

# ***BIOEN FAPESP: new knowledge for the future of bioenergy in Brazil***

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<http://www.fapesp.br>

<http://bioenfapesp.org>



# *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 bussiness R&D
    - 1,200 SBE's (three awards per week in 2007)

# *New challenges for Brazil's strategy in Bioenergy*

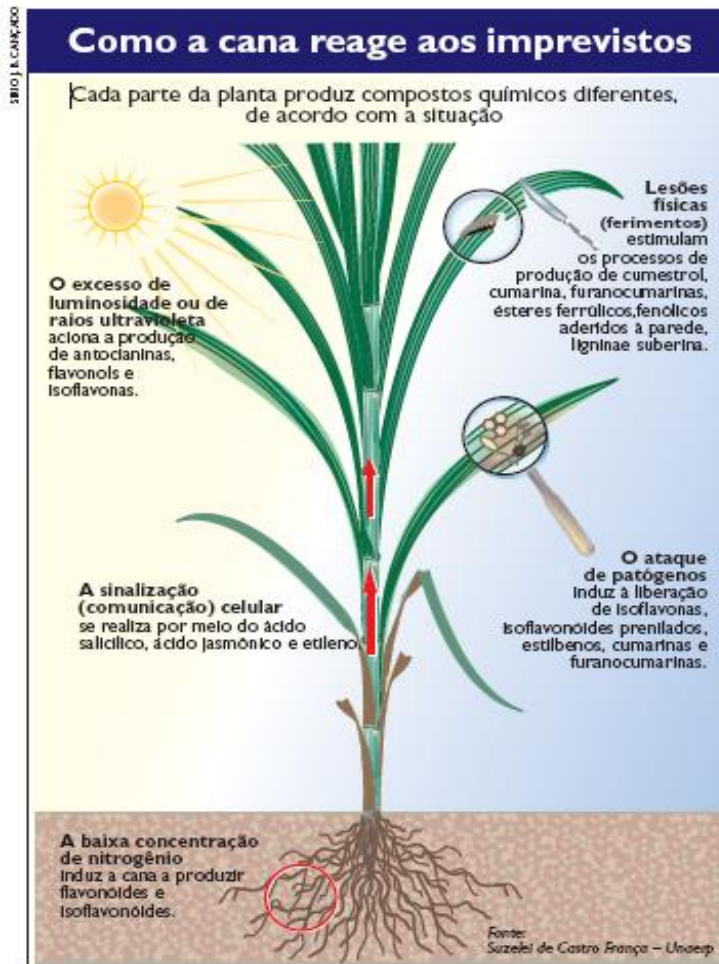
- International competition
- Stronger scientific base – radical innovation
  - Genomics
  - Bioprocesses
  - Chemistry, biochemistry
- Science based decision and planning
  - Sustainability
    - Water, fertilizer, energy balance, GHG
  - LUC; iLUC
- International presence
  - High impact scientific publications

# *FAPESP and Bioenergy*

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- First initiative in 1999
  - SucEST Project for sugarcane genomics
- Then, three initiatives starting 2007-2008
  - Roadmap
  - BIOEN
  - SP Bioenergy Research Center

# FAPESP: Sugarcane genomics, 1999



- Started 1999
- Molecular Biology tools for improving sugarcane
- Science and Technology of sugarcane
  - Articles, thesis and patents
  - Human resources
- Partners:
  - CTC and Ridesa



# FAPESP: three articulated initiatives

- Science and Technology bottlenecks
  - A road map that oriented steps 2 and 3 below
    - Research Project; R\$ 0,3 million; 14 workshops, >100 researchers; a book published internationally
- BIOEN
  - Research Program; 5-10 years
    - Has a core of fundamental research
    - Connections to applications through industry partnerships
  - 52 projects/100 fellowships (so far, only one CFP – more will follow)
    - FAPESP: R\$ 57 million
    - Industry: R\$ 3,7 million
- São Paulo Bioenergy Research Center
  - Based in the three State universities: USP, Unicamp, Unesp
  - Estimated investment: R\$ 162 million in 10 years
    - GESP: R\$ 54 million (already disbursed)
    - Universities: R\$ 54 millions in contracts for new professors in 10 years
    - FAPESP: R\$ 54 million to be disbursed in research grants and fellowships in 10 years

