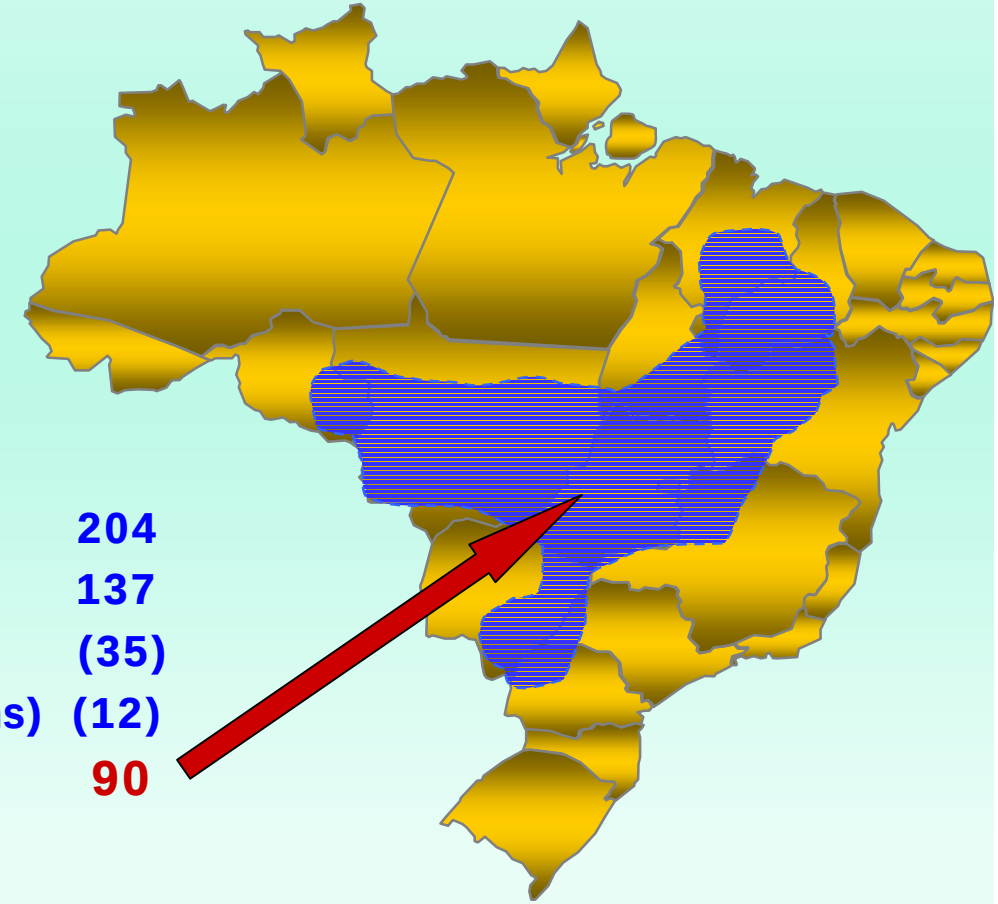
biodiesel reduces CO_2 emissions by 78 % compared to diesel oil

Source: NREL 1998

BRAZIL: Agribusiness Expansion

Brazil is one of the few countries with great capacity to expand its agricultural production →opportunities for bio-energy and sustainable development

Expansion area in the " Brazilian Cerrado" region



(million hectares)

Total Area	204
Area good for agriculture.....	137
Area in use for cattle raising...	(35)
Occupied area (forests & plantations)	(12)
Available Area for expansion.....	**90**

Source: EMBRAPA/MAPA

Thank You

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