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# *The Fapesp Research Program on Bioenergy, BIOEN*

Carlos H de Brito Cruz

Scientific Director

The São Paulo Research Foundation, FAPESP

<http://www.fapesp.br>

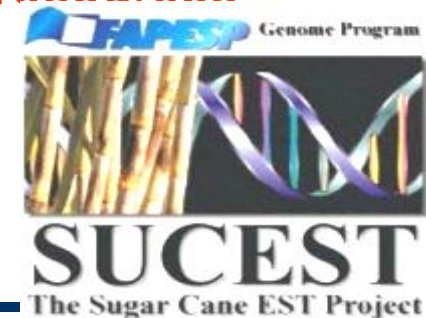
<http://bioenfapesp.org>



# ***FAPESP (The São Paulo Research Foundation): SUCEST Program, 1999***



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

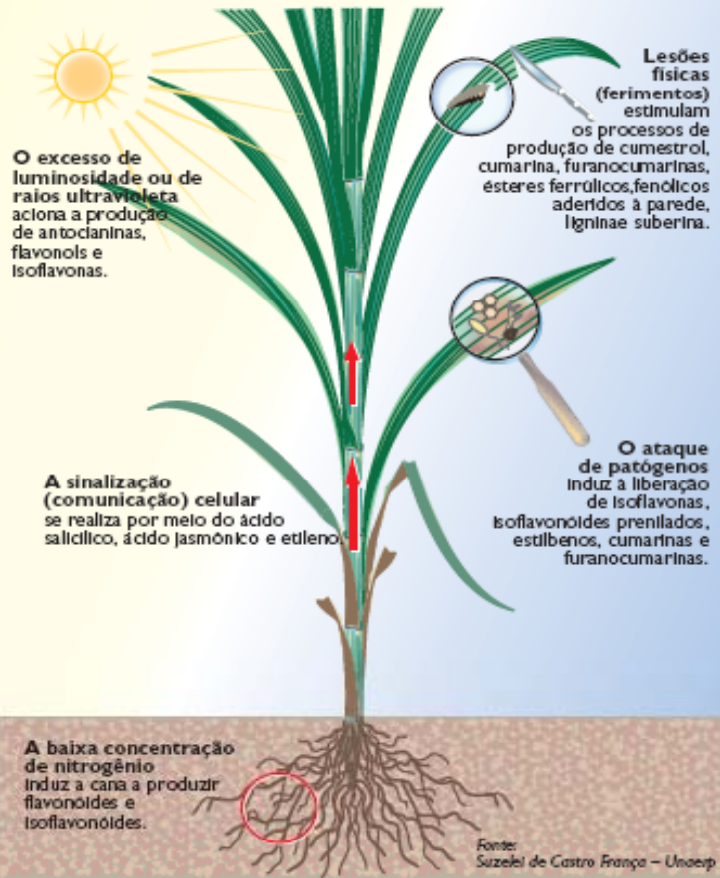


# FAPESP: Sugarcane genomics 2000

SIRIO B. CANÇADO

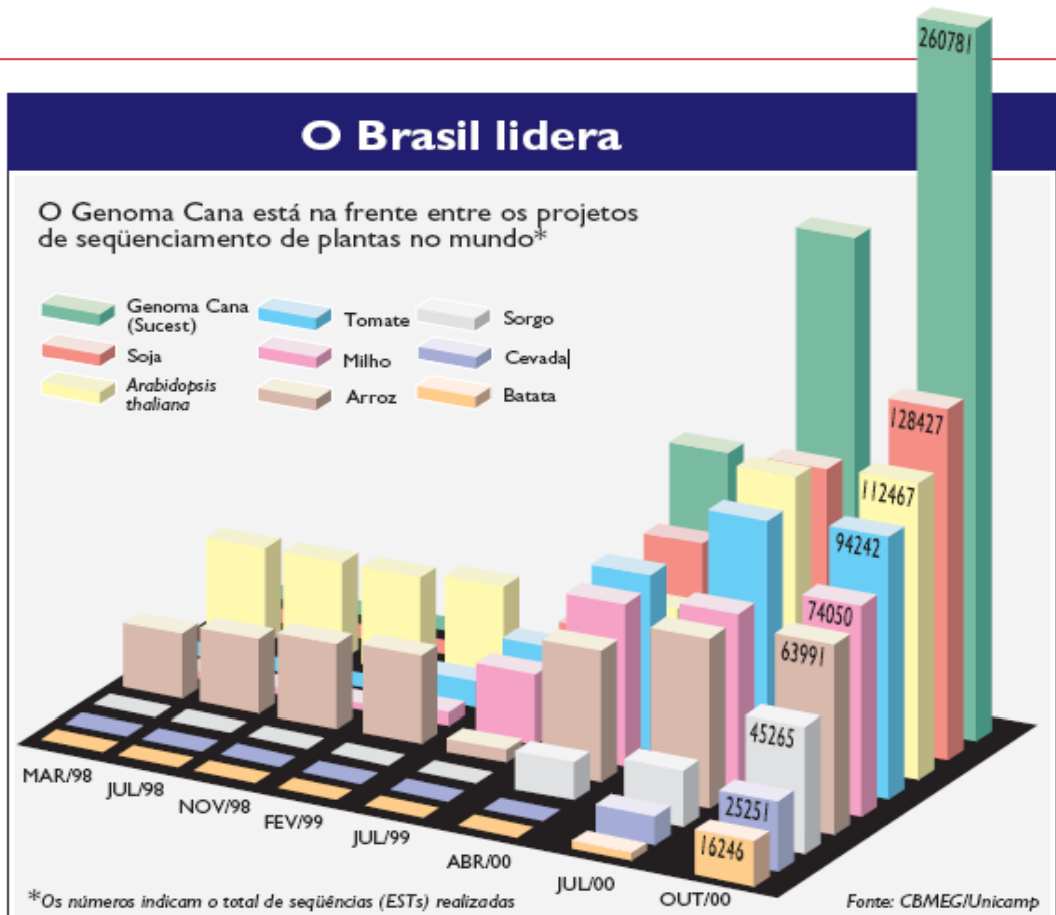
## Como a cana reage aos imprevistos

Cada parte da planta produz compostos químicos diferentes, de acordo com a situação



## O Brasil lidera

O Genoma Cana está na frente entre os projetos de seqüenciamento de plantas no mundo\*



SIRIO B. CANÇADO

**Signal transduction-related responses to phytohormones and environmental challenges in sugarcane**

Flávia R Rocha<sup>1</sup>, Flávia S Papini-Terzi<sup>1</sup>, Milton Y Nishiyama Jr<sup>1</sup>, Ricardo ZN Vêncio<sup>2</sup>, Renato