
Science, Technology and Innovation in Brazil

Carlos H Brito Cruz
Scientific Director
Fapesp

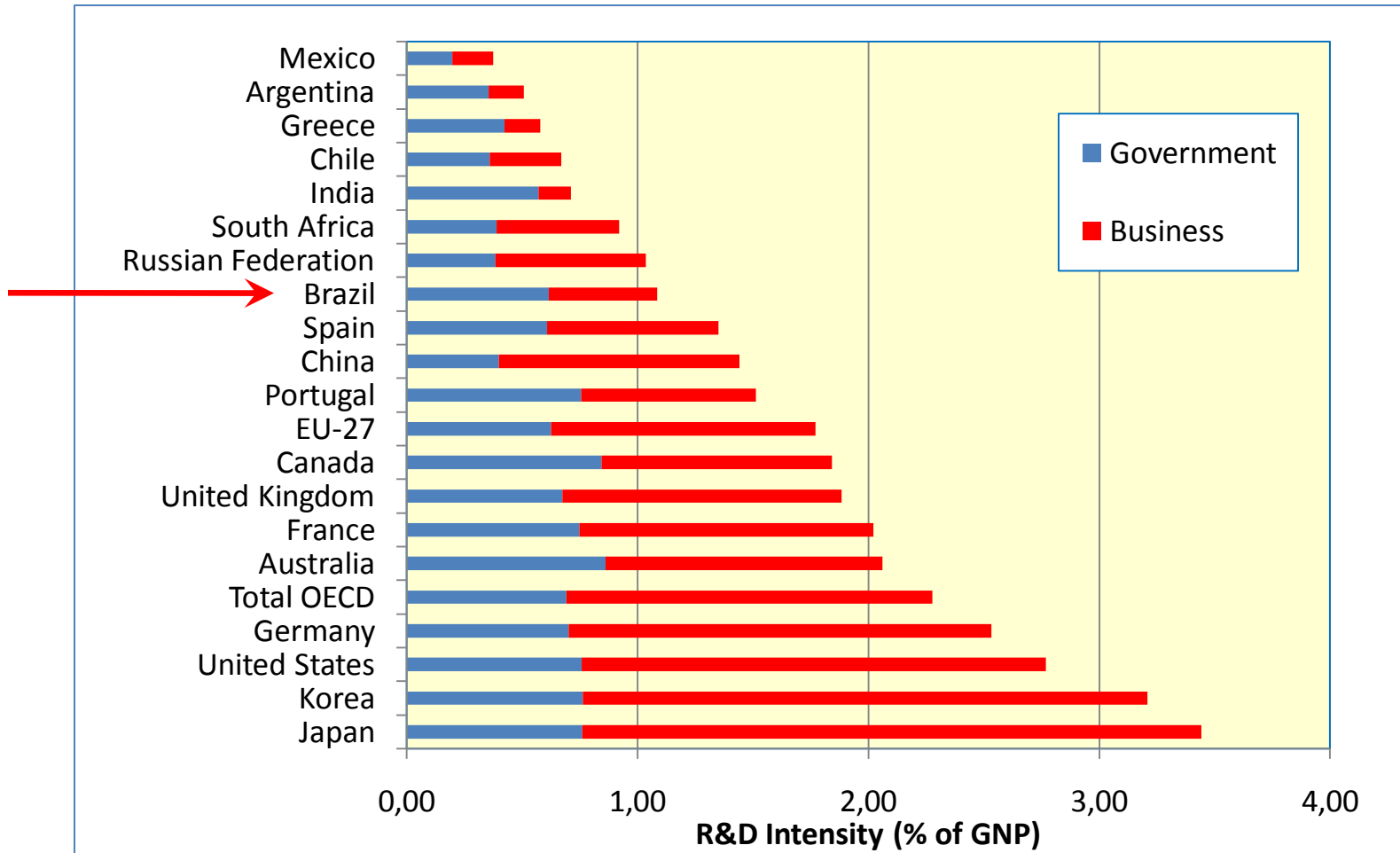
Summary

- Brazil's S&T&I policies
- Results:
 - doctorates and articles and things that make money
- State level R&D support
- Energy and the Environment

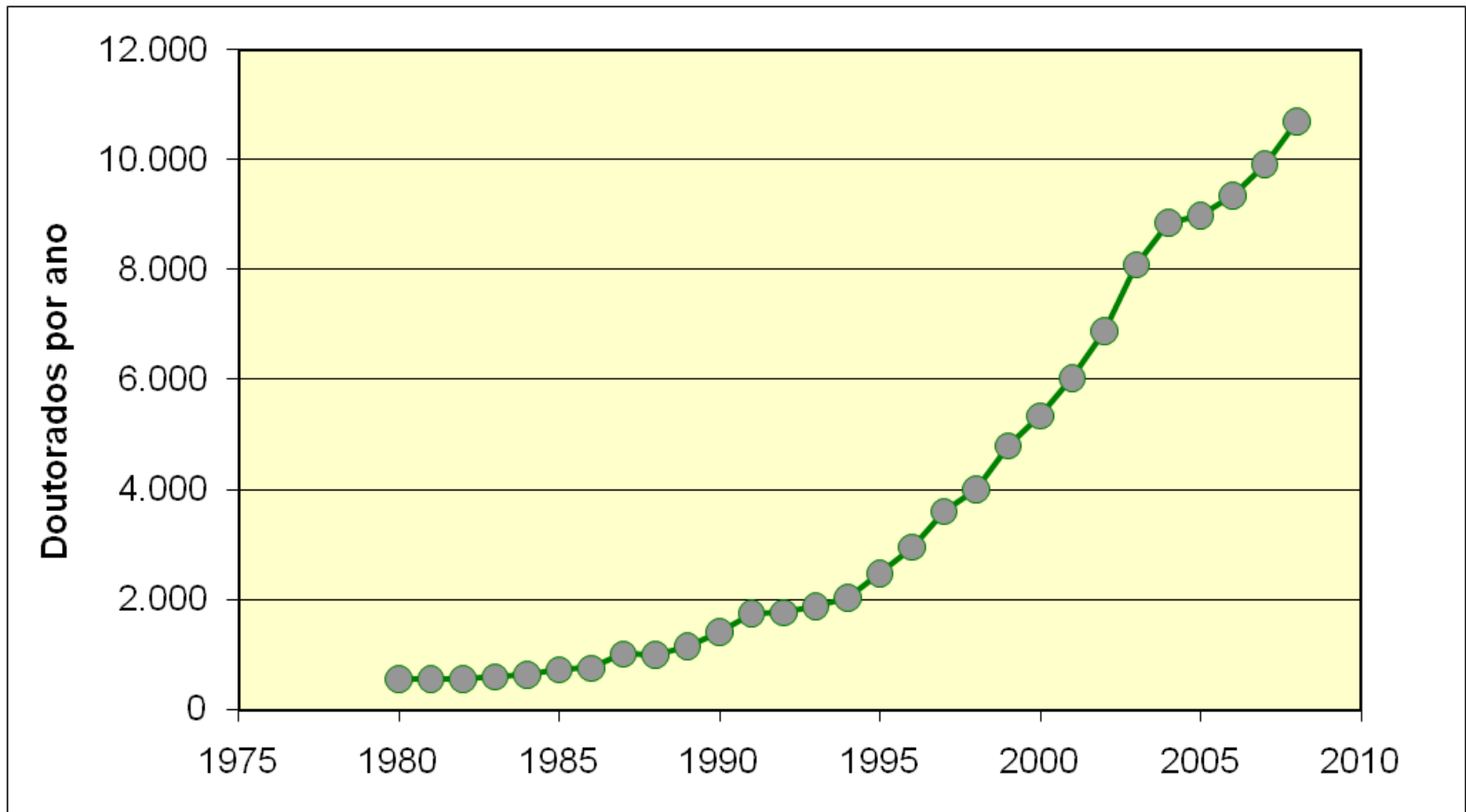
Brazil: S&T Policy

- 1951: National Research Council, CNPq
 - Fellowships, research grants
- 1951: Coordination for the Qualification of Higher Education Personnel, CAPES
 - Accredit and evaluate graduate courses, fellowships
- 1962: São Paulo Research Foundation, FAPESP
 - Fellowships, research grants
- 1967: Research and Projects Funding, FINEP
 - Research grants, infrastructure, business R&D
- 1969: National Science and Technology Fund, FNDCT
 - Federal funds operated by FINEP
- 1934 – 1985: USP, Unicamp, UFMG, UFRJ plus 50+ universities
 - 1960: Full time professorships start in São Paulo (USP)

