Bioenergy: a successful case of innovation in Brazil

Innovation in Brazil, India and South Africa
Geneva, July 2009

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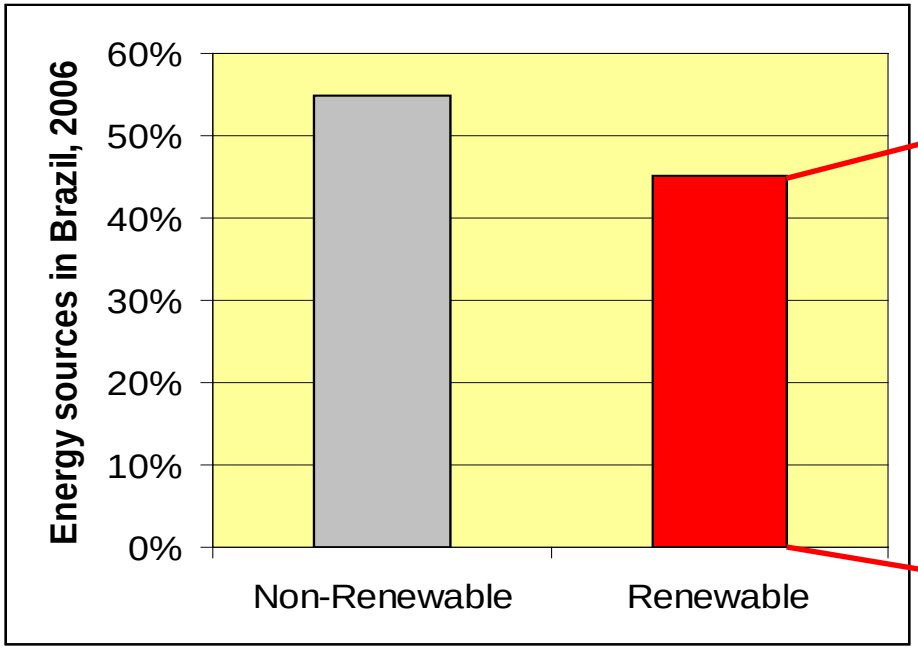
Rationale

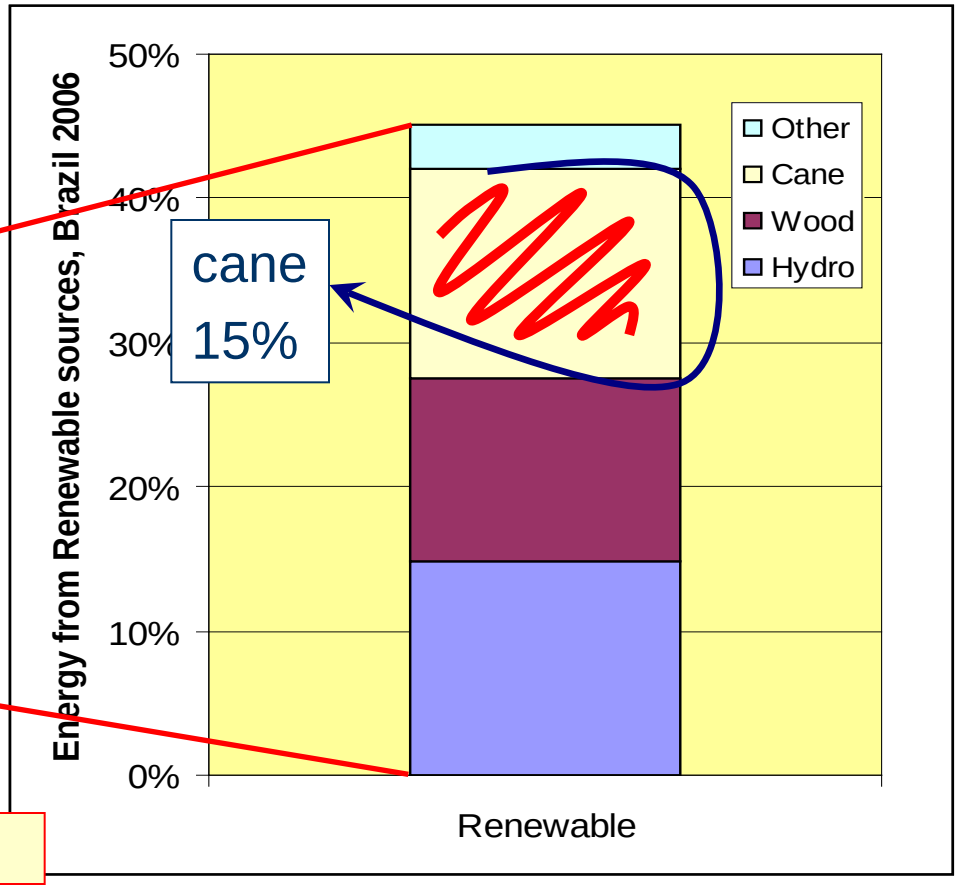
- Global Climate Change: Reducing greenhouse gas emissions
- Scarcity of resources
  - Oil is finite
- Energy security (as Food Security)
  - Each nation would like to generate its own energy, or at least most of it, or at least as much as possible of it while not having to pay too much for the rest and having a secure source

Brazil: 190 million people, 9th GDP

Brazil

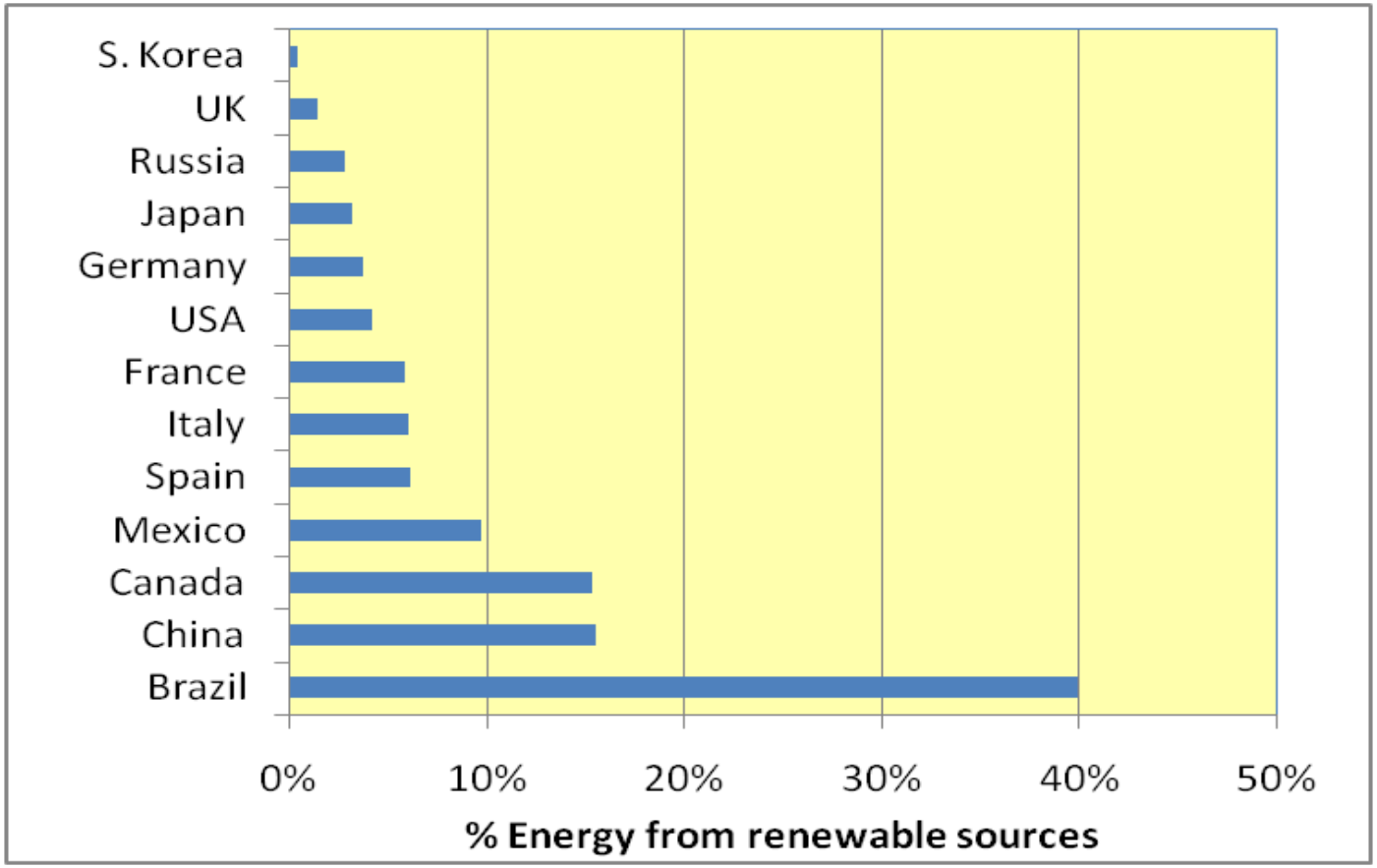
More than 40% of Brazil's energy comes from renewable sources





