Sustainable Bioenergy Production: land, persons and inclusion

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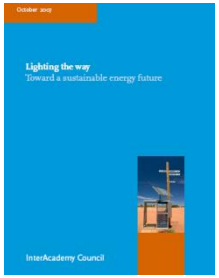

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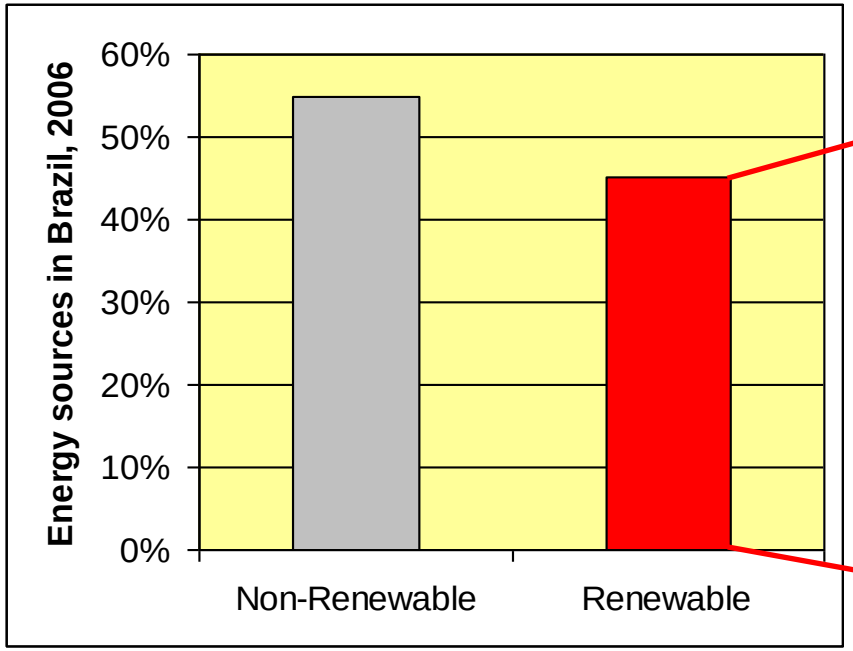
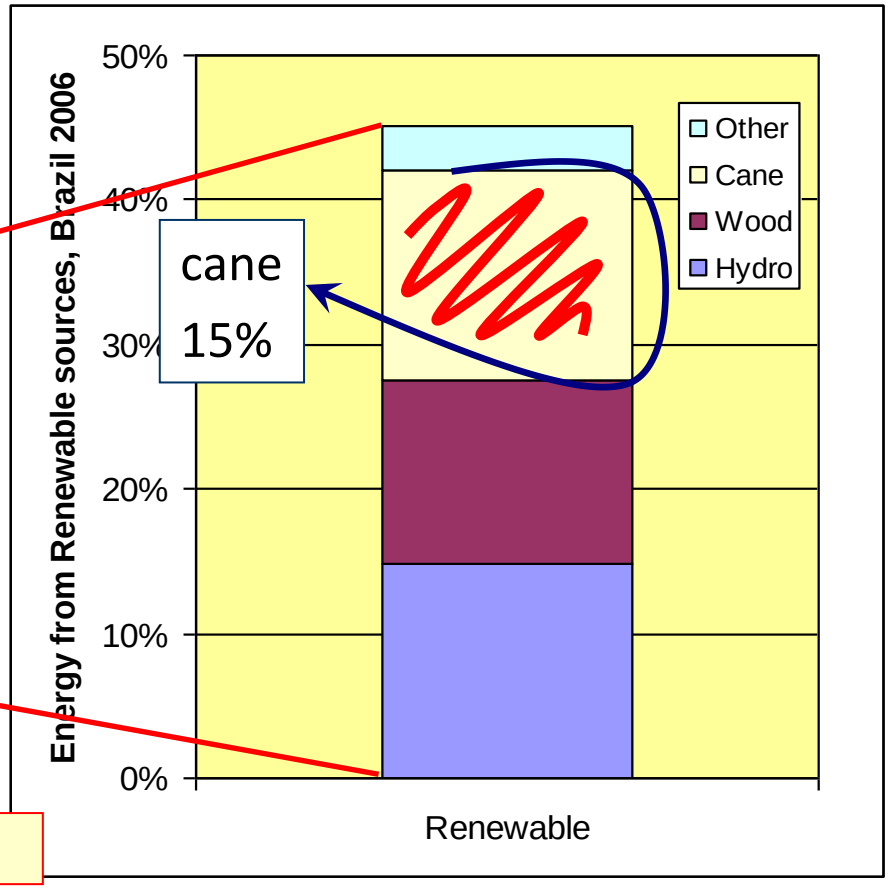
Nonetheless, the Study Panel believes that, given the dire prospect of climate change, the following three recommendations should be acted upon **without delay and simultaneously:**

- Concerted efforts should be mounted to improve energy efficiency and reduce the carbon intensity of the world economy, including the worldwide introduction of price signals for carbon emissions, with consideration of different economic and energy systems in individual countries.
- Technologies should be developed and deployed for capturing and sequestering carbon from fossil fuels, particularly coal.
- **Development and deployment of renewable energy technologies should be accelerated in an environmentally responsible way.**

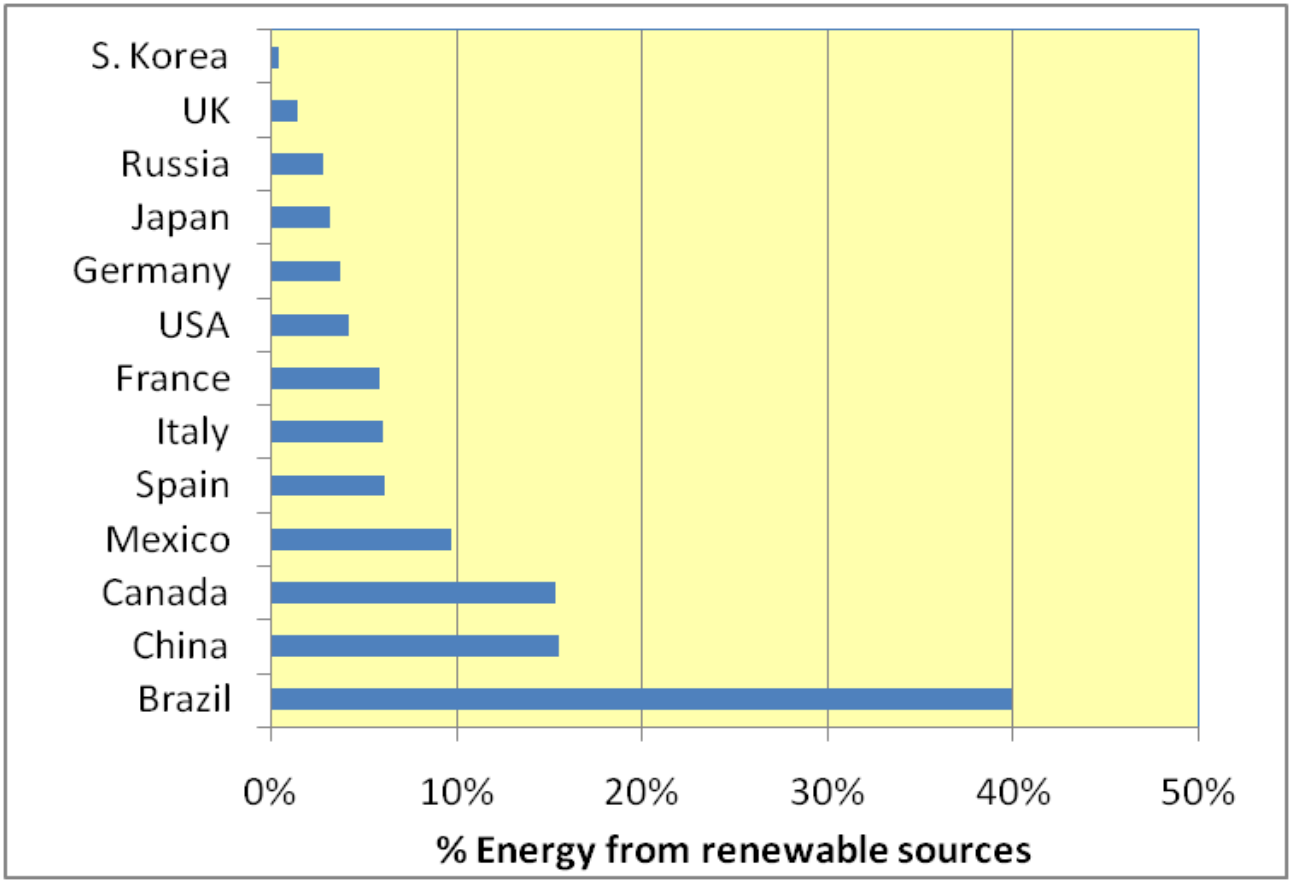
46% of Brazil's energy comes from renewable sources