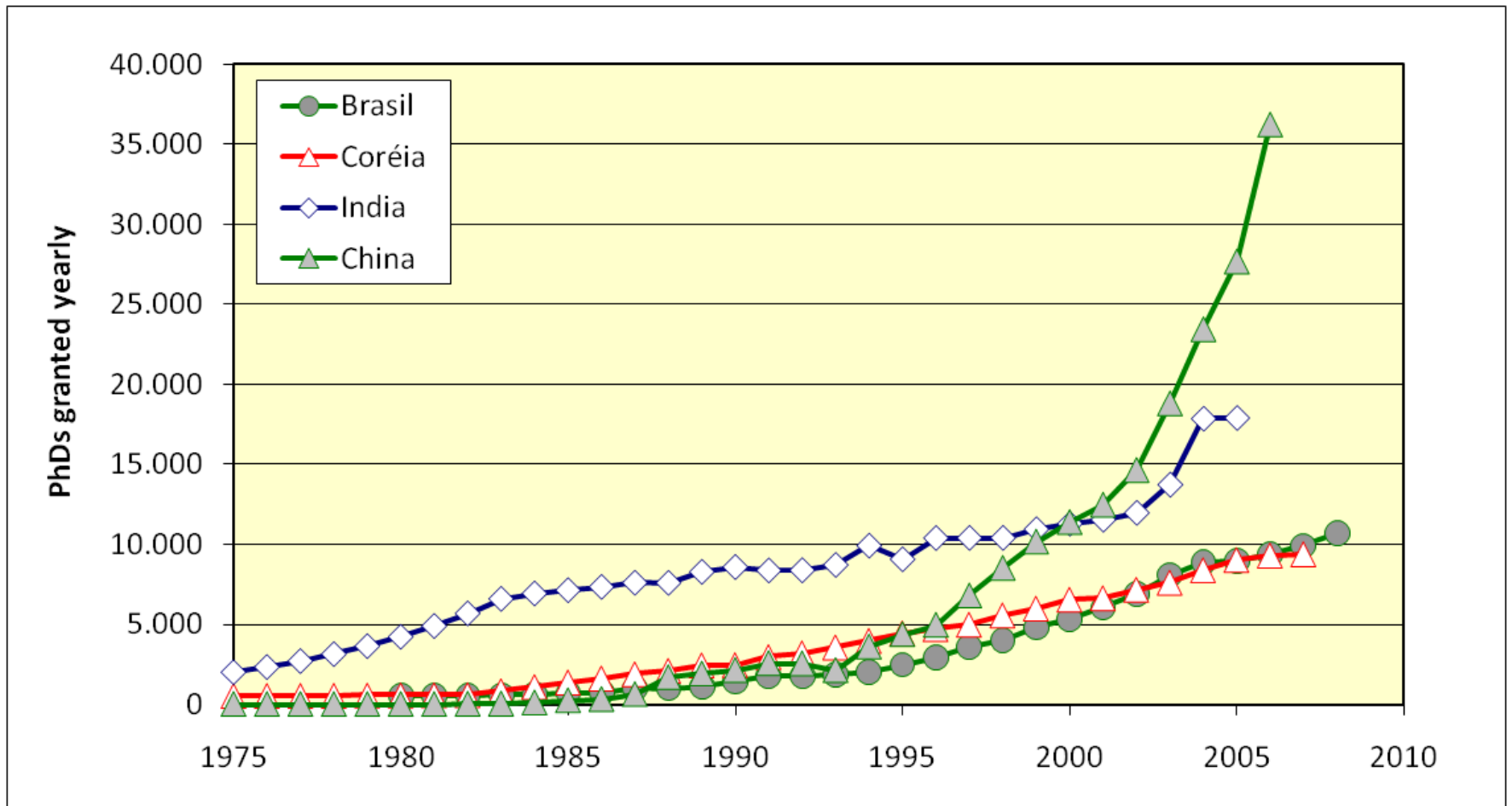
Compared R&D Intensity



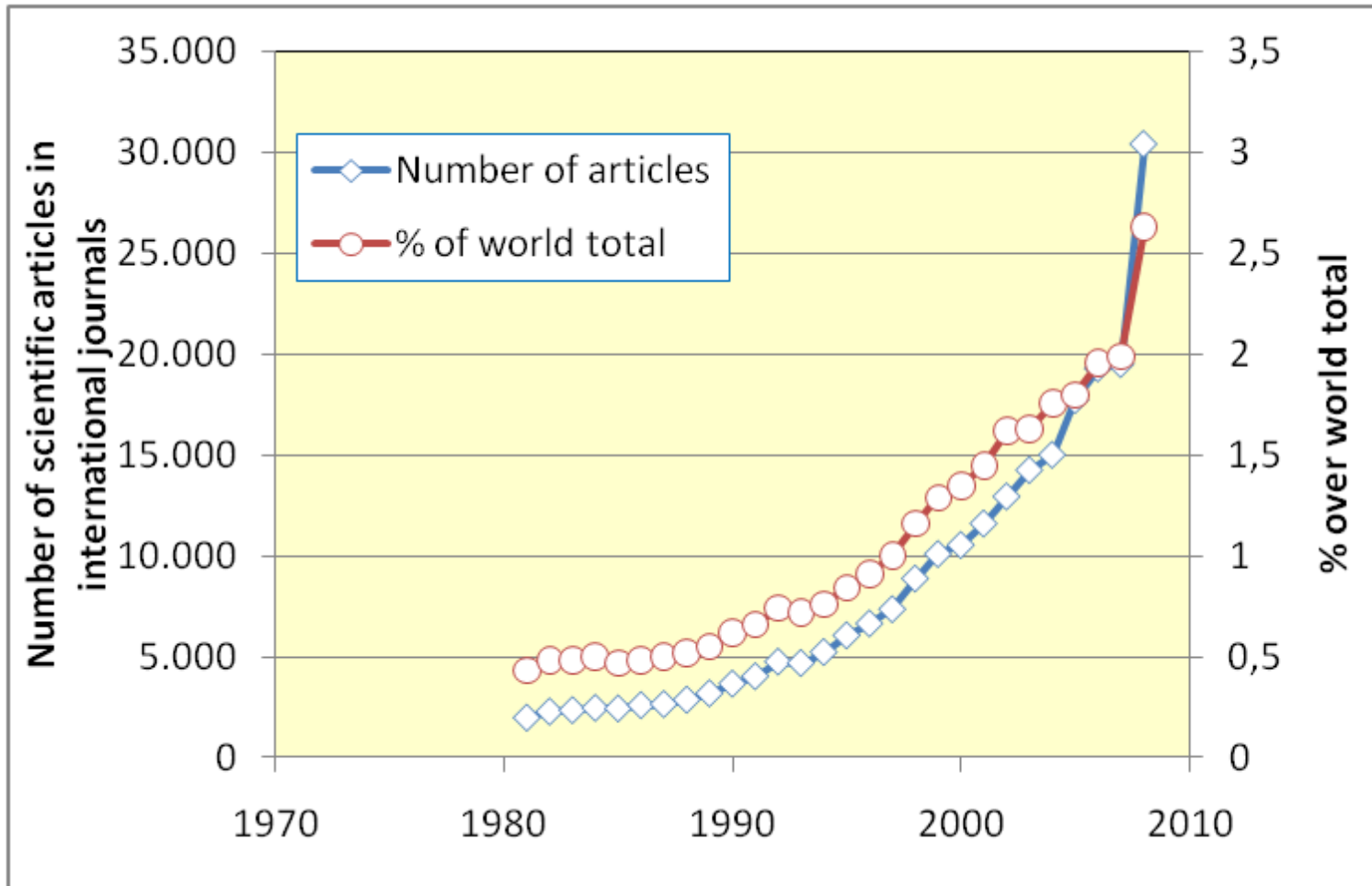
Brazil: 10,711 PhDs formed in 2008



China, India, Brazil and S. Korea: PhDs granted yearly



Growth in scientific articles



R&D in Brazil

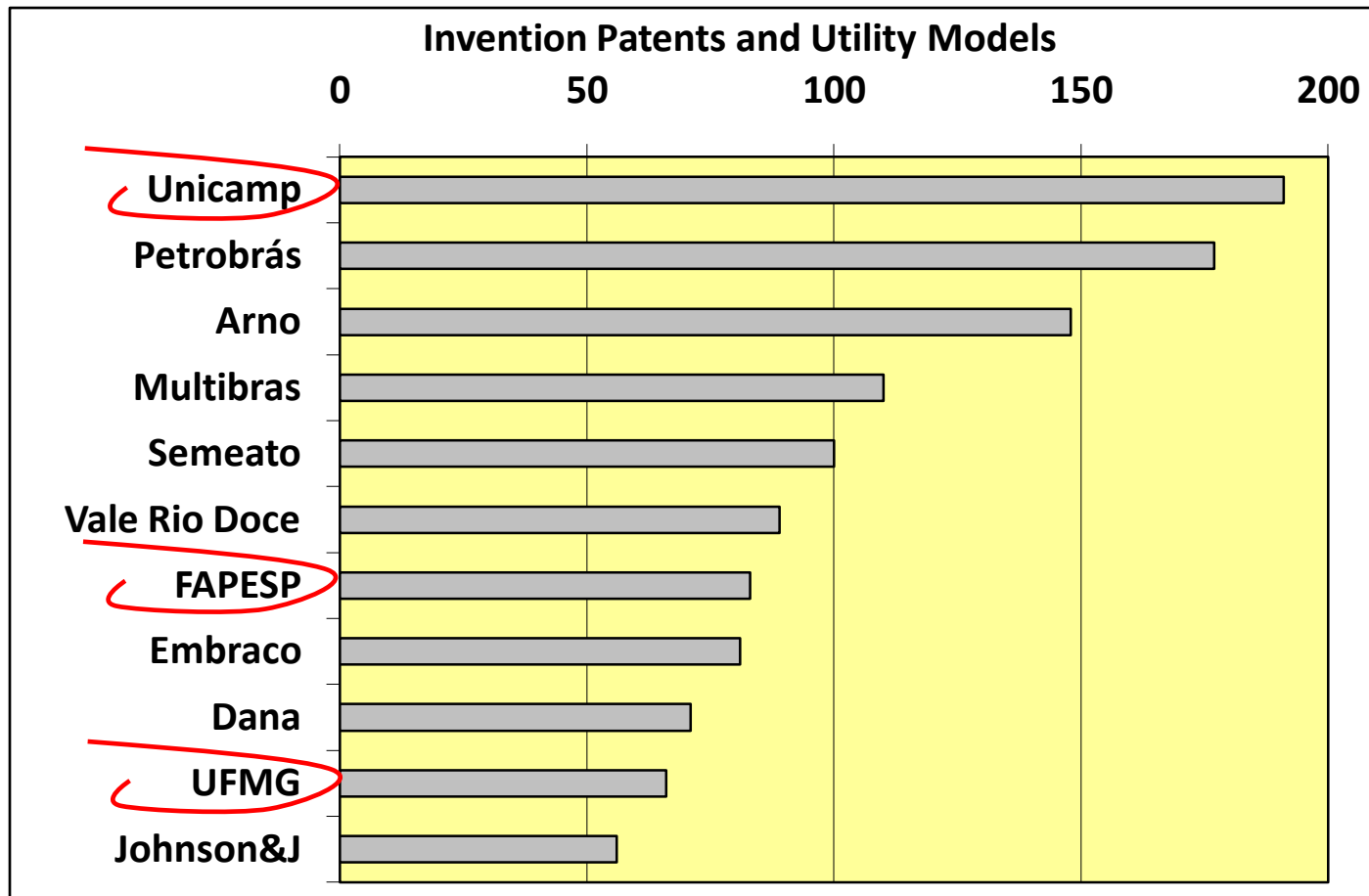
- A strong academic base
 - 10,000 Doctorates granted yearly
 - 14,000 scientific papers published yearly
- Growing intensity of industry R&D
 - Brazilian companies:
 - Petrobrás: 11st in R&D in Oil Sector
 - Embraer: 17th in R&D in Aerospace
 - Embrapa and state institutes: agrobusiness driver (Brazil 1st in soy productivity, 1st in meat exports, ..)
 - But still: only 30% of scientists work in industry

Innovation environment: Continuing policies

- Industry R&D and innovation (1999), Sectoral Funds (2000), II National S&T&I Conference (2001), Innovation Law submitted to Congress (2002)
- Innovation Law: Law 10.937/2004
 - University-Industry joint R&D
 - Academic Intellectual Property
 - Fostering industrial R&D
 - Tax incentives, procurement, subvention, subsidized loans
- Plus: Industrial and Technology Policy (PITCE, PDP)
 - Focal sectors, articulation

Universities value their IP

Main IP stocks: 1999-2003



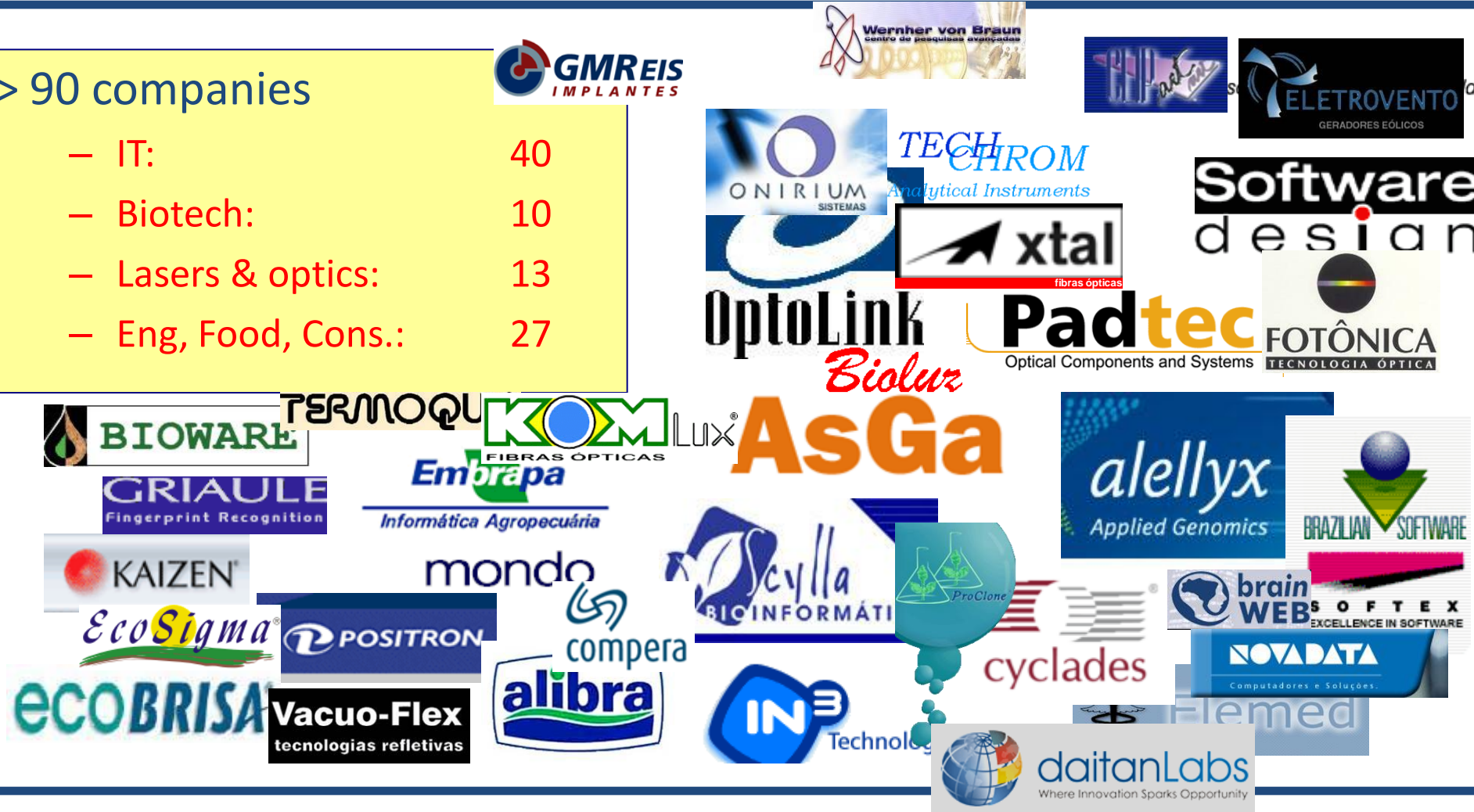
Fonte: http://www.inpi.gov.br/ultimas_noticias/pdf/Dspositantes03maio_VF_.pdf