Renewables in Brazil: 46%; World: 13%; OECD: 6%

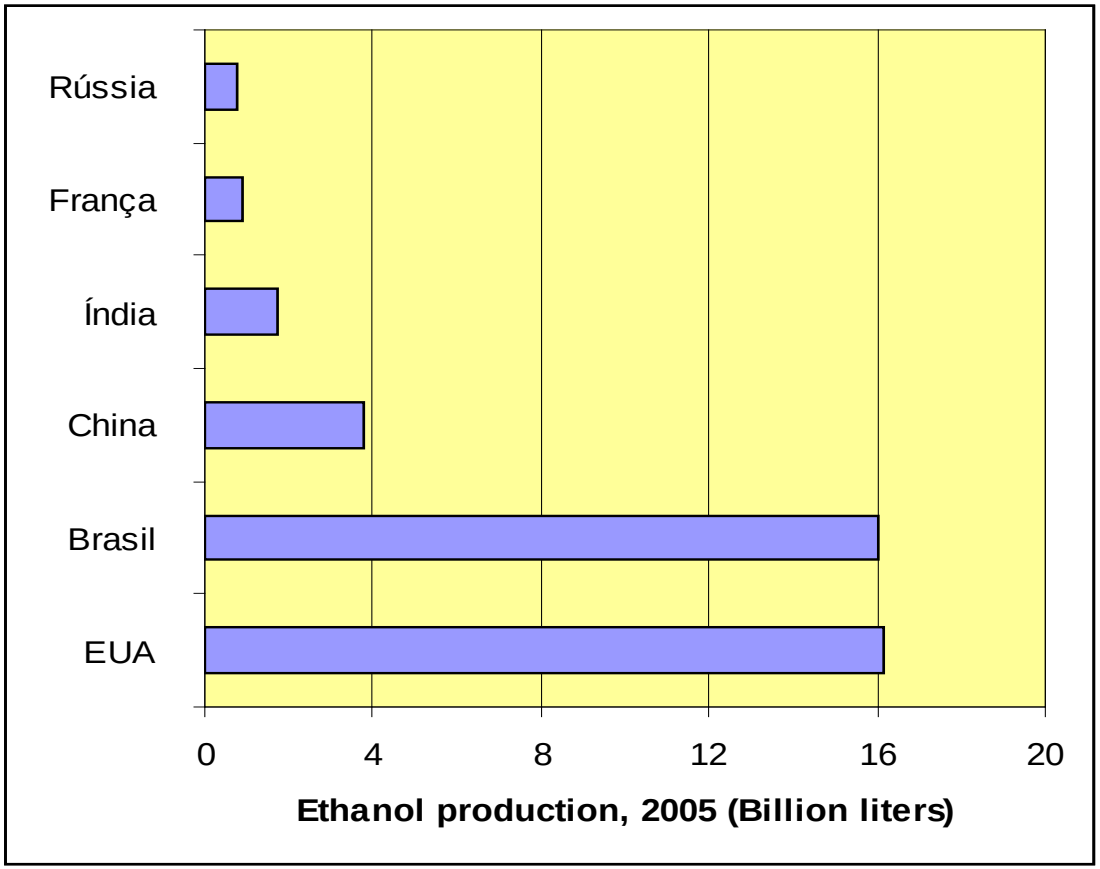
Energy from renewable sources
Some industrialized countries



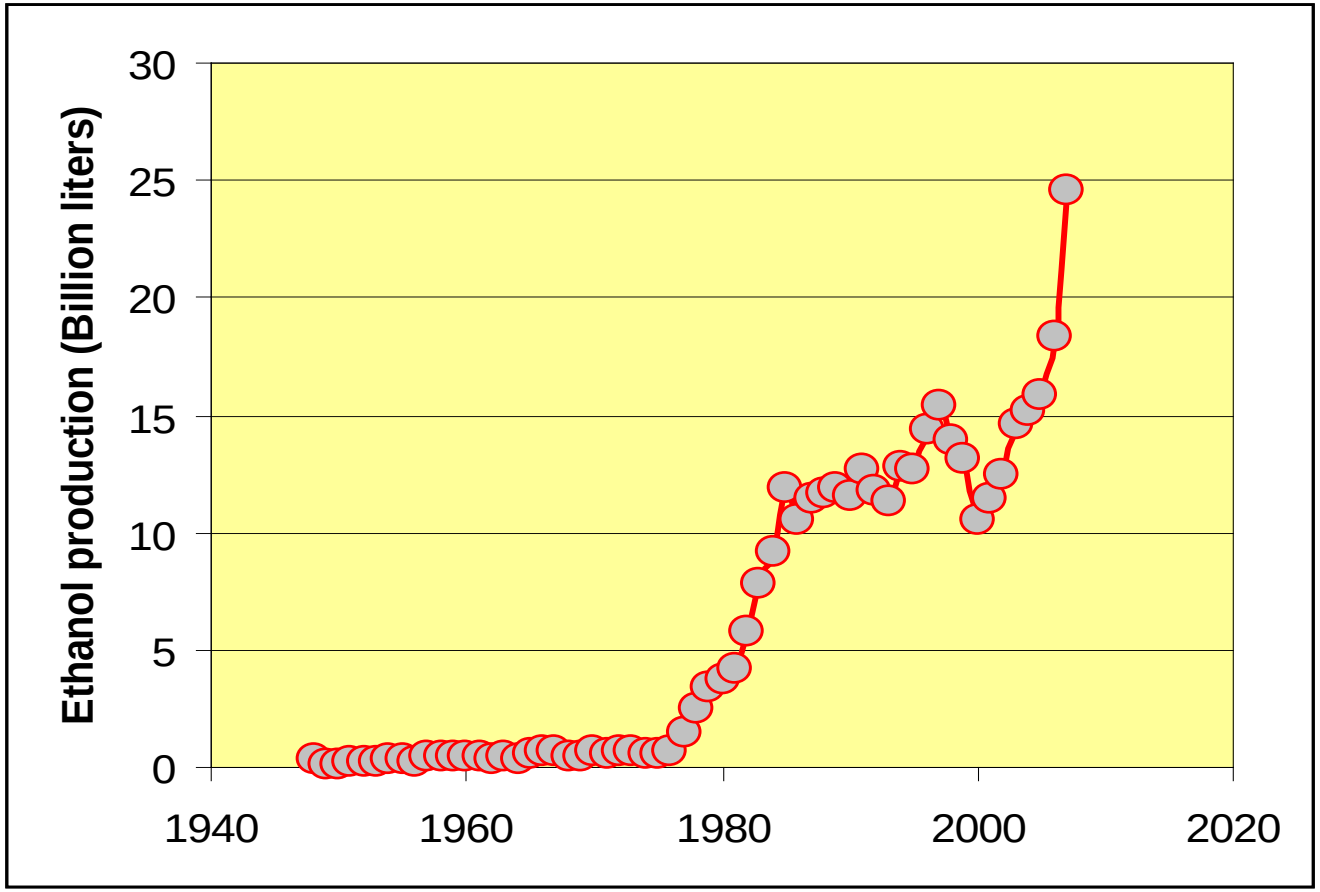
Source: IEA, Renewables Factsheet, 2007

Ethanol: World Production

- Brasil is 2nd largest producer
- In 2005:
  - Brazil 35% (cane)
  - USA 35% (corn)
- Brazilian production
  - Sucrose: 1/3 of cane
  - Cellulose used for energy



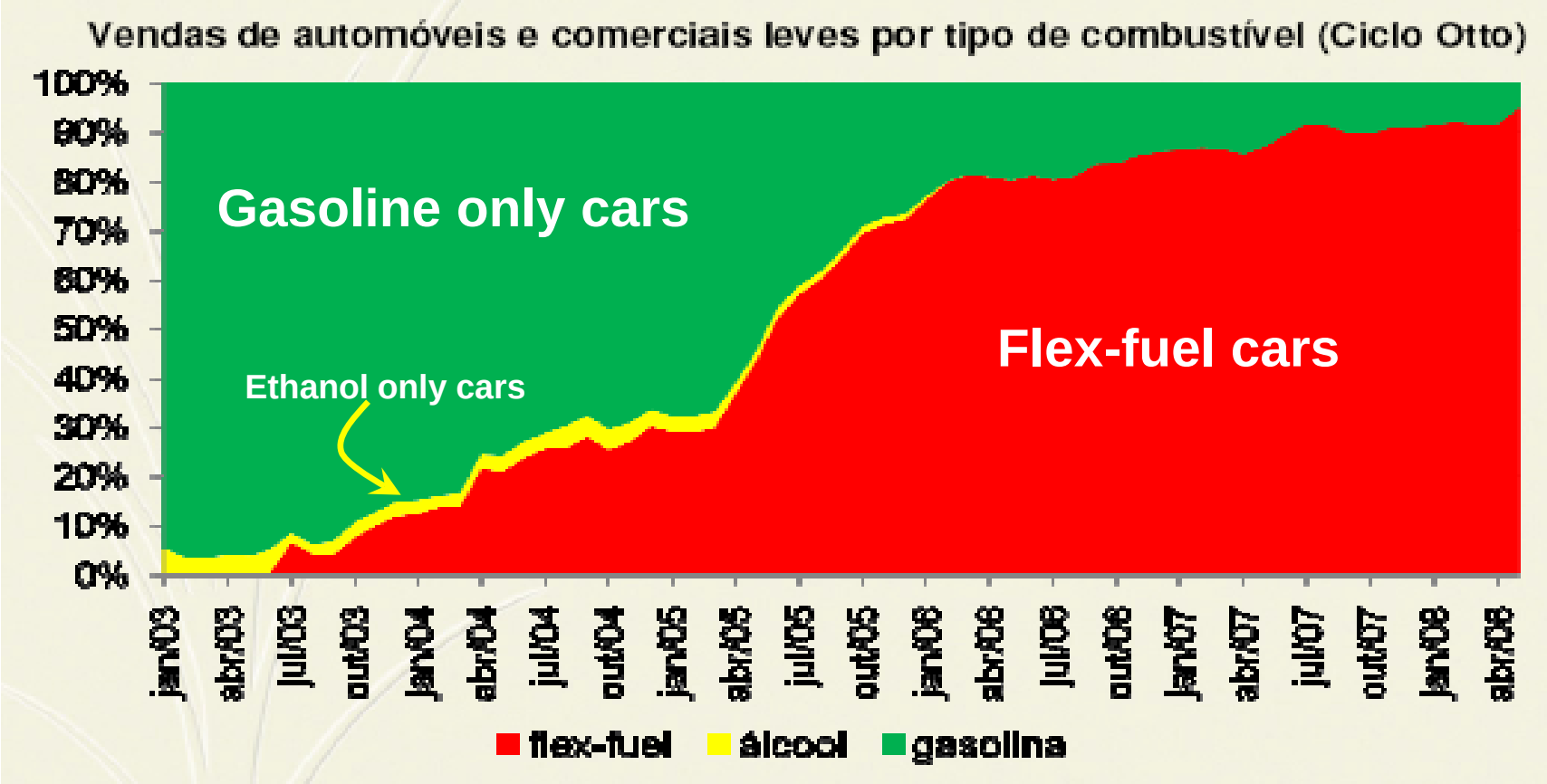
Brazil: Ethanol production 1948-2007



- 1975: Proalcool Program
- 2003: Flex-fuel vehicles
  - 95% of new vehicles sold today are Flex
- Gasoline has 25% Ethanol added
  - No pure gasoline in Brazil
- 33,000 gas+ethanol stations (out of 36,000)