Vicentini<sup>3</sup>, Rodrigo DC Duarte<sup>3</sup>, Vicente E de Rosa Jr<sup>3</sup>, Fabiano Vinagre<sup>4</sup>, Carla Barsalobres<sup>5</sup>, Ane H Medeiros<sup>5</sup>, Fabiana A Rodrigues<sup>7</sup>, Eugênio C Ullian<sup>6</sup>, Sônia M Zingaretti<sup>7</sup>, João A Galbiatti<sup>7</sup>, Raul S Almeida<sup>8</sup>, Antonio VO Figueira<sup>8</sup>, Adriana S Hemerly<sup>4</sup>, Marcio C Silva-Filho<sup>5</sup>, Marcelo Menossi<sup>3</sup> and Gláucia M Souza<sup>\*1</sup>

# SUCEST-FUN Project

Published: 13 March 2007

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BMC Genomics 2007, 8:71 doi:10.1186/1471-2164-8-71

Accepted: 13 March 2007

Int J Plant Genomics. 2008; 2008: 458732.  
Published online 2007 December 16. doi: 10.1155/2008/458732.  
Copyright © 2008 M. Menossi et al.

PMCID: PMC2216073

**Sugarcane Functional Genomics: Gene Discovery for Agronomic Trait Development**

M. Menossi,<sup>1</sup> M. C. Silva-Filho,<sup>2</sup> M. Vincentz,<sup>1</sup> M.-A. Van-Sluys,<sup>3</sup> and G. M. Souza<sup>4\*</sup>