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

Energy from renewable sources
Some industrialized countries



Source: IEA, Renewables Factsheet, 2007

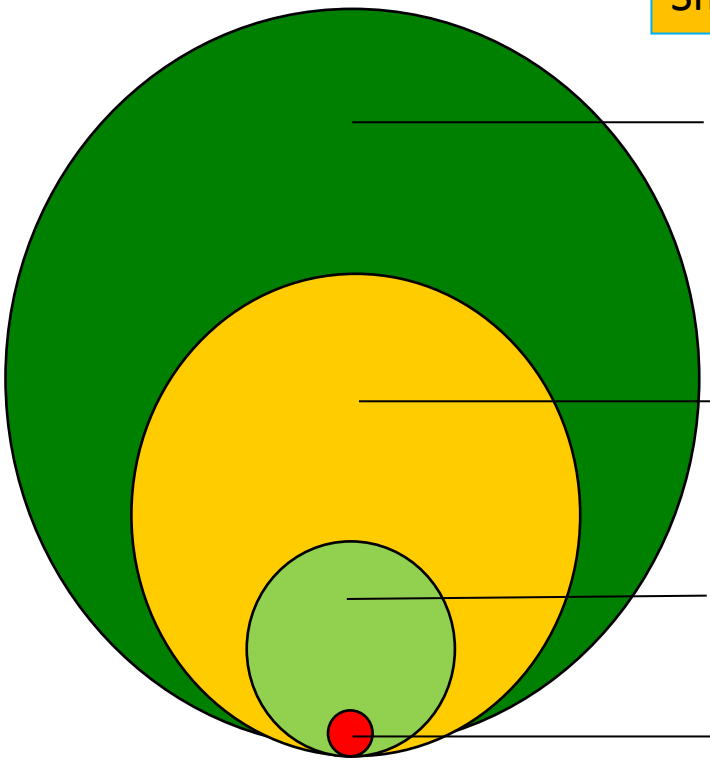
Brazil: 1% of arable land displaces 30%+ of the gasoline

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

Sugarcane for ethanol uses 0,4% of Brazil's total area

Small bioenergy footprint



Total country area (851 MHa, 100%)

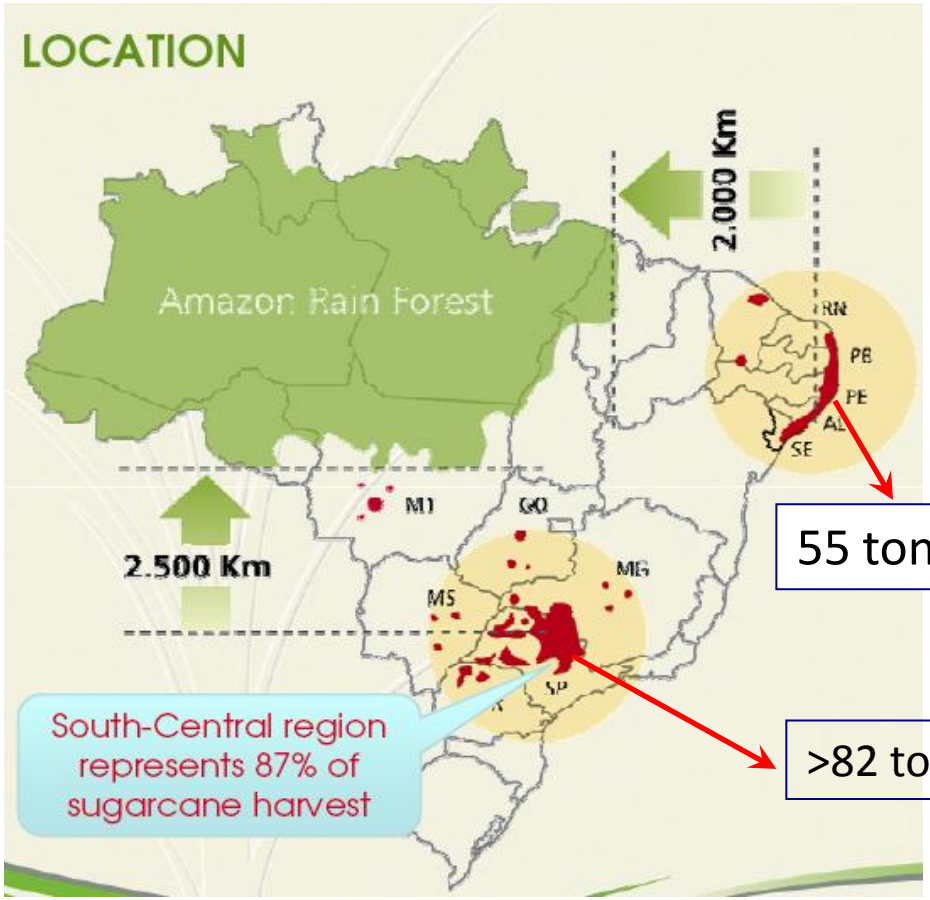
Rural properties area (355 MHa, 42%)

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

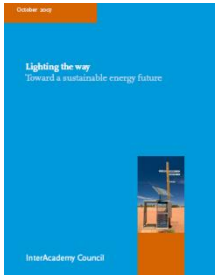
Area used for sugarcane for ethanol (3,4 MHa, 0,4%)

Source: Horta Nogueira e Seabra (2008)

Where does Brazil plant Sugarcane?



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



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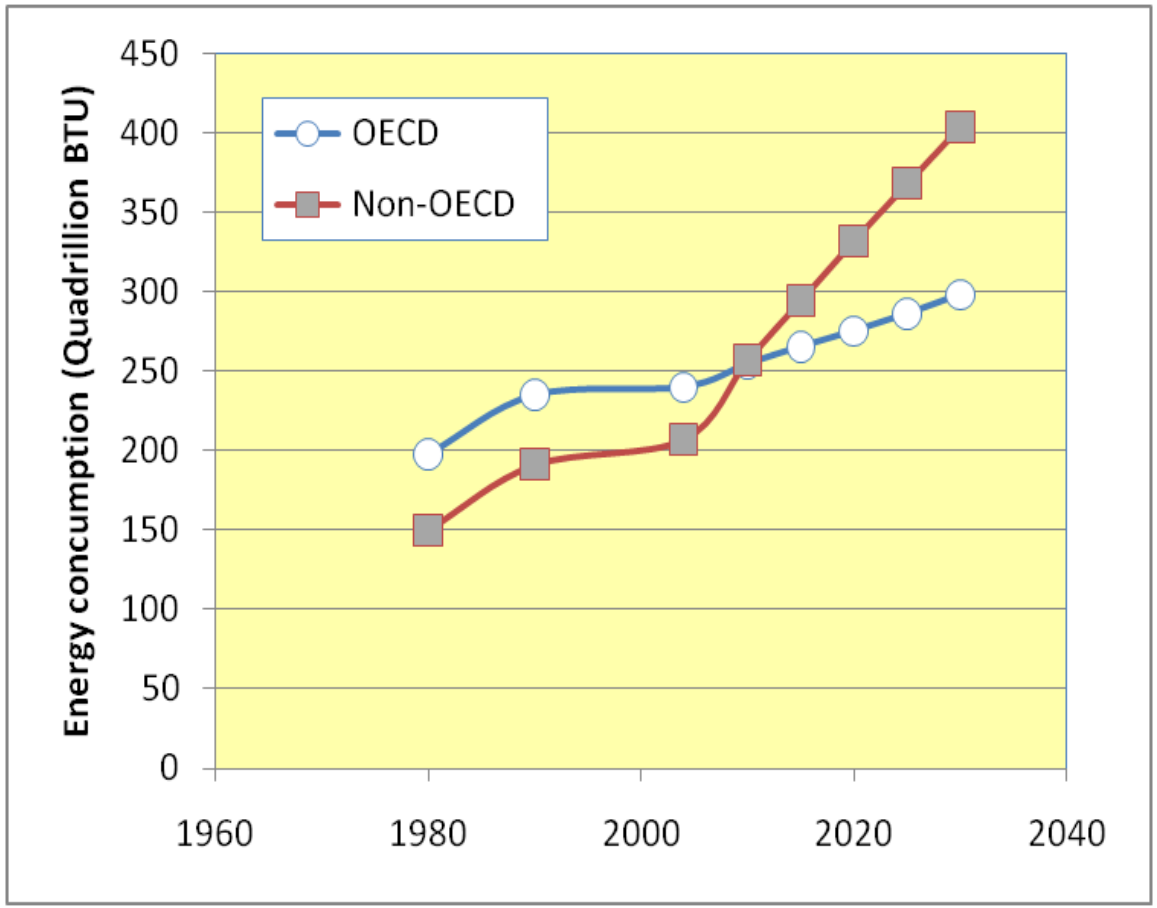
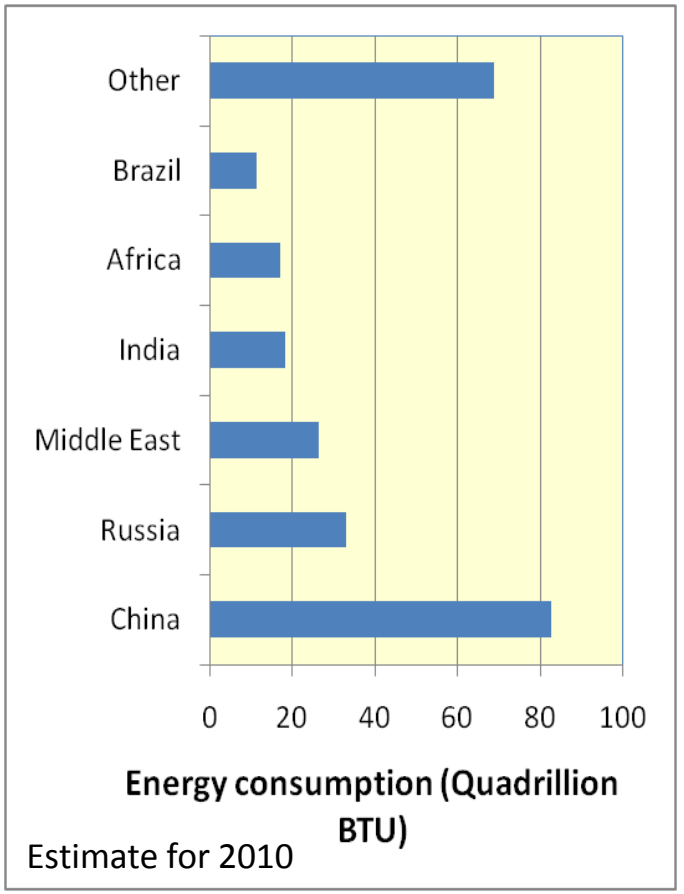
Taking into account the three urgent recommendations above, another recommendation stands out by itself as a moral and social imperative and should be pursued with all means available:

The poorest people on this planet should be supplied with basic, modern energy services.

