Ethanol and sustainability issues – The case of Brazil and new opportunities for innovation and development

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PÓLO NACIONAL DE BIOCOMBUSTÍVEIS

Brazilian Center for Biofuels`s background

Brazilian Center for Biofuels at the University of Sao Paulo – School of Agronomy – Sao Paulo State

The roles and functions of the Brazilian Center for Biofuels:

“ A Think Tank” @ the University of Sao Paulo

Contribution to:

- Strategic and applied research
- S&T&I supporting and influencing policies
- Awareness raising and capacity building
- Mitigation of GHGs and carbon projects

Key biofuels drivers

Global and larger frameworks supporting biofuels deployment

Oil consumption and prices: a security issue

IPCCC and Stern report – environmental and economic impacts of GHGs

USA – goals of reducing 10% gasoline consumption in 20 years

EU – Directives on Biofuels 2003/30/EC & Biofuels Vision 2030

Kyoto targets and voluntary commitments

Cost effective substitution and future technologies available….

Competitive prices and being renewable

Some remarks...

Energy intensity economies – developed versus developing countries

Asymmetric impacts of GHGs in countries – the poor will suffer the most

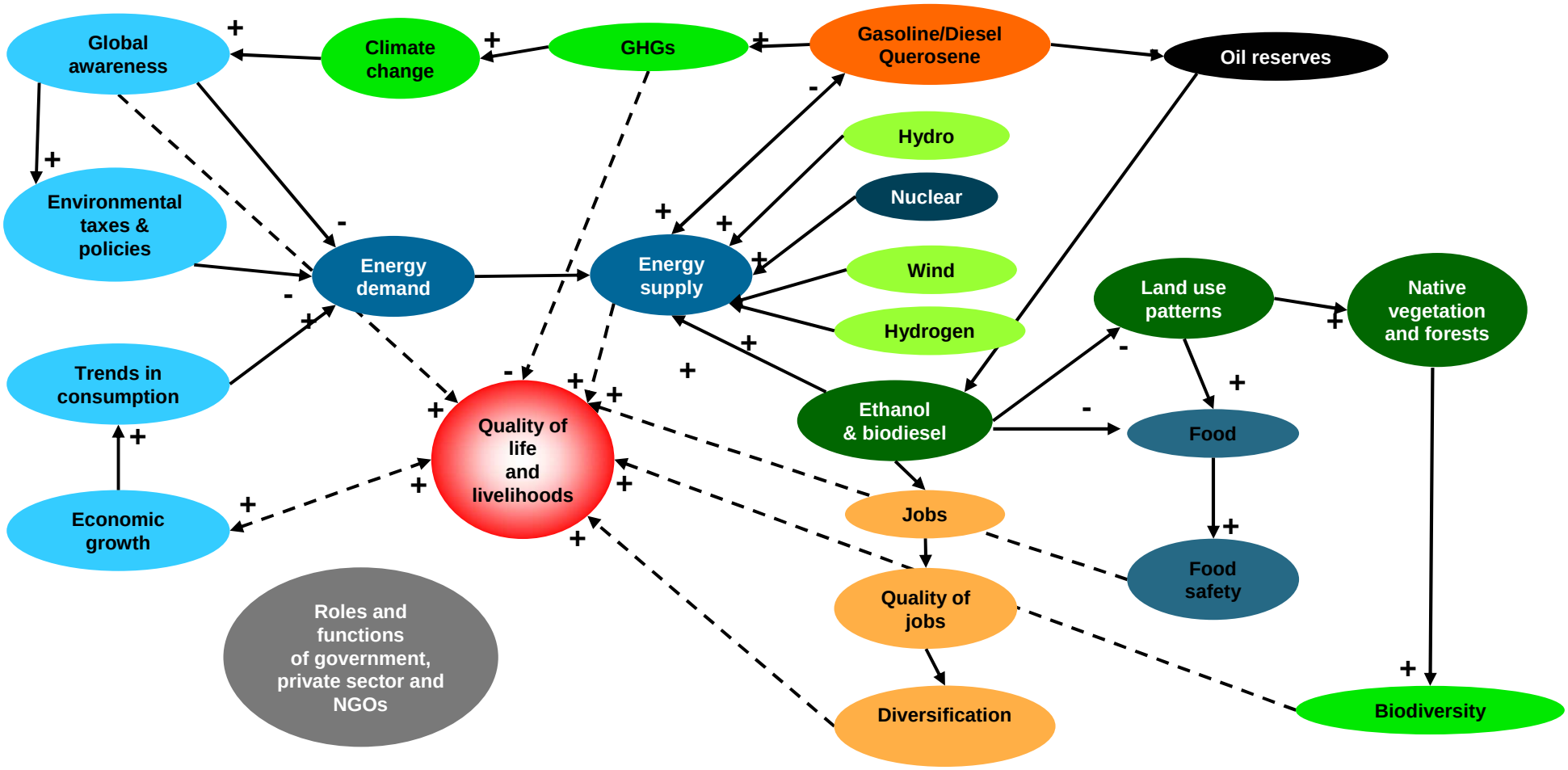
Livelihoods ... trends in consumption patterns and cultural behavior

The role of renewable energy sources

Technologies and biofuels: competitiveness and innovation

Biofuels framework - understanding key drivers of energy supply and demand

System dynamics and their multiple interactions



Brazil is well positioned in terms of economy, size and potential

Key indicators of the BRIC countries

	GDP/cap		GDP (billion)		Area	Agribus (M ha)		Pop	Poverty[1)]	HDI
	PPP	US$	PPP	US$	(M KM2)	Areable	Potential	(million)	% pop	
US	41.399	42.101	12.427	12.485	9,20	173		280	13%	0,94
China	7.204	1.703	9.412	2.225	9,60	142		1.300	10%	0,76
India	3.344	714	3.633	775	3,30	160		1.050	25%	0,60
Brazil	**8.584**	**4.316**	**1.577**	**792**	**8,50**	**59**	**360**	**180**	**22%**	**0,79**
Russia	11.041	5.369	1.576	766	17,10	123		150	25%	0,80

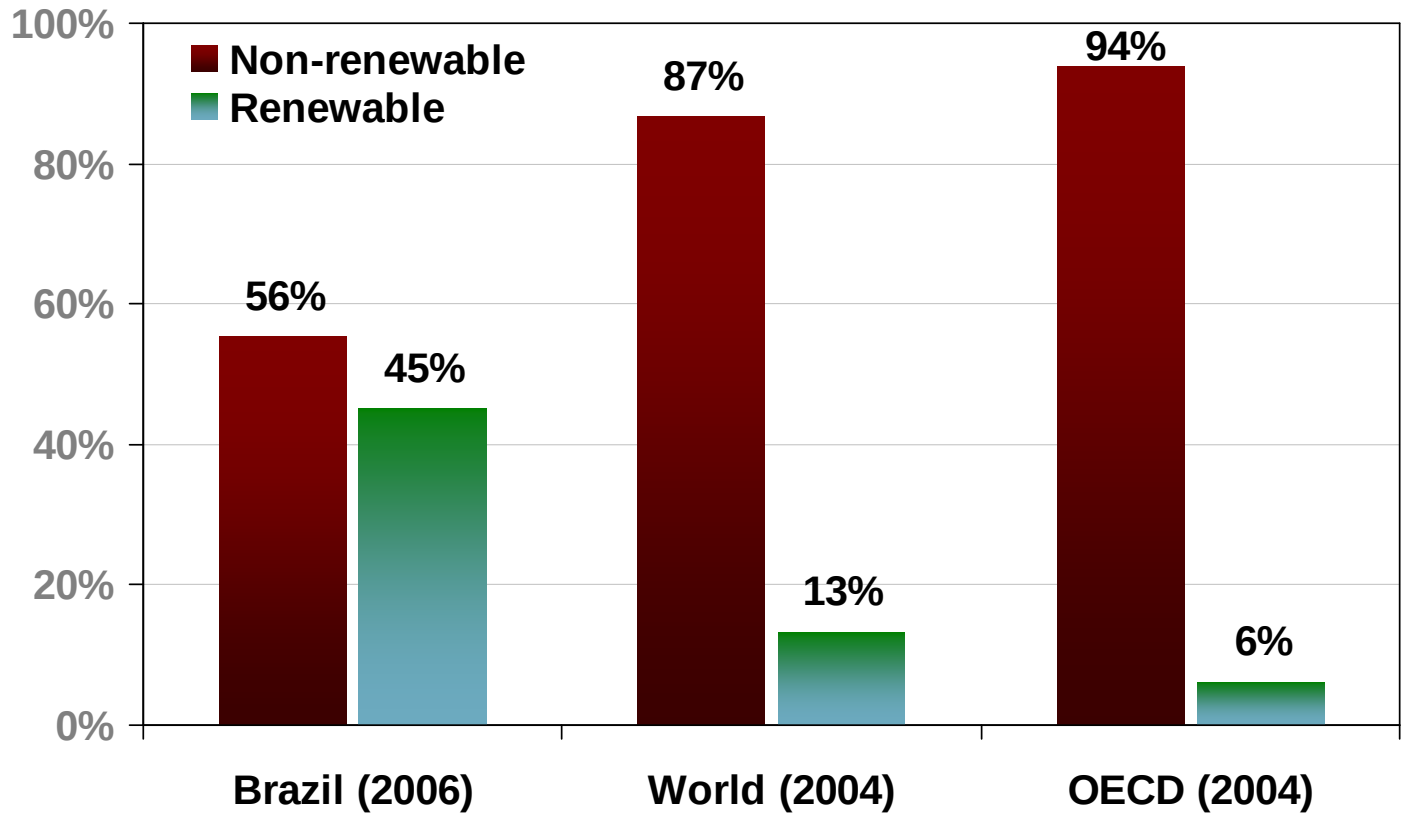
Brazil's positioning

- Average developing country
- 9th largest economy
- 5th in area but with greatest agricultural potential
- Average Human Development Index

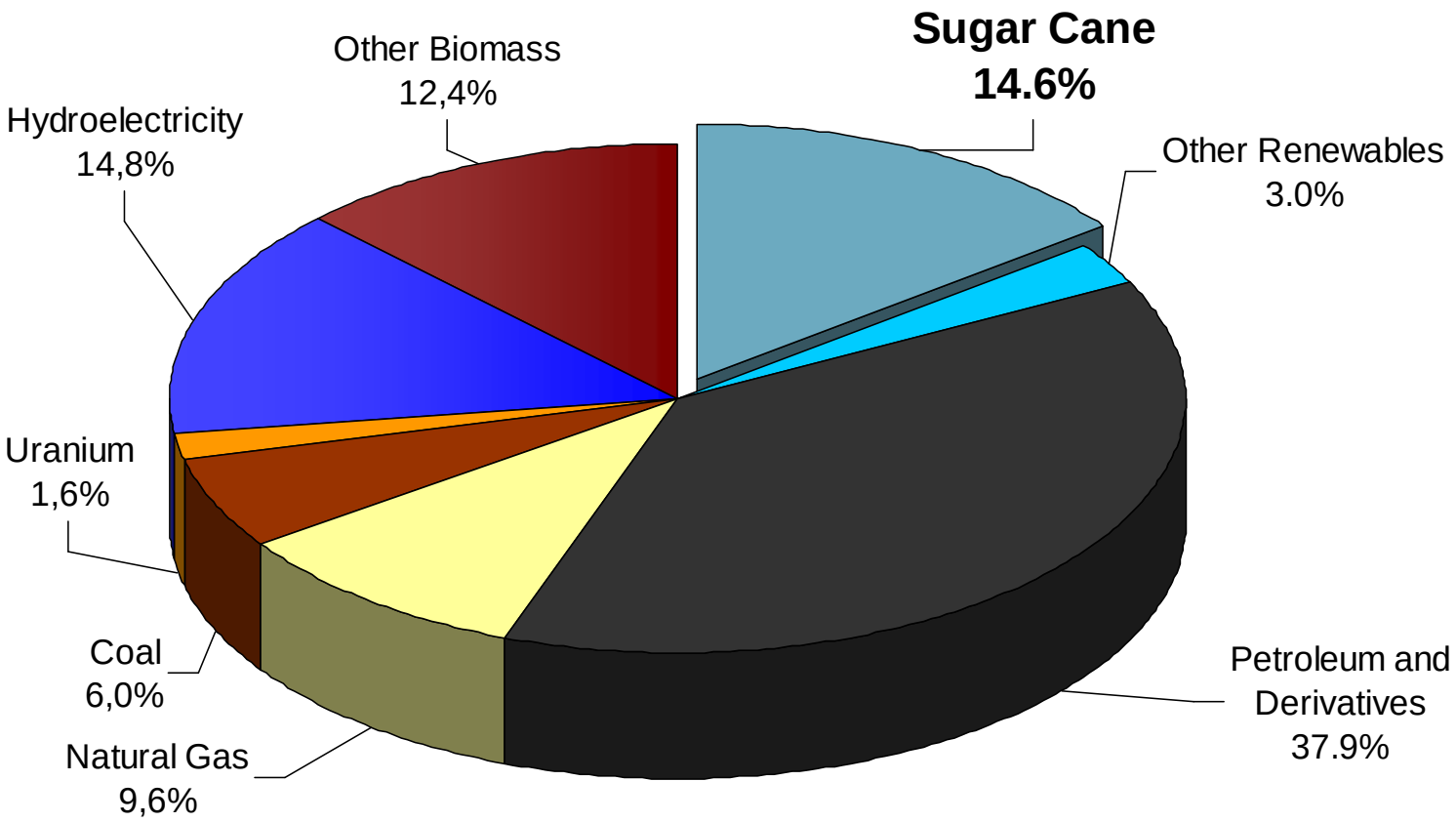
1) The poverty line set by the Chinese government is approximately 1/13th the standard set by the World Bank. China's poverty line of 0.2 US$ /person daily should be reevaluated. If a daily standard of 0.3 US$ were set the number below poverty standard would triple