University start-ups

90+ “spin-offs” from Unicamp

> 90 companies

- IT: 40
- Biotech: 10
- Lasers & optics: 13
- Eng, Food, Cons.: 27

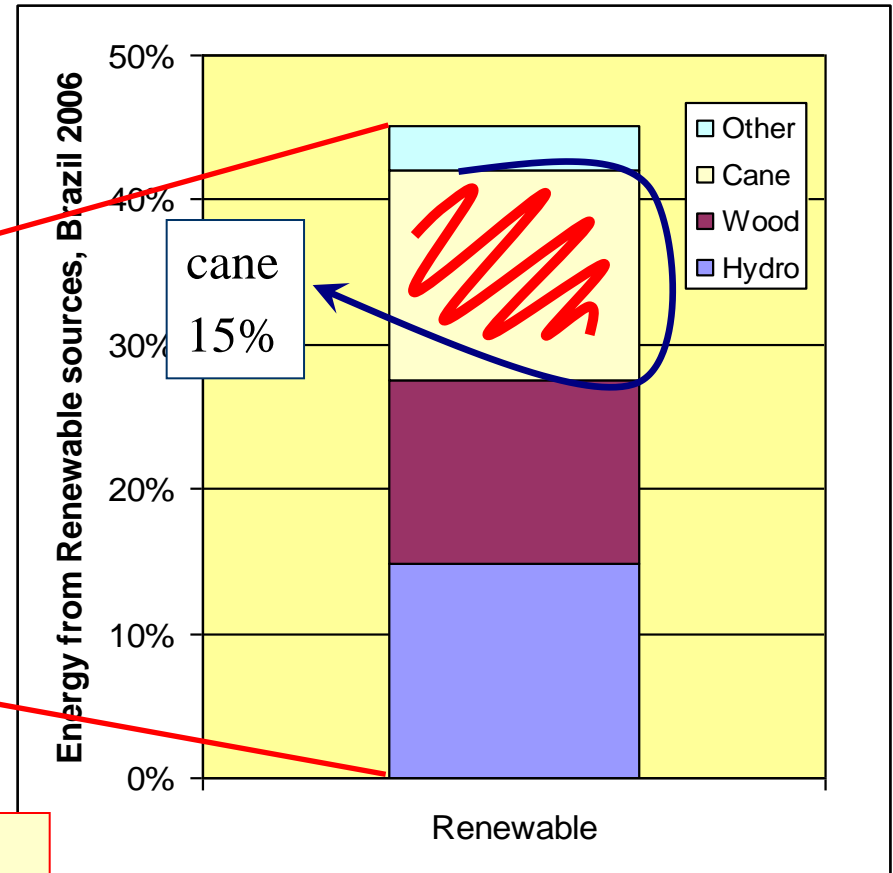
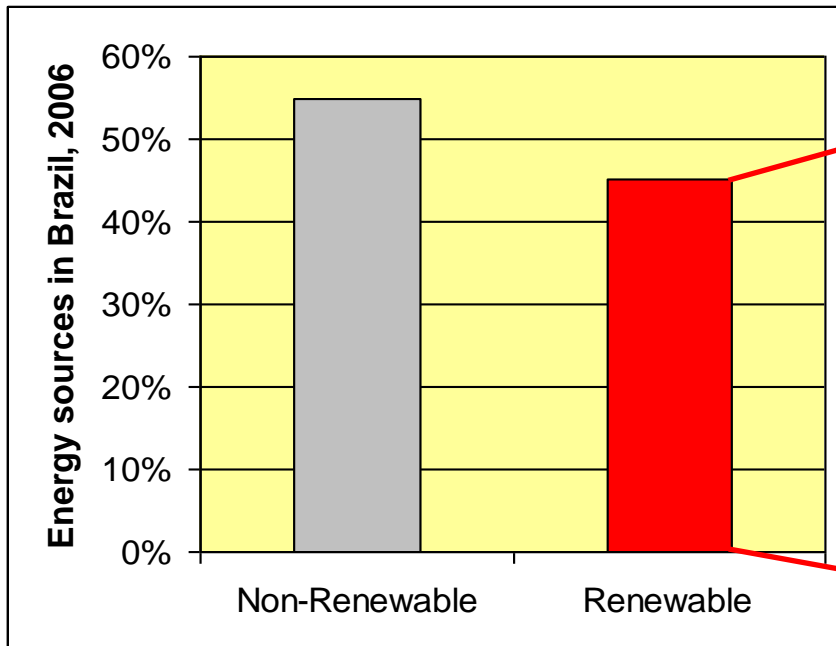


Some of Brazil's R&D results

- Drilling oil at 5,000 ft under the sea
 - 100% of Brazilian consumption
- Best 50 seater jet – Embraer ERJ 145
 - Starting 2006: 90 -110 seat jet ERJ 190
- Most productive soybean in the world
- Largest and most efficient Ethanol producer in the world
 - 35% of world Ethanol production
 - > 1 milion flex-fel vehicles, 90% of sales

ENERGY

Energy sources in Brazil



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

GHG and Energy Balance: evolving knowledge

Goldemberg J et al., “Energy Balance for Ethyl Alcohol Production from Crops”, Science 201 p. 903-906 (1978)

Macedo IC, Seabra JEA, Silva JEAR. Green house gases emissions in the production and use of ethanol from sugarcane in Brazil: The.... Biomass and Bioenergy (2008), doi:10.1016/j.biombioe.2007.12.006

Green house gases emissions in the production and use of ethanol from sugarcane in Brazil: The 2005/2006 averages and a prediction for 2020

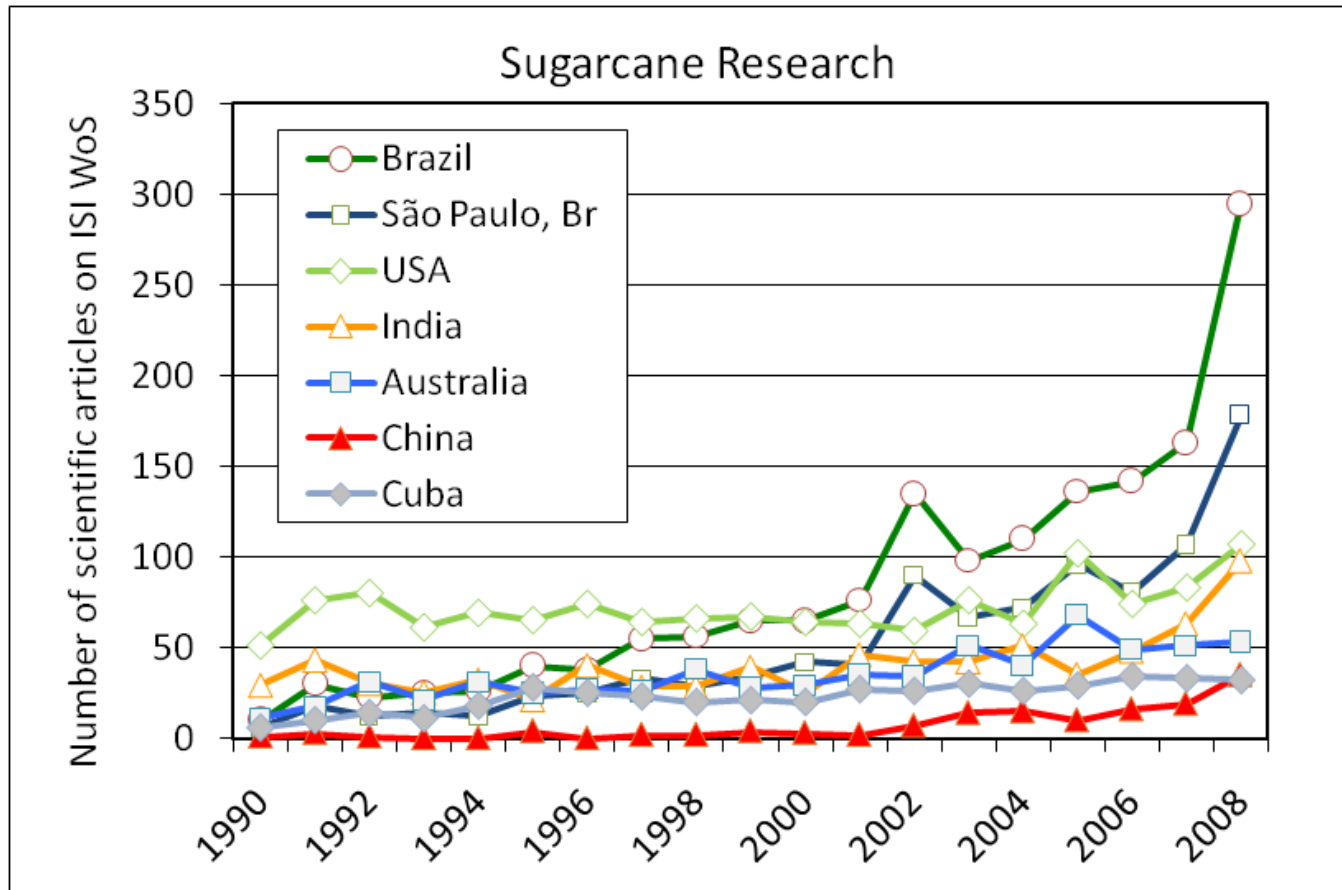
Isaias C. Macedo^{a,*}, Joaquim E.A. Seabra^b, João E.A.R. Silva^c

^aInterdisciplinary Center for Energy Planning (NIPE), State University of Campinas (Unicamp), CEP 13084-971, Campinas, SP, Brazil

^bCollege of Mechanical Engineering, State University of Campinas, Cidade Universitária “Zeferino Vaz”, CEP 13083-970, Barão Geraldo, Campinas-SP, Brazil

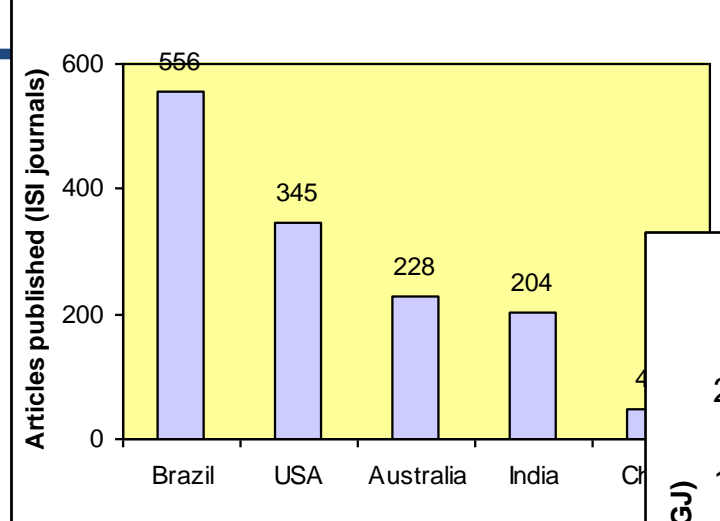
^cCentro de Tecnologia Canaveieira (CTC), CEP 13400-040, Piracicaba, SP, Brazil

Sugarcane research

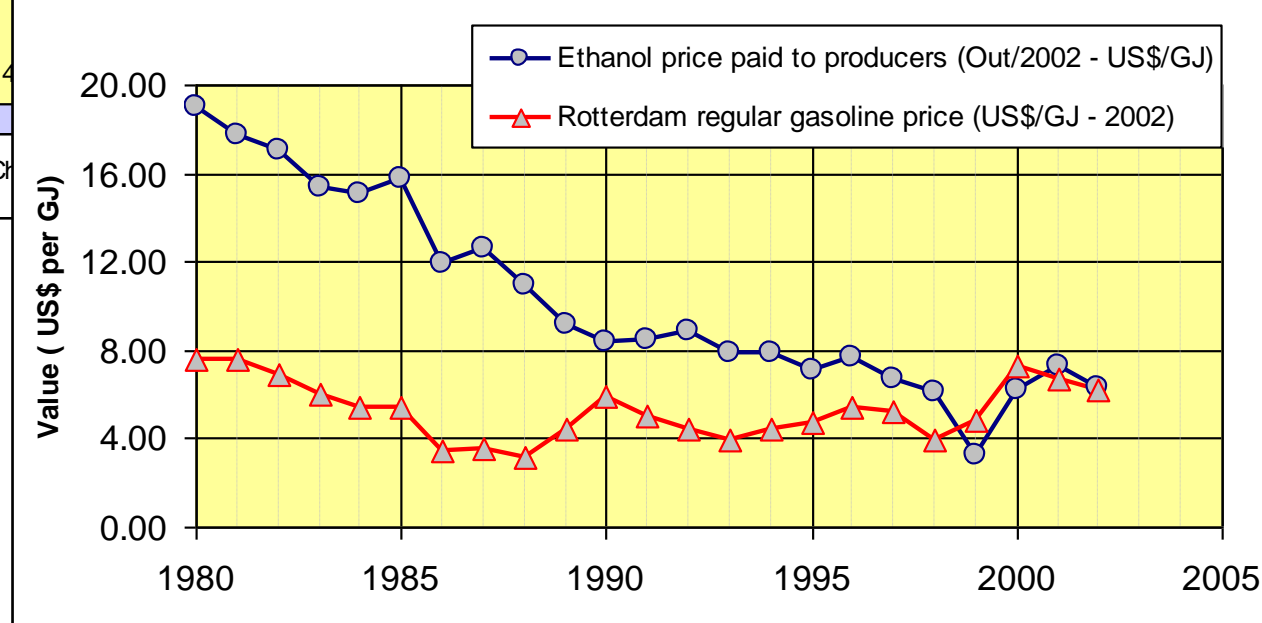


Ethanol and Sugarcane research

Sugarcane Research (2001-2005)