Papini-Terzi, F.S. *et al.*

Proc. Int. Soc. Sugar Cane Technol., Vol. 26, 2007

**THE SUCEST-FUN PROJECT: IDENTIFYING GENES THAT REGULATE SUCROSE CONTENT IN SUGARCANE PLANTS**

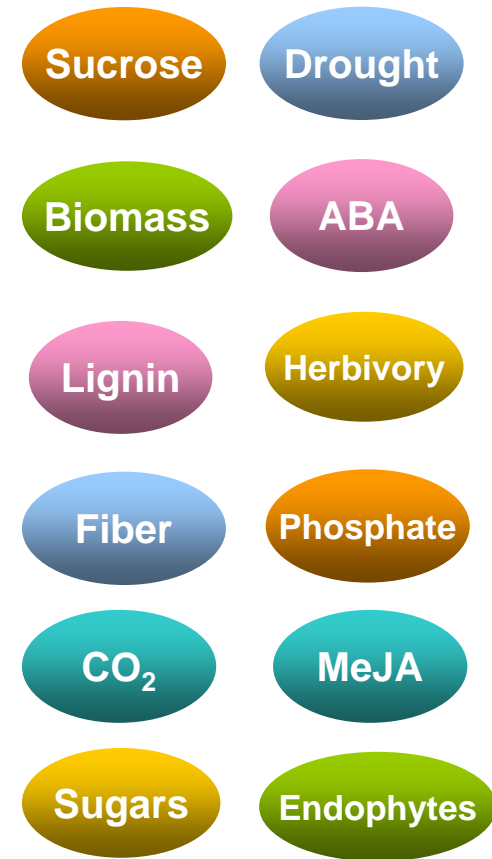
By

F.S. PAPANI-TERZI<sup>1\*</sup>, J.M. FELIX<sup>2\*</sup>, F.R. ROCHA<sup>1</sup>, A.J. WACLAWOVSKY<sup>1</sup>, E.C. ULIAN<sup>3</sup>, S. M. CHABREGAS<sup>3</sup>, M.C. FALCO<sup>3</sup>, M.Y. NISHIYAMA-JR<sup>1</sup>, R.Z.N. VÊNCIO<sup>4</sup>, R. VICENTINI<sup>2</sup>, M. MENOSSI<sup>2</sup> and G.M. SOUZA<sup>1</sup>

DNA RESEARCH 12, 27–38 (2005)

**Transcription Profiling of Signal Transduction-Related Genes in Sugarcane Tissues**

Flávia STAL PAPANI-TERZI,<sup>1,†</sup> Flávia RISO ROCHA,<sup>1,†</sup> Ricardo ZORZETTO NICOLIELLO VÊNCIO,<sup>2</sup> Kátia Cristina OLIVEIRA,<sup>1</sup> Juliana de Maria FELIX,<sup>3,4</sup> Cristiane de SOUZA ROCHA,<sup>4</sup> Ana Carolina QUIRINO SIMÕES,<sup>1</sup> Eugênio César ULIAN,<sup>5</sup> Sônia Marli ZINGARETTI DI MAURO,<sup>6</sup> Aline Maria DA SILVA,<sup>1</sup> Carlos Alberto de BRAGANÇA PEREIRA,<sup>2</sup> Marcelo MENOSSI,<sup>3,4</sup> and Gláucia MENDES SOUZA<sup>1,\*</sup>



# Maps and Markers

## Functional integrated genetic linkage map based on EST-markers for a sugarcane (*Saccharum* spp.) commercial cross

Karine M. Oliveira · Luciana R. Pinto · Thiago G. Marconi · Gabriel R. A. Margarido ·  
 Maria Marta Pastina · Laura Helena M. Teixeira · Antônio V. Figueira ·  
 Eugênio César Ulian · Antônio Augusto F. Garcia · Anete Pereira Souza