Source: IMF 2005

Brazil - the energy matrix & the role of renewable sources



The role of sugar cane in the energy matrix



Sugar cane value chain

6,5 million ha
73 thousand growers

Harvest
410 million tons

390 mills & distilleries
(Operation & projects)

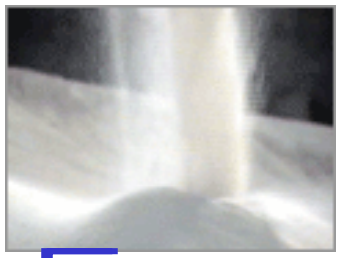
ETHANOL
22 billion liters

Ethanol

Food

Pharmacy

SUGAR
28 million tons



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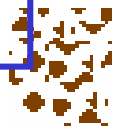


Lysine

BAGASSE

BIODIESEL
O NOVO COMBUSTÍVEL DO BRASIL

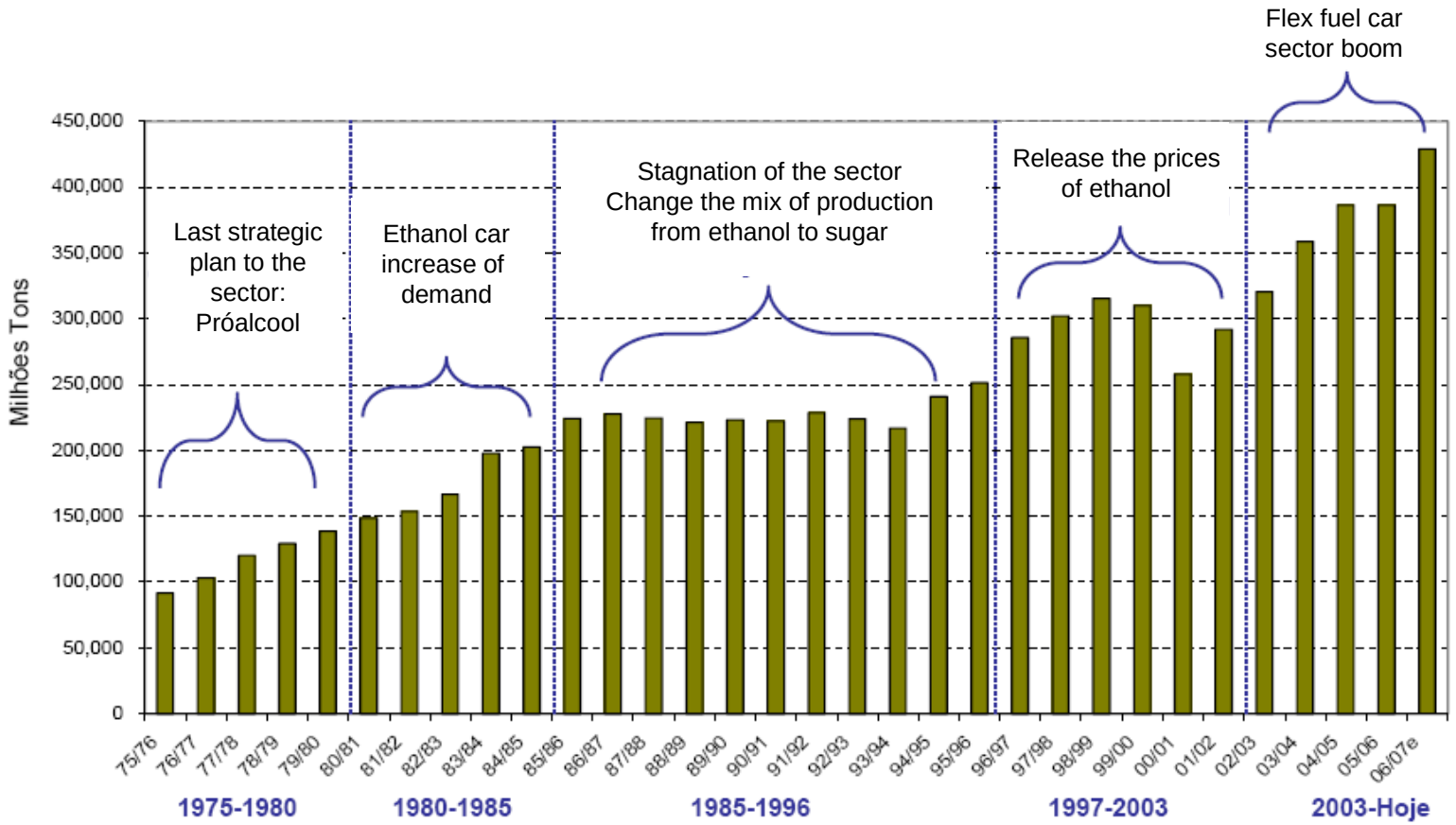
Bioplastic

Future markets

Credits of Carbon

Total production of sugarcane in Brazil increased significantly with the deployment of the ethanol vehicles

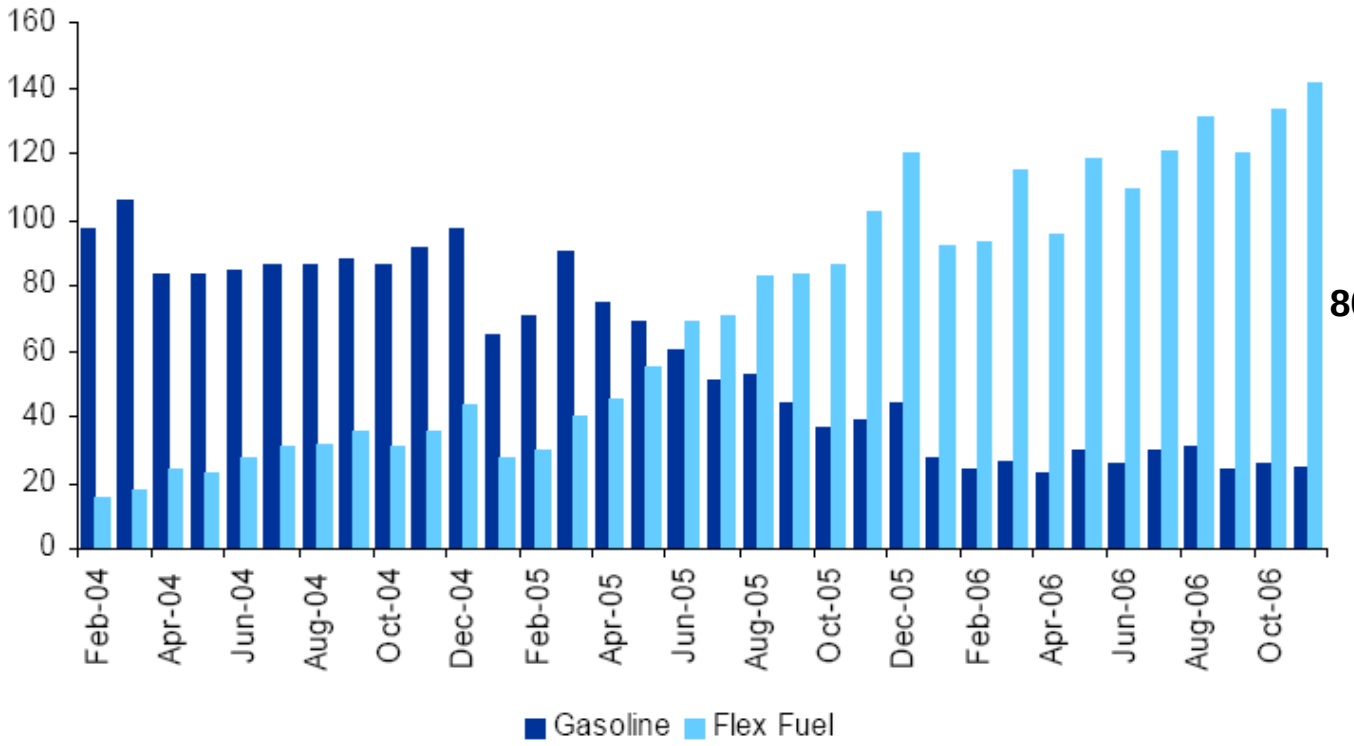
The evolution of the Brazilian ethanol industry – M tons of processed sugarcane



Source: Datagro

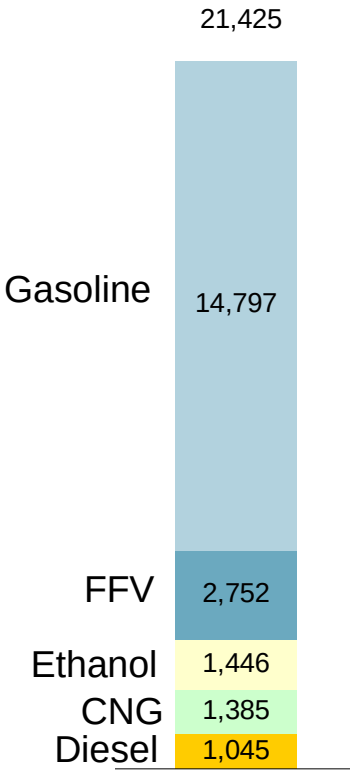
Flex fuel cars account for more than 80% of total cars produced in Brazil

Evolution of light vehicles production and Total Brazilian Fleet – ‘000 vehicles



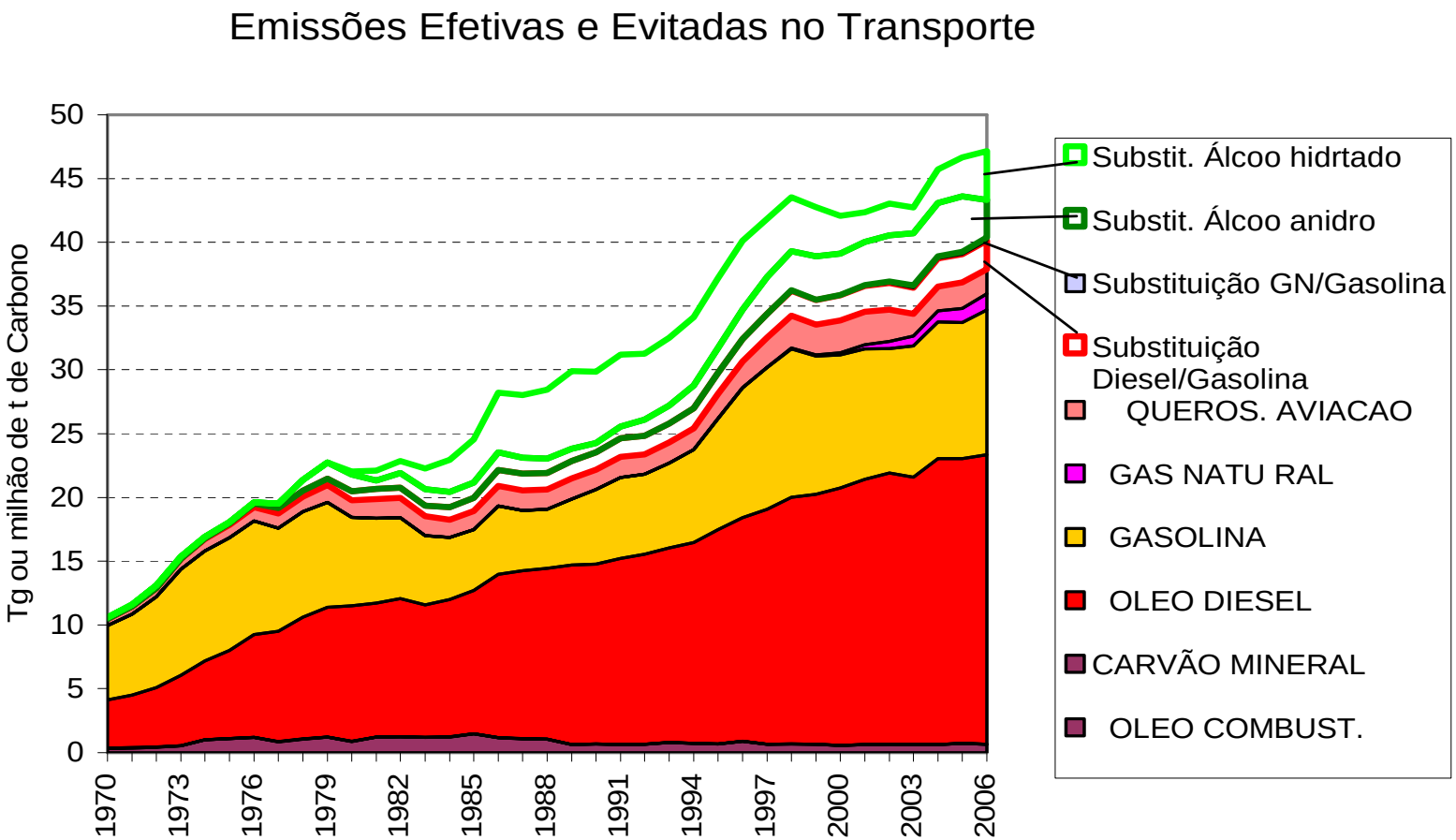
80%

Brazilian Fleet (2007)