Energy consumption OECD and Non-OECD





Source: International Energy Outlook 2009

2050: Available land for biofuels

(Doornbosch and Steenblik, 2007; "Biofuels: Is the cure worse than the disease?")

	Land (in Gha)	North Am.	South & Centr. Am.	Europe & Russia	Africa	Asia	Oceania	World
	Total land surface	2,1	2,0	2,3	3,0	3,1	0,9	13,40
1	Apt for Rainfed cultivation	0,4	0,9	0,5	0,9	0,5	0,1	3,30
2	Apt and Under forest	0,1	0,3	0,1	0,1	0,0	0,0	0,80
3	Apt, already in use	0,2	0,1	0,2	0,2	0,6	0,1	1,50
4	Necessary for food, housing and infrastructure until 2030/50	0,0	0,1	0,0	0,1	0,1	0,0	0,30
5	Available (Gross) [5=1-2-3-4]	0,00	0,25	0,08	0,44	-0,07	0,04	0,74
6	% for grassland	0%	0%	50%	60%	n/a	0%	
7	**Additional land potentially available (7)=(5)x(1-% for grassland)**	**0,00**	**0,25**	**0,04**	**0,18**	**-0,07**	**0,04**	**0,44**

a. Most studies assume that only a small fraction of additional land is needed to feed the world's growing population — from 6.5 billion people at present to 9 billion people in 2050 — and that most of the increase in food requirements will be met by an increase in agricultural productivity.6 Here it is assumed that 0.2 Gha is needed for additional food production (based on Fisher and Schrattenholzer, 2001 where a yearly increase in agricultural productivity of 1.1% is assumed); the remainder (roughly 0.1 Gha) is needed for additional housing and infrastructure.

b. A negative number is shown here as more land is cultivated than potentially available for rain-fed cultivation because of irrigation. The negative land available has not been rounded to zero because food imports are likely to be needed from other region with implications on their land use.

c. Numbers in this column don't add up because of rounding.

So. Centr. Am: 0.25GHa @ 10kL/Ha.yr → 2,500GL /yr (in 2005: 40 GL)

Reference quantities

Area available in South & Central America by 2050: 0,25 Gha
Area available in Africa by 2050: 0,18 Gha
(both according to Doornbosch & Steenblik, OECD, 2007)
So. And Central America + Africa: 0,430 Gha
10% of 0.43GHa @ 10kL/Ha.yr → 430 GL /yr (in 2005: 40 GL)

	2004	2050
Gasoline consumption (1)	1,200 GL	2,200 GL
Ethanol consumption	30 GL	
Ethanol substituting 15% gasoline		400 GL
Ethanol substituting 100% gasoline		2,650 GL

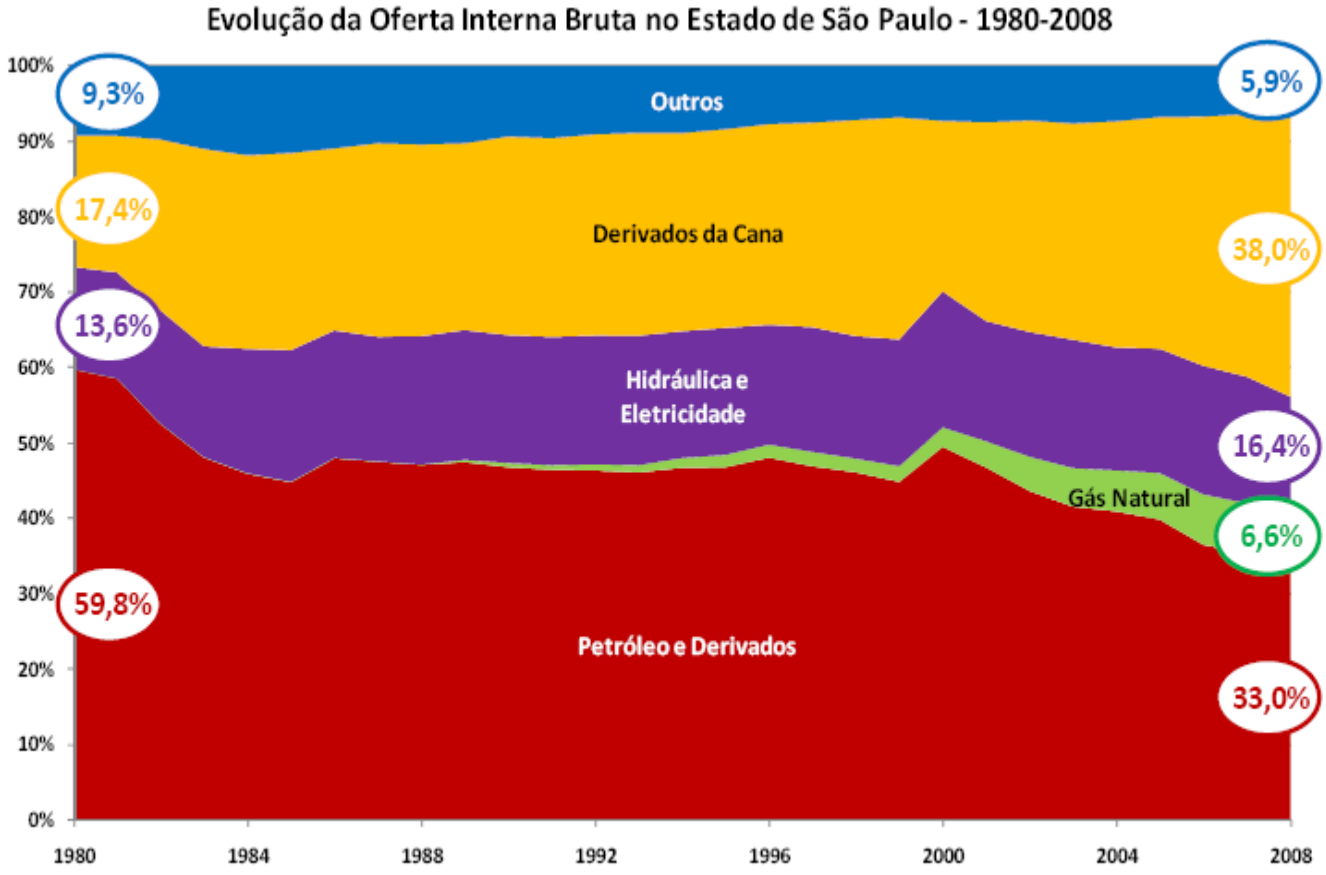
(1) Source: *National Energy Information Center (NEIC)*

Potential for substituting for 15% of the world gasoline demand considering only the available area in South and Central America and Africa