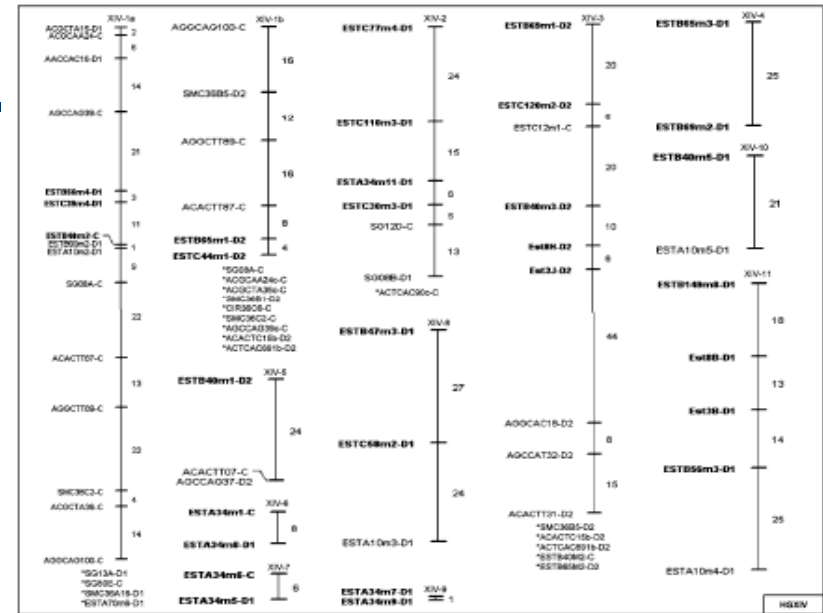
Theor Appl Genet (2006) 112: 298–314  
 DOI 10.1007/s00122-005-0129-6

ORIGINAL PAPER

A. A. F. Garcia · E. A. Kido · A. N. Meza  
 H. M. B. Souza · L. R. Pinto · M. M. Pastina  
 C. S. Leite · J. A. G. da Silva · E. C. Ulian  
 A. Figueira · A. P. Souza

## Development of an integrated genetic map of a sugarcane (*Saccharum* spp.) commercial cross, based on a maximum-likelihood approach for estimation of linkage and linkage phases

Hereditas 144: 78–79 (2007)



## OneMap: software for genetic mapping in outcrossing species

G. R. A. MARGARIDO<sup>1</sup>, A. P. SOUZA<sup>2</sup> and A. A. F. GARCIA<sup>1</sup>

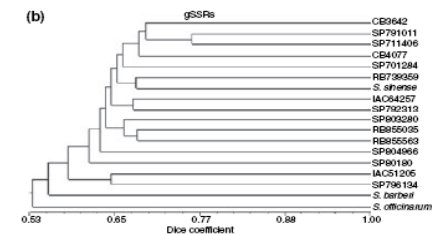
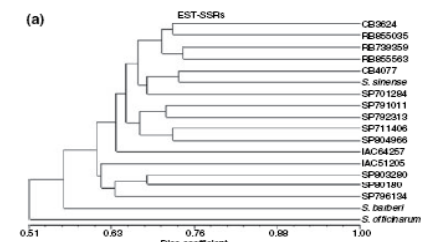
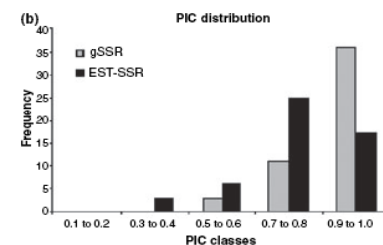
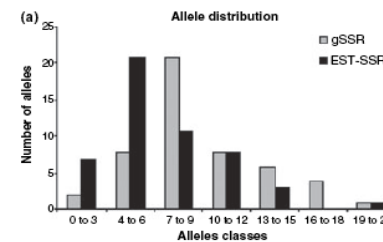
<sup>1</sup>Department of Genetics, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo (USP), Piracicaba, São Paulo, Brazil

<sup>2</sup>Centro de Biologia Molecular e Engenharia Genética (CBMEG), Universidade Estadual de Campinas (UNICAMP), Campinas, São Paulo, Brazil

Plant Breeding 125, 378–384 (2006)  
 Journal compilation © 2006 Blackwell Verlag, Berlin  
 No claim to original US government works

## Characterization of novel sugarcane expressed sequence tag microsatellites and comparison with genomic SSRs

L. R. PINTO<sup>1</sup>, K. M. OLIVEIRA<sup>2</sup>, T. MARCONI<sup>2</sup>, A. A. F. GARCIA<sup>3</sup>, E. C. ULIAN<sup>4</sup> and A. P. DE SOUZA<sup>2</sup>



# ***SUCEST: Gene Discovery and Functional Genomics***

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- Genes associated to traits of interest
- In association with planters R&D center
  - Sugarcane Transcriptome Project (University of São Paulo, USP)