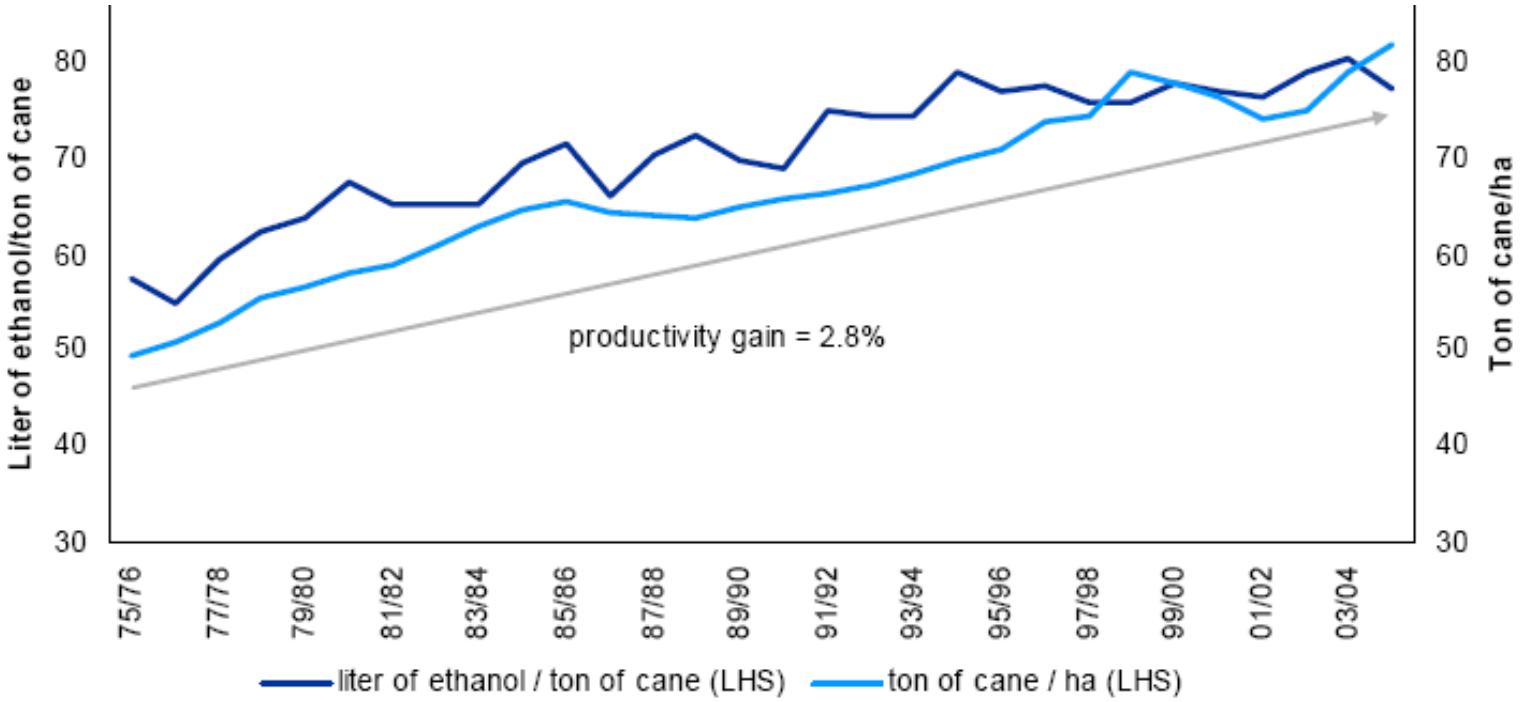


Source: ANFAVEA; VPB estimates

Mitigation measures due to biofuels



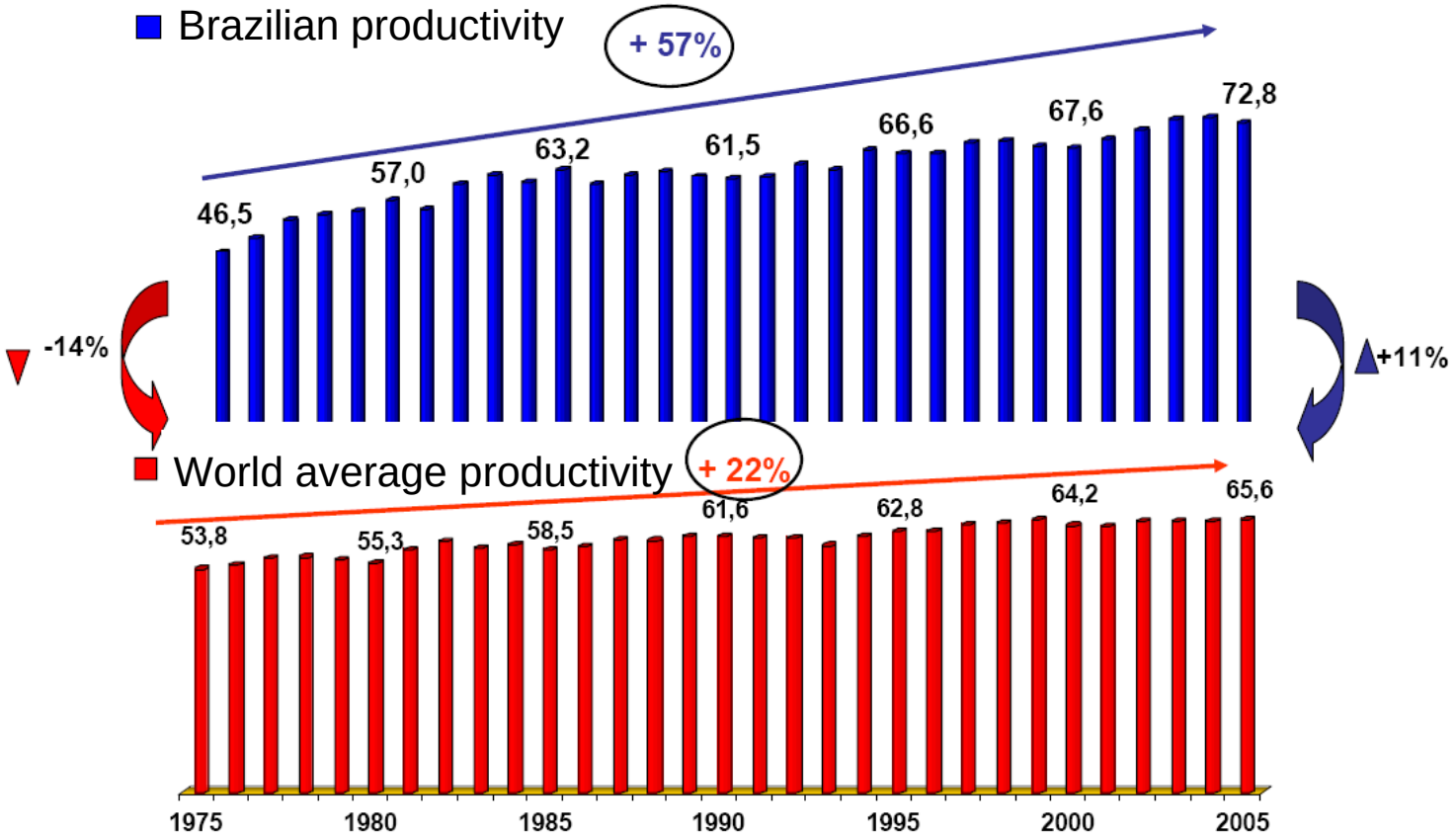
Ethanol productivity – liters/ha growing at 2,8%/year in the last 30 years



Fonte: Itaú Corretora

Brazilian sugar-cane productivity is 11% higher and has increased more than twice the world productivity