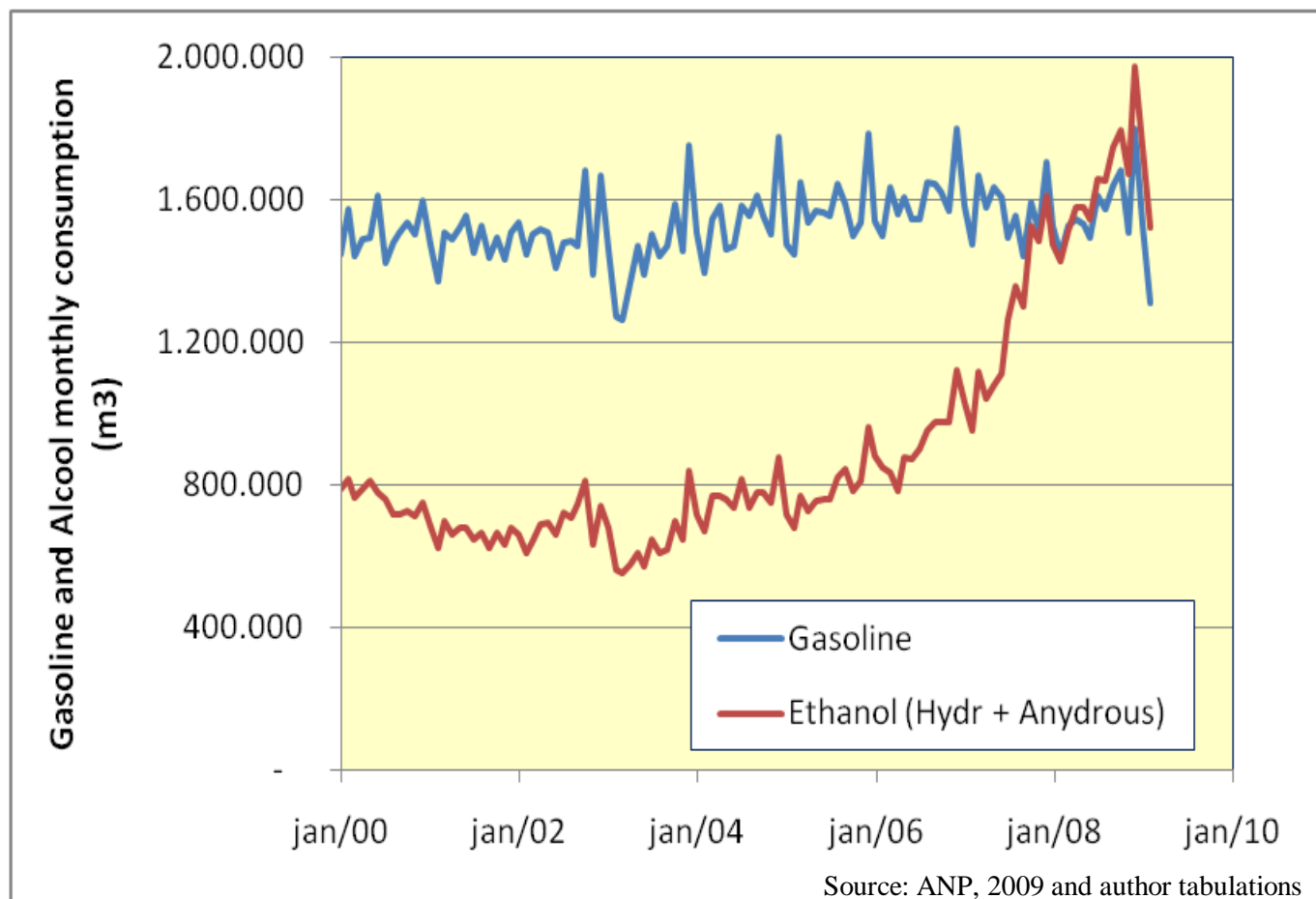
Cost of Ethanol x Cost of Gasoline



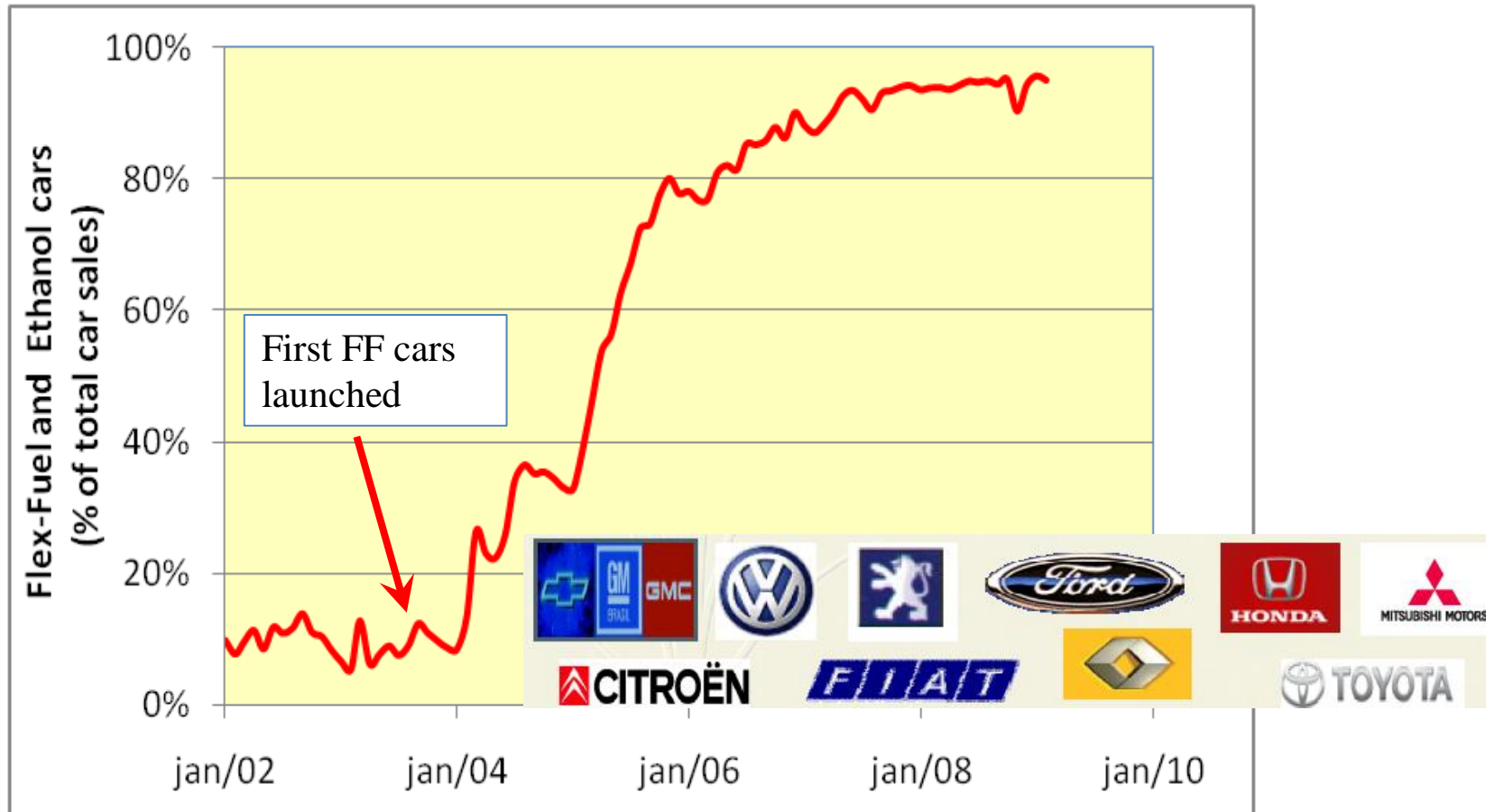
(Source: Goldemberg et al, 2004)



Ethanol and Gasoline use in Brazil

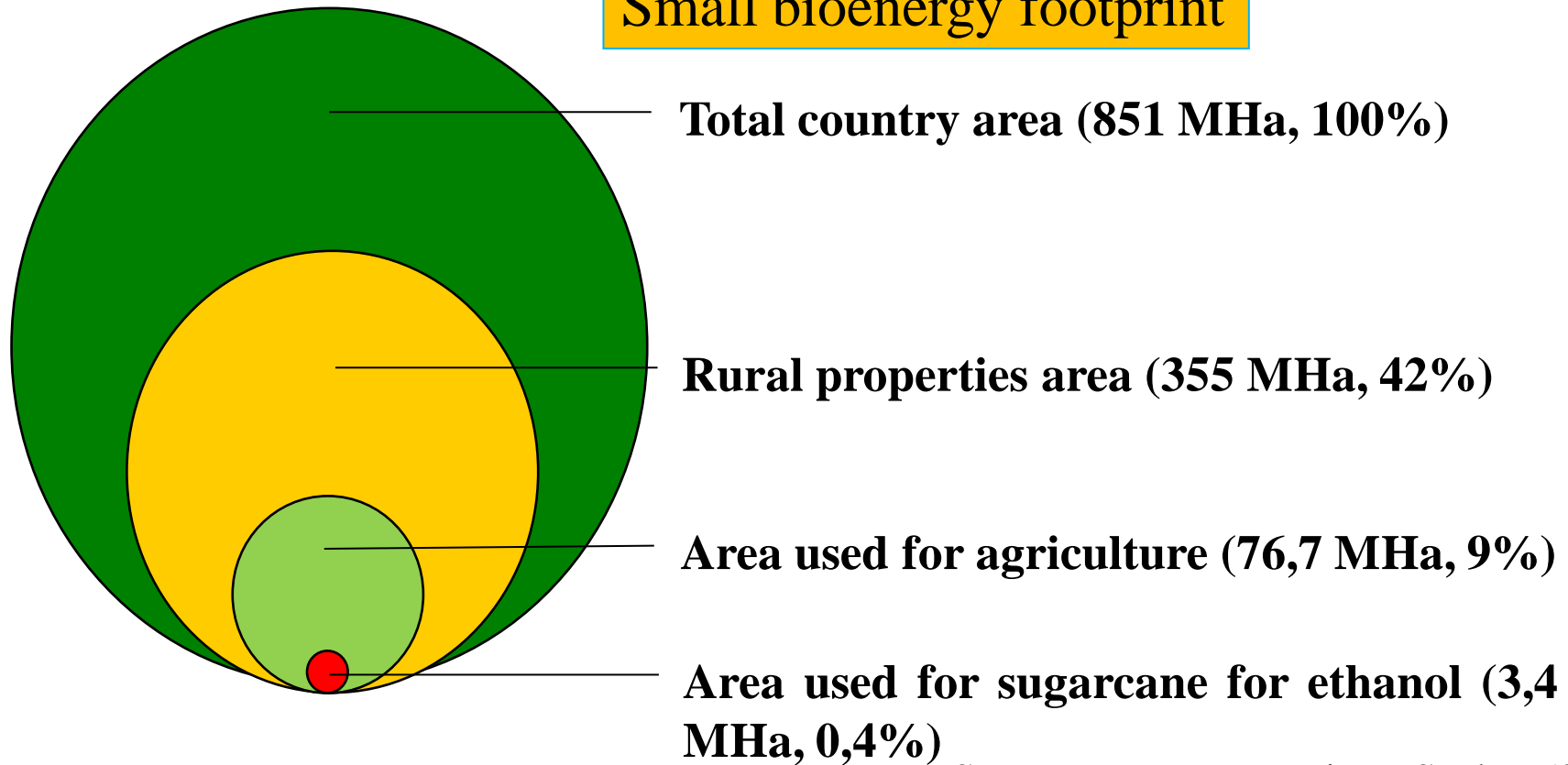


95% of cars sold monthly are Flex-Fuel (FF in Brazil: E10 – E100)