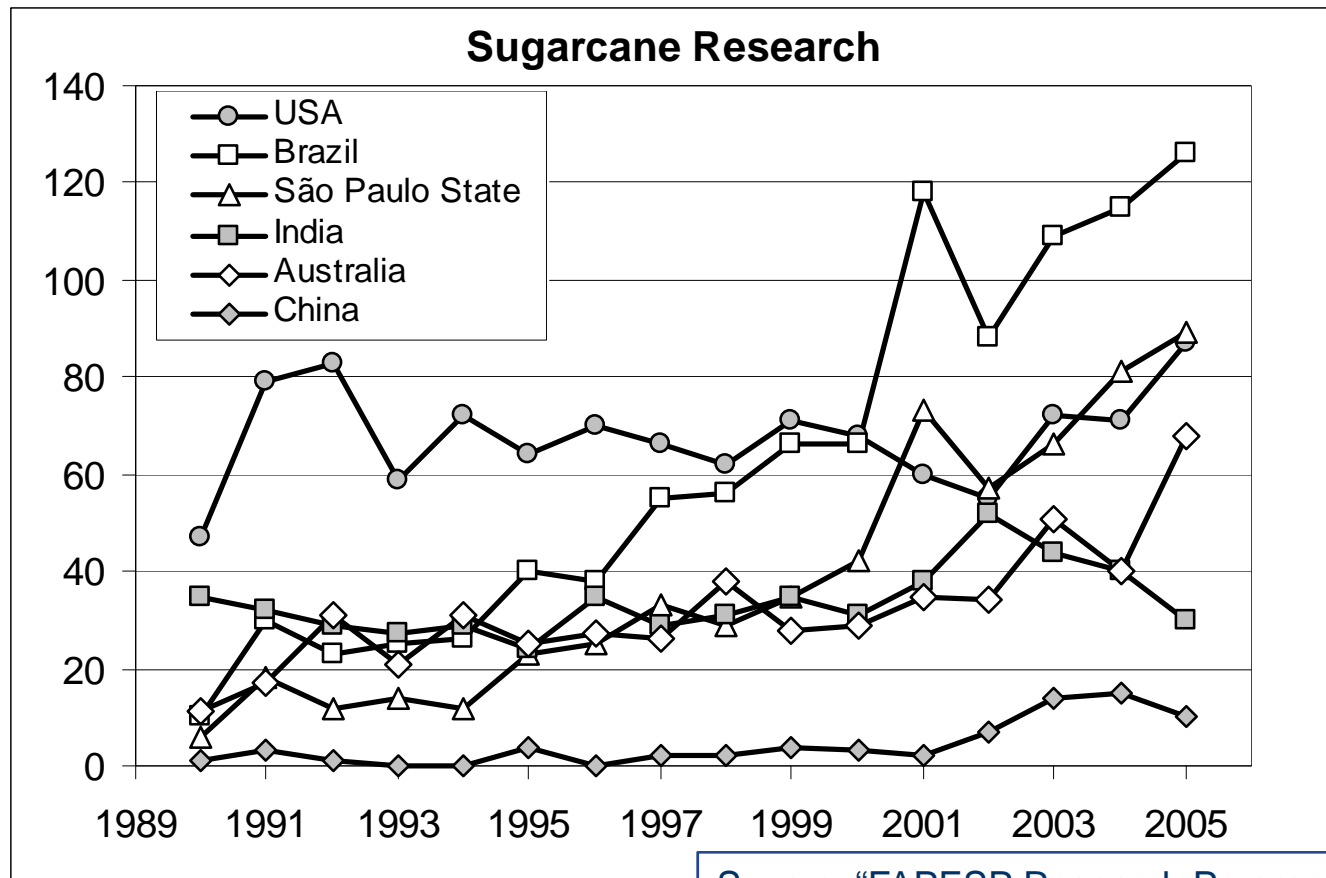
- Over 1,000 trait genes (sucrose, herbivory, drought, nutritional responses) identified through genomics tools applied to the study of the Brazilian germplasm (Pat pending USPTO11/716,262)

- Sugarcane Molecular Marker Development Project (University of Campinas, UNICAMP)



- A functional map and markers associated to sucrose content developed for breeding populations

# Scientific papers in Sugarcane topics



Source: "FAPESP Research Program BIOEN", June, 2008

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

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1. Improvements in the feedstock: building a better cane plant for energy - EnergyCane
2. Production of Ethanol and other products: hydrolysis, pyrolysis, gasification, fermentation, distillation
3. New processes in alcohol-chemistry
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 Program Comittee***