# *FAPESP's Research Program on Bioenergy (BIOEN): 5 divisions*

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1. Improvements in the feedstock: building a better cane plant for energy – EnergyCane; sugarcane agriculture; other feedstocks

Partner: ETH

2. Production of Ethanol and other products: hydrolysis, pyrolysis, gasification, fermentation, distillation

Partners: Oxiteno, Dedini

3. New processes in alcohol-chemistry

Partners: Braskem

4. Ethanol based engine and fuel cell developments

5. The Economics of Ethanol, Ethanol production and the environment, Social impacts, the new agriculture of food and energy

# ***BIOEN: FAPESP-Industry agreements for joint funding***

- Joint industry-university research (next 5 years)

<b>Company</b>	<b>Subject</b>	<b>Val. (Indus.+FAPESP)</b>
Oxiteno	Lignocellulosic materials	R\$ 6,000,000
Braskem	Alcohol-chemistry	R\$ 50,000,000
Dedini	Processes	R\$ 100,000,000
ETH	Sugarcane	R\$ 20,000,000

- Agreement with ETH, Braskem and Dedini will have yearly calls for proposals



# BIOEN: 314 scientists

- 55 research projects
  - R\$ 55 61 million
- 314 scientists
  - 229 from São Paulo
  - 33 from other Brazilian states
    - MG 12; RJ 8; Pr 3; RS 3
  - 52 from other countries
    - U.S. 26; Fr 7; Ge 4; Ne 4; De 3; Sp 3

# Transgenic cane: 9x increased conversion of glucose/fructose into sucrose

**BMC Genomics**

BioMed Central

BMC Genomics 2009, 10:120 doi:10.1186/1471-2164-10-120

Research article

Open Access

## Sugarcane genes associated with sucrose content

Flávia S Papini-Terzi<sup>1</sup>, Flávia R Rocha<sup>1</sup>, Ricardo ZN Vêncio<sup>2</sup>,  
Juliana M Felix<sup>3,5</sup>, Diana S Branco<sup>3</sup>, Alessandro J Waclawovsky<sup>1</sup>, Luiz EV Del  
Bem<sup>3</sup>, Carolina G Lembke<sup>1</sup>, Maximiller DL Costa<sup>1</sup>, Milton Y Nishiyama Jr<sup>1</sup>,  
Renato Vicentini<sup>4,5</sup>, Michel GA Vincentz<sup>3,4</sup>, Eugênio C Ulian<sup>5,6</sup>,  
Marcelo Menossi<sup>4</sup> and Glaucia M Souza\*<sup>1</sup>

(12) **United States Patent**  
Souza et al.

(10) Patent No.: **US 7,732,664 B2**  
(45) Date of Patent: **Jun. 8, 2010**

(54) GENES ASSOCIATED TO SUCROSE  
CONTENT

(52) U.S. Cl. .... 800/285; 800/278; 800/295;  
800/298; 435/320.1; 536/23.1

(75) Inventors: **Glaucia Mendes Souza**, Sao Paulo

(58) Field of Classification Search ..... None  
See application file for complete search history.

**USP, Unicamp, CTC, Monsanto, Central de Alcool Lucélia**

# Higher productivity sugarcane: 84 → 148 → 212 → 381 ton/Ha??

## Review article

# Sugarcane for bioenergy production: an assessment of yield and regulation of sucrose content

Alessandro J. Waclawovsky<sup>1,†,‡</sup>, Paloma M. Sato<sup>1,‡</sup>, Carolina G. Lembke<sup>1</sup>, Paul H. Moore<sup>2</sup> and Glaucia M. Souza<sup>1,\*</sup>