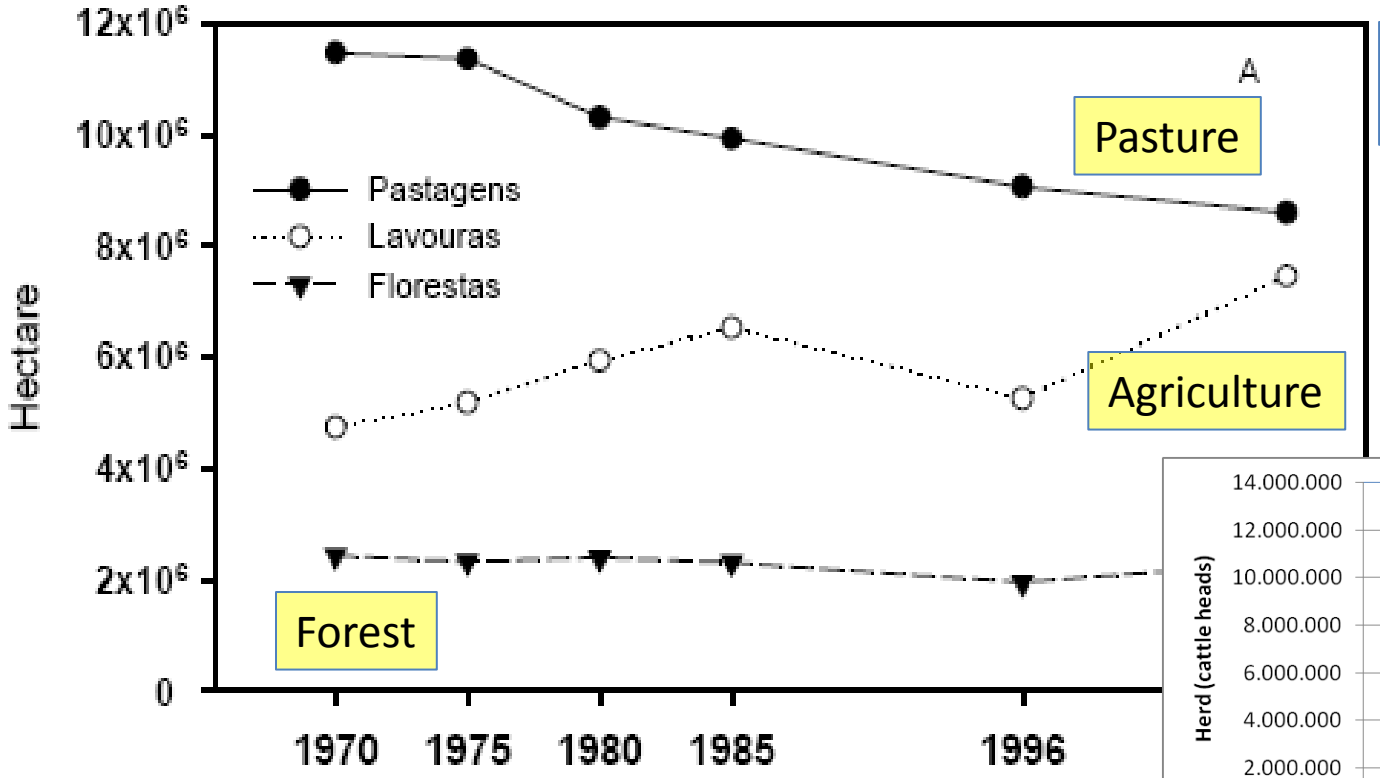
Energy sources in the State of São Paulo, Brazil

State of São Paulo
- 41 million people
- 35% of Brazil's GNP

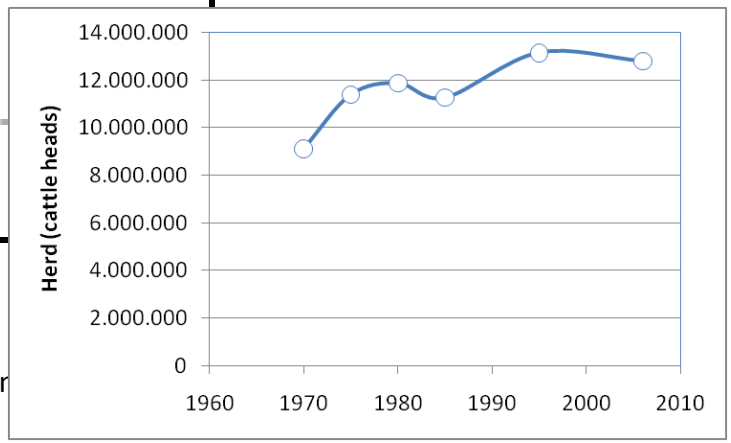
1980 – 2008
- Oil down from 60% to 33%
- Cane up from 17% to 38%



São Paulo: Land Use Change, 1970-2006

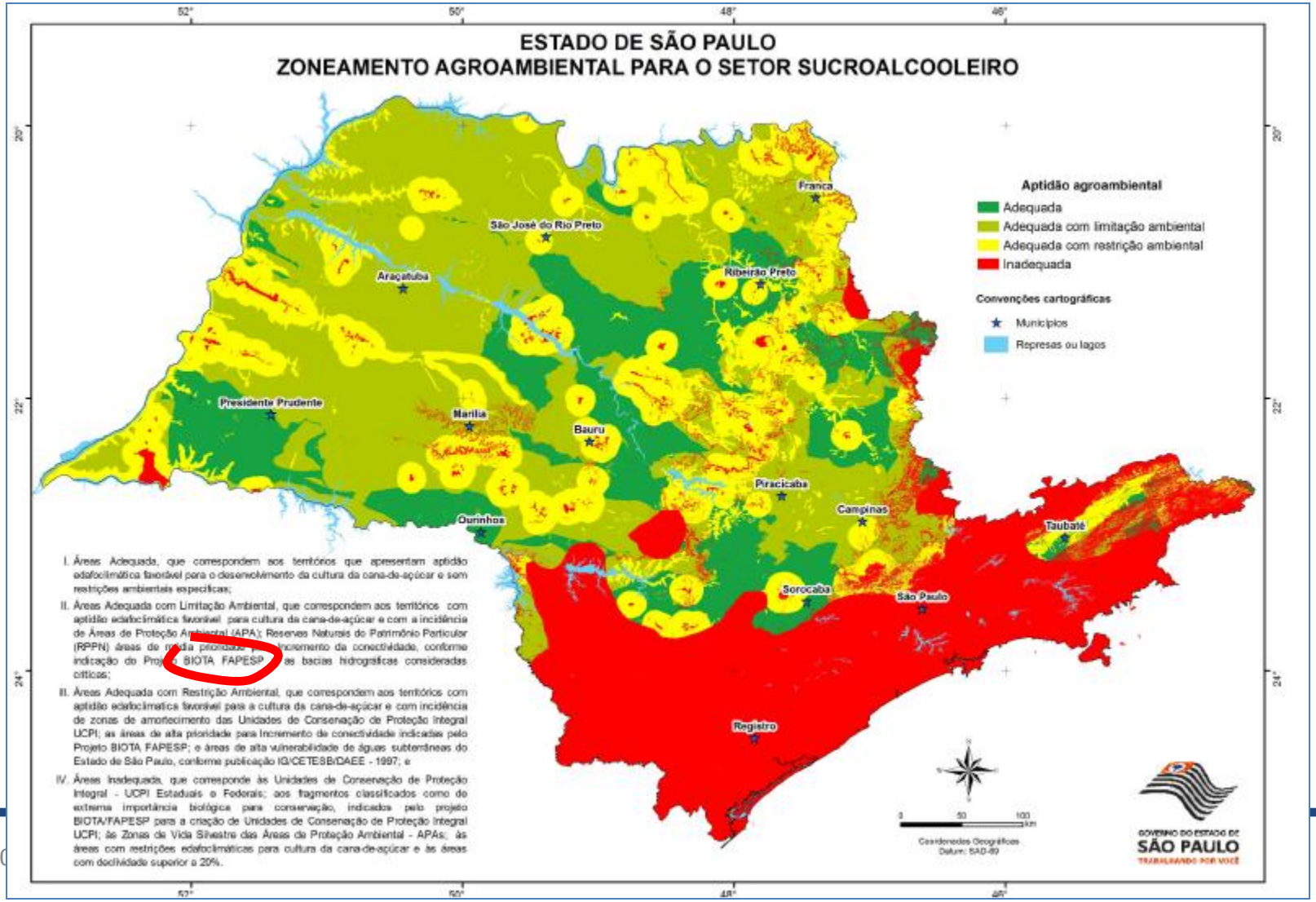


Sugarcane x Pasture: fixation of 0,5 Mg C/ha.yr



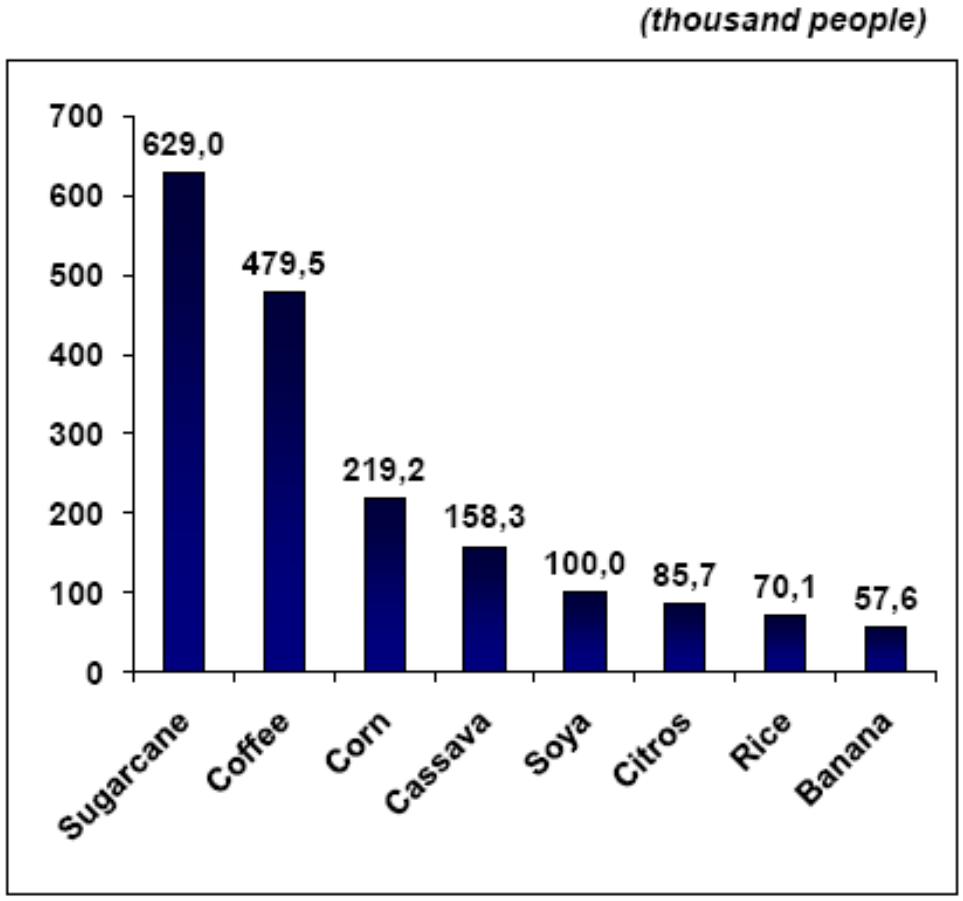
Source: Boddey, R.M, "GHG Emission Mitigation Though Ethanol from Sugarcane ir