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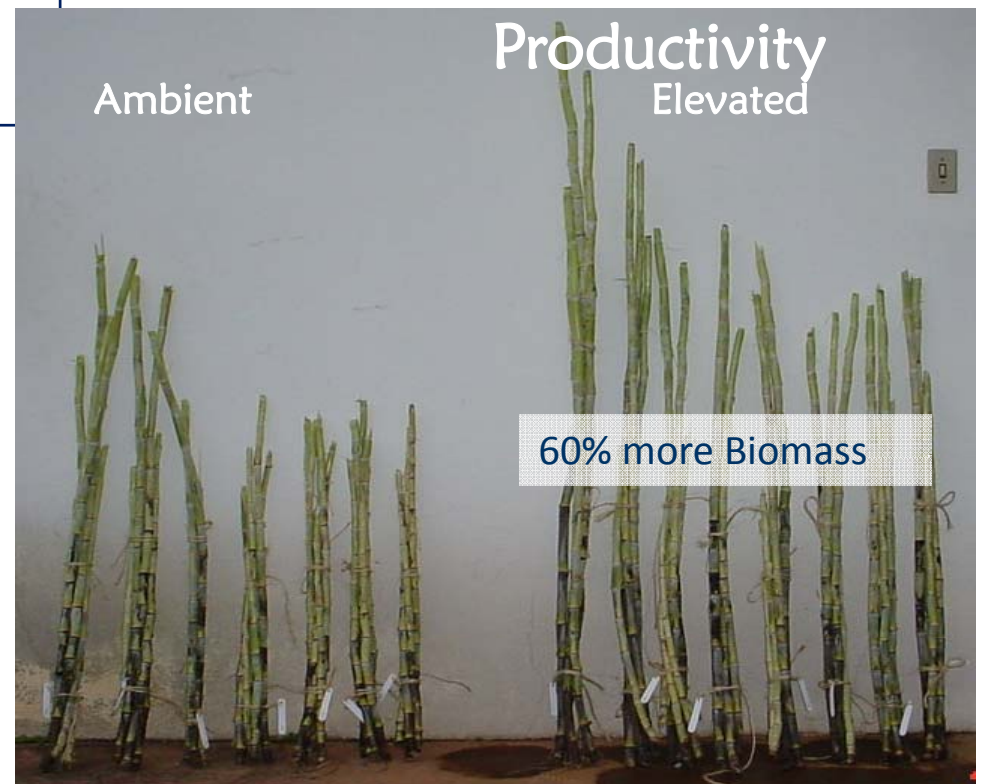
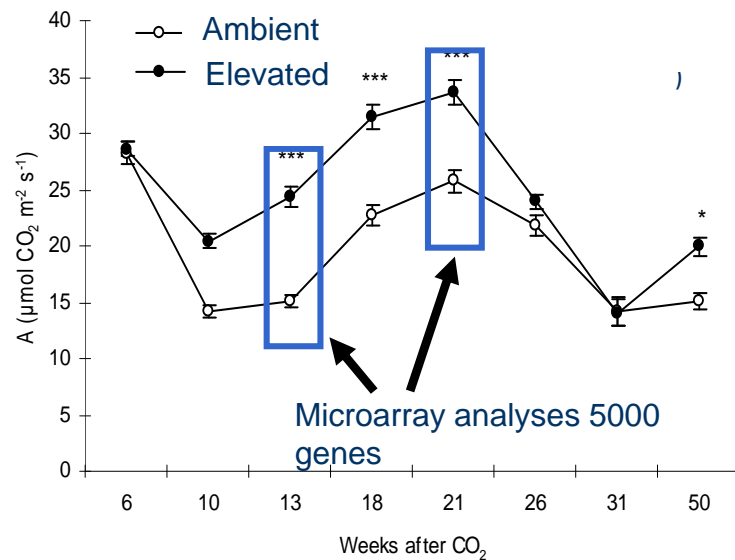
- Gláucia Mendes de Souza
  - Marcos Buckeridge
  - Marie-Anne van Sluys
  - Anete Pereira de Souza
  - Rubens Maciel
  - Heitor Cantarella
  - André Nassar
- Plus consultants during the preparation phase:
    - Luiz Cortez
    - José Goldemberg

