Challenges and Opportunities for Public Research Universities in Brazil

Carlos Henrique de Brito Cruz
Scientific Director
São Paulo Research Foundation
Outline

- Universities and development in Brazil
- Size challenges: enrollment in higher education
- Research universities: graduate system and science
- Challenges for the national higher education system: concentration, quality, completion
- Higher education and research in the state of São Paulo
  - The São Paulo Research Foundation, FAPESP
  - Fundamental and applied research
  - International collaboration opportunities
Brazil: Universities and Development

• Universities are determinant for Brazilian development
  – Not “will be”, they are relevant now and have been for many years
  – Education
    • Operating industry, services and government
    • Accelerated development led to a scarcity of qualified personnel
  – Other ways in which universities can impact regional/national development
    • Business (large and small) development, help attract FDI, public policies, regional opportunities, quality of government,..

• Regional initiatives are also determinant
  – Economic growth brought a rebirth of regional initiatives country-wide
Three missions

• Education
• Knowledge creation through research
• Research/education based community engagement
  – Knowledge transfer, licensing, joint research with industry/government/NGOs, consulting, policy making/evaluation, social and cultural life, public understanding of science
## Brazil: Undergraduate Enrollment, Higher Ed. Institutions and Universities

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2011</th>
<th>Var %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HEI</td>
<td>Univ.</td>
<td>HEI</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3,030,754</td>
<td>1,956,542</td>
<td>5,746,762</td>
</tr>
<tr>
<td><strong>Public</strong></td>
<td>939,225</td>
<td>816,913</td>
<td>1,595,391</td>
</tr>
<tr>
<td><strong>Private</strong></td>
<td>2,091,529</td>
<td>1,139,629</td>
<td>4,151,371</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Public</strong></td>
<td>31%</td>
<td>42%</td>
<td>28%</td>
</tr>
<tr>
<td><strong>Private</strong></td>
<td>69%</td>
<td>58%</td>
<td>72%</td>
</tr>
<tr>
<td><strong>Pop. age 18-24</strong></td>
<td>23,158,000</td>
<td></td>
<td>23,873,680</td>
</tr>
<tr>
<td><strong>Gross Enr. Rate</strong></td>
<td>13%</td>
<td></td>
<td>24%</td>
</tr>
</tbody>
</table>

Research Universities in Brazil

• Mostly public universities, with few exceptions among private universities
  – The percentage of faculty with a doctoral degree:
    • 54% - public universities
      – 91% in the State of São Paulo public universities
    • 24% - in private universities
Doctorates approved
Brazil, 1980-2011
Growing number of international scientific articles
Scientific articles by authors in Brazil as a % of world total

Articles by authors in Brazil as a % of the world total

Brazil: growth in international scientific articles, 1995-2010
Challenges for the national higher education system

• Quality
  – Quantity and quality of high school education
  – Qualification of faculty
    • Federal universities: 60% of faculty with a PhD degree

• Lack of autonomy
  – Restriction to the use of funds, hiring, career,...

• Heterogeneity/Concentration
Stagnated quantity of high school graduates
Concentration: 11 universities respond for 74% of the articles

<table>
<thead>
<tr>
<th>University</th>
<th>State</th>
<th>1990</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>USP</td>
<td>SP</td>
<td>29%</td>
<td>26%</td>
</tr>
<tr>
<td>UNICAMP</td>
<td>SP</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>UFRJ</td>
<td>RJ</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>UNESP</td>
<td>SP</td>
<td>3%</td>
<td>7%</td>
</tr>
<tr>
<td>UFRGS</td>
<td>RS</td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td>UNIFESP</td>
<td>SP</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>UFMG</td>
<td>MG</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>UFSC</td>
<td>SC</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>UFSCAR</td>
<td>SP</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>UFF</td>
<td>RJ</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>UFPE</td>
<td>PE</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>70%</strong></td>
<td><strong>74%</strong></td>
</tr>
<tr>
<td><strong>Brasil</strong></td>
<td></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
One state (SP) responds for 50% of the articles published by authors from Brazil.
State of São Paulo, Brasil

- 41 Million people
- 34% of Brazil’s GDP
- 50% of Brazilian science
- 13% of State budget to HE and R&D
- 1.64% GDP for R&D

- 3 State Universities
- 3 Federal Universities
- 52 State Tech Faculties
- 45% of the PhDs graduated in Brazil (4,937 in 2010)
- 22 Research Institutes (19 state/3 federal)
- 1 Research Foundation
- 62% of R&D public support comes from State sources

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State level support for R&D in Brazil, 2010

Source: Indicadores C&T, MCTI

R&D expenditures (MR$, 2010)

- São Paulo: 5.012.2; 71%
- SP: 5.012.2; 71%
- RJ: 488.9; 7%
- PR; 413.5; 6%
- MG: 213.9; 3%
- SC: 209.9; 3%
- BA: 120.4; 2%
- Outros: 540.9; 8%