Science based Sugarcane Agroecological Zoning in São Paulo



Agricultural workers in Brazil

- 2,773,885 agricultural workers in 2008
  - 23% in sugarcane
  - 17% in coffee
  - 8% in corn



Source: Prepared based on data provided by PNAD 2008

Source: Marcia Azanha, "Biofuels and Social Inclusion", www.fapep.br/gsb

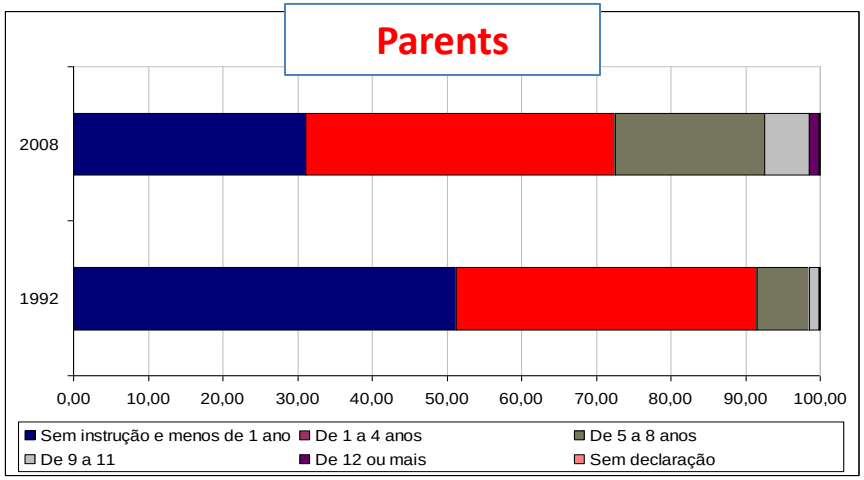
Sugarcane agricultural workers schooling and labour rights

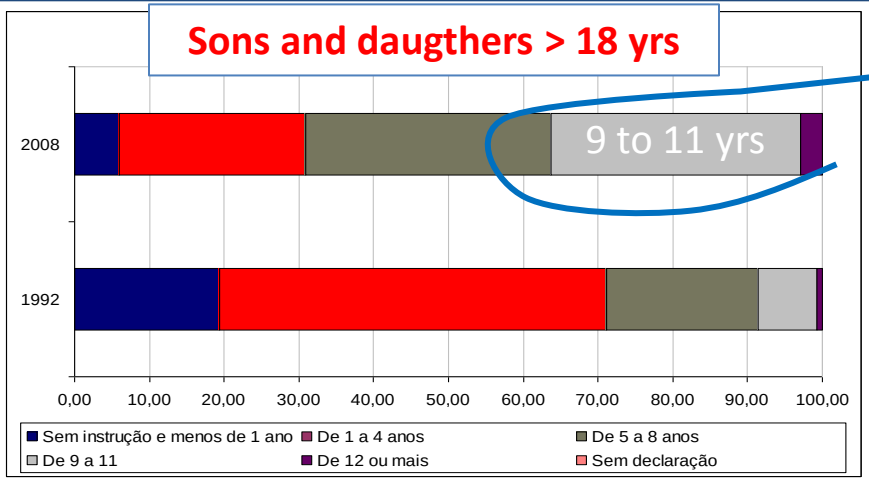
- In agriculture in Brazil
  - 4 years of schooling
- Sugarcane
  - 4.3 years of schooling
  - 24% illiterate

- In Agriculture
  - 40%
- In Sugarcane
  - 81%
- In Sugarcane in SP
  - 95%
- Entitled to
  - Unemployment insurance
  - Paid annual vacation
  - Extra mont pay (13º)

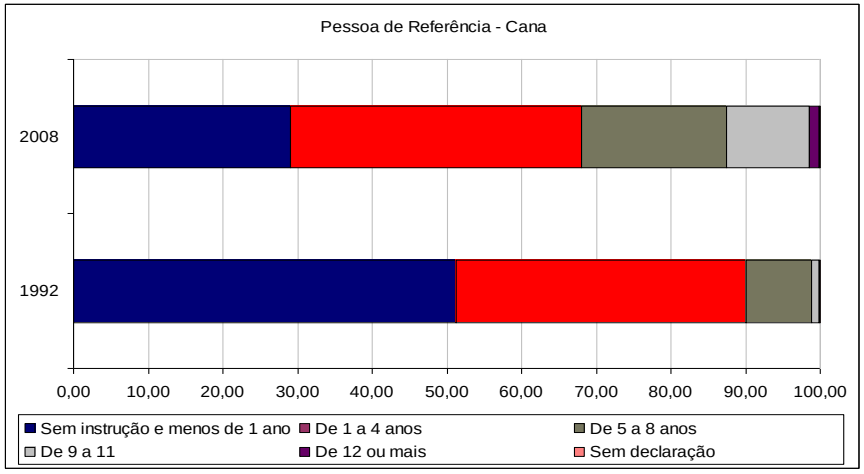
Children of sugarcane workers gain more years of education