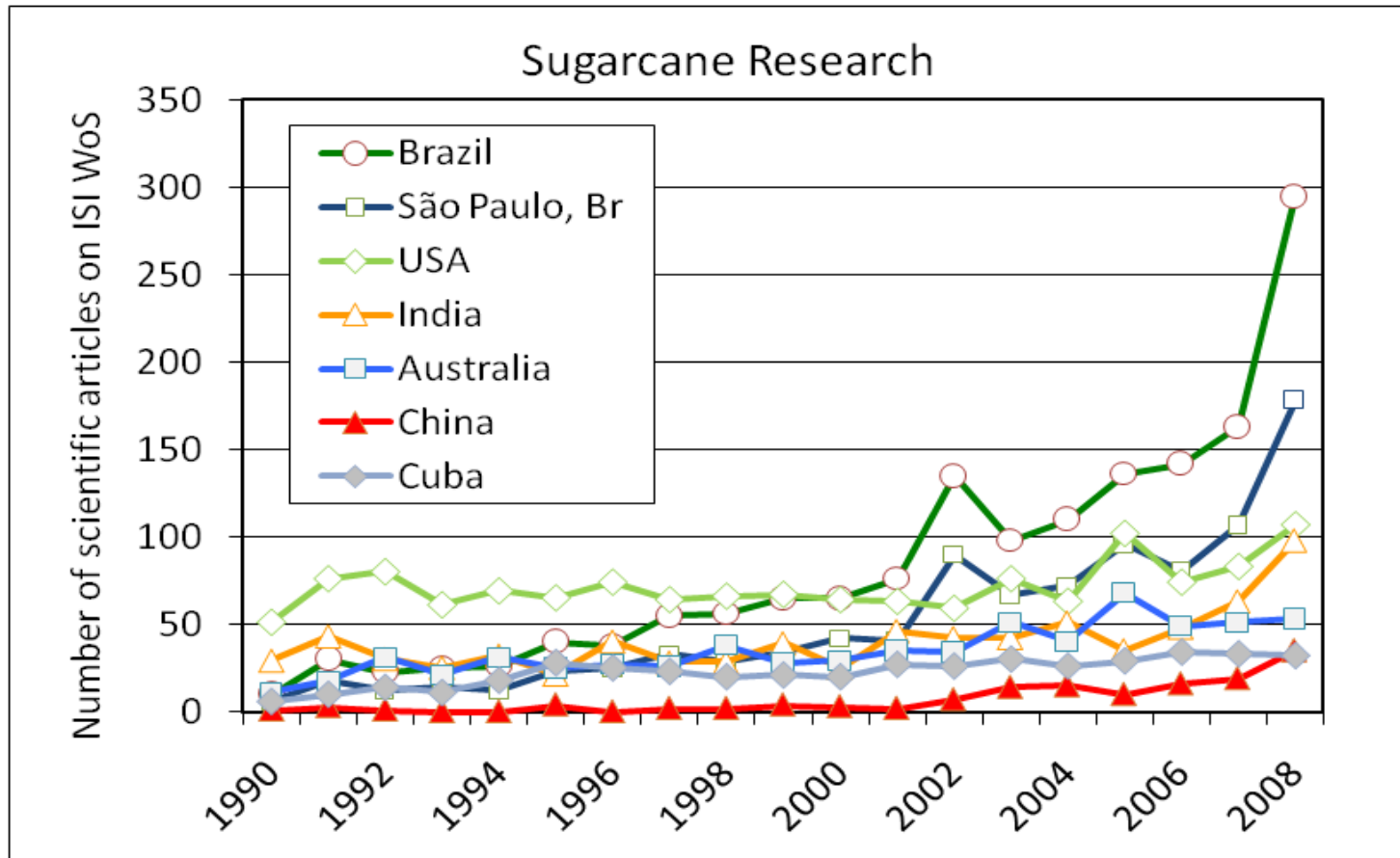
<sup>1</sup>Departamento de Bioquímica, Instituto de Química, Av. Prof. Lineu Prestes, São Paulo, Brazil

<sup>2</sup>Hawaii Agriculture Research Center, Kunia, HI, USA

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

Type of yield	Cane yield	Biomass*	
	t/(ha yr)	t/(ha yr)	g/(m <sup>2</sup> d)
Commercial Average	84	39	10.7
Commercial maximum	148	69	18.8
Experimental maximum	212	98	27.0
Theoretical maximum	381	177	48.5