Sugarcane for ethanol uses 0,5% of total area

Small bioenergy footprint



Source: Horta Nogueira e Seabra (2008)

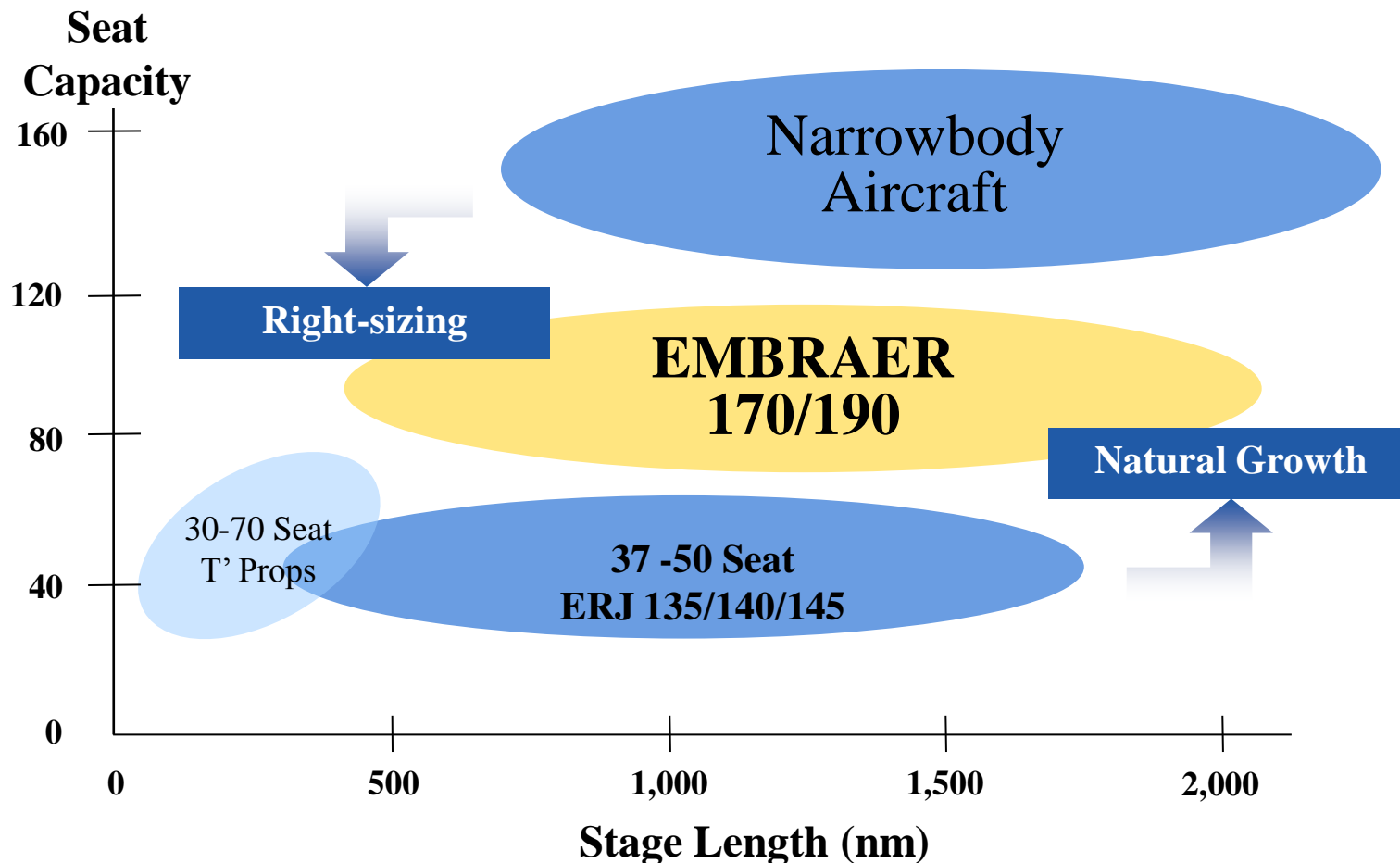
AIRCRAFT

EMB145: 50 seat regional jet



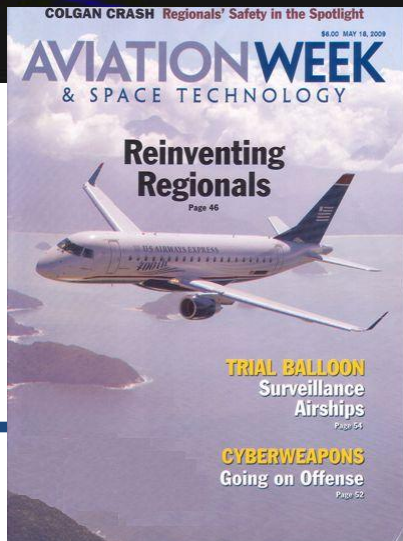
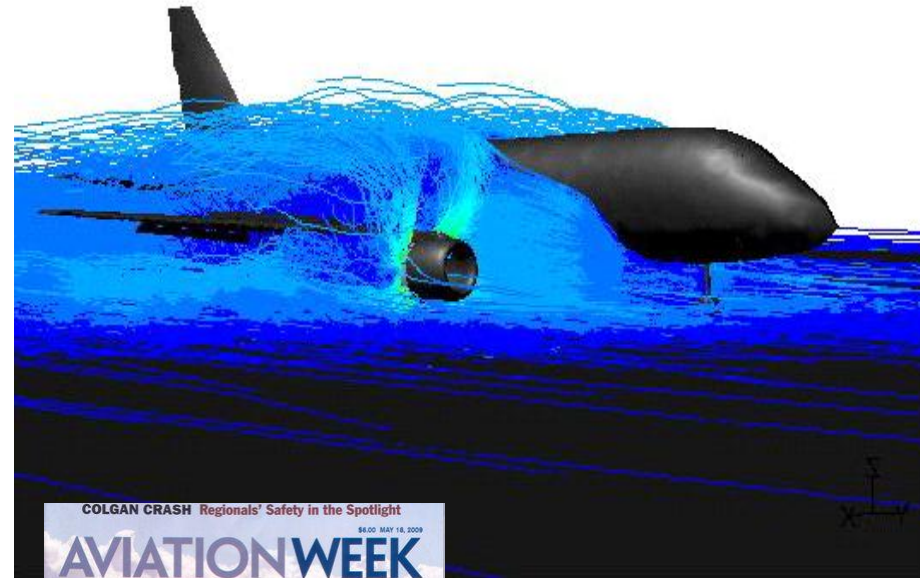
1st item in Brazil's export list for many years (late 90's)

Embraer: Filling the Seat Capacity Gap



Embraer: *R&D to build an innovative jet*

CFD simulation and tests
Research co-funded by FAPESP, PIs
in several universities



State level R&D funding

- 35% of S&T funding in Brazil comes from state sources
- Mostly:
 - 21 State Foundations for Research Support
 - Oldest: Fapesp, 1962 (São Paulo)
 - Newest: Fapego, 2005 (Goiás)
 - State Universities

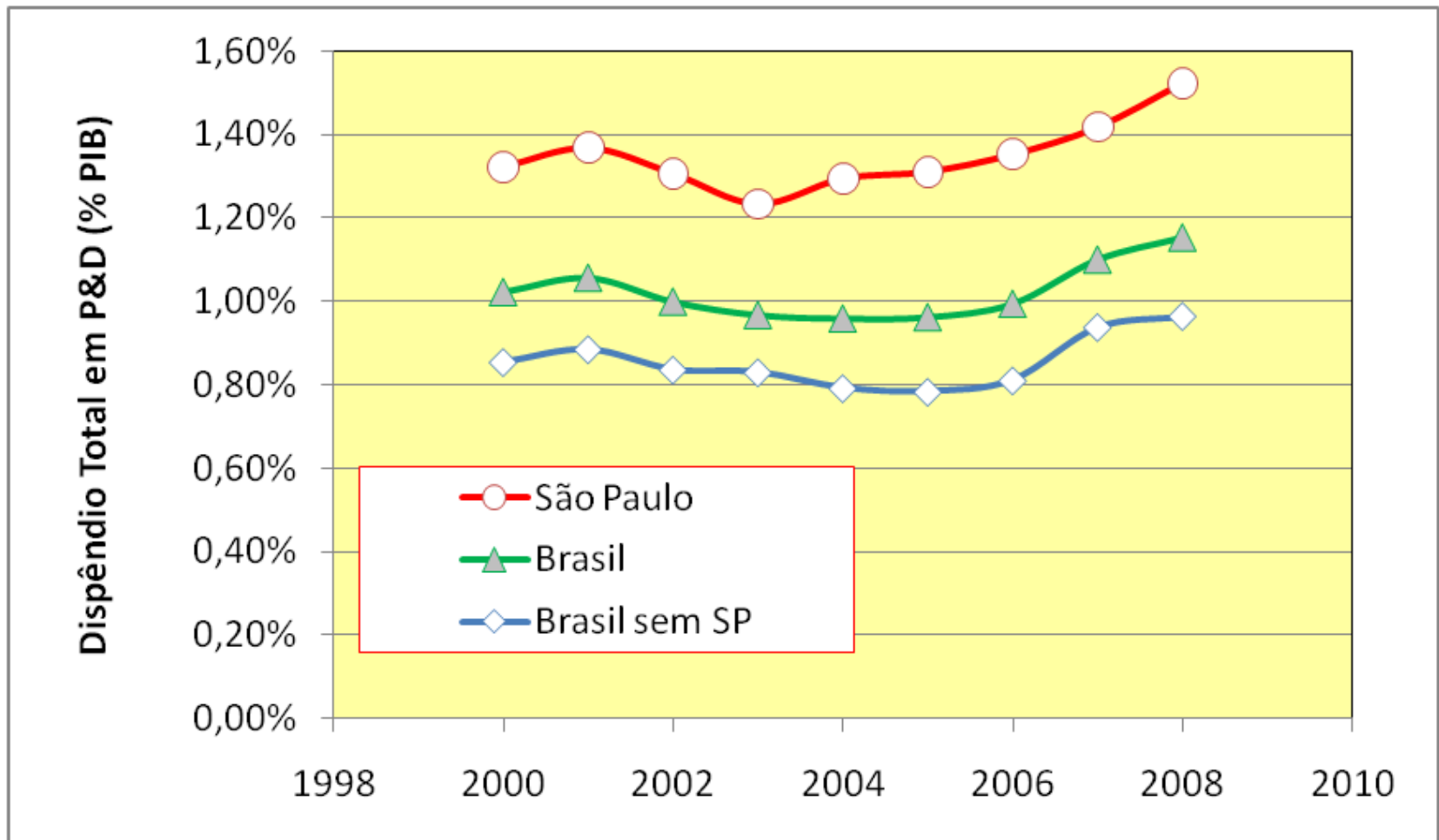
State of São Paulo, Brasil



34% of Brazil's GNP
 40 Million people
 52% of Brazilian science
 13% of State budget to HE and R&D
 1,5% GNP for R&D