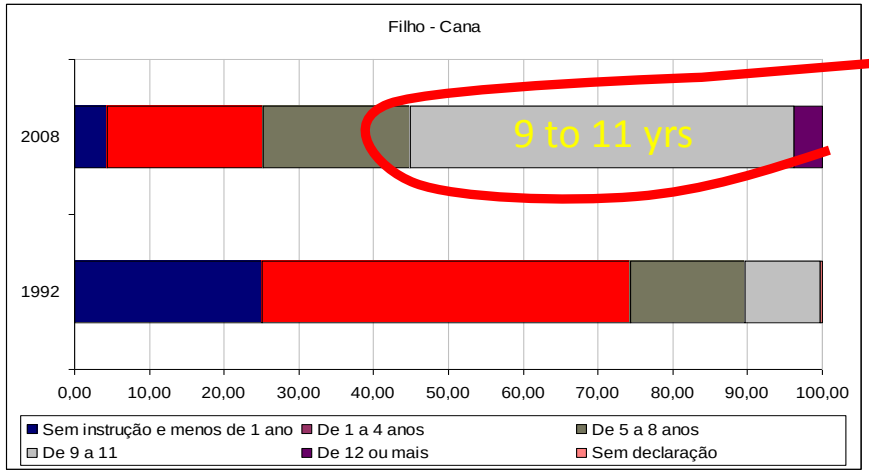
Agriculture excl. cane





Sugarcane





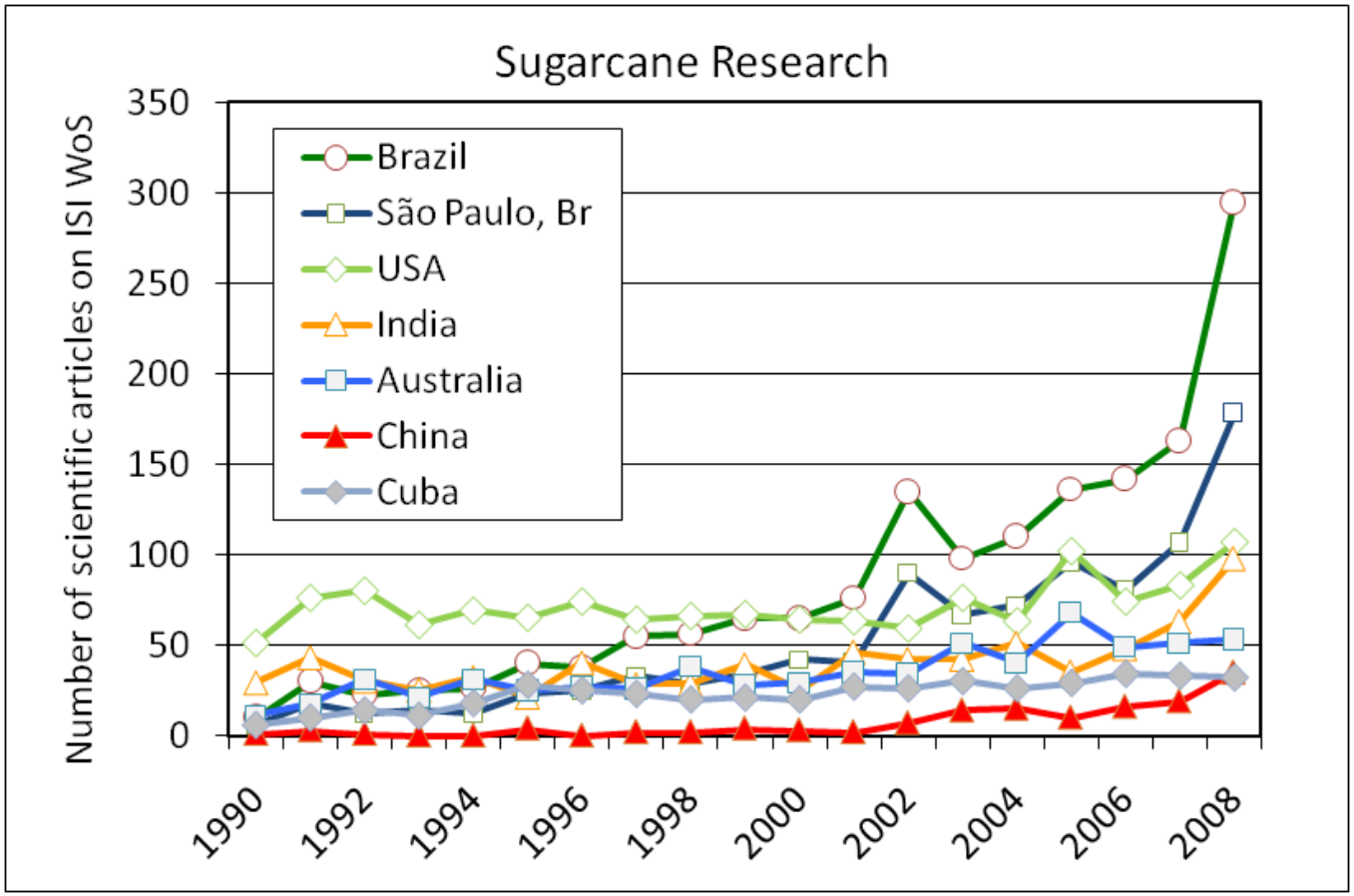
Challenges in Bioenergy in Brasil

- Productivity
  - Biomass production
  - Conversion processes
  - Cellulose uses: electricity x liquid fuel
- Sustainability
  - Emissions (LUC, ILUC, N)
  - Water use
  - The new agriculture of Food and Energy
  - Environmental impacts
  - Social impacts
  - Economics: regulation, standards, certification

Main Research Initiatives in Cane and Ethanol in Brazil

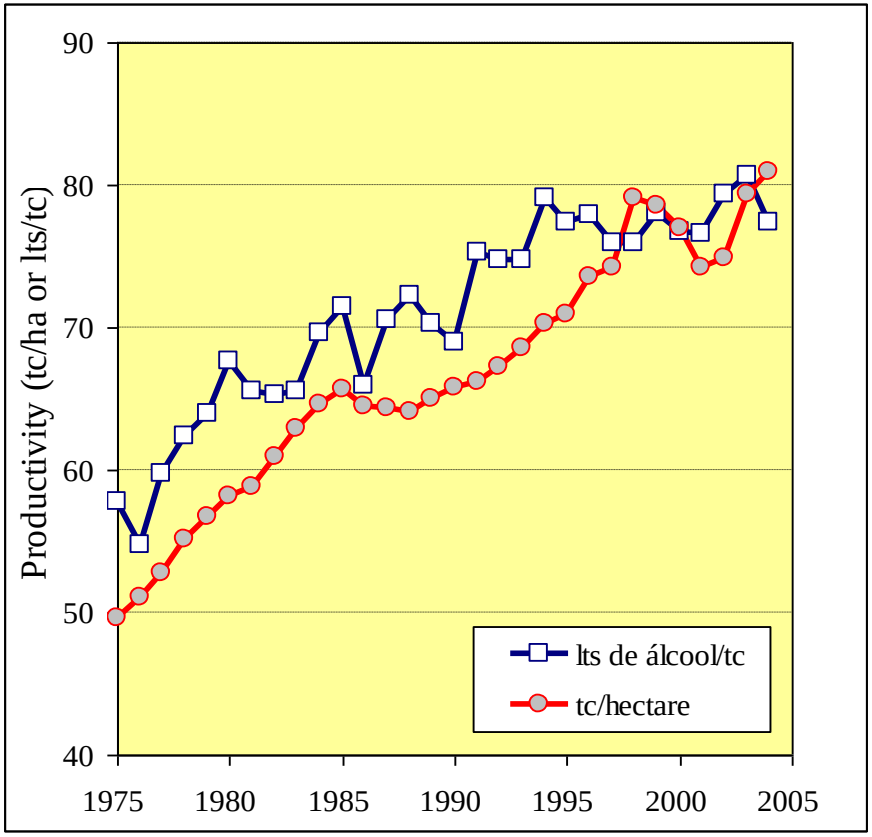
- CTC: private center to assist industry
- Ridesa: public/private network for cane breeding
- IAC: public center on agronomic research
- Universities
- INMETRO: Certification
- CTBE: Bioethanol Research Center
- EMBRAPA Agroenergy Center
- Fapesp Initiatives on Bioenergy

Sugarcane research

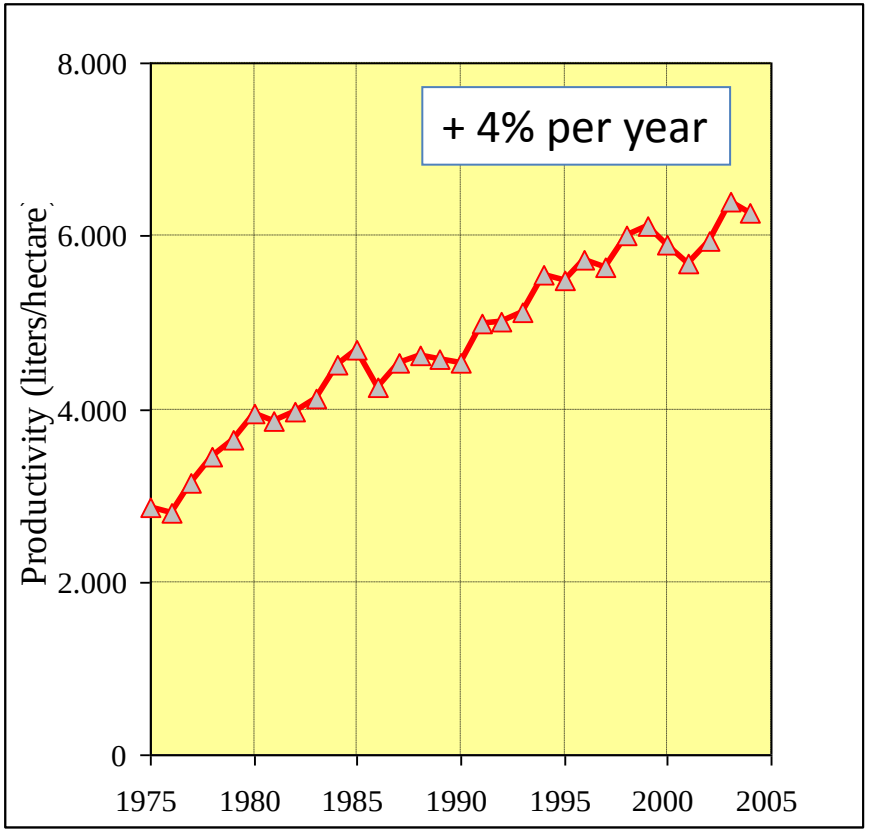


Increase in productivity through R&D

Agricultural and Industrial product.



Total productivity



Sugarcane: present and potential yield

Type of yield	Cane yield ($t\ ha^{-1}\ yr^{-1}$)	Biomass *	
		($t\ ha^{-1}\ yr^{-1}$)	($g\ m^{-2}\ d^{-1}$)
Commercial Average	84	39	10.7
Commercial maximum	148	69	18.8
Experimental maximum	212	98	27.0
Theoretical maximum	381	177	48.5

(Waclawovski et al, "Sugarcane for bioenergy production: assessment of yield and regulation of sucrose content ", PBJ 2009)

Three fronts at FAPESP

- Scientific and Technology roadmap
  - Research Project in our Public Policy Program
- BIOEN
  - Research program; 5-10 anos
  - Basic research core
  - Conections to application through partnership with companies
- Bioenergy State Research Center
  - Hubs in the three state universities – USP, Unicamp, Unesp
  - Funding: State Government, FAPESP and the Universities