# Sugarcane research



# *Biofuel research challenges*

- Productivity
  - Biomass production
    - 90 ton/Ha → 200+ ton/Ha
  - Processes → 2nd generation; other fuels; chemicals
  - Cellulose use (electricity x liquid fuel)
- Sustainability
  - Emissions(LUC, ILUC, N)
  - Water use
  - Agriculture for Food and for Energy
  - Environmental impacts
  - Social impacts



# *Some results*

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- BIOTA Programa oriented State Legislation for Sugarcane Zoning
- Sugarcane in high CO<sub>2</sub> environment
- Sugarcane genomics
- Increase in the number of papers about sugarcane

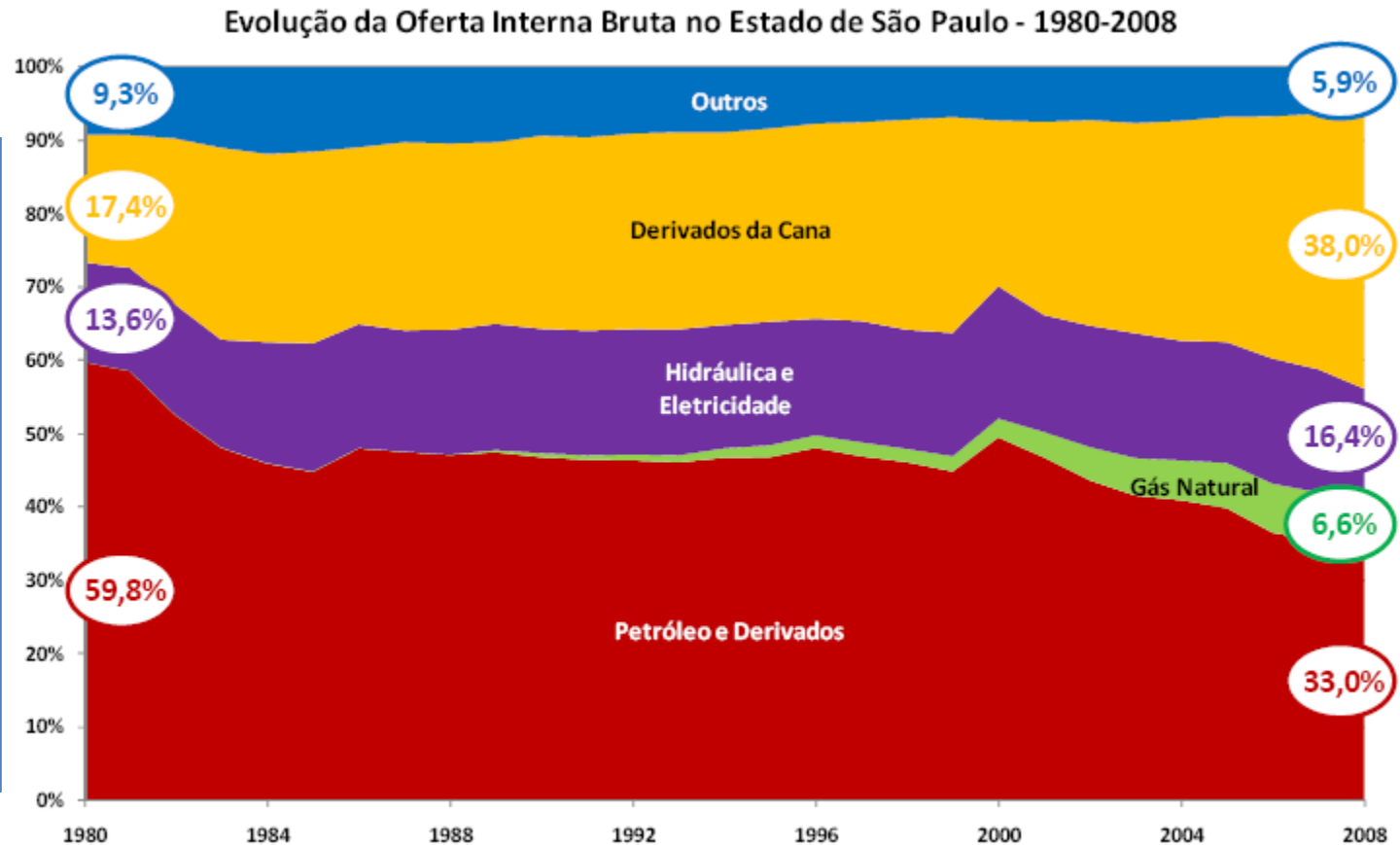
# Energy sources in the State of São Paulo, Brazil