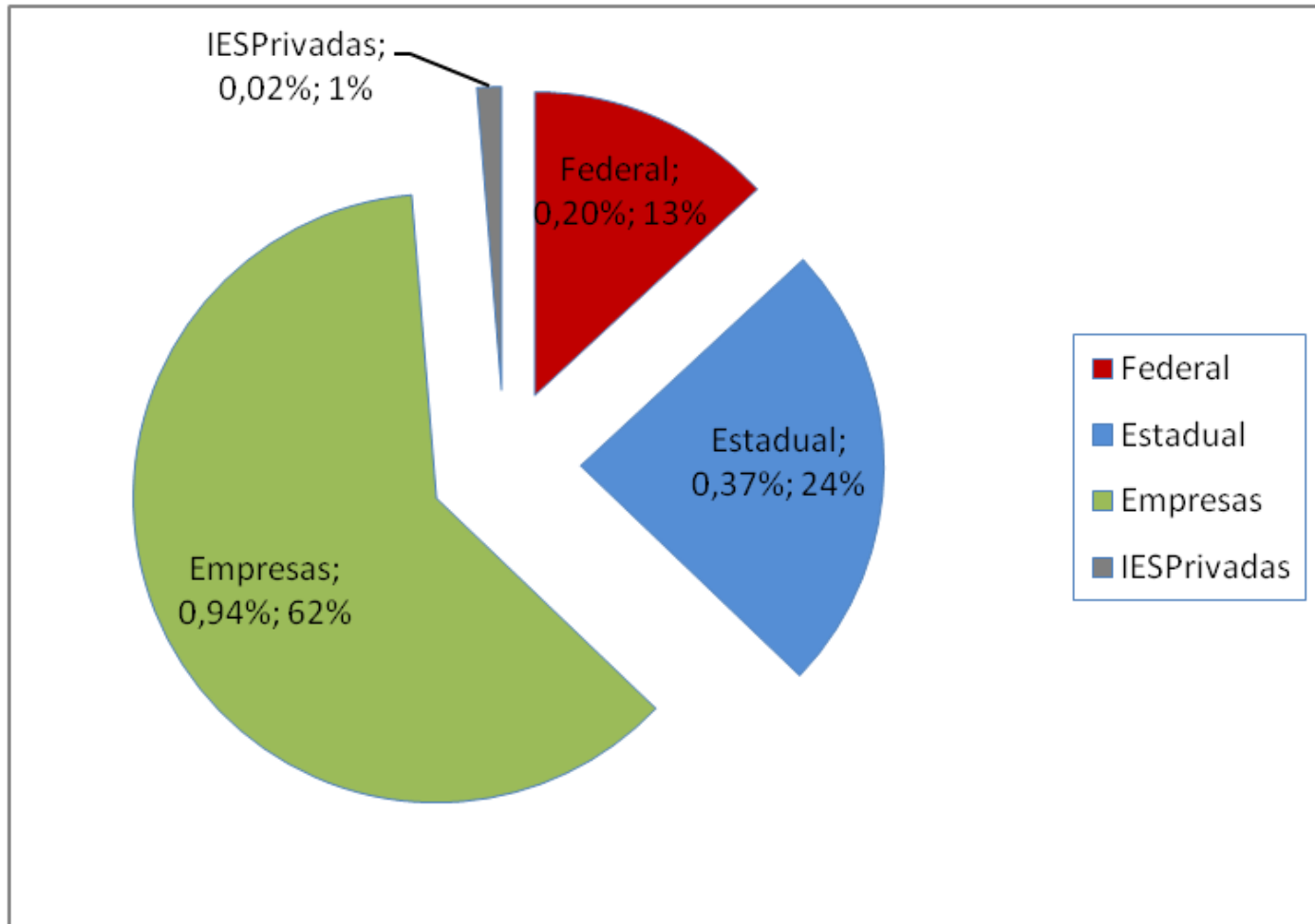
3 State Universities
 19 Tech Faculties
 45% of the PhDs formed in Brazil (4,500 in 2008)
 19 State Research Institutes
 1 Research Foundation
 65% of R&D public support comes from State sources

R&D Expenditures in SP: 1.52% of State GDP in 2008

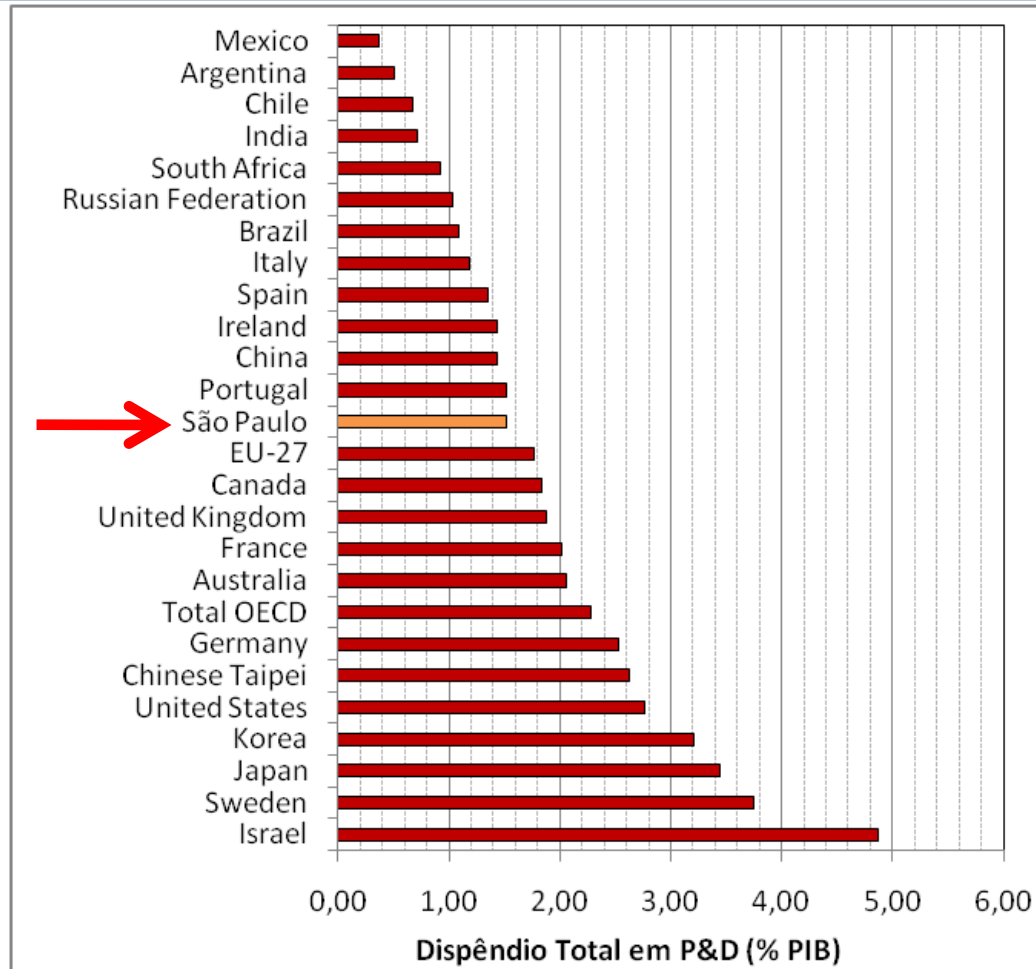


SP R&D Expenditures, 2008

By source



SP, R&D Expenditure International standing



SP: target R&D expenditure for 2020

	2008	2020
R&D Expenditure (% State GDP)	1,52%	2,30%
Public R&D Expenditure (% State GDP)	0,56%	0,80%
Business R&D Expenditure (% State GDP)	0,96%	1,50%
SP GDP (Billion US\$ 2008; 4,5% a.a.)	566	960
Dispêndio em P&D em SP (bilhões R\$ 2008)	8,6	22,1

SP R&D Expenditures 2008 a 2020

200 billion US\$ from 2008

Fapesp: São Paulo Research Foundation

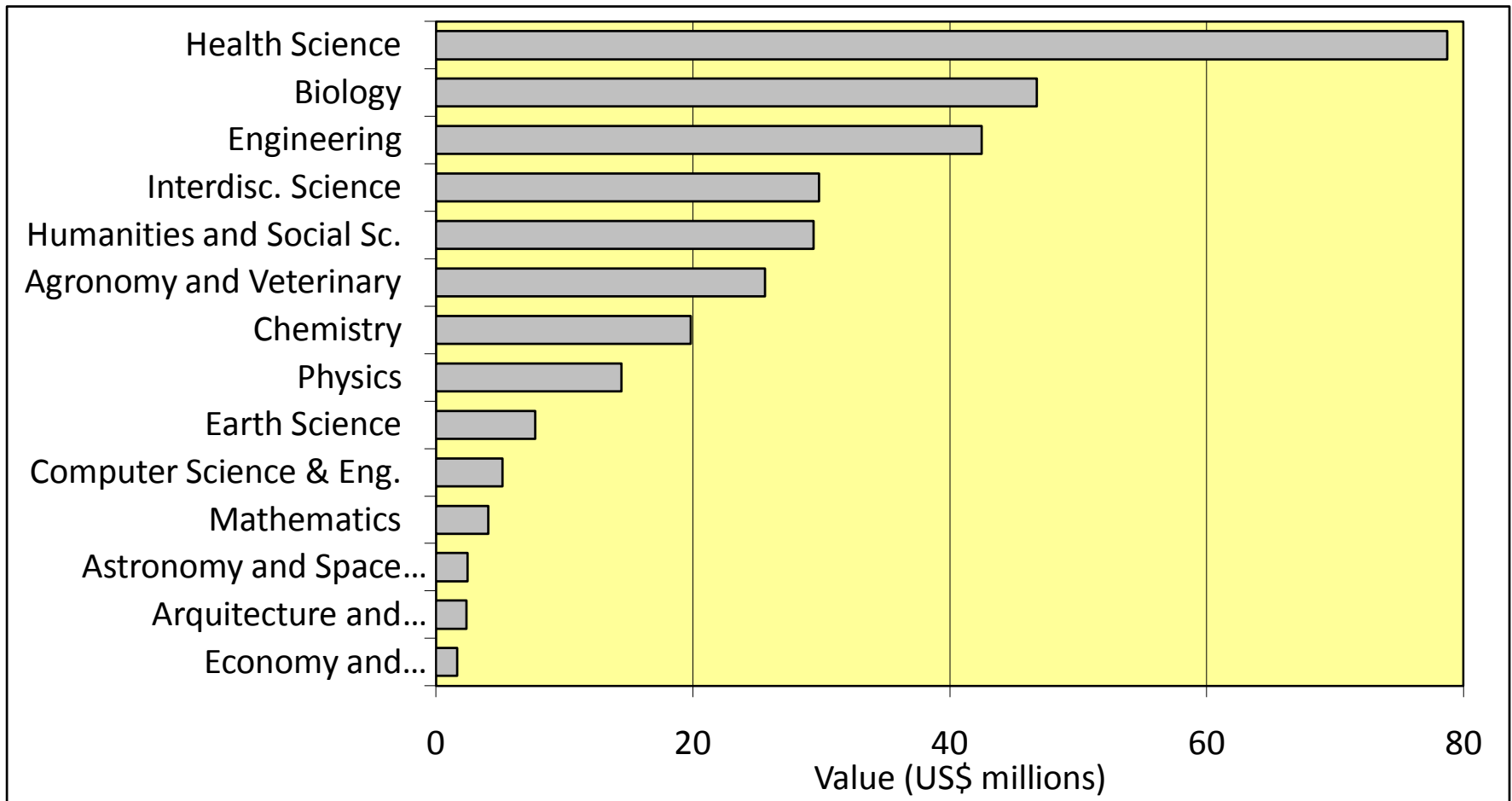
- Mission: support research in all fields
- Receives 18,000 proposals per year, all peer reviewed
- Funded by the State of São Paulo with 1% of all state tax revenues
- Started operations in 1962
- Annual budget: US\$ 408 M in 2009
 - Fellowships (3,000 SI, 3,000 MS, 3,000 DR, 1,300 PD)
 - Academic R&D
 - Young Investigators
 - University-Industry Joint R&D
 - Small business R&D
 - 1,200 SBE's (three awards per week in 2007)