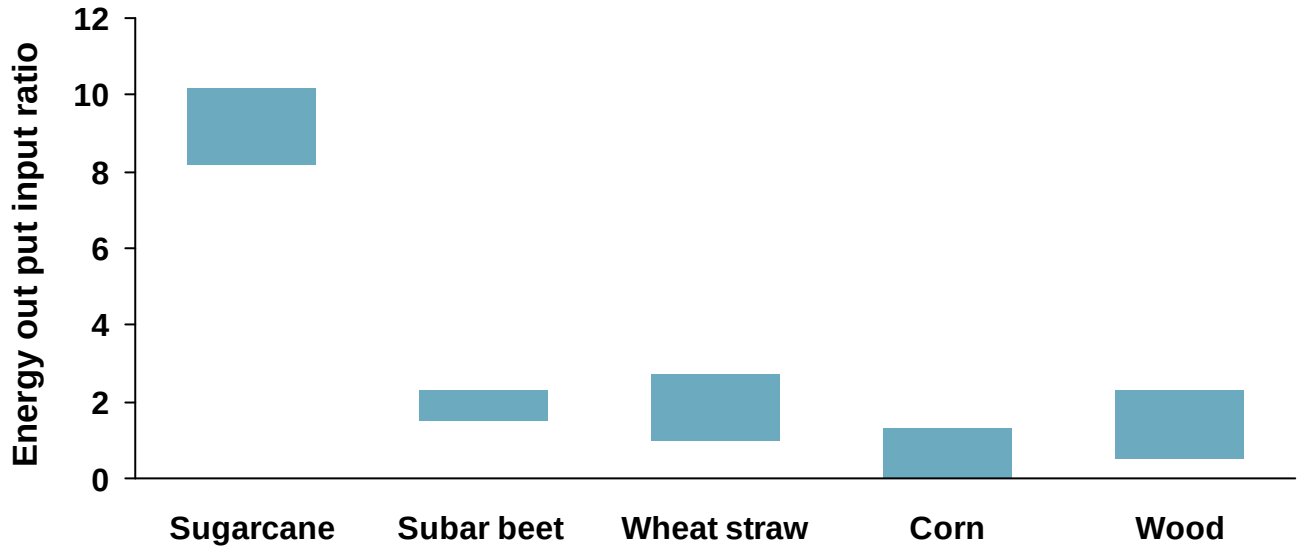
Agricultural productivity – M tons/ha



Source: Petrobrás

Sugarcane is the most energy efficient raw material to produce ethanol

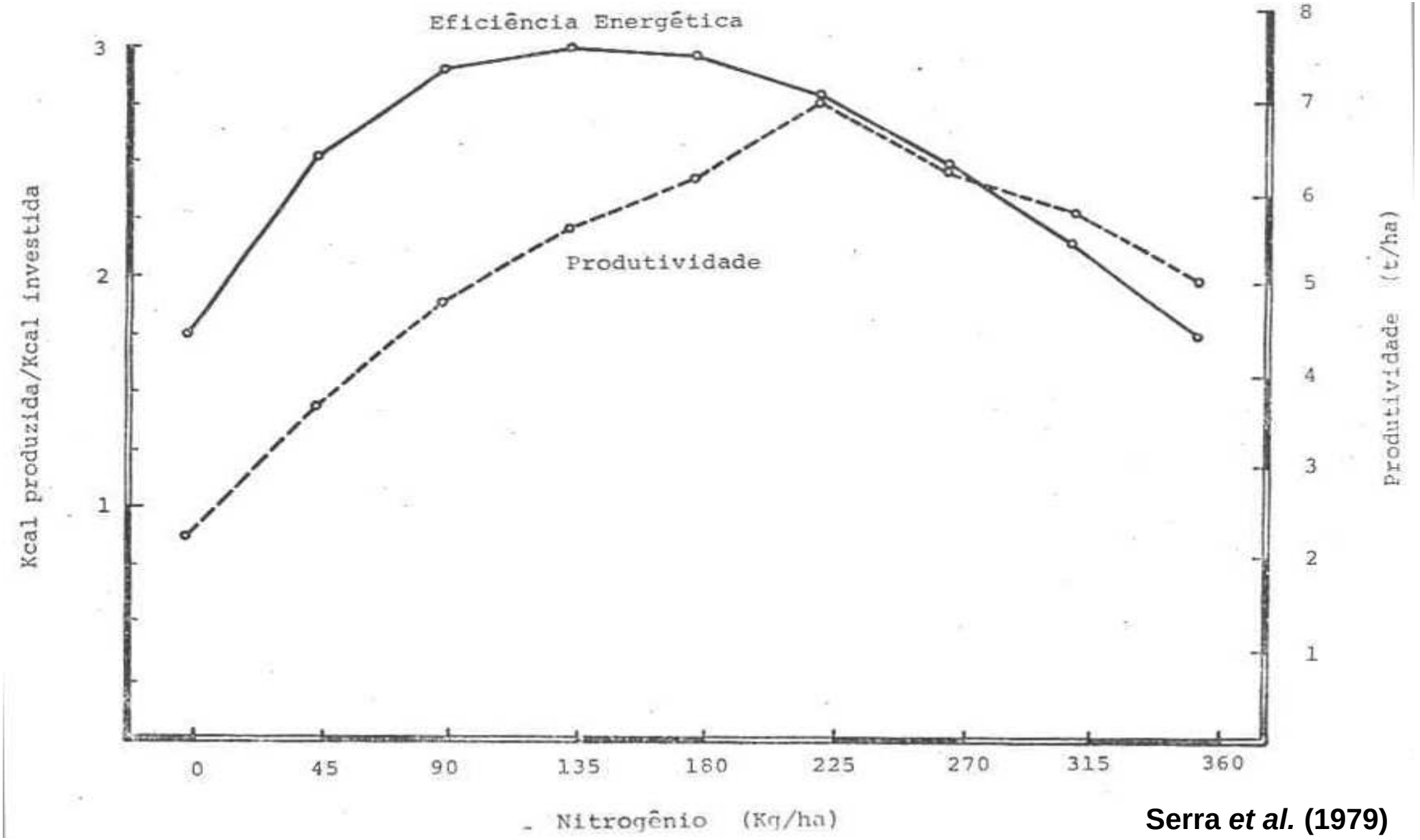
Energy balance of ethanol production from different feedstocks



Raw material	Production /ha (kg)	Quantity of Ethanol /ha	Energy Output/ Energy Input
• sugarcane	• 85.000	• 7.080 liter	• 8.3
• Corn	• 10.000	• 4.000 liter	• 1.3 - 1.8

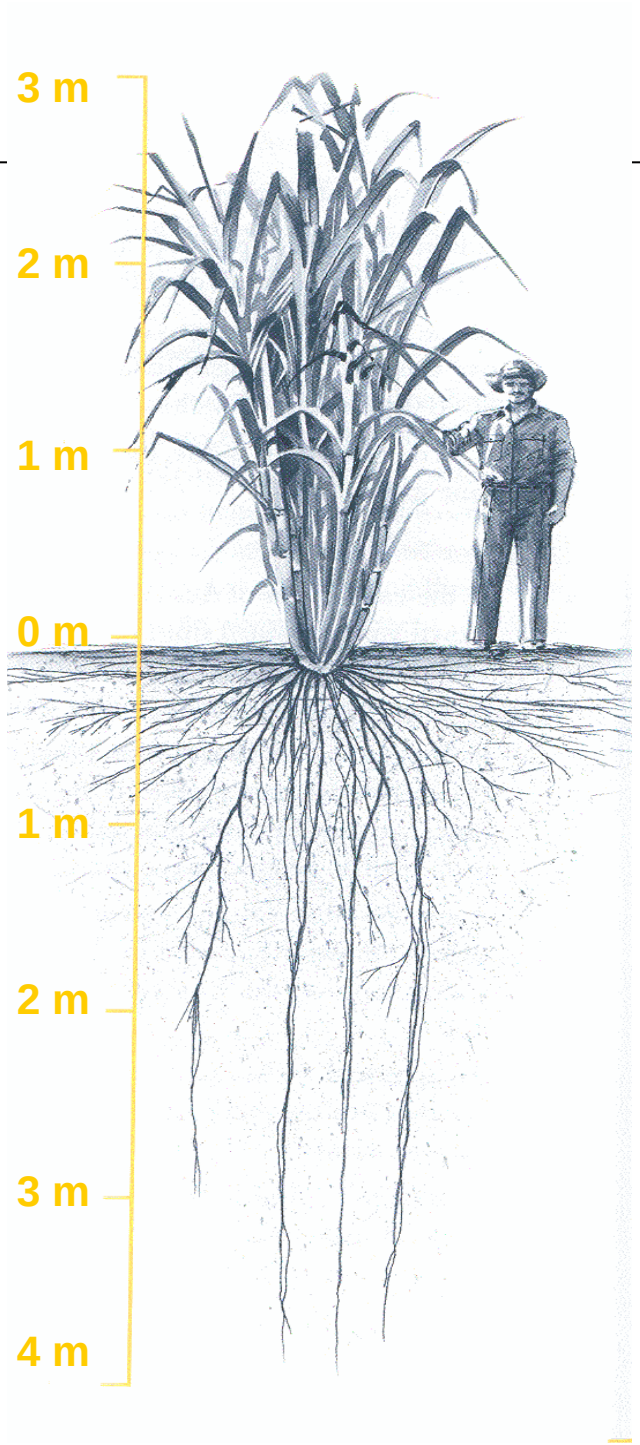
Source: Petrobrás, Coehlo/Cenbio

ENERGY EFFICIENCY



Serra *et al.* (1979)

Sugar Cane in Brazil



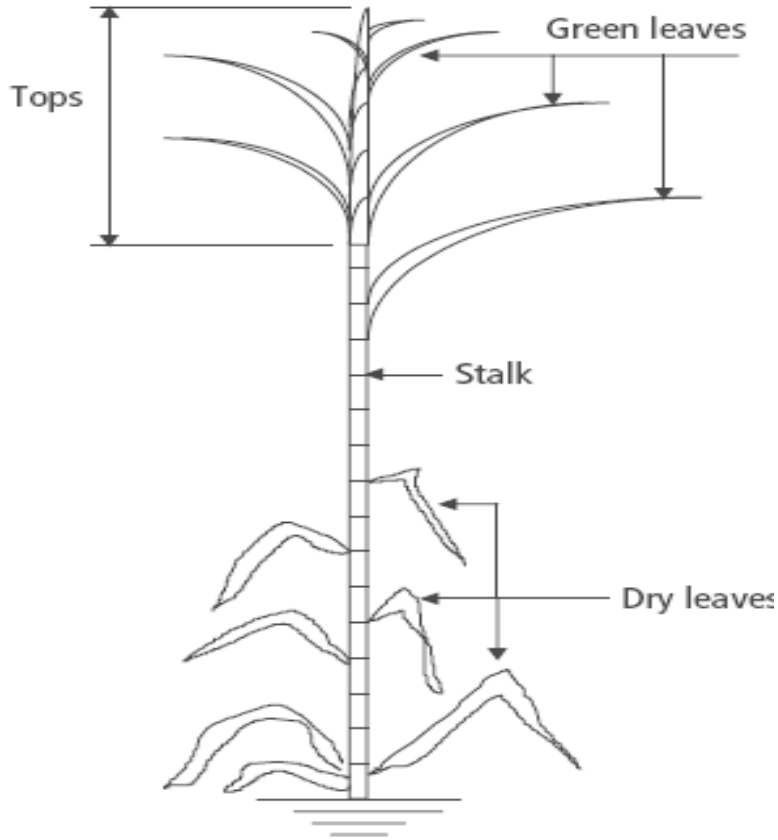
Energy factory –
1 ton of cane is equivalent of ...

- **1/3 sugar – 145 kg**
  1/3 fibre – 140 kg
  1/3 leaves and tops – 140kg

First generation
- **1ha = 9.000 l ethanol - 65 b of oil**

- **6.5 MM ha of sugar cane –**
  Uptake/year = 25,8 M tons of CO_2 equivalent

Sugar allometric patterns and challenges



Cane plant parts.

Candidate genes and traits: the roles for GM sugar cane

- Water deficit
- Max. productivity potential – with irrigation
- Longer management cycles
- Sugar versus fiber content: new allometric models

Variety	Stage of cut	Yield (t/ha)	Trash* (t/ha)	Trash/stalk ratio
SP79-1011	Plant cane	120	17.8	15%
	2nd ratoon	92	15.0	16%
	4th ratoon	84	13.7	16%
SP80-1842	Plant cane	136	14.6	11%
	2nd ratoon	101	12.6	13%
	4th ratoon	92	10.5	11%
RB72454	Plant cane	134	17.2	13%
	2nd ratoon	100	14.9	15%
	4th ratoon	78	13.6	17%
Average		104	14.4	14%

* Dry matter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International weekly journal of science
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Sugar Cane EST Genome Project

SUCEST is part of the ONSA network, a network of research laboratories in the State of São Paulo funded by FAPESP to implement its Genome Program.
The aim of the project is to identify 50,000 sugarcane genes. The project will be considered finished when this goal is reached or when 300,000 reads are deposited.

FAPESP Genome Program

SUCEST
The Sugar Cane EST Project

About Sucest
General, Organization, History, Data Mining, Bioinformatics, FAQ, Sponsors

Agenda
Important Dates, Meetings, Events

Teams & People
Teams, People, Search People

Web Site
Info, Site Map, Site Search

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Public Reports
Project Progress, Current Status

Download Docs
Sequencing Protocols, Micro-Prep Sheet, DNA Sequencing Guide, Other Forms

Related Links
Other EST projects, Fapesp Genome projects, Genome Research Centers

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Go

News

Older news in History

Last update: 2001-05-24

Some estimates say Brazil has about 263 million ha of available land for sugar cane. It is the largest land availability in the world. Low productivity pastures for cattle takes over most of the available land.

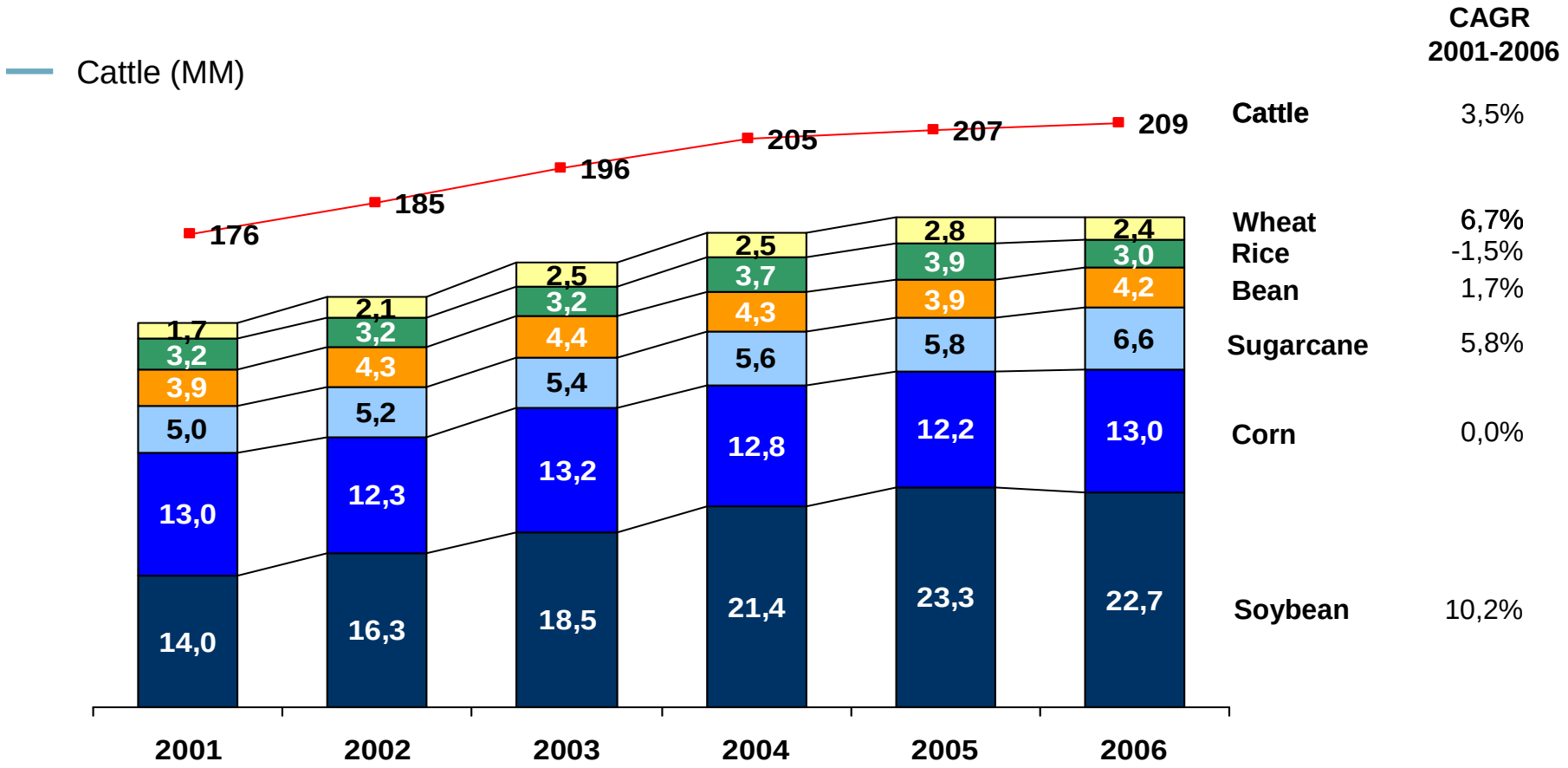
Available land in Brazil

Type	Area (Mha)
• **Total country**	**851**
• Native Amazon Forest	370
• Secondary Amazon Forest and Others	180
• Native Forests	6
• Pasture	197
• Temporary Crops	58
• Permanent Crops	8
• **Available land**	**263**
• **Available land with low impact[1)]**	**90**

Source: FAO, 2002, Emprapa

...without having to displace food production, as seen in recent years.