## State of São Paulo

- 63% of Brazilian ethanol
- 41 million people
- 35% of Brazil's GNP

1980 – 2008

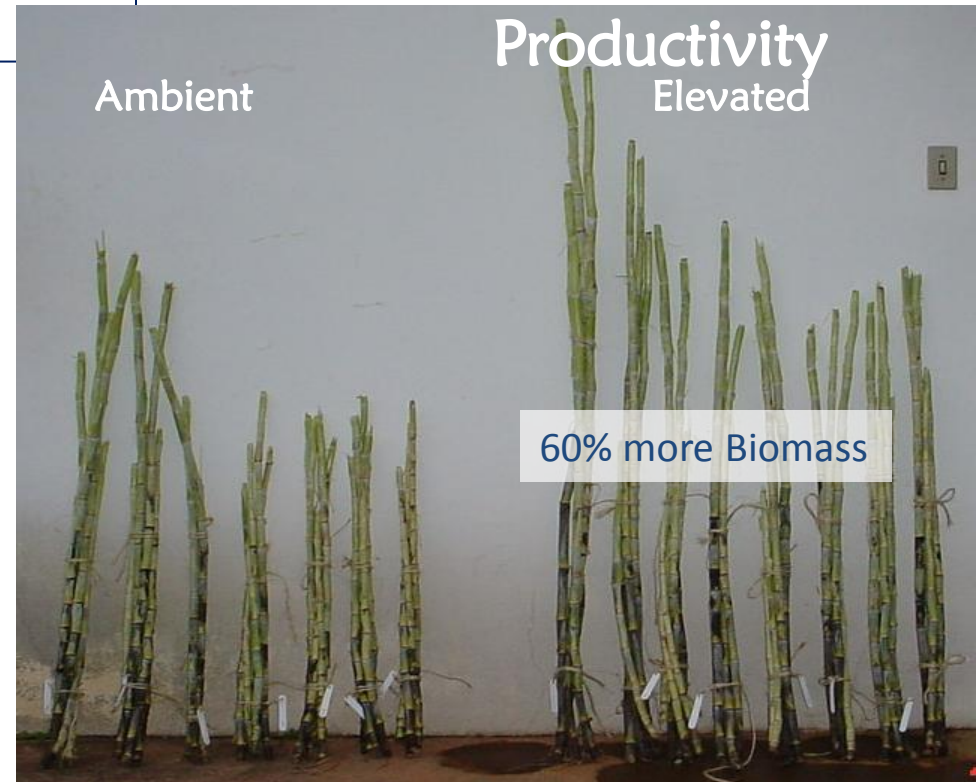
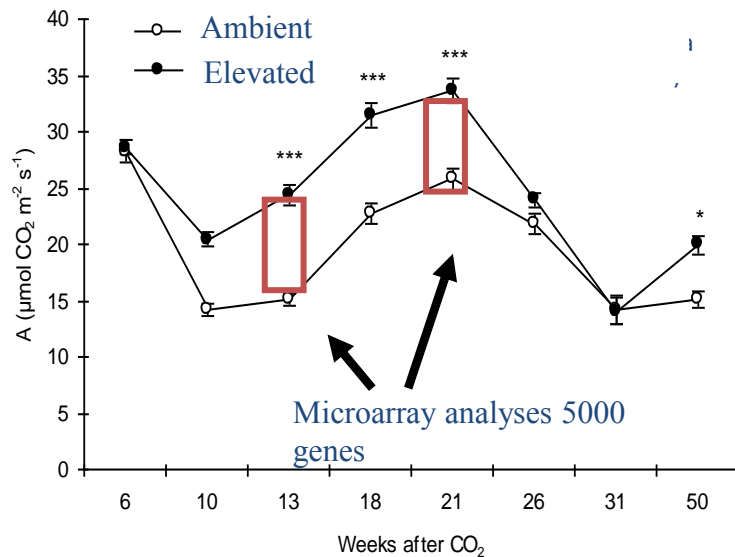
- Oil down from 60% to 33%
- Cane up from 17% to 38%