Gasoline is the ALTERNATIVE fuel in Brazil

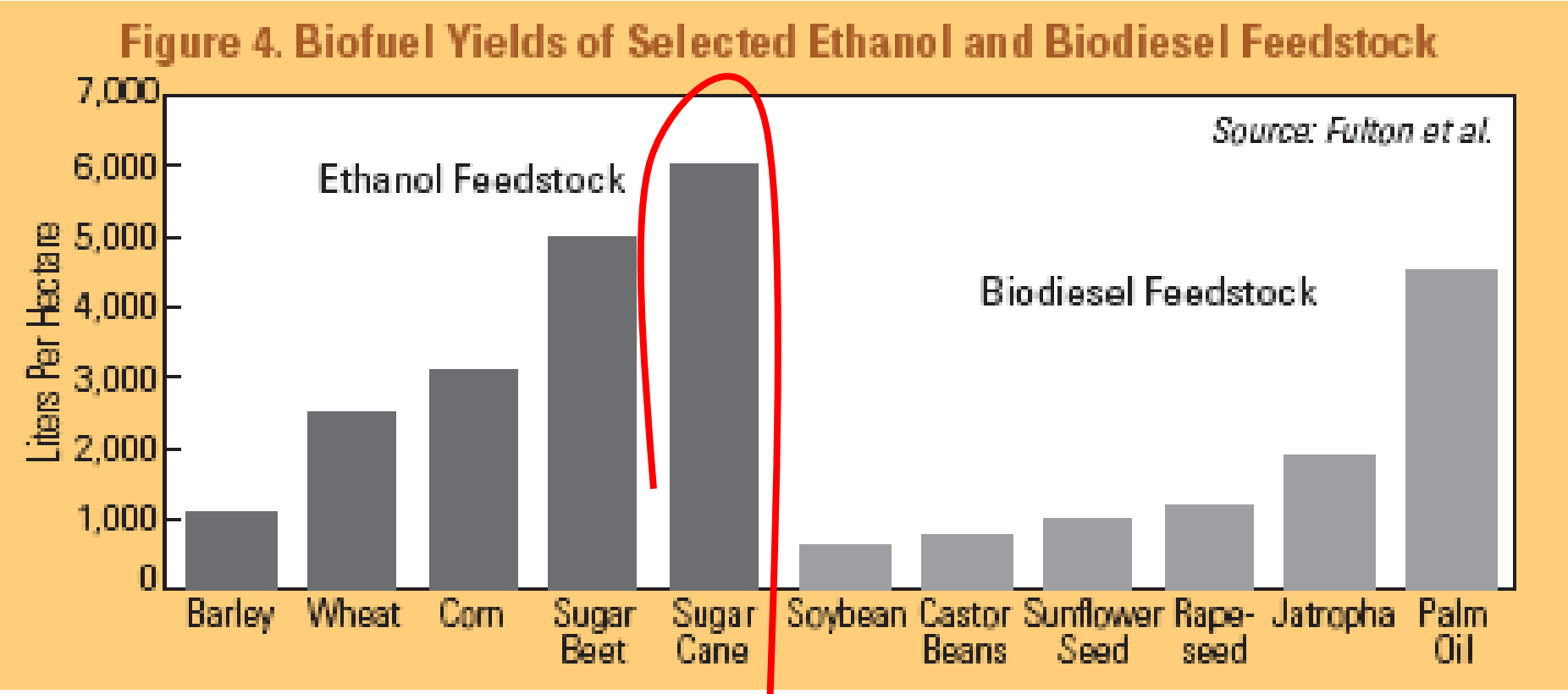
More than 90% of cars sold are Flex-Fuel