Brazilian Main Cropped Areas
(MM Ha)

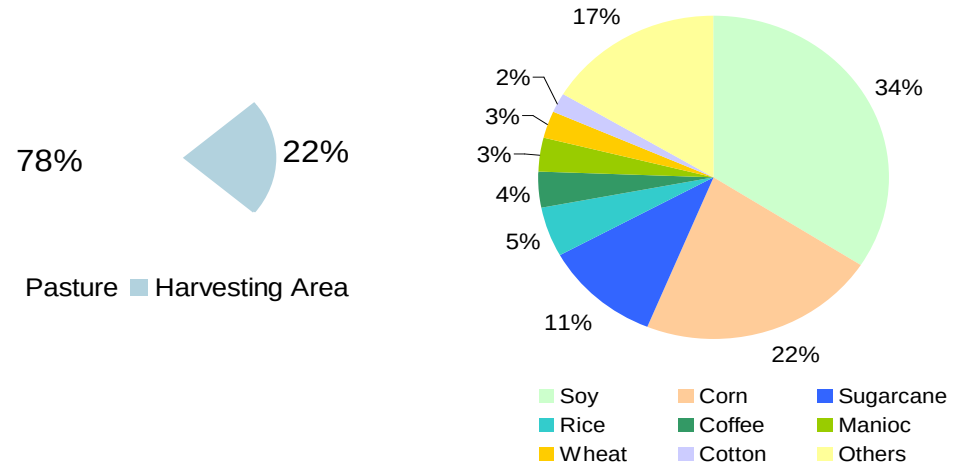


	CAGR 2001-2006
Cattle	3,5%
Wheat	6,7%
Rice	-1,5%
Bean	1,7%
Sugarcane	5,8%
Corn	0,0%
Soybean	10,2%

Source: MAPA; CONAB

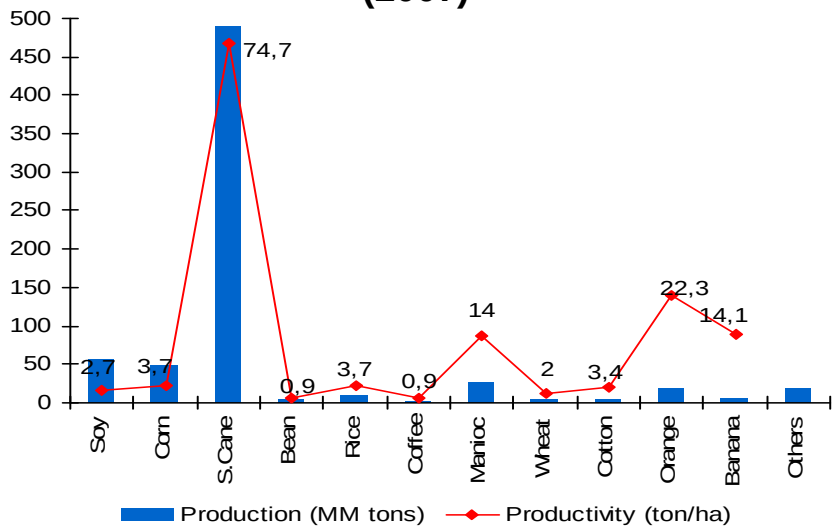
Footprint and productivity explain the sugarcane promise as a 2nd Gen biofuels feedstock in Brazil.

Crop Occupied Area (2007)

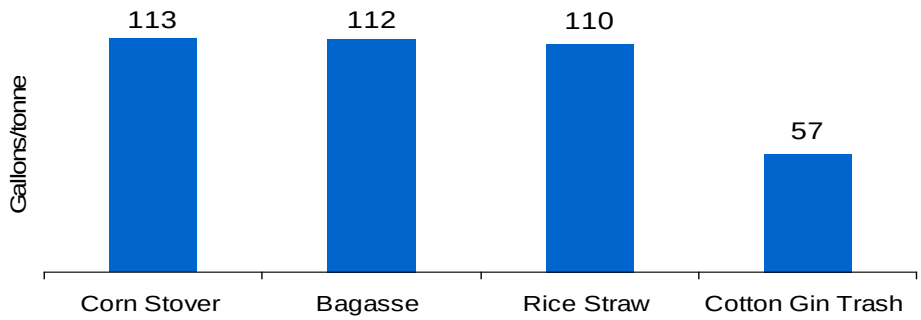


Total Occupied Area (Harvesting + Pasture): 270MM ha

Production and Productivity per Crop (2007)



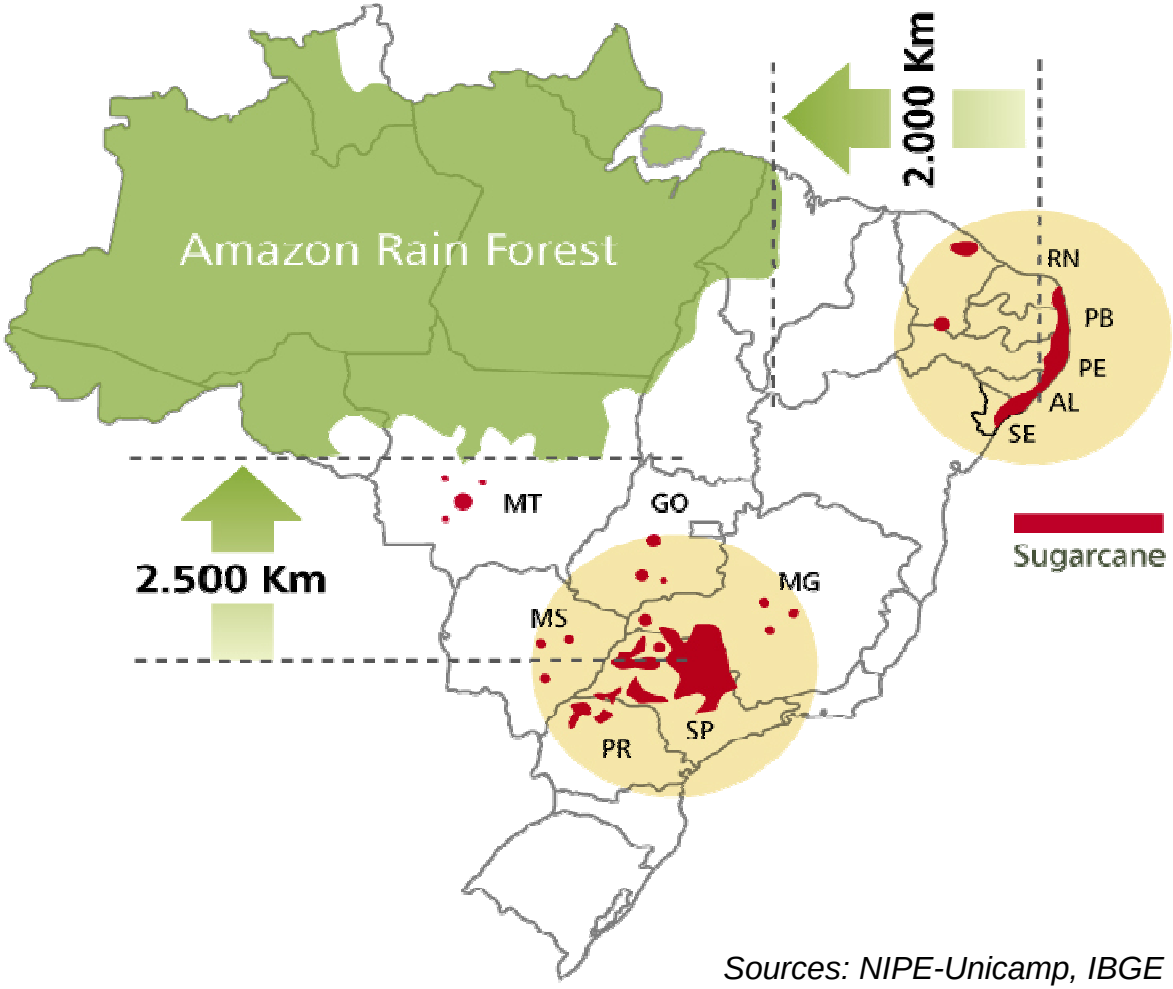
Theoretical Cellulosic Ethanol Yield by Dry Feedstock



Unlike 1st generation ethanol, cellulosic ethanol yield does not vary significantly between feedstocks in terms of gallons / ton. Therefore, the determining factor of end yield will be ton / hectare of biomass for each feedstock, giving sugarcane an advantage over other crops.