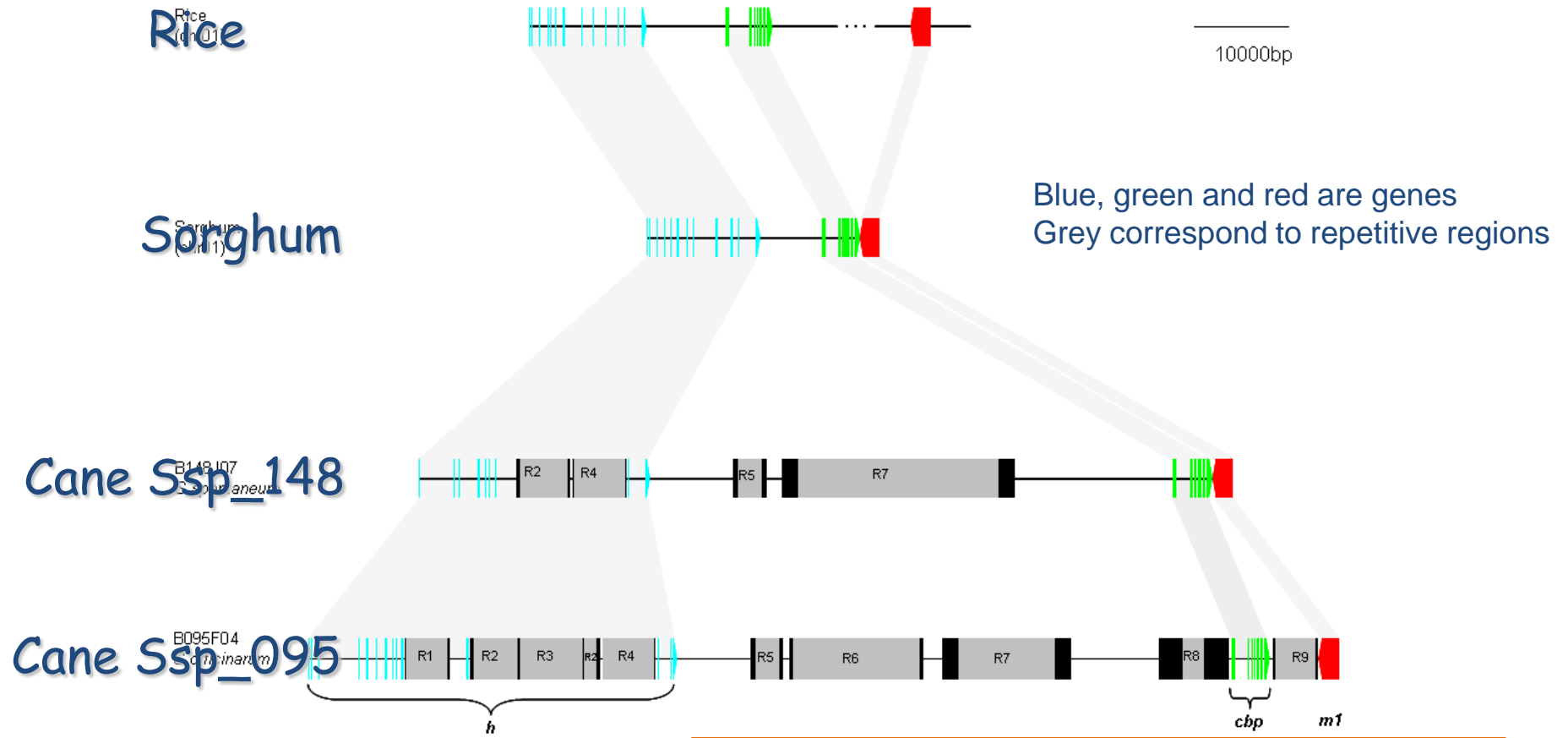


# Sugarcane in increased CO<sub>2</sub>

Buckeridge M. Et al. Plant Cell and Environment, vol.31, p. 1116 (2008)