FAPESP, 2009

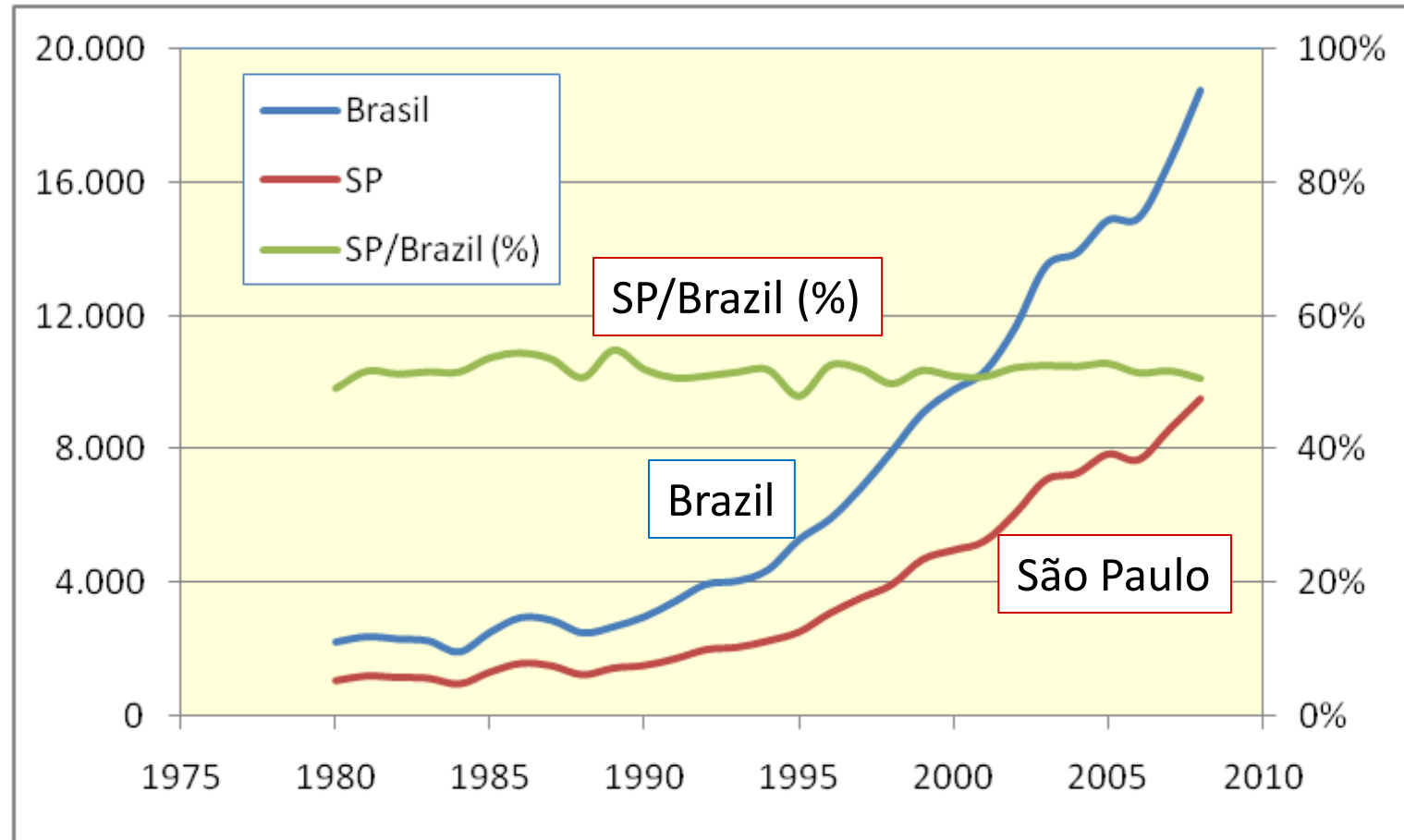
Revenues	Value (US\$)
State appropriations (1%)	357.002.158
Other	51.080.617
Total	408.082.775

Expenditures	Value (US\$)
Fellowships	134.782.815
Grants	157.952.788
Grants - Special Programs	42.166.258
Grants - Innovation	42.612.480
Operations	20.392.902
Capex	5.791.051
Total	403.698.294

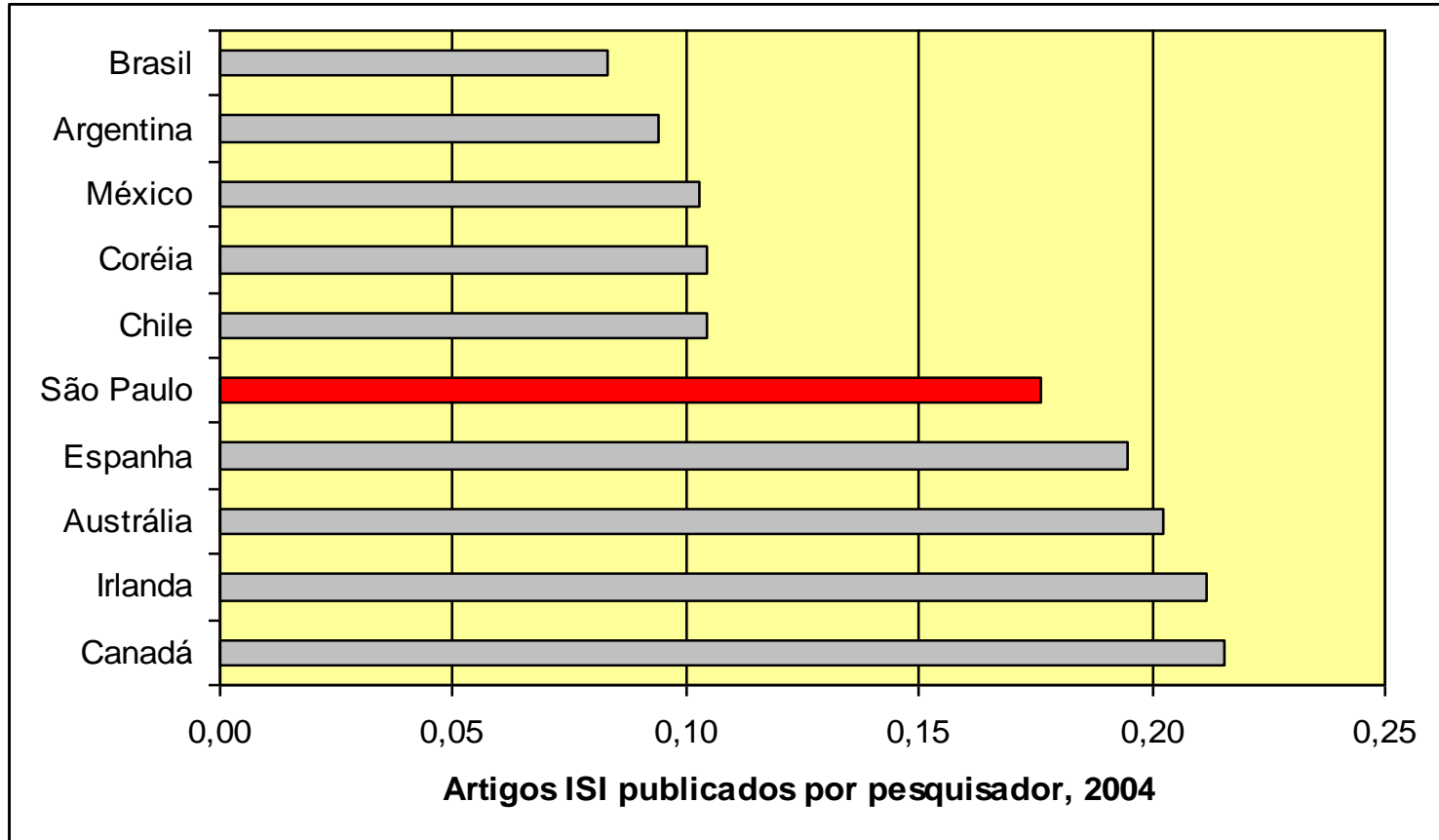
Expenditures, 2008 By Field of Knowledge



Brazil: growing scientific production



Articles ISI per scientist, 2004



Some of the main programs

- 11 Research, Innovation and Diffusion Centers (CEPID)
 - 11 years funding
- Biota: Virtual Institute for Biodiversity
 - Started 1997; BIOTA 2.0 started 2008
- BIOEN: Bioenergy Research
- PFGCC: Global Climate Change Research
- Neurosciences: Epilepsy (using imaging)
- IT and Advanced Internet

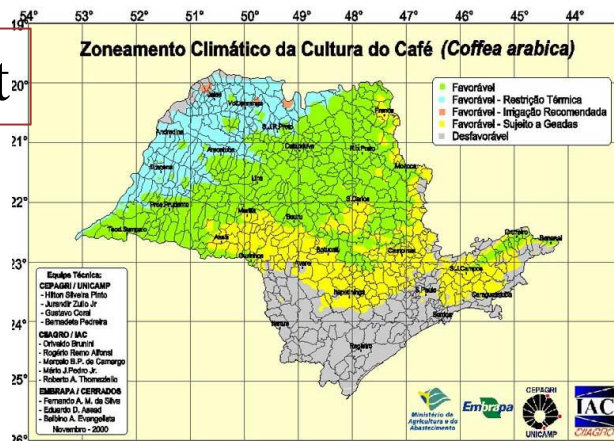
FAPESP Research Program on Global Climate Change

- Global Climate Modelling
 - Supercomputer – 15 Tflops sustainable
 - FINEP + FAPESP
- Calls for Proposals
- Water, Carbon and Nitrogen cycles, Ecosystems, Aerosols, Land use change, Agriculture and husbandry, Human health, Human dimensions

GCC effects on Coffee plantations in SP

SP

Present

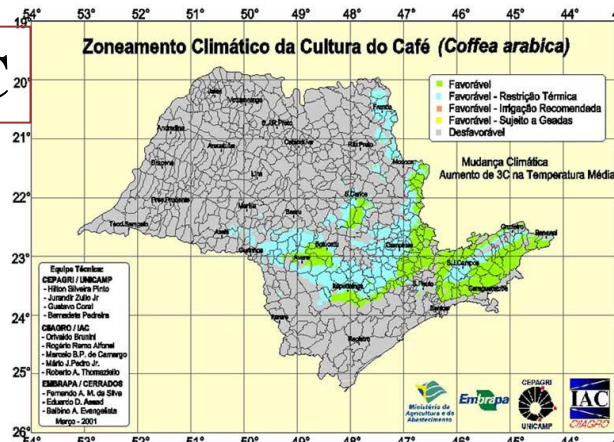


Zoneamento Climático da Cultura do Café (*Coffea arabica*)

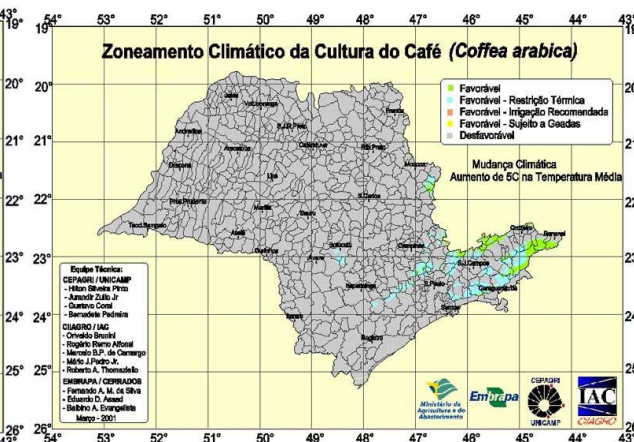


+1°C

+3°C



Zoneamento Climático da Cultura do Café (*Coffea arabica*)



+5°C

Biodiversity Virtual Institute

BIOTA

- A network of 200+ scientists
- Characterize the biodiversity of the State of São Paulo, and define mechanisms for its conservation and sustainable use
 - Study and disseminate data, information, and knowledge about São Paulo's biodiversity and its importance.
 - Increase public and private organizations' capacity in managing, monitoring and using biodiversity.
 - Promoting informed decisions
- <http://www.biota.org.br/>

BIOTA: Science – Perspectives, April 6, 2009



PERSPECTIVES

ECOLOGY

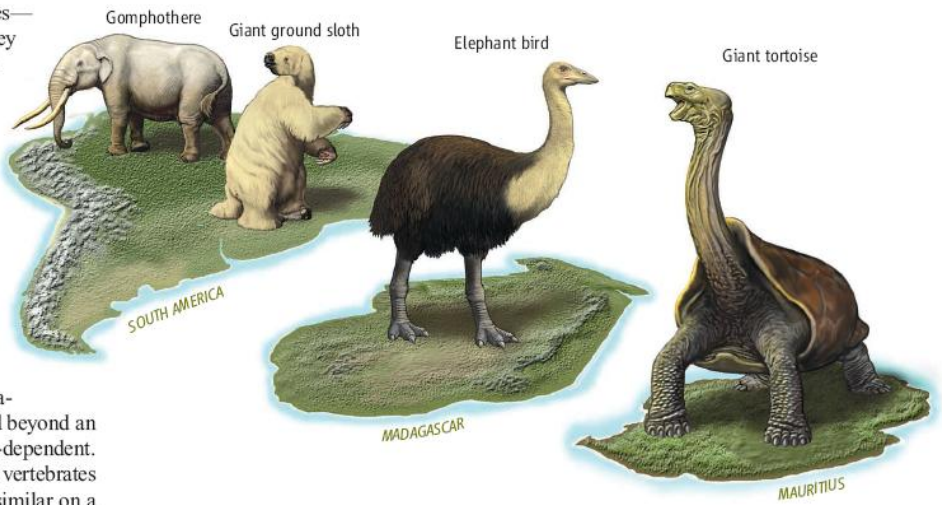
The Forgotten Megafauna

An expanded megafauna concept elucidates how extinctions of the largest vertebrates in any ecosystem have similar effects.

Dennis M. Hansen¹ and Mauro Galetti^{1,2}

Large terrestrial vertebrates—called megafauna—play key roles in ecosystem dynamics by feeding on plants and by maintaining habitat heterogeneity (1). A global wave of megafauna extinctions occurred 50,000 to 10,000 years ago, when many large continental mammals were lost (2–5). Classical definitions of megafauna are based on such continental mammals and are variously given as animals larger than 44 kg (6) or above 1000 kg (7). Here, we argue that the megafauna concept should be extended beyond an absolute animal size to be context-dependent. In any given ecosystem, the largest vertebrates have ecosystem impacts that are similar on a relative scale to those of the largest vertebrates in another ecosystem: One ecosystem's mesofauna is another ecosystem's megafauna.