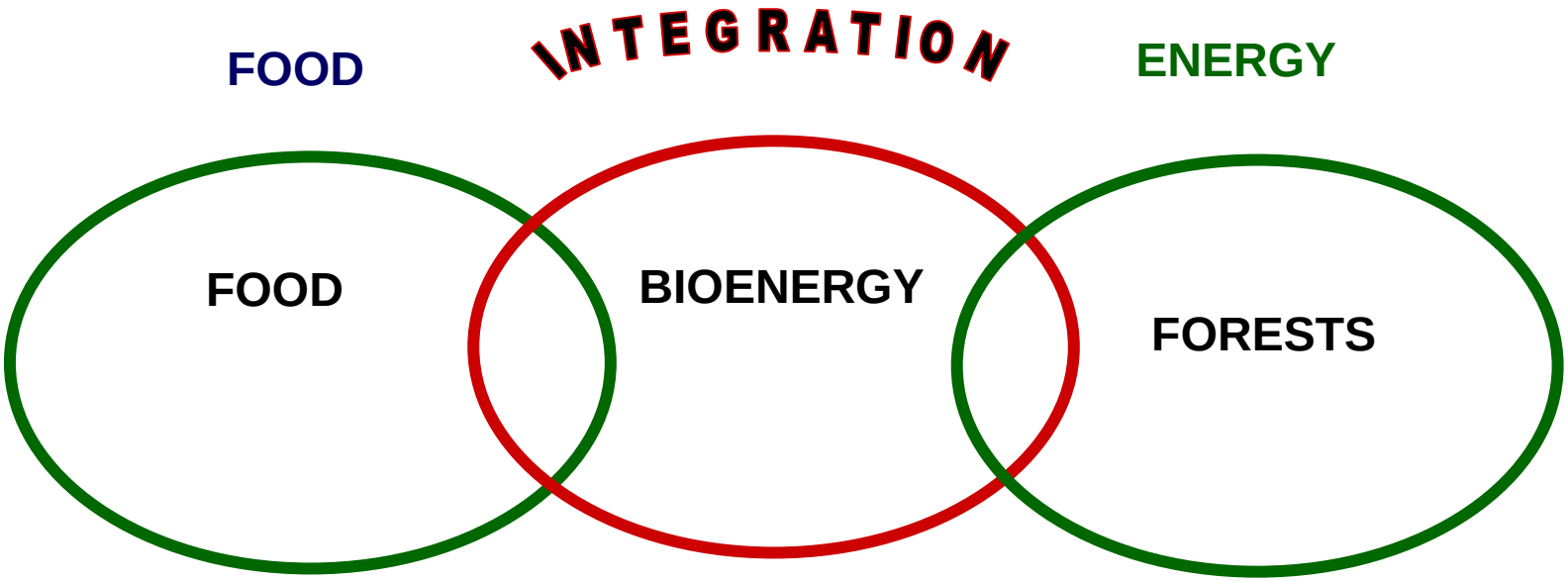
Source: CONAB; IBGE; IEA

Sugarcane producing regions in Brazil



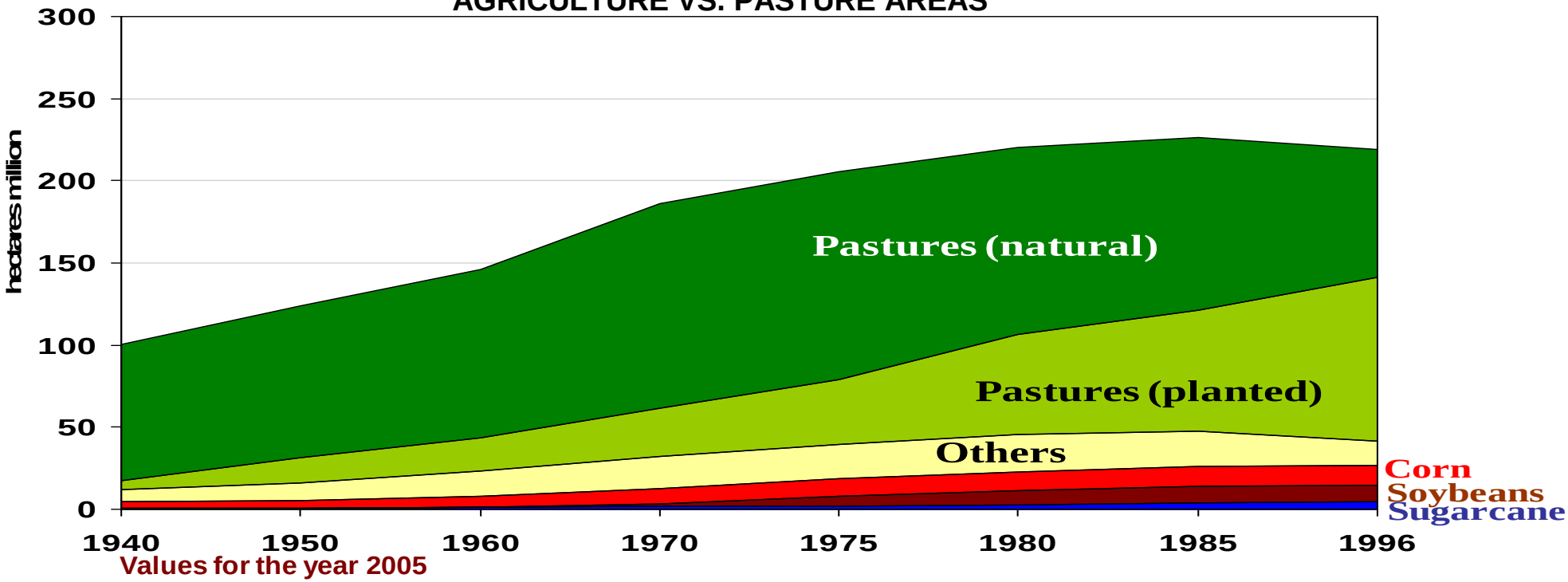
Sources: NIPE-Unicamp, IBGE and CTC

An land use approach: the supply side



- INTERNATIONAL AND NATIONAL DEMANDS: food & fuel
- SUSTAINABLE USE OF LAND AND LANDSCAPES
- ADDED VALUE OF BIOENERGY MATERIALS
- INTEGRATION OF AGRICULTURE/FORESTS
- DIVERSIFYING THE PORTFOLIO OF FARMER´S OPTIONS

BRAZIL: AGRICULTURE VS. PASTURE AREAS



Values for the year 2005

	Number of bovine animals (million heads)	Pasture areas (million hectares)	Average density (heads/hectare)
Brasil	**207.1**	**200-220**	**≈ 1.0**
São Paulo	**14.1**	**10**	**≈ 1.4**

If the average density in Brazil was 1.4 head/hectare

50-70 million hectares of pasture could be used for agriculture

Source: Brazilian bovine flock → IBGE. Pesquisa agropecuária municipal. Accessed 12/09/2007; Bovine flock and pasture areas in São Paulo → Amaral, A.M.P. et al. Animal production estimates in the São Paulo state for 2006. Economic ionformation. São Paulo: Instituto de Economia Agrícola, v.37, n.4, p.91-104, abr.2007.

Technologies for biomass conversion – 2nd generation of biofuels

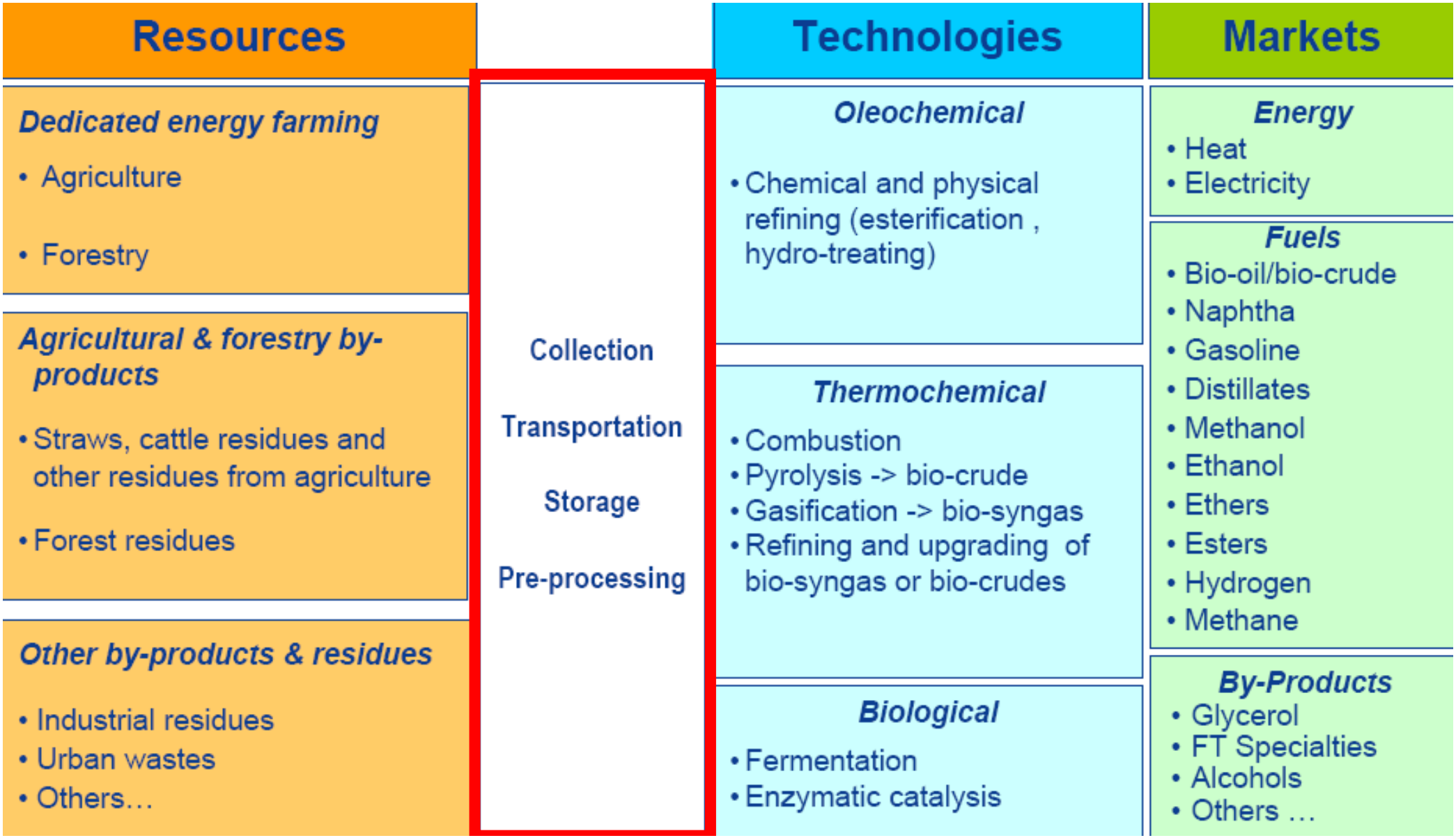
Second generation and feedstocks

Other feedstocks for ethanol second generation

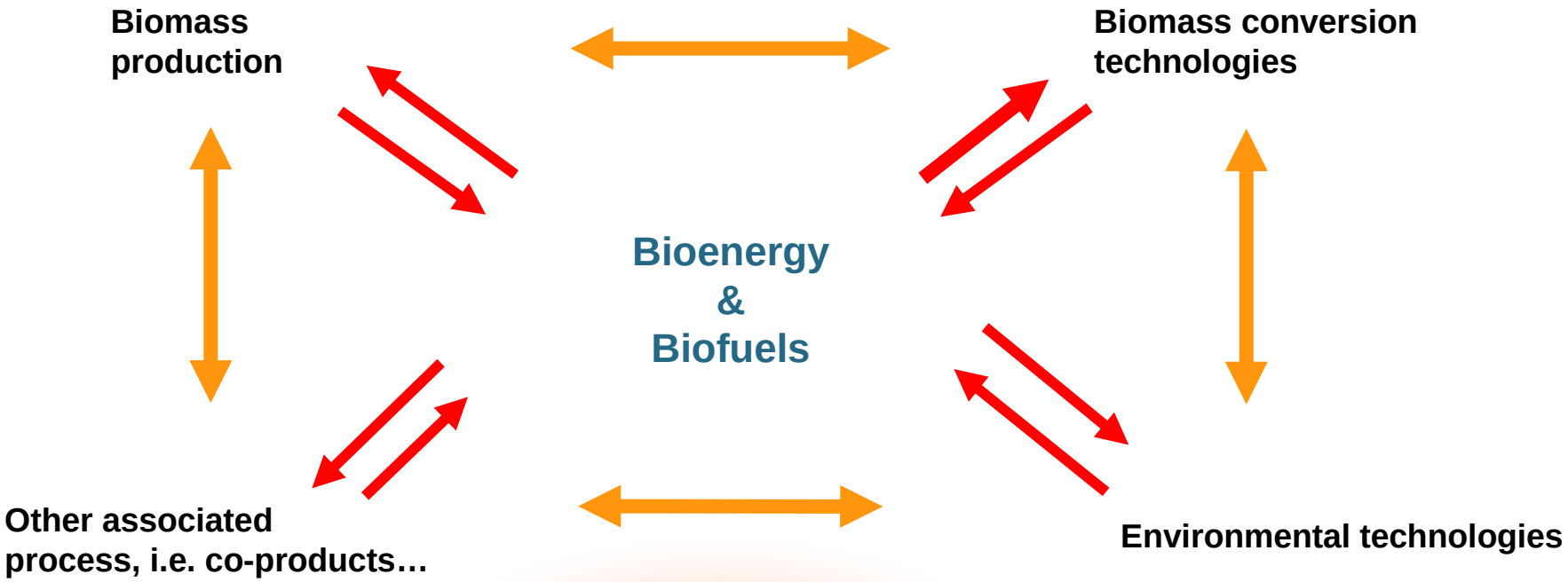
Source of feedstock	Area [000 ha]	Production [000 t/year]	Produtivity [t/ha.year]	Proprieties (%)			Potential
				lignin	celullose	hemicelullose	
Cane Straw	6,600	72,600	9 a 13	**26**	**37**	**28**	High
Bagasse	6,600	72,600	9 a 13	**20**	**41**	**25**	High
Corn stover	11,549	64,029	5 a 8	**15**	**30 a 45**	**50 a 35**	Medium
Soybean stover	22,933	80,747	3 a 4	**15 a 25**	**30 a 40**	**25 a 35**	Medium
Rice stover	3,919	2,937	4 a 6	**23 a 35**	**36 a 40**	**-**	Medium
Eucalyptus residues	4,000	94,600	22 a 24	**20**	**45**	**30**	High
Pine residues	2,000	38,700	18 a 20	**28**	**42**	**27**	Medium
Pastures	115,000	460,000	3 a 5	**10 a 30**	**25 a 40**	**35 a 50**	Low

Fonte: McMillan, 1994; Wood for Alcohol Fuels, 2002; Saad, 2005; IBGE; CONAB; SBS

From resources to markets – opportunities



Biotechnology is supporting the deployment of bioenergy and biofuels production in four main interconnected areas