# *Plant Research: selected projects as of May, 2009*

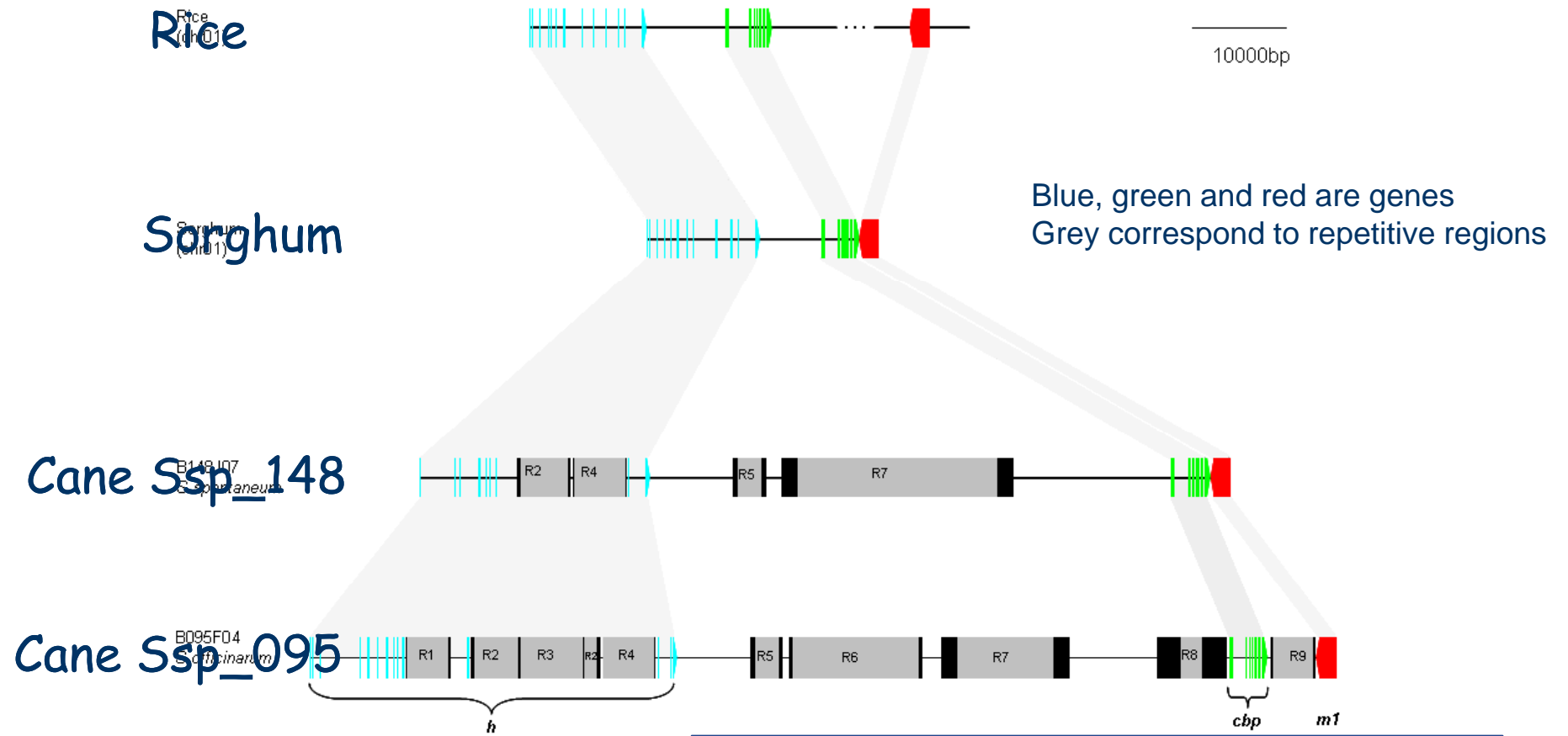
<b>Modal.</b>	<b>Interessado</b>	<b>Unidad Entid e</b>		<b>Título</b>
APTem	Anete Pereira de Souza	IB	Unicamp	Genomic-Assisted Breeding Of Sugarcane: Using Molecular Markers For Understanding The Genetic Architecture Of Quantitative Traits And To Implement Marker Assisted Selection.
APTem	Glaucia Mendes Souza	IQ	USP	Sugarcane Signaling And Regulatory Networks.
APTem	Helaine Carrer	ESALQ	USP	Functional Genomics Of Photosynthetic Genes In Sugarcane.
APTem	Marcio de Castro Silva Filho	ESALQ	USP	Herbivory And Intracellular Transport Of Proteins
APTem	Marie Anne Van Sluys	IB	USP	Sugarcane Genome Sequence: Plant Transposable Elements Are Active Contributors To Gene Structure Variation, Regulation And Function.
APTem	Heitor Cantarella	IAC	SAASP	Nitrogen Nutrition Pf Sugarcane With Fertilizers Or Diazotrophic Bacteria
APTem	Luis Eduardo Aranha Camargo	ESALQ	USP	Functional'omics Of The Ratton Stunting Disease Of Sugarcane
APTem	Marcos Guimaraes de Andrade Landell	IAC	SAASP	Sustainable Bioenergy Sugarcane Breeding And Cultivar Development
APR	Marcelo Menossi Teixeira	IB	Unicamp	Analise Dos Mecanismos de Tolerancia a Seca Em Cana-De-Acucar Atraves do Uso da Analise Transcritomica e Metabolomica
PITE	Ana Teresa Lombardi	CCBS	Ufscar	Cultivo de Microalgas Em Fotobiorreator Como Ferramenta para O Sequestro de Co2 Atmosférico