- Rio de Janeiro: 10 x
- Paraná: 23 x
- Amazonas, Pernambuco, Ceará, Distrito Federal, Rio Grande do Sul, Bahia
- Santa Catarina, Minas Gerais, Paraná, Rio de Janeiro, São Paulo
- Mato Grosso do Sul, Sergipe, Espírito Santo, Maranhão, Pará, Goiás, Paraíba, Mato Grosso, Acre, Alagoas, Amapá, Roraima, Rondônia

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State R&D Expenditures and State GDP in relation to those of São Paulo

<table>
<thead>
<tr>
<th>State</th>
<th>PIB 2008</th>
<th>DTPD 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Catarina</td>
<td>3,3%</td>
<td>12,3%</td>
</tr>
<tr>
<td>Rio Grande do Sul</td>
<td>1,4%</td>
<td>19,9%</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>10,9%</td>
<td>34,2%</td>
</tr>
<tr>
<td>Pernambuco</td>
<td>7,0%</td>
<td>17,9%</td>
</tr>
<tr>
<td>Paraná</td>
<td>10,4%</td>
<td></td>
</tr>
<tr>
<td>Minas Gerais</td>
<td>4,8%</td>
<td>28,2%</td>
</tr>
</tbody>
</table>
Higher Education in the State of São Paulo, Brazil

- 59 higher education technical faculties (FATECs)
  - 3 year courses
- 3 state funded universities: USP, Unicamp, Unesp
  - Funded with 9.57% of the state VAT (since 1989)
  - Autonomy to hire, fire, define pay level, career, ..
Doctoral degrees
USP, Unicamp and UNESP, 2009

<table>
<thead>
<tr>
<th></th>
<th>EUA</th>
<th>Doctorates</th>
<th>Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brasil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USP</td>
<td>2,244</td>
<td>5,434</td>
<td></td>
</tr>
<tr>
<td>Unicamp</td>
<td>871</td>
<td>1,743</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EUA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>856</td>
<td>2,028</td>
<td></td>
</tr>
<tr>
<td></td>
<td>821</td>
<td>2,500</td>
<td></td>
</tr>
<tr>
<td><strong>Unesp</strong></td>
<td>805</td>
<td>3,554</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>740</td>
<td>2,033</td>
<td></td>
</tr>
<tr>
<td></td>
<td>735</td>
<td>3,081</td>
<td></td>
</tr>
<tr>
<td></td>
<td>724</td>
<td>4,016</td>
<td></td>
</tr>
<tr>
<td></td>
<td>719</td>
<td>5,272</td>
<td></td>
</tr>
<tr>
<td></td>
<td>716</td>
<td>n.d.</td>
<td></td>
</tr>
</tbody>
</table>

EUA 2008: S&E Doctorate Awards, 2008, Table 3.
USP, Unesp e Unicamp: 2009
Spin-off start-ups: 206
R&D Expenditures in SP:
1.62% (est.) of State GDP in 2012

(Fonte: Indicadores FAPESP CT&I)
São Paulo R&D Expenditures

International standing

- R&D expenditures total 1.64% of state GDP
  - Grew from 1.52% in 2008
- Public expenditures
  - State 62%
  - Federal 38%
Fapesp: São Paulo Research Foundation

- Started 1962. Mission: support research in all fields
- Funded by the State of São Paulo with 1% of all state revenues
- All proposals are peer reviewed (21,600 proposals in 2012)
  - 65 days average turnaround time
- Annual budget: $PPP 600 M in 2011
  - Fellowships (3,000 SI, 2,600 MSc, 4,000 DrSc, 1,800 Post-docs, 800 other)
  - Academic R&D (Thematic, Regular, Young Investigators)
  - University-Industry Joint R&D: Microsoft, Agilent, Braskem, Oxiteno, SABESP, VALE, Natura, Petrobrás, Embraer, Padtec, Biolab, Cristalia, Whirlpool, Boeing, GSK, BP, BG, PSA-Peugeot-Citroën...
  - Small business R&D: 1,200 SBE’s (two PIPE+PAPPE awards per week in 2011)
FAPESP expenditures, 2011
Total: R$ 938 million
FAPESP: Basic Science Focus

• The “utilitarian” view about Science
  – Science that makes business more competitive
  – Science that heals the sick
  – Science that makes the poor rich

• In addition, FAPESP also values a not so “utilitarian” item
  – Science that makes mankind wiser
    • In all fields there are fundamental questions
    • Philosophy, Archeology, Literature, High Energy Physics, Cosmic Rays, Astronomy, Evolution,..
Embraer-FAPESP: R&D to build an innovative jet

CFD simulation and tests
Research co-funded by FAPESP, using several universities
Infrared afterglow observation after a GRB - unveils the explosion which happened 13 billion years ago. These results demonstrated that GRBs can be used to trace the star formation, metallicity, and reionization histories of the early Universe.