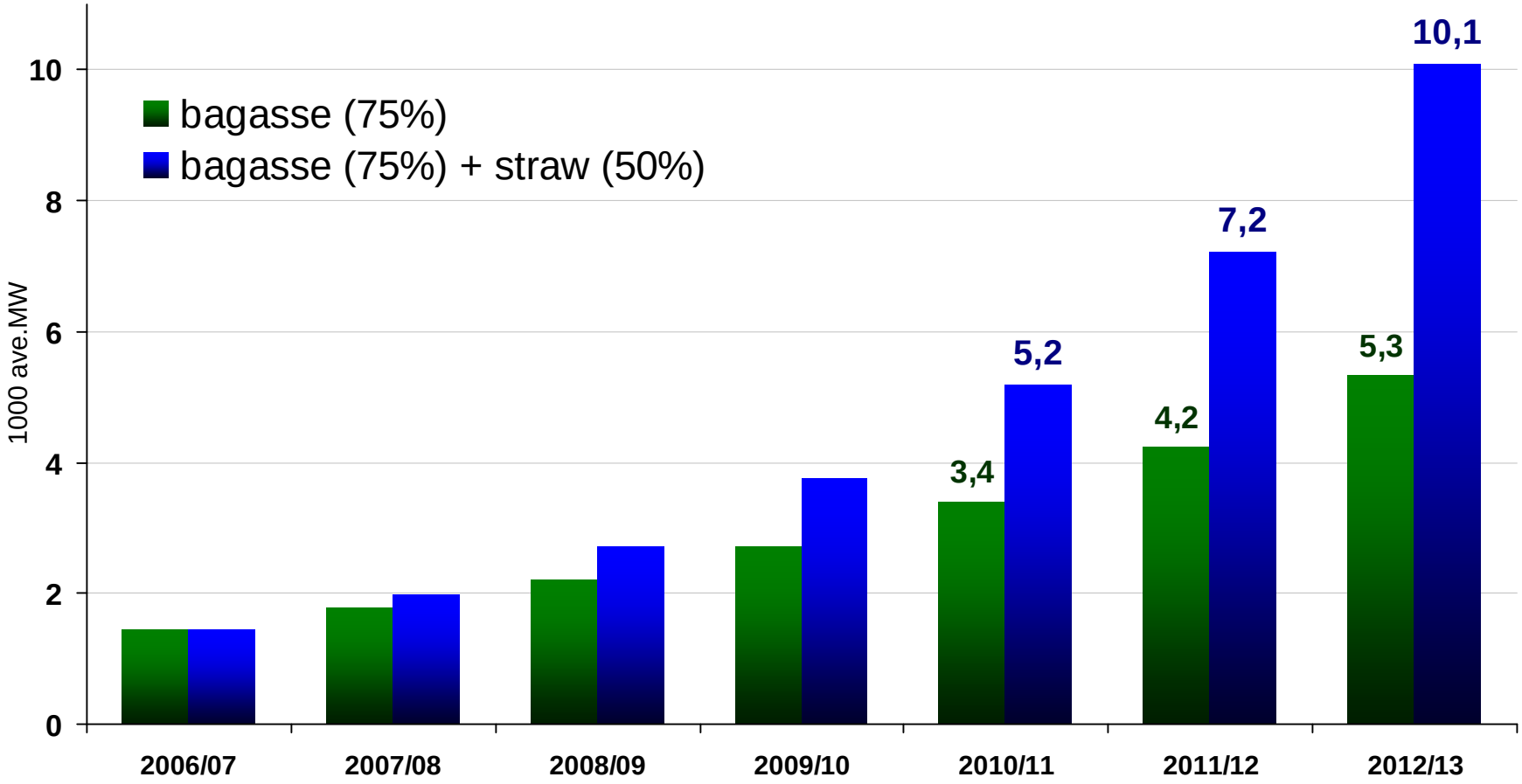
Just the production of biofuels at competitive costs is not sufficient now …beyond yield

We need to understand biofuels externalities and energy balances

Sectoral policies affecting ethanol

- Energy
- Transport
- Agriculture
- Environment
- Conservation of biodiversity
- Economics
- etc

Bioelectricity forecast from sugar cane and possible competition for bagasse in the near future – opportunity costs



Biofuels Certification – “The Babel of Certifications”

PBCB
Brazilian Biofuels Program
Certification
Brazilian Goverment

Ethanol

Several certification initiatives are under discussion now

How to attend to all certification discussions?

EU Directives
European Union

Biofuels Certification
Meó Consulting Team
German Government

Sustainable Production of Biomass
Cramer Commission
Dutch Government

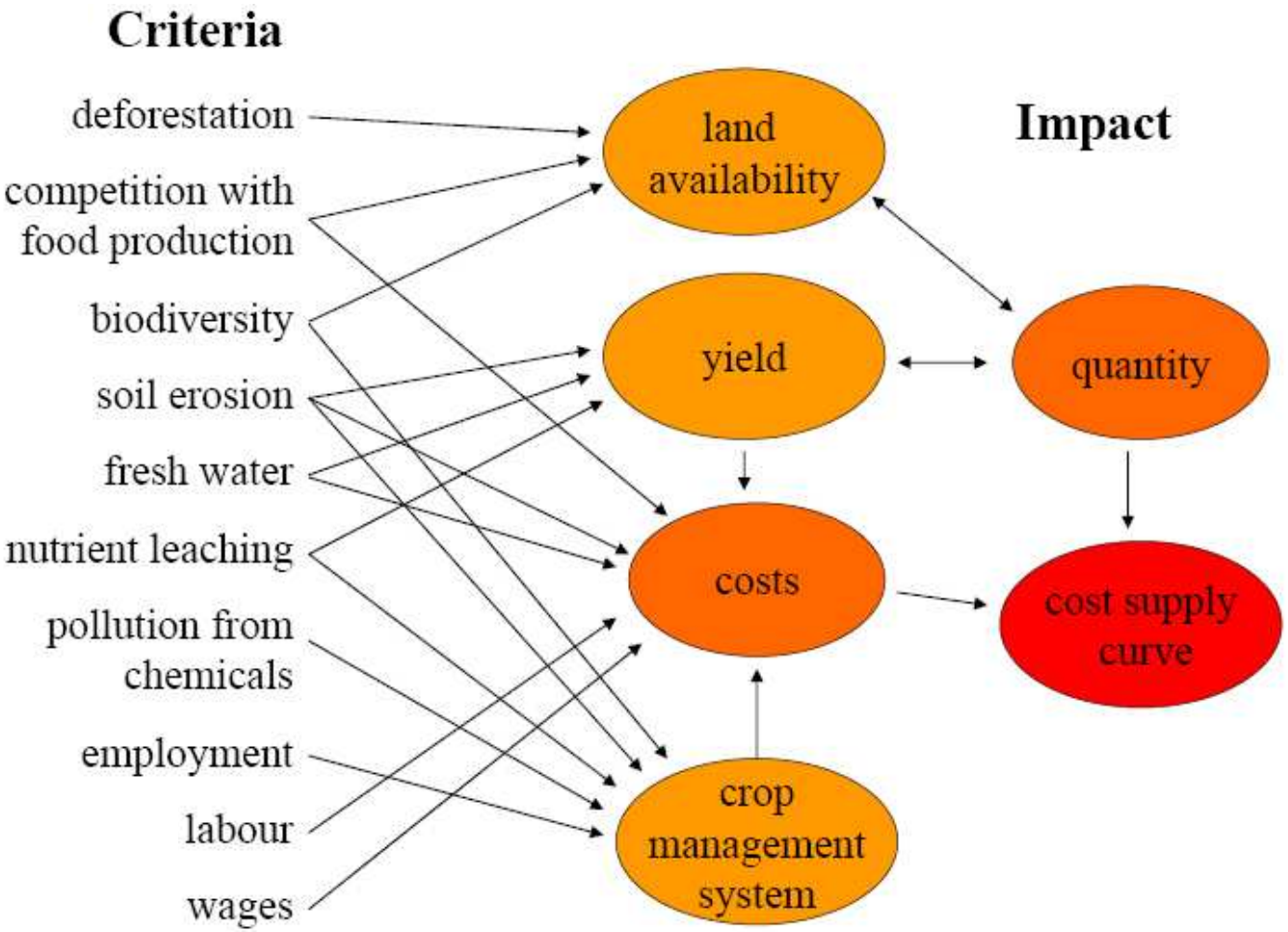
RTFO
Renewable Transport Fuel Obligation
UK Government

RTSB
Round Table on Sustainable Biofuels
Switzerland

National Certifications
SEKAB, GREENERGY
Sweden, United Kingdom

Collaboration on C&I - Certification

Some issues to consider....



Brazilian frameworks supporting S&T&I in biofuels

- Good examples from Pro-Alcool - ca. US$ 2 billion – 30 years

- Federal level -
Ministry of Science & Technology - Agencies – CNPq and FINEP

Ministry of Education - CAPES

- State level – SP - the case of FAPESP

- Innovation law in BR – being implemented – facilitate interactions between academia and private sector

Players and investments in sugarcane & ethanol R&D in Brazil.

Crops and biofuels R&D initiatives and experience

- More than 15 universities, 14 research centers and 150 researchers focus on biofuels in only one initiative (Bioetanol project)
- Only in CTC (sugarcane technology center) more than 300 people work in R&D activities
- Efforts are made to share knowledge between universities and research centers (ex: Bioetanol project, conferences)
- International participation in R&D initiatives (Bioethanol Project, Oxiteno, Votorantim)
- Country is a world leader in the production of sugarcane plants capital goods (ex: Dedini)

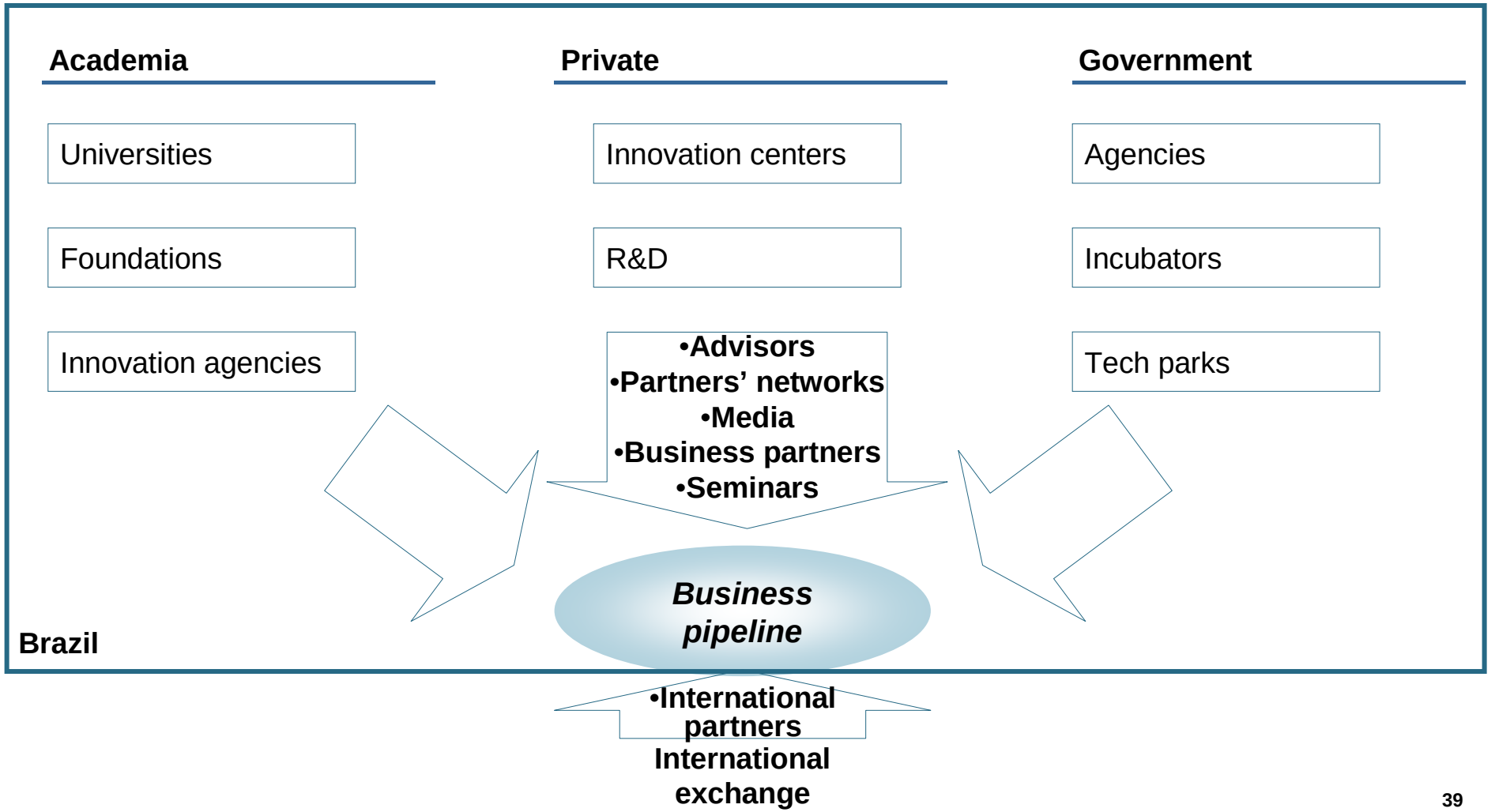
Innovation and scientific achievement on biofuels feedstocks