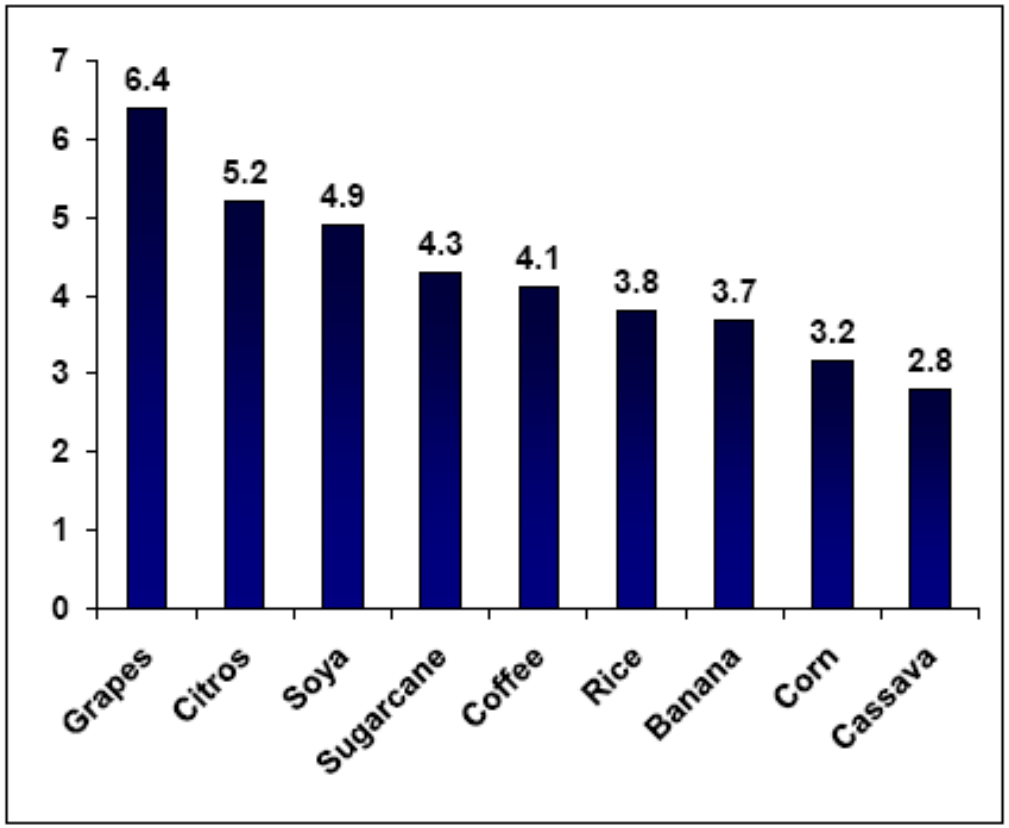
FAPESP's Research Program on Bioenergy (BIOEN): 5 areas

- Improvements in the feedstock: building a better cane plant for energy - EnergyCane
- Production of Ethanol and other products: hydrolysis, pyrolisis, gasification, fermentation, distillation
- New processes in alcohol-chemistry
- Ethanol based engine and fuel cell developments
- The Economics of Ethanol, Ethanol production and the environment, Social impacts, the new agriculture of food and energy

Conclusion

- Large scale biofuels are possible now
  - Latin America an Africa have land for 1st generation technology to suceed
  - New science can make it even easier
- S&T advances will make biofuels more widely available
  - Especially for countries with less available land
- In LA and Africa biofuels can be a gateway to growth, development and social inclusion

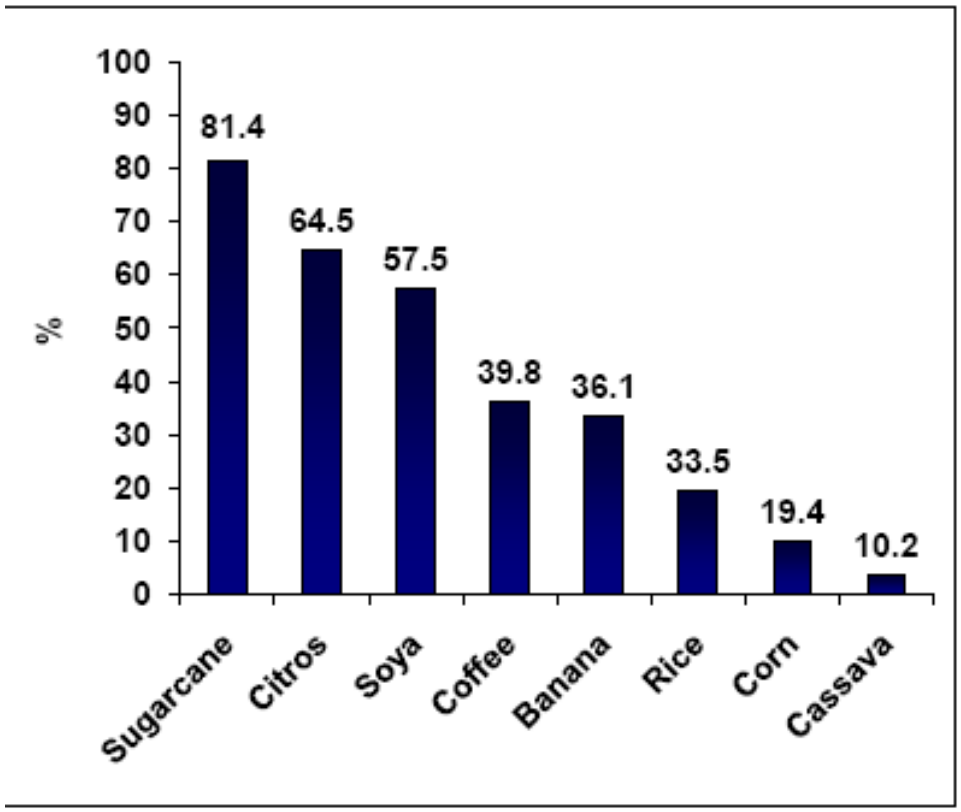
Agricultural workers average 4 years of schooling



Source: Prepared based on data provided by PNAD 2008

- Sugarcane
  - 4.3 years of schooling
  - 24% illiterate

Formally registered workers



Source: Prepared based on data provided by PNAD 2008

- In Agriculture
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- In Sugarcane
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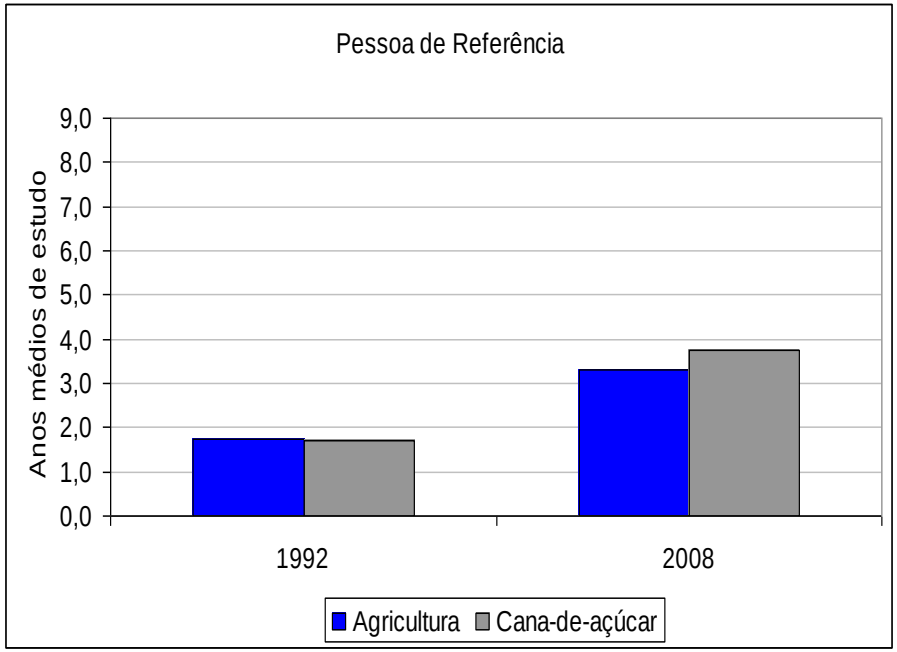
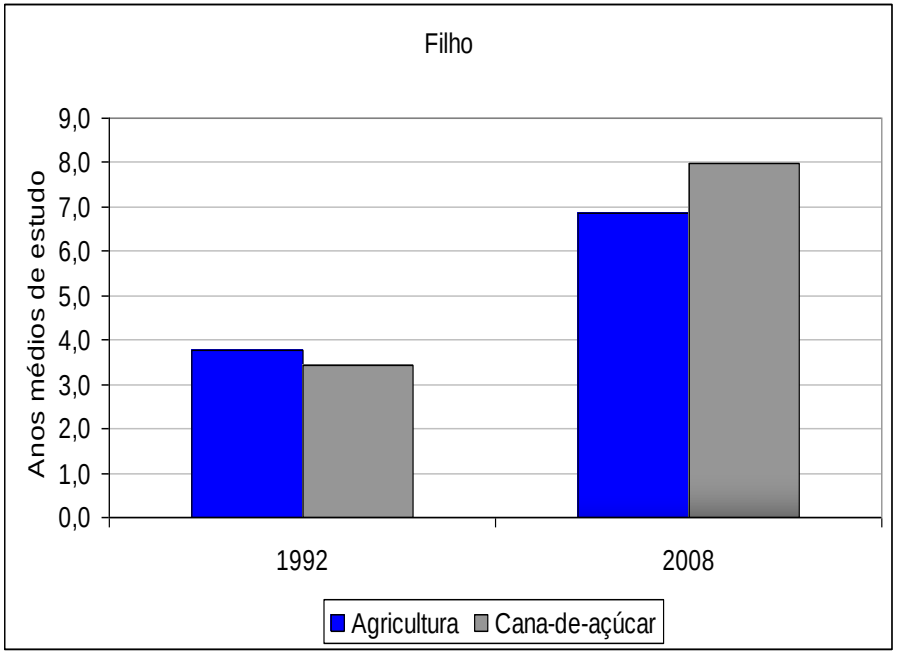
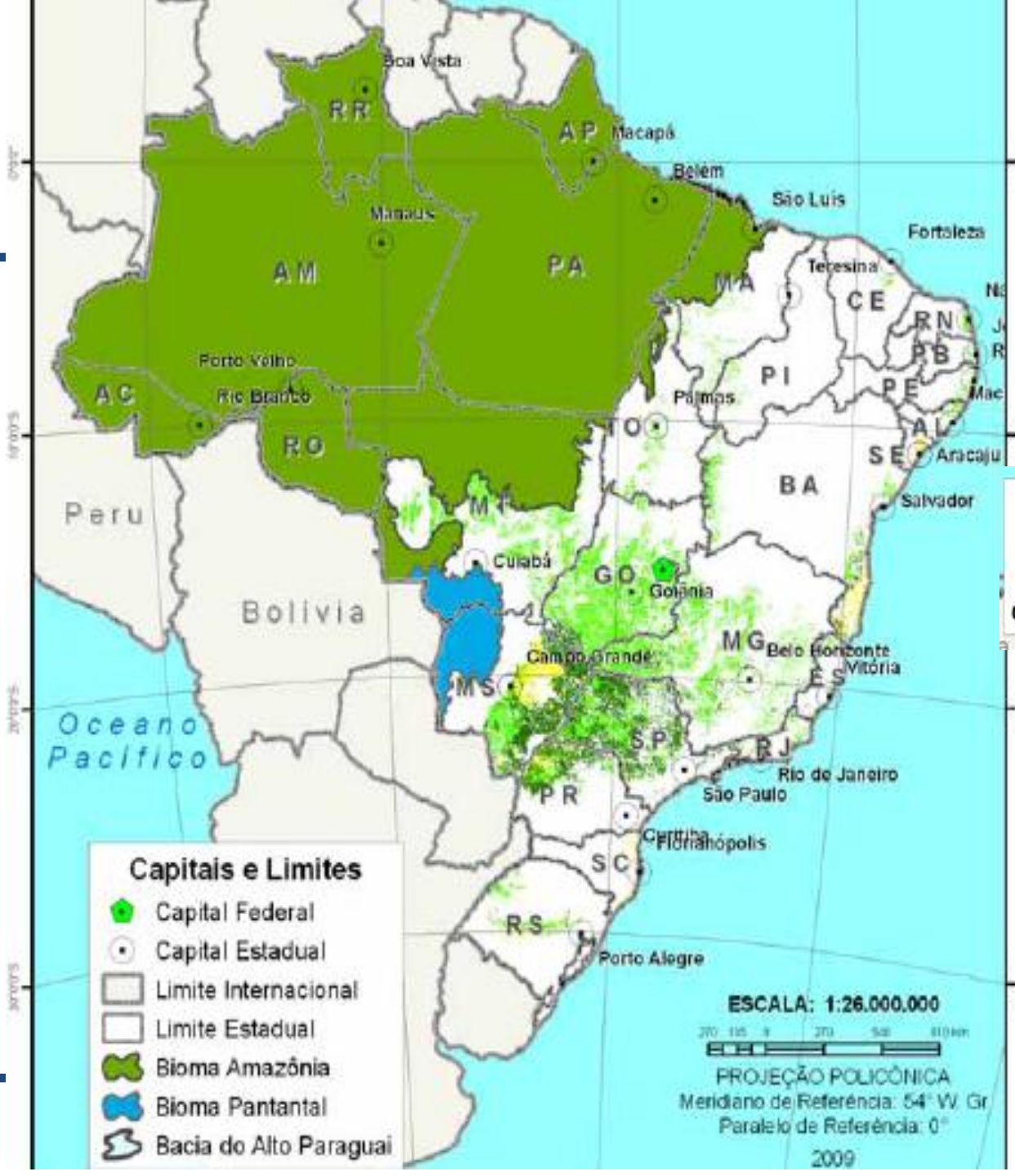
Generational advances in access to education