# Syntenic regions: rice, sorghum, two cane alleles



M.Anne van Sluys et al., in preparation

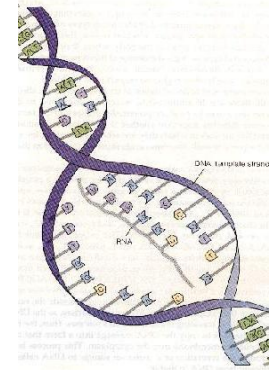
# Genome Research

13:2725-2735 ©2003 by Cold Spring Harbor Laboratory Press ISSN 1088-9051/03 \$5.00; www.genome.org

## Analysis and Functional Annotation of an Expressed Sequence Tag Collection for Tropical Crop Sugarcane

André L. Vettore,<sup>1,24</sup> Felipe R. da Silva,<sup>1,25</sup> Edson L. Kemper,<sup>1,26</sup> Glauca M. Souza,<sup>3</sup> Aline M. da Silva,<sup>3</sup> Maria Inês T. Ferro,<sup>6</sup> Flavio Henrique-Silva,<sup>8</sup> Éder A. Giglioti,<sup>9</sup> Manoel V.F. Lemos,<sup>7</sup> Luiz L. Coutinho,<sup>10</sup> Marina P. Nobrega,<sup>11</sup> Helaine Carrer,<sup>10</sup> Suzelei C. França,<sup>12</sup> Maurício Bacci Jr.,<sup>13</sup> Maria Helena S. Goldman,<sup>14</sup> Suely L. Gomes,<sup>3</sup> Luiz R. Nunes,<sup>15</sup> Luis E.A. Camargo,<sup>10</sup> Walter J. Siqueira,<sup>16</sup> Marie-Anne Van Sluys,<sup>4</sup> Otavio H. Thiemann,<sup>17</sup> Eiko E. Kuramae,<sup>18</sup> Roberto V. Santelli,<sup>3</sup> Celso L. Marino,<sup>19</sup> Maria L.P.N. Targon,<sup>20</sup> Jesus A. Ferro,<sup>6,27</sup> Henrique C.S. Silveira,<sup>8</sup> Danyelle C. Marini,<sup>9</sup> Eliana G.M. Lemos,<sup>6</sup> Claudia B. Monteiro-Vitorello,<sup>10</sup> José H.M. Tambor,<sup>11</sup> Dirce M. Carraro,<sup>10,24</sup> Patrícia G. Roberto,<sup>12</sup> Vanderlei G. Martins,<sup>21</sup> Gustavo H. Goldman,<sup>22</sup> Regina C. de Oliveira,<sup>15</sup> Daniela Truffi,<sup>10</sup> Carlos A. Colombo,<sup>16</sup> Magdalena Rossi,<sup>4</sup> Paula G. de Araujo,<sup>4</sup> Susana A. Sculaccio,<sup>17</sup> Aline Angella,<sup>18</sup> Marleide M.A. Lima,<sup>18</sup> Vicente E. de Rosa Jr.,<sup>18</sup> Fábio Siviero,<sup>3</sup> Virginia E. Coscrato,<sup>19</sup> Marcos A. Machado,<sup>20</sup> Laurent Grivet,<sup>23</sup> Sonia M.Z. Di Mauro,<sup>6</sup> Francisco G. Nobrega,<sup>11</sup> Carlos F.M. Menck,<sup>5</sup> Marília D.V. Braga,<sup>2,28</sup> Guilherme P. Telles,<sup>2</sup> Frank A.A. Cara,<sup>2</sup> Guilherme Pedrosa,<sup>2</sup> João Meidanis,<sup>2</sup> and Paulo Arruda<sup>1,27,29</sup>

**50 labs**  
**200 researchers**



**238000 ESTs**  
**43000 Transcripts**



# 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