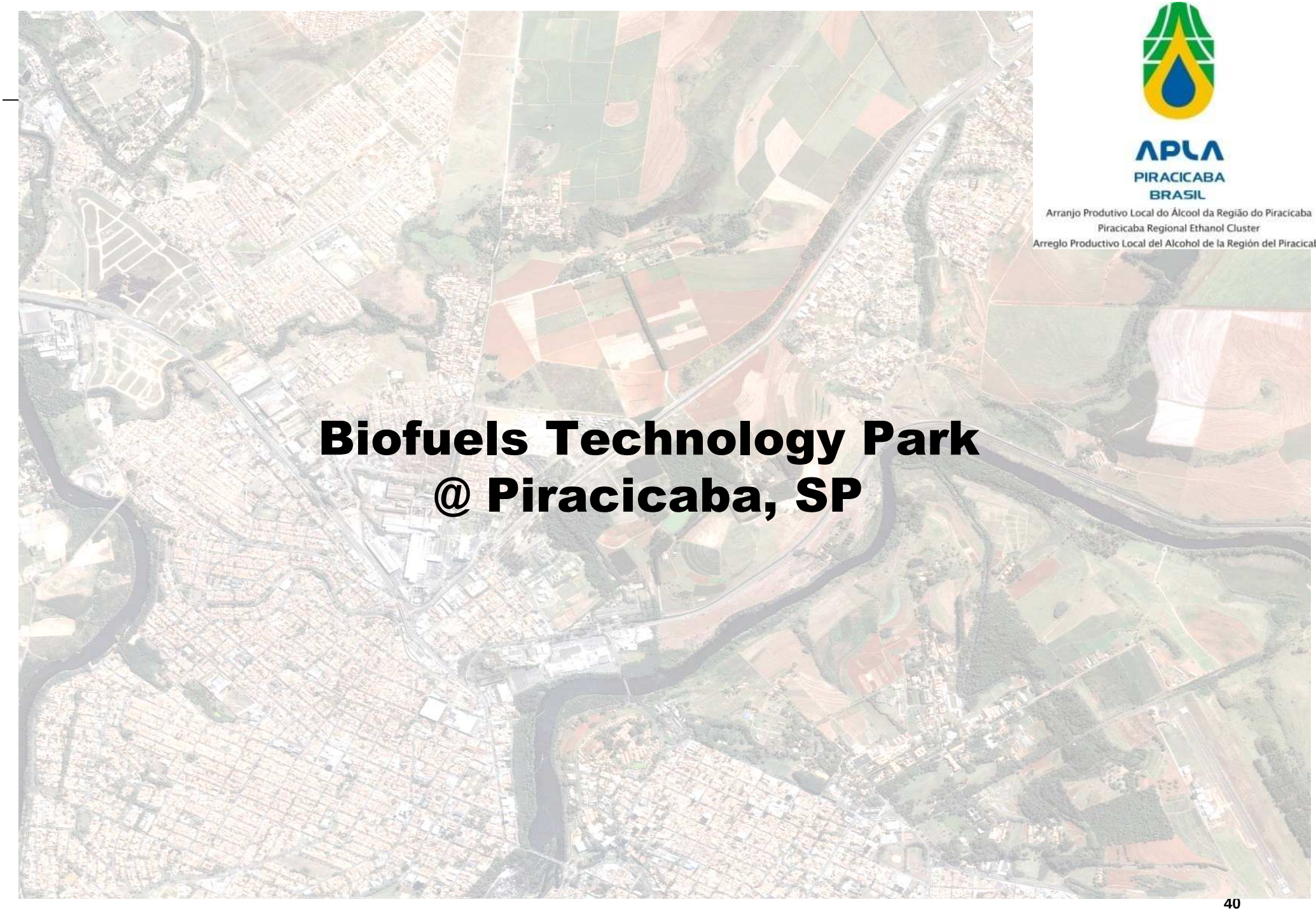
- Productivity improvements through sugarcane genetic modifications, from 55 tons/ha in 1970 to 75 tons/ha in 2006
- Almost 300 sugarcane varieties developed by CTC

Investments in R&D

- Almost 80% of investments in biofuels in Brazil come from the private sector
- In 2005 MCT (Science and Technology Ministry) invested US$840 MM in R&D, 21% of which went to agriculture-related research (US$176MM)
- US$105 MM to be invested between 2003 and 2008 in agroenergy by MCT
- Votorantim invested US$ 40 MM in biotechnology in the last 4 years developing 15 transgenic sugarcane varieties

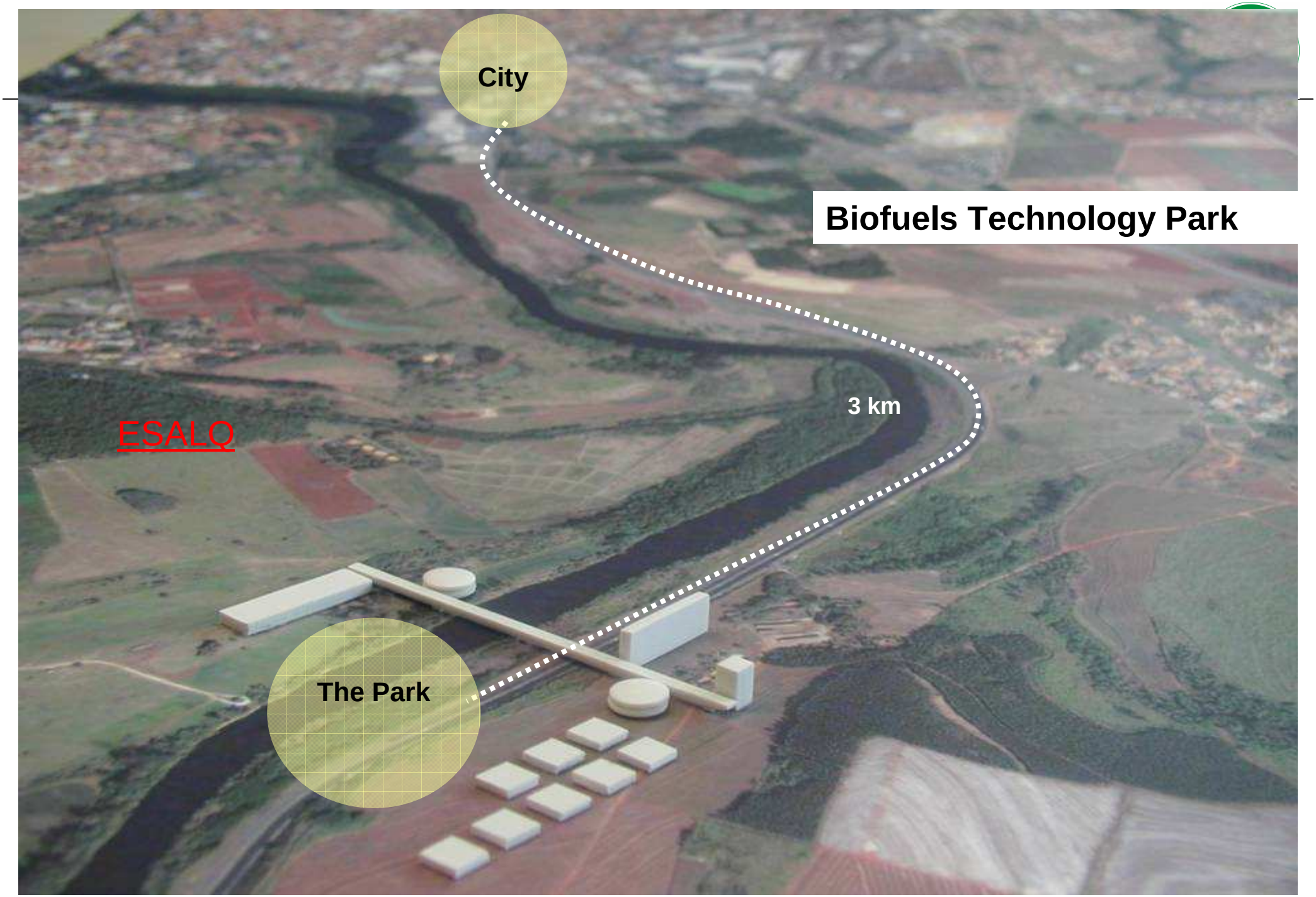
Biofuels framework for innovation

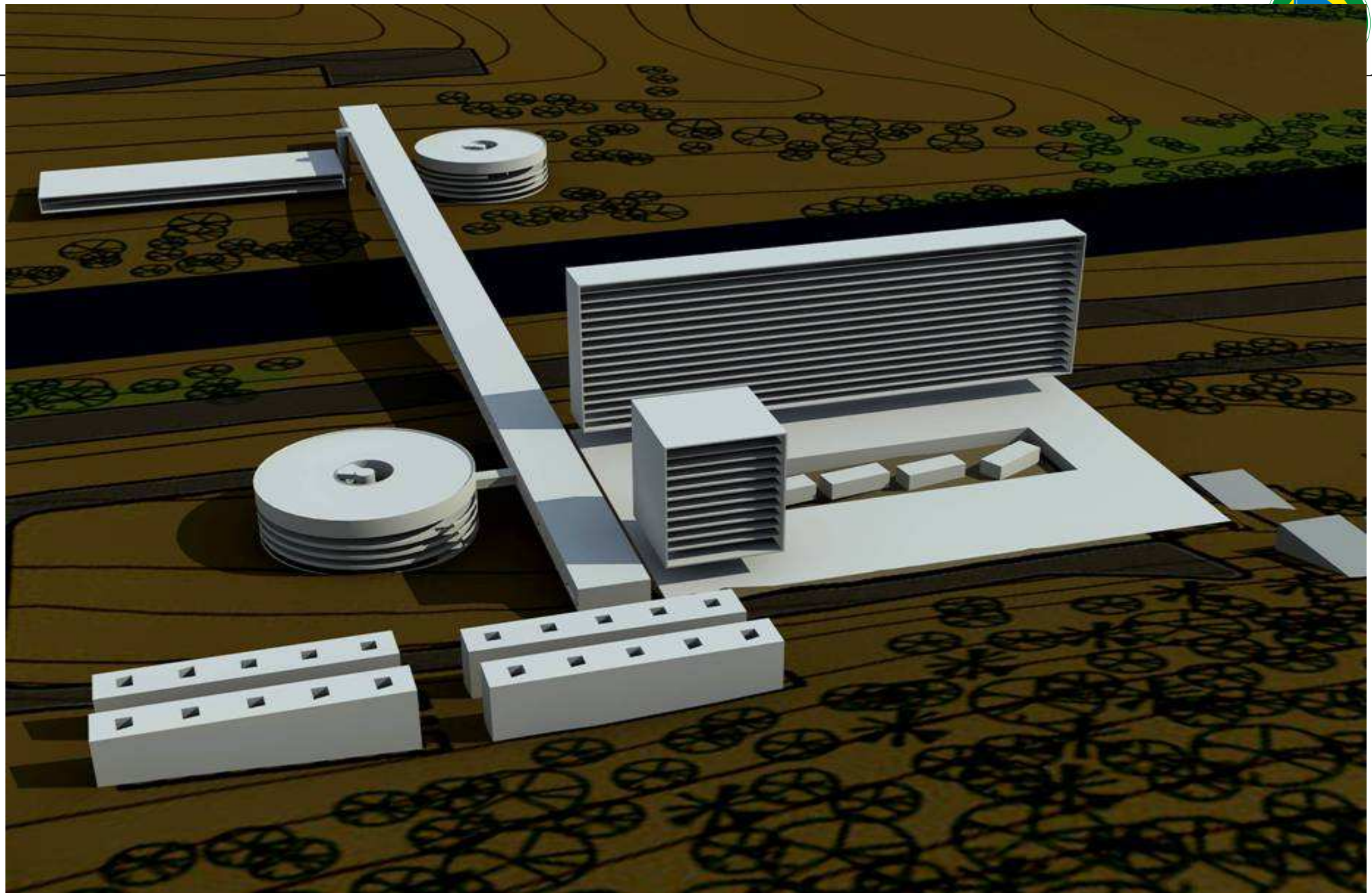




APLA
PIRACICABA
BRASIL
Arranjo Produtivo Local do Álcool da Região do Piracicaba
Piracicaba Regional Ethanol Cluster
Arreglo Productivo Local del Alcohol de la Región del Piracicaba

Biofuels Technology Park @ Piracicaba, SP


City
Biofuels Technology Park
3 km
ESALQ
The Park



Concluding remarks - Four pillars on ethanol competitiveness 1/2

- Need for a global market for biofuels
- Improving the logistics
- Planning the sugar cane expansion sustainably
- Innovation

Deploying the global opportunities – can´t afford not to have… 2/2

Concentration and concerted efforts: focus and scale

Continuity: 30 years of investments worthwhile – the Brazil case

Complementarity: bioenergy sources and expertise – need for an interdisciplinary approach

Commitment: to make a change

Coordination