Source: ANFAVEA e UNICA, 2008

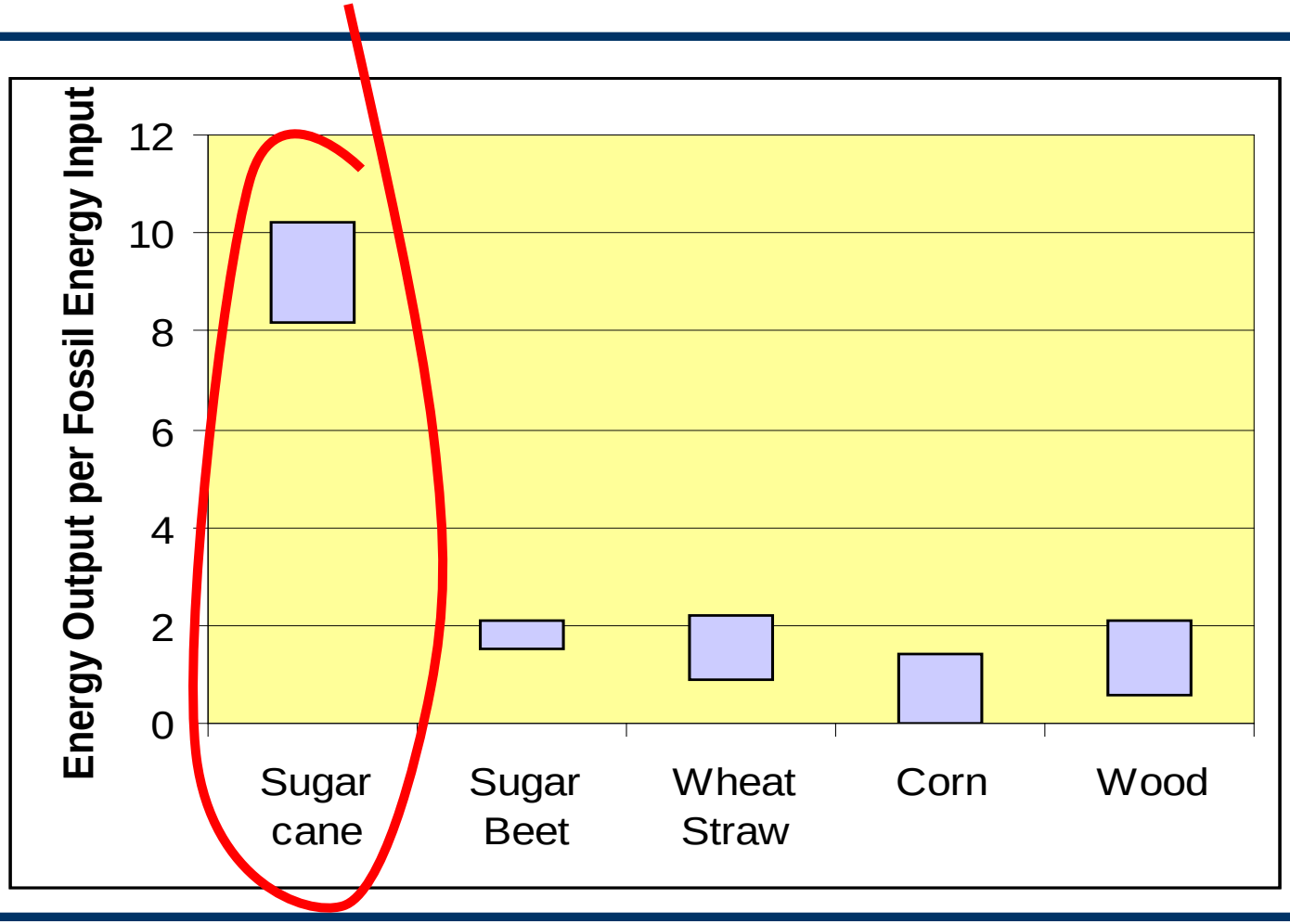
Ethanol from sugarcane main advantages

Biofuel yield per hectare

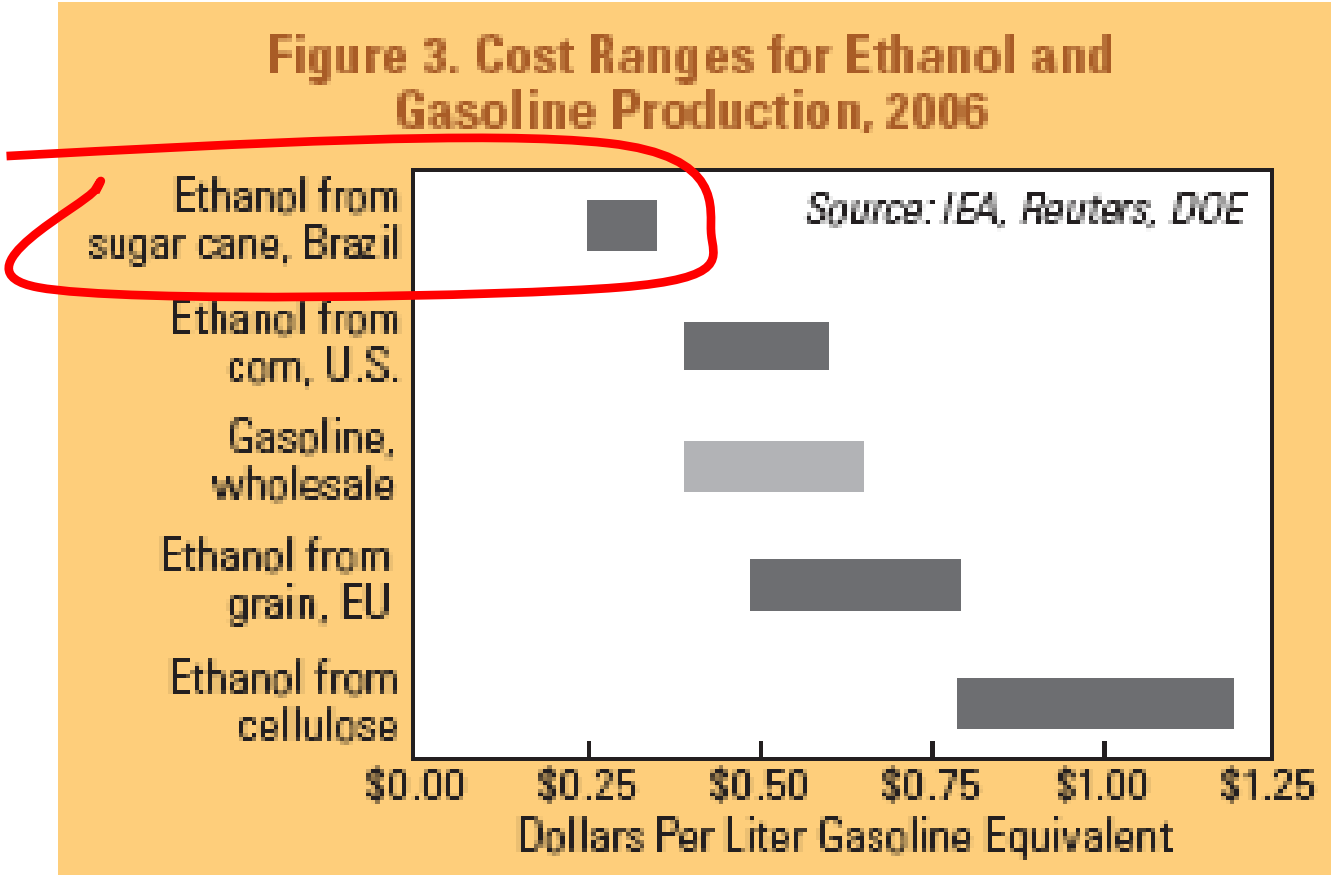


World Watch 2006, http://www.worldwatch.org/system/files/EBF008_1.pdf

Energy balance

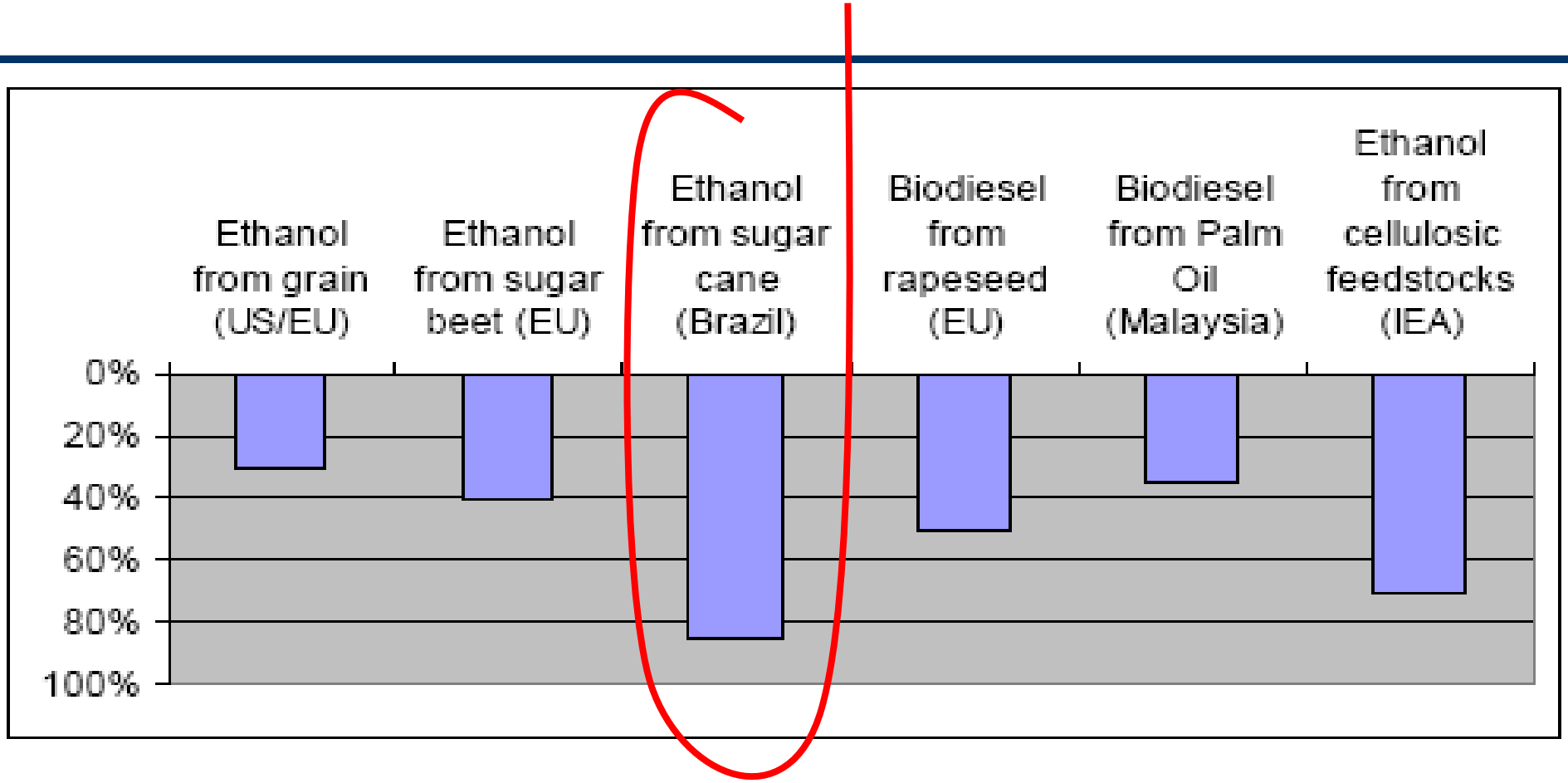


Biofuels costs



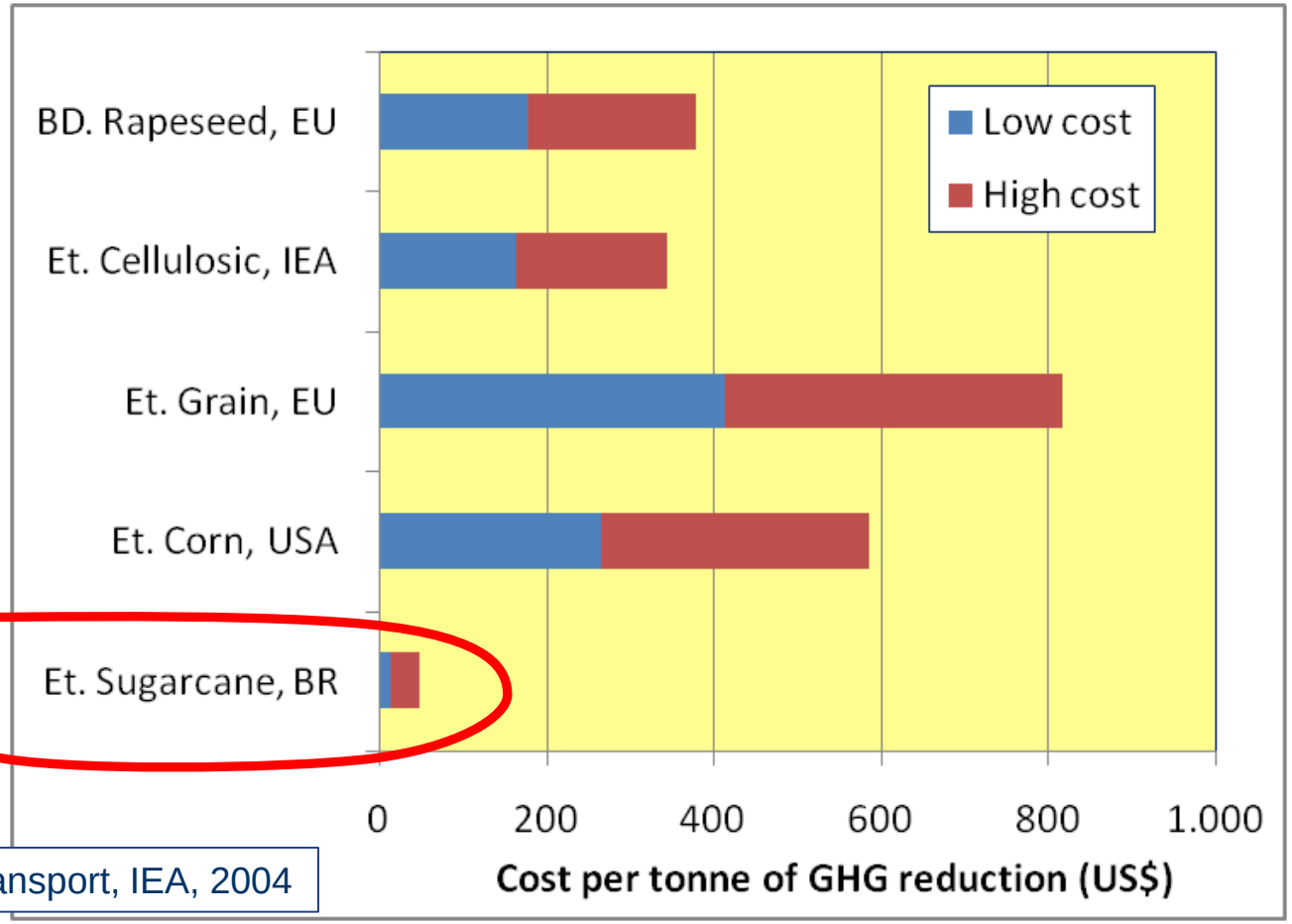
World Watch 2006, http://www.worldwatch.org/system/files/EBF008_1.pdf