An ecosystem function that clearly illustrates this argument is animal-mediated seed dispersal. Here, the link between animal body

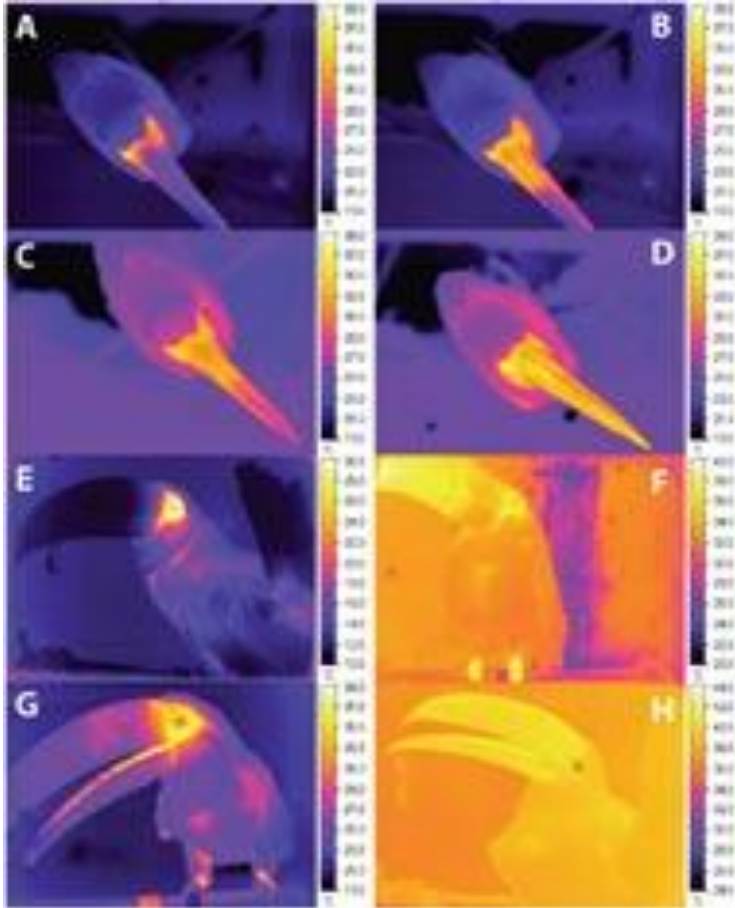


Scaling the megafauna. The magnitude of loss of frugivorous megafauna is currently most dramatic on islands, as illustrated by the smaller drawn sizes of the giant ground sloth and the gomphothere from South America, compared with the elephant bird in Madagascar and the giant tortoise of Mauritius. However, many continental regions are poised to catch up.

To illustrate our point, we have examined in relative terms, led to a greater megafaunal

www.sciencemag.org on April 6, 2009

BIOTA: Science, July 2009



Heat Exchange from the Toucan Bill Reveals a Controllable Vascular Thermal Radiator
Glenn J. Tattersall, *et al.*
Science 325, 468 (2009);
DOI: 10.1126/science.1175553

REPORTS

Heat Exchange from the Toucan Bill Reveals a Controllable Vascular Thermal Radiator

Glenn J. Tattersall,^{1,3} Denis V. Andrade,^{2,3} Augusto S. Abe^{2,3}

The toco toucan (*Ramphastos toco*), the largest member of the toucan family, possesses the largest beak relative to body size of all birds. This exaggerated feature has received various interpretations, from serving as a sexual ornament to being a refined adaptation for feeding. However, it is also a significant surface area for heat exchange. Here we show the remarkable capacity of the toco toucan to regulate heat distribution by modifying blood flow, using the bill as a transient thermal radiator. Our results indicate that the toucan's bill is, relative to its size, one of the largest thermal windows in the animal kingdom, rivaling elephants' ears in its ability to radiate body heat.

SP Environment Secretary bases Resolution on BIOTA research



SECRETARIA DE ESTADO DO MEIO AMBIENTE

GABINETE DO SECRETÁRIO

PUBLICADA EM 14/03/88 – SEÇÃO I – PÁG.36

RESOLUÇÃO SMA-15 DE 13 DE MARÇO DE 2008.

Dispõe sobre os critérios e parâmetros para concessão de autorização para supressão de vegetação nativa considerando as áreas prioritárias para incremento da conectividade.

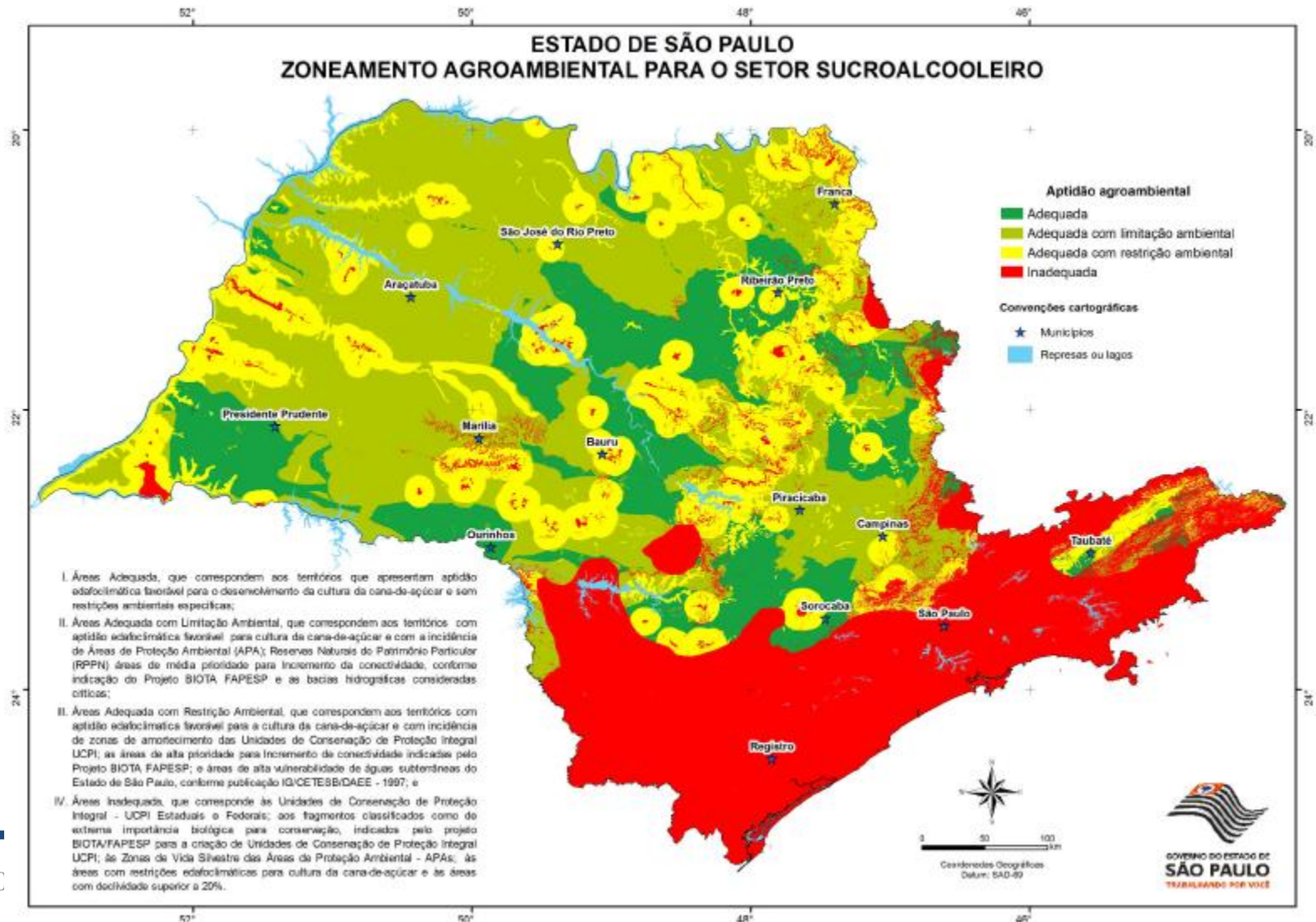
O **SECRETÁRIO DE ESTADO DO MEIO AMBIENTE**, em cumprimento ao disposto nos artigos 23, VII, e 225, § 1º, I, da Constituição Federal, nos artigos 191 e 193 da Constituição do Estado, nos artigos 2º e 4º da Lei federal nº 6.938, de 31 de agosto de 1981, e nos artigos 2º, 4º e 7º da Lei estadual nº 9.509, de 20 de março de 1997, e

Considerando os resultados obtidos pela equipe de pesquisadores do Projeto Biota FAPESP e as informações presentes no mapa de "Áreas prioritárias para incremento da conectividade" e "Áreas prioritárias para criação de Unidades de Conservação" resultantes do Projeto Biota FAPESP;

- Plus two Governor's Edits

- Decree 53.939, 06Jan09
- Legal Reserves
- Decree 54.746, 04Sep09
- Conservation Units Cantareira

BIOTA's Map for Sugarcane Agroecological Zoning



SMALL BUSINESS RESEARCH AND INNOVATION

Small Business Innovative Research (PIPE)

- SBIR
 - Innovative content
 - Commercial potential of associated R&D
 - Increase company competitiveness
 - Foster an “innovation culture” in small businesses in SP
- Conditions
 - Non refundable funding
 - Up to US\$ 350.000 per project
 - Principal Investigator must be an employee of SB

PIPE: 1,281 awards since 1997

Location	Quantity
São Paulo	347
Campinas	220
São Carlos	201
S.J. dos Campos	83
Ribeirão Preto	42
Outros	388
Total	1281

Fonte: Crab e Sage

(*) Foram incluídos projetos aprovados p/ a Fase I e diretamente p/ a Fase II

**More than 2 per week
since 1998**

Fapesp –Industry: joint calls for proposals

- Fapesp and a company issue a joint call for proposals
 - Themes proposed by industry
 - Exploratory R&D
 - Joint Steering Committee
 - Merit review by Fapesp
- Microsoft Research, Embraer, Natura, Ouro Fino, Oxiteno, Telefónica, Dedini, Braskem, PadTec.....

The challenge of collaboration in S&T in Latin America

- International collaboration
 - LA countries tend to collaborate more with US and Europe than among them
 - Good exception: RICyT, CABBIO
 - FAPESP, 2008
 - Out of 188 foreign visitors supporters only 17 from LAC (Am. Latina e Caribe)
 - Out of 161 Research Fellowships Abroad only 5 to LAC
 - FAPESP is actively looking for outstanding LAC students who want to do a PhD in São Paulo
 - Any field; fellowships include travel money for family and allowance for research expenditures

Agreements for joint research funding

- FAPESP has agreements with several foreign funding agencies
 - DFG (Ge), RCUK (UK), NSF (US), FCT (Portugal), CNRS (Fr), INSERM, INRIA, INRA (Fr)
 - CONICET (Ar) – in process

Post-doctoral fellowships

- Three year duration (5 years in some cases)
 - Stipend
 - Travel for awardee and family
 - Support for moving and installation
 - Plus 15% fo research incidentals (travel, small equip.)
- 1,213 proposals, 683 concessions in 2009
 - 56% success rate
 - 1,257 fellowships paid last month

Young Investigator Awards

- 4 years grant
 - Fellowship for PI
 - Equipments
 - Consummables
 - Travel
 - Fellowships for students
- 2,100 proposals, 753 concessions since 1996
 - 242p/81c in 2009

Brazil: a Natural Knowledge Economy

(K. Bound, Demos, 2008)

- http://www.demos.co.uk/files/Brazil_NKE_web.pdf

brazil
the natural
knowledge
economy

Kirsten Bound

THE ATLAS OF IDEAS

DEMOS

‘São Paulo is another country’⁹³

The state of São Paulo in South Eastern Brazil is home to over 20 per cent of the country’s population. Almost 11 million of these people live in metropolitan Sao Pãulo, one of the world’s five largest cities.⁹⁴ The state contributes over a third of Brazil’s GDP. As a result of its demographic and economic power, São Paulo dominates Brazilian science and innovation. The state spends more on research and development than any Latin American country apart from Brazil. Of the eight best Brazilian universities, five are in São Paulo. One university, USP, accounts for more than a quarter of the scientific publications produced by the country, and the state has the highest number of innovative companies.