Parents



Sons and daughters with 18 years or more





Áreas aptas ao cultivo da cana de açúcar por classe de aptidão agrícola, atualmente utilizadas com Pastagens, Agropecuária ou Agricultura

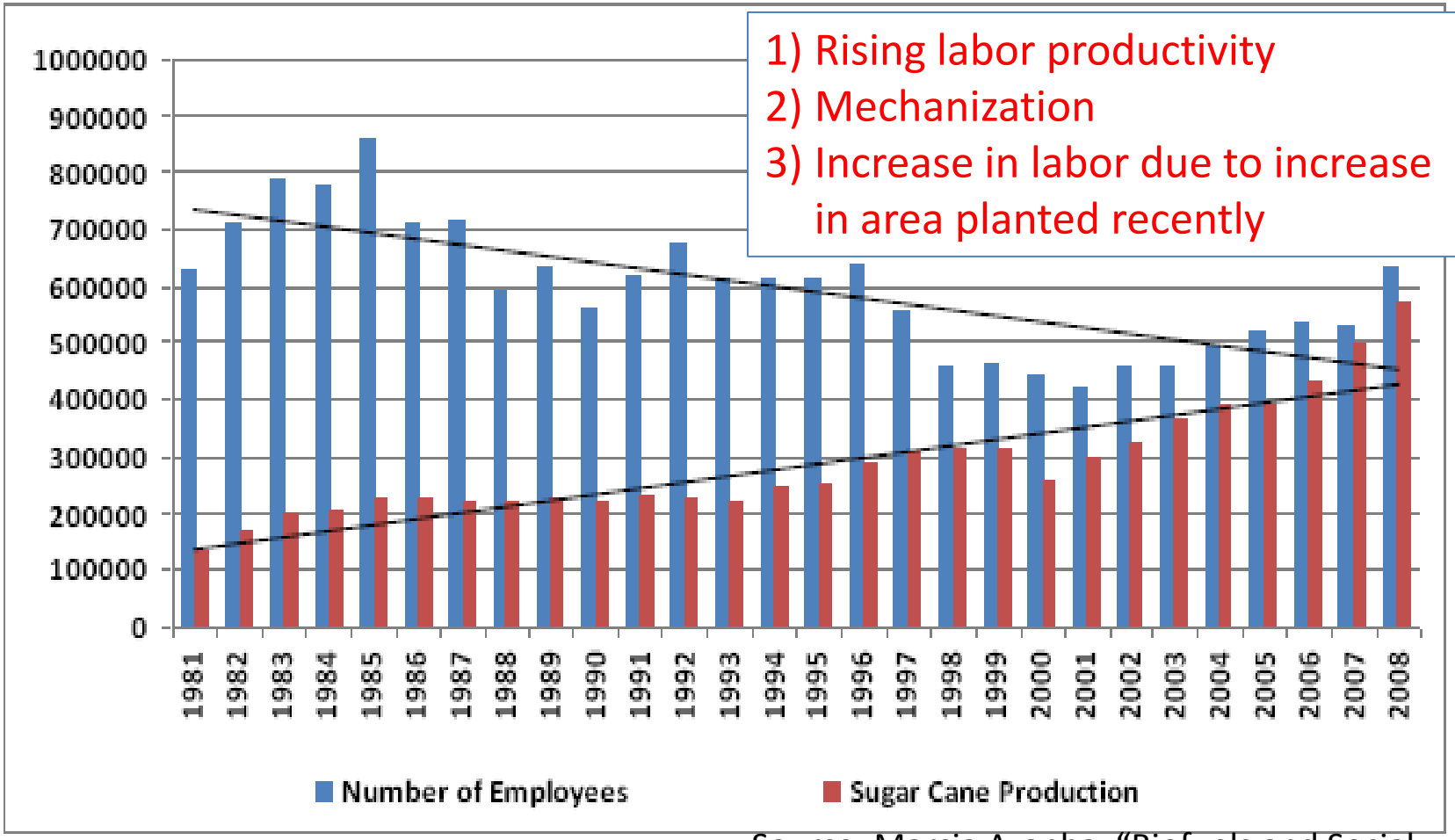
Classes de aptidão: Alta | Média | Baixa

Agroecological Zoning, Brazil: available area for cane

Áreas aptas no Brasil por classe de aptidão e tipo de uso						
Brasil	Classes de Aptidão	Áreas aptas por tipo de uso da terra (ha)			Área por Aptidão (ha)	
		Ap	Ag	Ac	Ap + Ag	Ap + Ag + Ac
	Alta (A)	11.302.342,95	600.766,55	7.360.310,26	11.903.109,50	19.263.419,76
	Média (M)	22.863.866,09	2.015.247,91	16.344.644,29	24.879.114,00	41.223.758,29
	Baixa (B)	3.041.122,07	483.326,14	731.076,97	3.524.448,21	4.255.525,18
	A+M	34.166.209,05	2.616.014,46	23.704.954,55	36.782.223,51	60.487.178,05
	Total	**37.207.331,12**	**3.099.340,60**	**24.436.031,52**	**40.306.671,72**	**64.742.703,23**

Nota: Classes de Aptidão: A: Alta; M: Média; B: Baixa – Uso atual: Ac: Agricultura; Ag: Agropecuária; Ap: Pastagem.

Sugarcane: rising productivity, decreasing number of workers



Source: Marcia Azanha, "Biofuels and Social Inclusion", www.fapep.br/gsb