Greenhouse gas reduction



Doornbosch and Steenblik, OECD 2007

Cost per tonne of reduced GHG

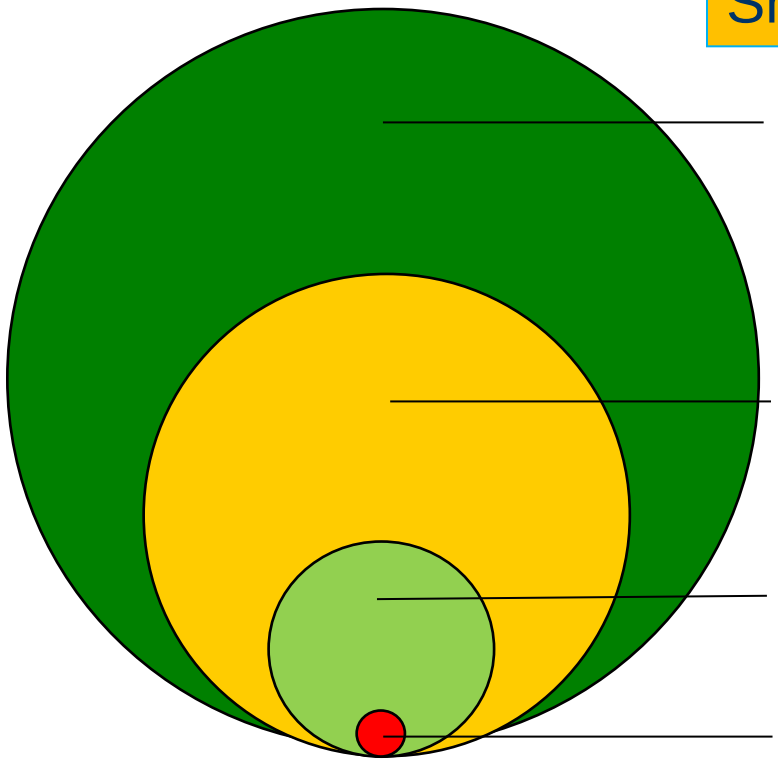


Source: Biofuels for Transport, IEA, 2004

Is ethanol production from sugarcane sustainable?

Sugarcane for ethanol uses 0,5% of total area

Small bioenergy footprint



Total country area (851 MHa, 100%)

Rural properties area (355 MHa, 42%)

Area used for agriculture (76,7 MHa, 9%)

Area used for sugarcane for ethanol (3,4 MHa, 0,4%)

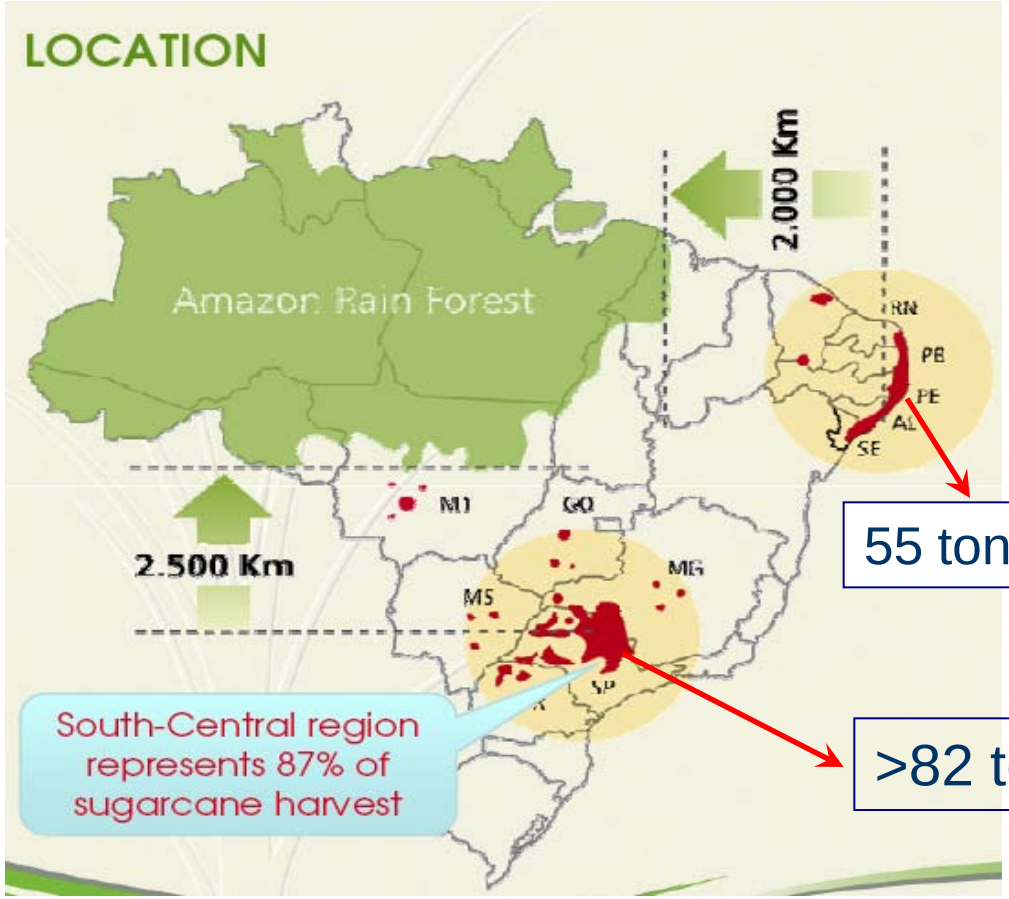
Source: Horta Nogueira e Seabra (2008)

Brazil: 1% of arable land displaces 30%+ of the gasoline

Millions of Hectares (2007)		% total land	% arable land
BRAZIL	851		
TOTAL ARABLE LAND	354.8		
1. Total Crop Land	76.7	*9.0%*	*21.6%*
Soybean	20.6	*2.4%*	*5.8%*
Corn	14.0	*1.6%*	*3.9%*
Sugarcane	7.8	*0.9%*	*2.2%*
Sugarcane for ethanol	3.4	*0.4%*	*1.0%*
Orange	0.9	*0.1%*	*0.3%*
2. Pastures	172.3	*20%*	*49%*
3. Available area Total arable land – (crop land + pastures)	105.8	*12%*	*30%*

Source: UNICA

Where does Brazil plant Sugarcane?

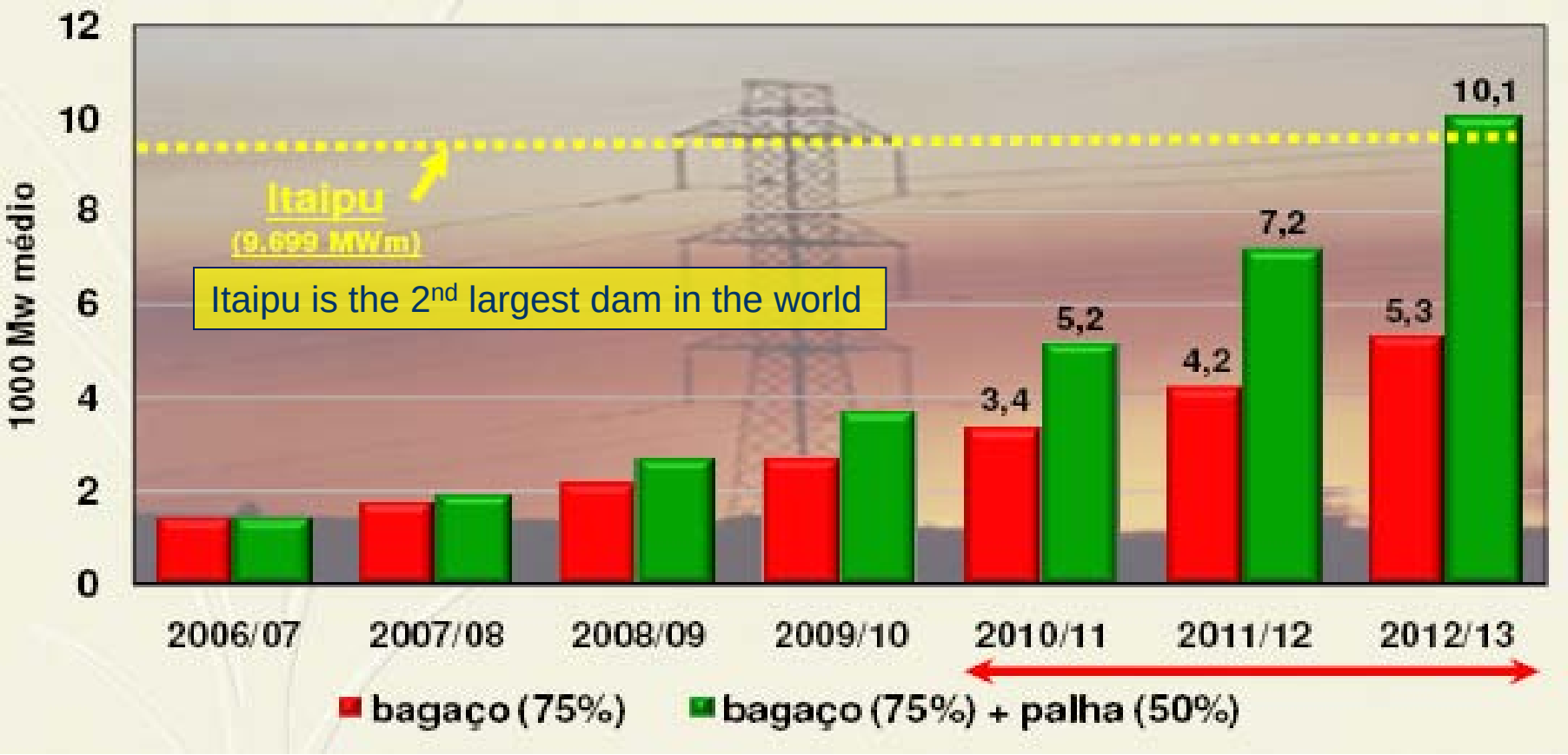


55 ton/ha

>82 ton/ha

- Not in the Amazon
- Best land for cane:
  - Northeast coast
    - Oldest (XVI century)
  - Southeast
    - highest productivity
  - Centralwest
    - main expansion area