J.B. Haislip et al., “A photometric redshift of $z = 6.39 \pm 0.12$ for GRB 050904”, Nature 440, 181-183 (9 March 2006).
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

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

- Several Governor Decrees and Resolutions
  - Decree 53.939, 06Jan09 – Legal Reserves
  - Decree 54.746, 04Sep09 – Conservation Units Cantareira

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

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;

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
Presidential regimes are considered to be prone to produce institutional deadlocks. In the generally shared view, influenced by the work of Juan Linz, presidentialism lacks a built-in mechanism to induce cooperation between the executive and legislative branches of the government. Representatives and the president have different constituencies, and their mandates are independent and fixed. Hence the chances that the legislative and the executive powers will have the same agenda are small.
Sugarcane for bioenergy production: an assessment of yield and regulation of sucrose content

Alessandro J. Waclawovsky¹, †, ‡, Paloma M. Sato¹, ‡, Carolina G. Lembke¹, Paul H. Moore² and Glaucia M. Souza¹,*

¹Departamento de Bioquímica, Instituto de Química, Av. Prof. Lineu Prestes, São Paulo, Brazil
²Hawaii Agriculture Research Center, Kula, HI, USA

Table 1 Average, maximum and theoretical sugarcane yields (Australia, Colombia, and South Africa) and total dry matter production

<table>
<thead>
<tr>
<th>Type of yield</th>
<th>Cane yield (t/(ha yr))</th>
<th>Biomass* (g/(m² d))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Average</td>
<td>84</td>
<td>39</td>
</tr>
<tr>
<td>Commercial maximum</td>
<td>148</td>
<td>69</td>
</tr>
<tr>
<td>Experimental maximum</td>
<td>212</td>
<td>98</td>
</tr>
<tr>
<td>Theoretical maximum</td>
<td>381</td>
<td>177</td>
</tr>
</tbody>
</table>
Brazil: 47% of energy from renewable sources (2009); 18% from sugarcane

Renewables in Brazil: 47%; World: 13%; OECD: 7,2%
The impacts of research

• Three impacts:
  – Intellectual
  – Social
  – Economic
**FAPESP: international agreements for joint research funding**

- Agreements with foreign funding agencies, universities and companies

<table>
<thead>
<tr>
<th>RCUK (UK)</th>
<th>UE-CNPq (Bioenergy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCL; Surrey; Southampton; Nottingham (UK)</td>
<td>CONICET (Ar); CONICYT (Ch)</td>
</tr>
<tr>
<td>DFG (Ge)</td>
<td>ISTP (Ca)</td>
</tr>
<tr>
<td>CNRS; ANR (Fr)</td>
<td>NSF (U.S.) – CNIC and ICC</td>
</tr>
<tr>
<td>INSERM; INRIA; INRA (Fr)</td>
<td>Microsoft Research</td>
</tr>
<tr>
<td>U. Toronto (Ca)</td>
<td>MIT, USC, Davis, Florida,</td>
</tr>
<tr>
<td>U. W. Ontario (Ca)</td>
<td>Ohio State U. (U.S.)</td>
</tr>
<tr>
<td>Hebrew Univ. Jerusalem (Israel)</td>
<td>FCT (Portugal)</td>
</tr>
<tr>
<td></td>
<td>Belmont Forum – Future Earth</td>
</tr>
</tbody>
</table>

- 303 joint proposals supported, 2005-2010
  - U.S 115; France 87; Germany 41; U.K. 27; Argentina 11; Canada 8; Portugal 8
Joint research agreements
Universities, U.S.

- Estados Unidos
  - Massachusetts Institute of Technology (MIT)
  - North Carolina State University
  - Ohio State U.
  - University of California Davis
    - Call for Proposals Open to May 15th
  - University of Florida
  - University of Michigan
  - University of Southern California
FAPESP international collaboration: sending scientists from SP abroad

• Research fellowships (2-12 mo; 158 in 2010)
• Special grants for participation in international conferences (903 awarded in 2010)
• Fellowship for short stays
  – 4 mo – 12 mo doing research work abroad
  – Eligible: all 11,000 FAPESP fellowship holders
FAPESP international collaboration: bringing foreign scientists to SP

• Post doctoral fellowships
  – Stipend, travel, some research money
• Young Investigator Awards (1.5 awards per week)
  – Stipend, travel, research money
• Visiting scientists
  – 205 in 2010 (travel, stipend; 2 weeks to 12 months)
• São Paulo Schools of Advanced Science (SPSAS)
  – Each one with 50-100 young Dr students from abroad
• São Paulo Excellence Chairs (SPEC)
  – For top notch scientists from abroad: full research grant for staying 3 mo. per year in SP for 3-5 years
FAPESP Newsletter – in English

• http://agencia.fapesp.br/en/
Challenges for higher education in Brazil

• Completion
• Quality
• Specific to Research universities
  – Research impact
    • Three impacts: social, economic, intellectual
  – Internationalization
  – Autonomy and stability
  – Academic values x politics, cronyism and unionism
• The “always forgotten challenge”: quality and access and completion in high school education
  – Visible effects in higher education