Sugarcane: Ethanol AND Electricity



(Source: UNICA)

Ethanol mills can “produce” water

Quinta-feira, Julho 03, 2008 (http://ethanolbrasil.blogspot.com/2008/07/dedini-launches-ethanol-mill-that.html)

Dedini launches ethanol mill that produces water.

Reuters, 07/03/2008.

Brazil's Dedini, the leading manufacturer of biofuel equipment, launched a new technology that enables cane-based sugar and ethanol mills to produce water as a byproduct.

Mills in Sao Paulo, Brazil's largest and most efficient cane producing state, consume currently about 1,800 liters of water from rivers or lakes to process each tonne of cane.

Through the use of water contained in cane, the new technology allows mills not only to be self-sufficient but also to sell the product for domestic and industrial usage.

Each tonne of sugar cane contains about 700 kilograms of water. With the new technology, mills could be able to sell up to 300 kilograms of this water per tonne of cane.

Less land, less water, less carbon, renewable energy source

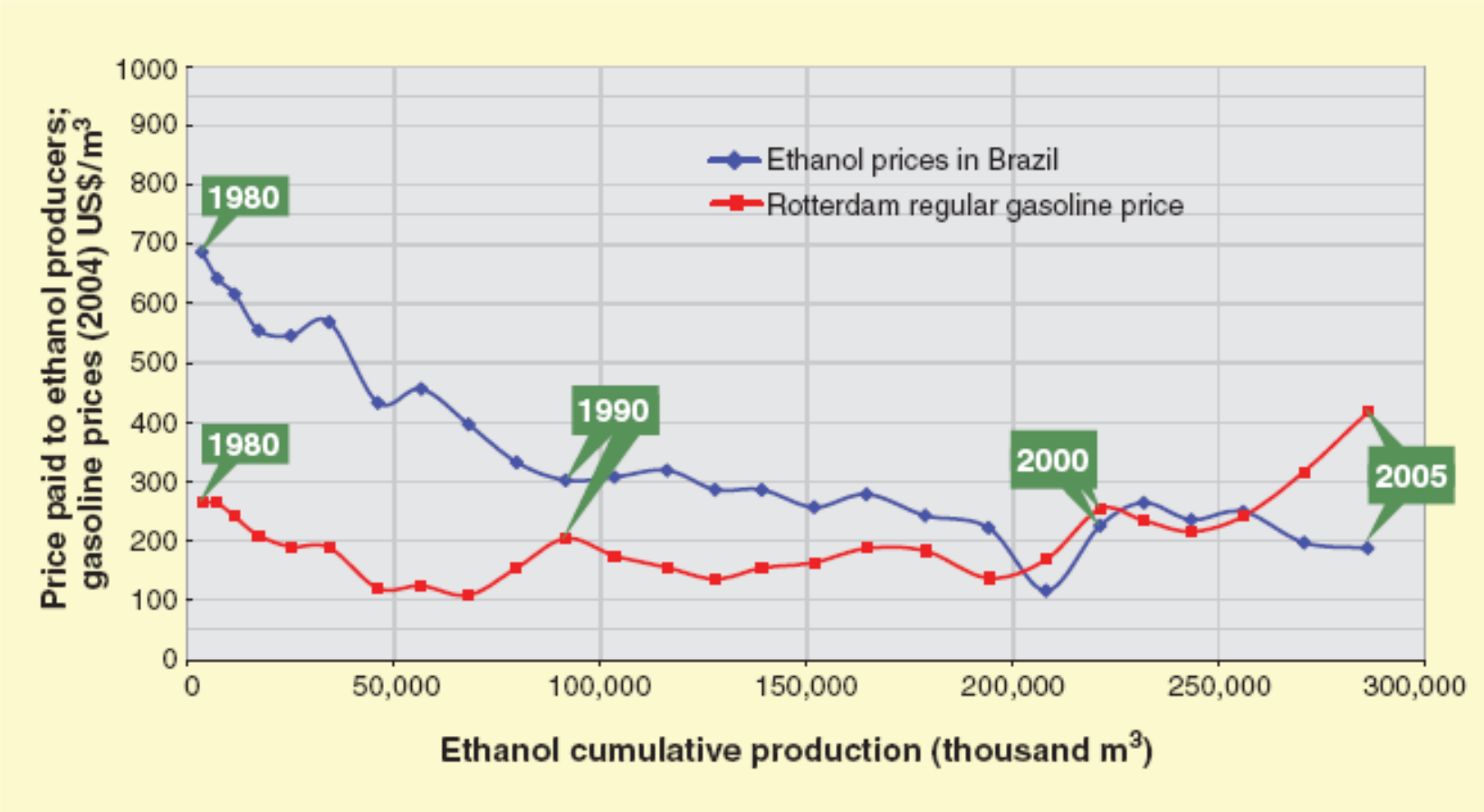
"Our goal is to figure out how to produce more with less land, less water and less pollution, so we won't be the only species left living on this planet."

Jason Clay, WWF

- Ethanol from sugarcane
  - Less land: - 4% per year
  - Less water: reuse
  - Less pollution
    - Reduces fossil fuel use
    - Reduces Carbon emissions
  - Use less energy

What is the role of innovation?

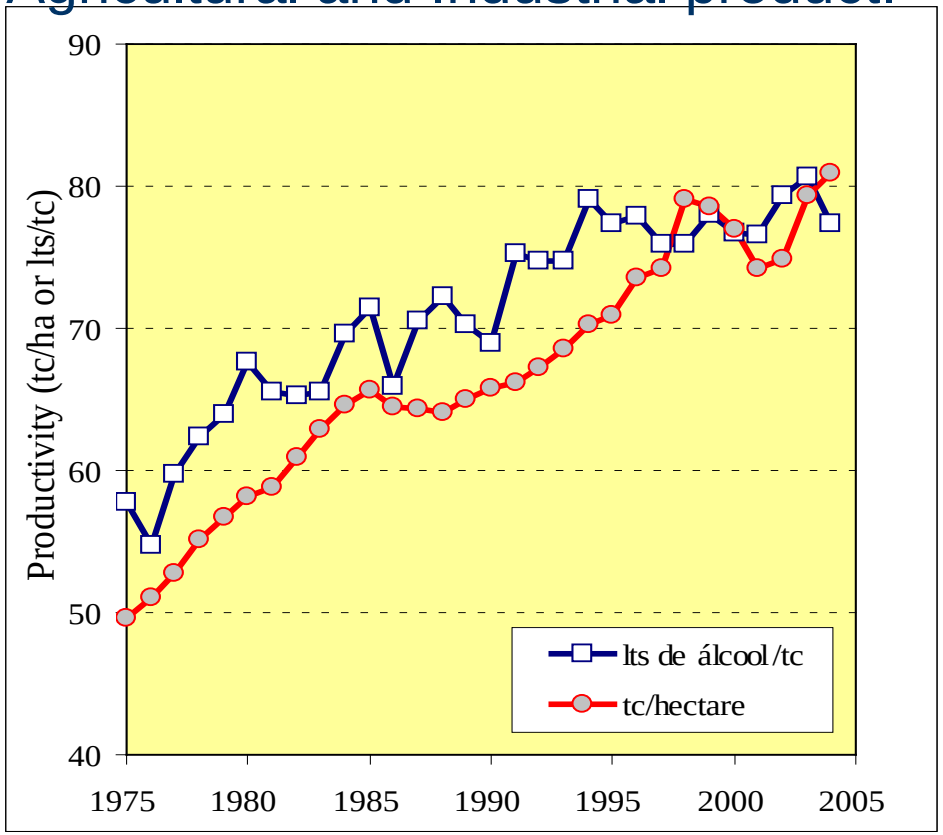
Economic competitiveness of ethanol fuel compared to gasoline



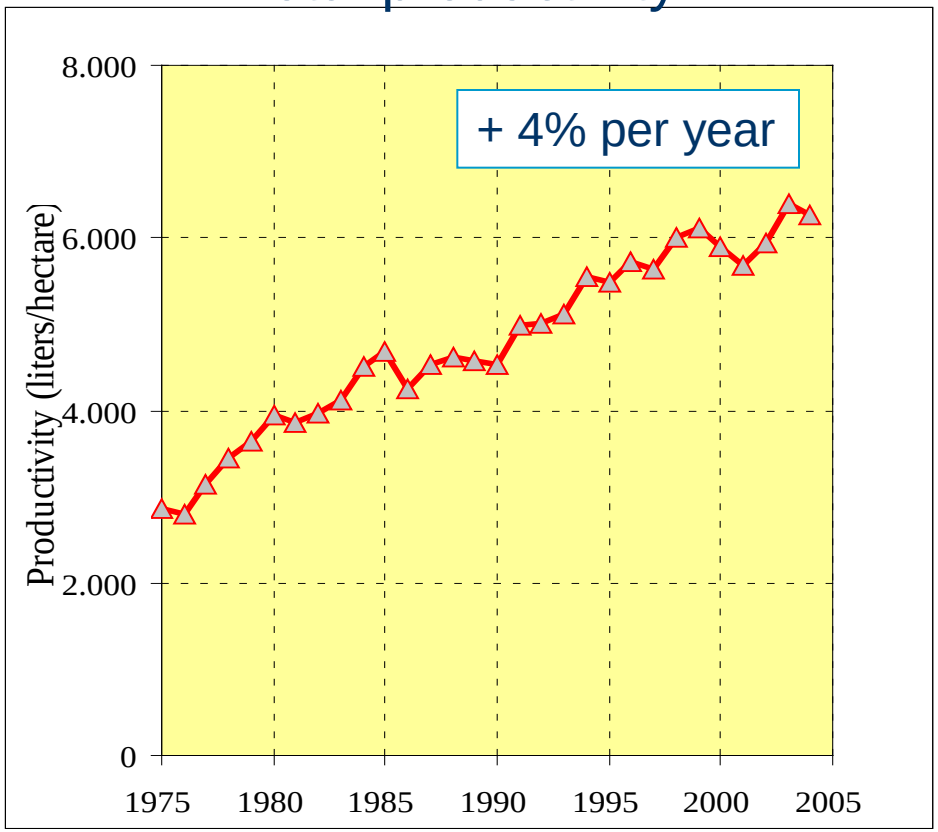
Source: Goldemberg, 2008

Increase in productivity through R&D

Agricultural and Industrial product.

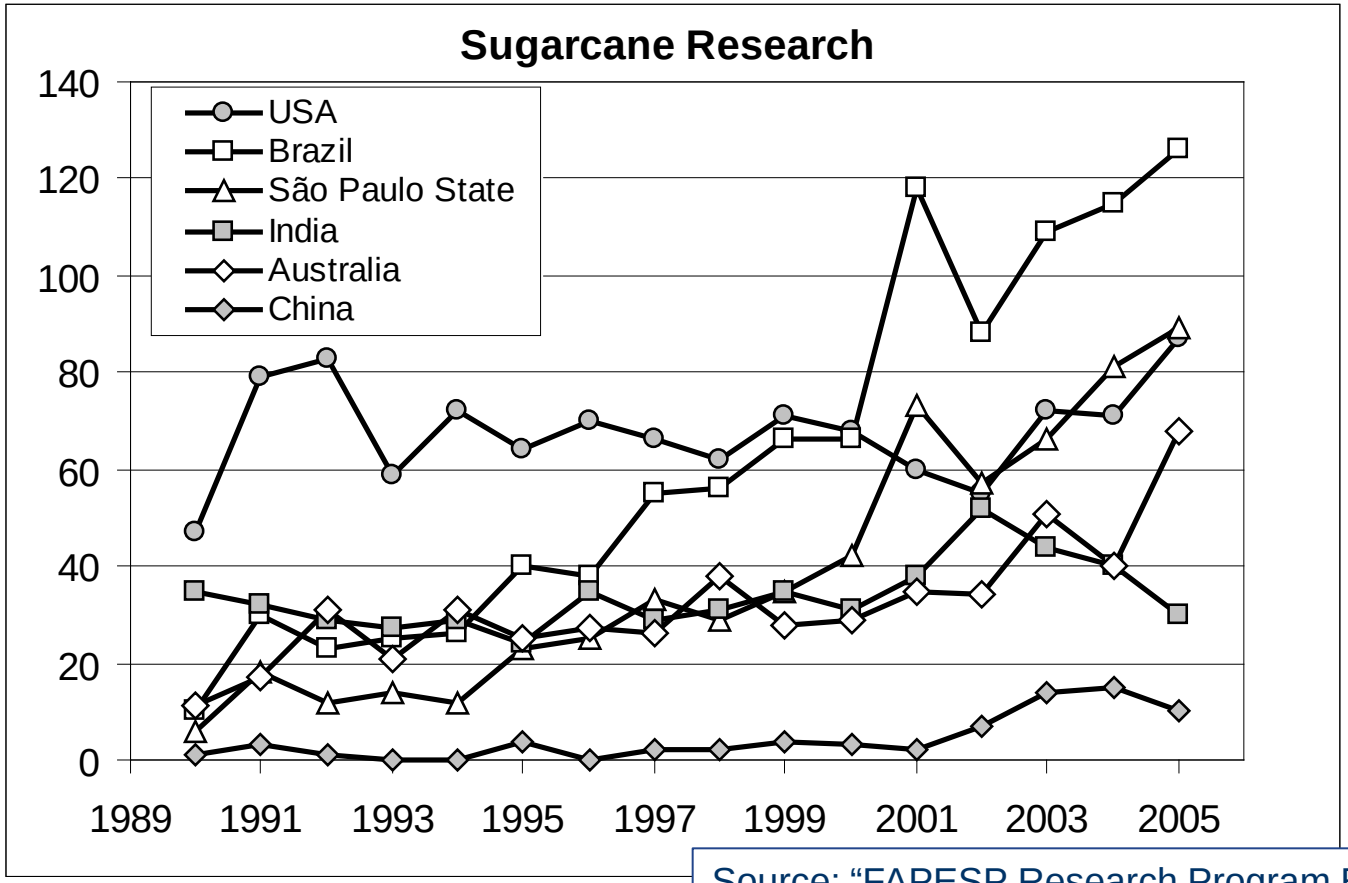


Total productivity



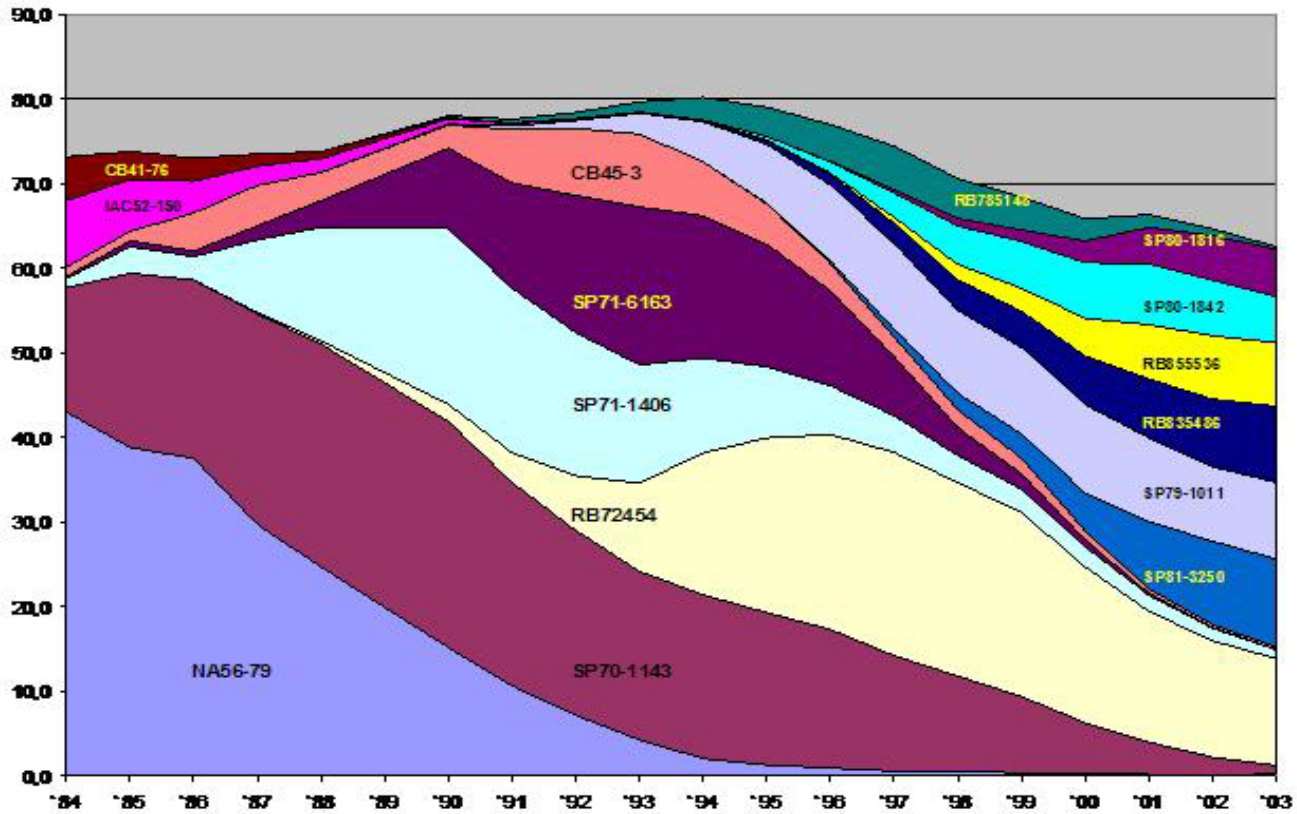
The importance of a strong science base

Scientific papers on Sugarcane topics



Source: “FAPESP Research Program BIOEN”, June, 2008

R&D: Increasing number of Sugarcane varieties used in Brazil



1984 1994 2003

- Developed by 3 research organizations
  - CTC
  - Ridesa
  - IAC
- Plus private companies
  - Alellyx
  - Canaviallis

Now Monsanto

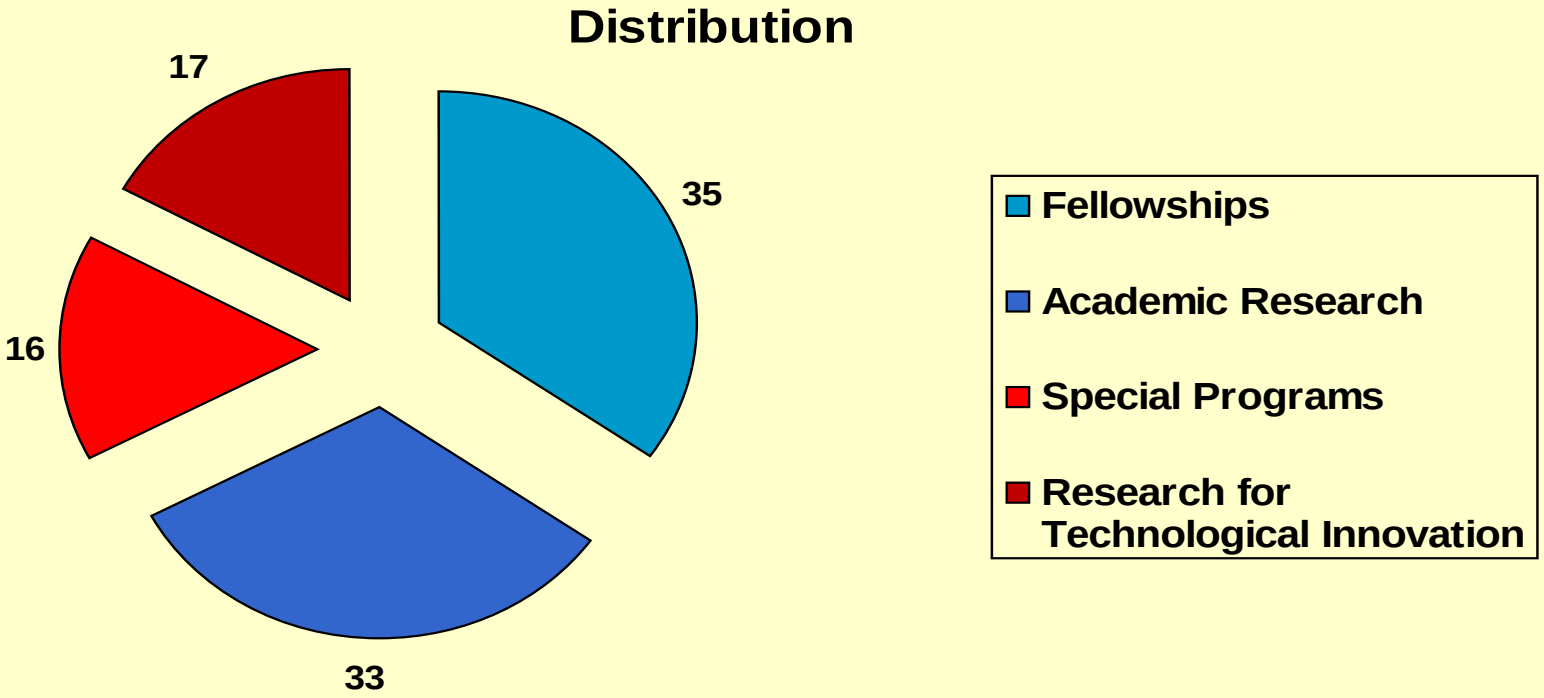
The role of Fapesp

FAPESP

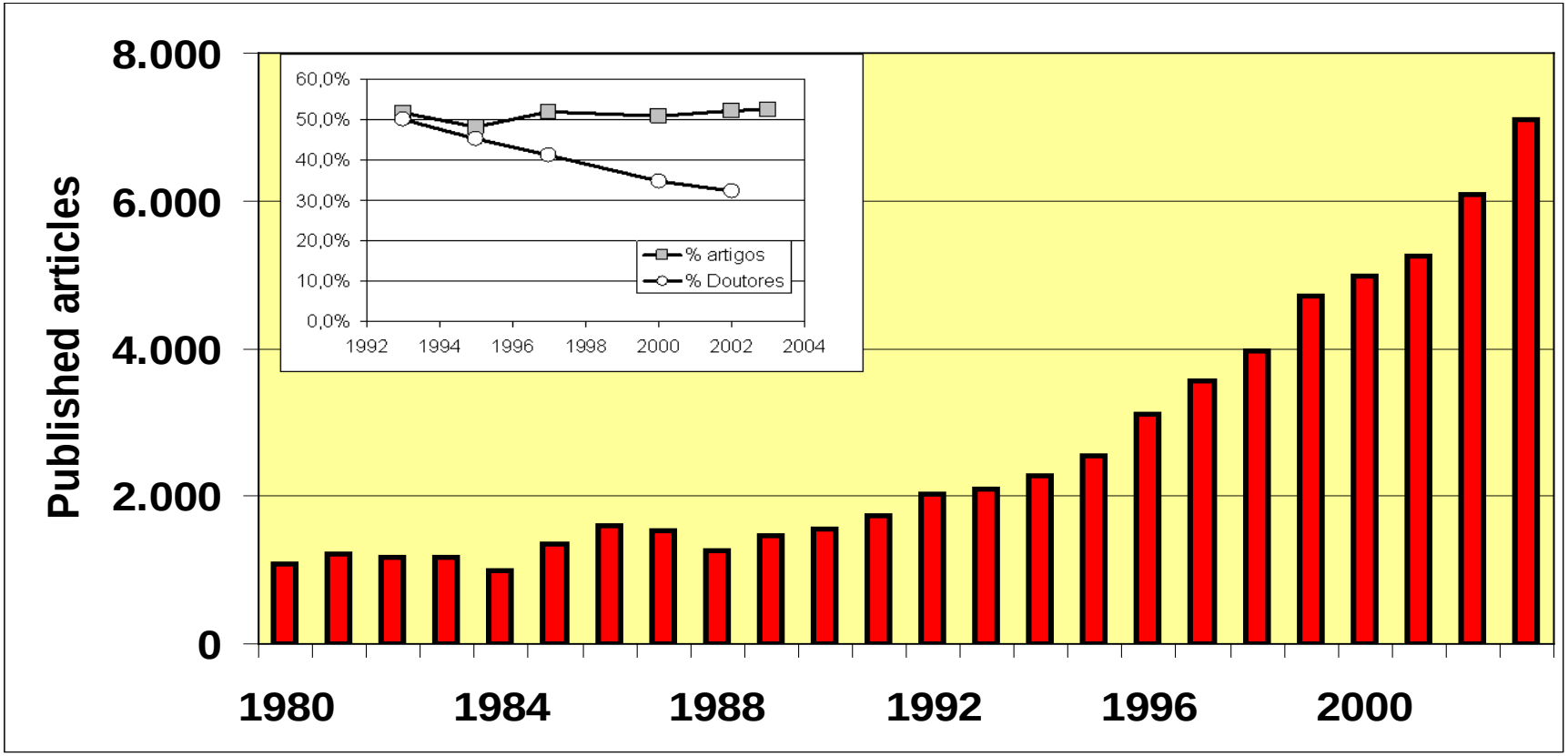
- 1962: Executive Decree 40.132 creates FAPESP
- 1989: New State of São Paulo Constitution
  - Article 271 – “The State shall grant no less than one percent of its total tax revenues to the Foundation for the Support of Research in the State of São Paulo, as a revenue to be privately managed by said foundation, to be applied in scientific and technological development”

FAPESP

- 2008 budget: ~ US$ 370 million



State of SP: articles in ISI referenced journals



Research for technological innovation

- PIPE – The Technological Innovation in Small Businesses Program
  - Research projects developed by researchers in small companies
- PITE – The Partnership for Technological Innovation Program
  - Research projects developed in partnership with R&D institutions in the State of São Paulo and businesses located in Brazil and abroad

FAPESP's Research Program on Bioenergy (BIOEN): 5 areas

1. BIOMASS RESEARCH: Focus on sugarcane, including genomics, biochemistry, cell biology, physiology, plant breeding and sugarcane farming technologies
2. ETHANOL TECHNOLOGIES RESEARCH: Focus on processing and engineering
3. ALCOHOLCHEMISTRY AND BIOREFINERIES: Integrated focus on sugarchemistry, alcoholchemistry and bio-products
4. ENGINES: Focus on ethanol applications for motor vehicles – Otto cycle engines and fuel cells
5. IMPACTS: Focus on social, economic and environmental studies, land use, intellectual property associated with the biofuel industry

State of São Paulo Bioenergy R&D – BIOEN

- Academic Basic and Applied Research
  - Advancement of knowledge – US$ 24M (2008) + 2009,..
    - Plus US$ 140 M (10 years) for a Statewide Research Center
  - Young Investigator Awards – US$ 6 M (2008) + 2009..
    - Open to foreign scientists who want to come to Brazil
- Joint industry-university research (5 years)

Company	Subject	Value by industry
Oxiteno	Lignocellulosic materials	US$ 3,000,000
Braskem	Alcohol-chemistry	US$ 25,000,000
Dedini	Processes	US$ 50,000,000

Conclusion

- Brazil created a large and successful experiment on planting fuel since 1975
  - More than 30 years accumulating technological and production capabilities
  - Incremental rather than radical innovation
  - Success is also based on scientific capabilities (Fapesp and other agencies such as CNPq, Capes etc play a role)
- Sugarcane has special characteristics
  - Productivity
  - Greenhouse gas reduction
  - Favorable energy balance

Conclusion

- R&D strategy: more with less (less area, water, energy,...)

- Brazilian strategy counts on many other countries producing Ethanol from various sources
  - Technology transfer
  - Cooperative R&D
- Most probable producers: Latin America and Africa
  - Access to energy and source of revenue for developing countries