# 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

# Sucrose related genes

**BMC Genomics**



This Provisional PDF corresponds to the article as it appeared upon acceptance. Fully formatted PDF and full text (HTML) versions will be made available soon.

## Sugarcane genes associated with sucrose content

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

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# *Processes I: academic projects selected as of May, 2009*

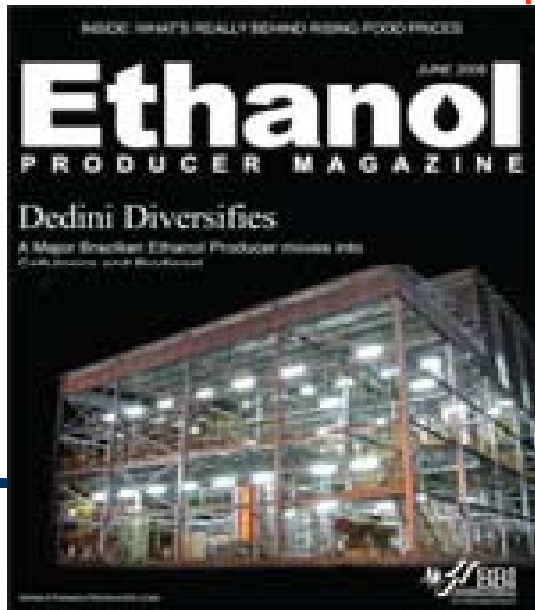
<b>Modal.</b>	<b>Interessado</b>	<b>Unid</b>	<b>Entidade</b>	<b>Título</b>
APR	Aldo Tonso	EP	USP	Engenharia Evolutiva de Leveduras
APJP	Fabio Tebaldi Silveira Nogueira	ESALQ	USP	Isolamento e Caracterizacao de Micrornas e seus Genes-Alvo em Cana-de-Acucar
APTem	Adriane Maria Ferreira Milagres	EEL	USP	Topochemistry, Porosity And Chemical Composition Determining Succesfull Enzymatic Sacarification Of Sugarcane Bagasse
APTem	Antonio Jose de Almeida Meirelles	FEA	Unicamp	Phase Equilibrium And Purification Processes In The Production Of Biofuels And Biocompounds
APTem	Gustavo Henrique Goldman	FCFRP	USP	Functional Analysis Of The Transcription Factor Xlnr Involved In Regulation Of Transcription Of Cellulases - And Hemicellulases-Enconding Genes In Aspergillus Niger
APTem	Igor Polikarpov	IFSC	USP	Structure And Function Of Enzymes And Auxiliary Proteins From Trichoderma, Active In Cell-Wall Hydrolysis
APTem	Roberto de Campos Giordano	CCET	Ufscar	Bioprocess Systems Engineering (Bse) Applied To The Production Of Bioethanol From Sugarcane Bagasse
APTem	Sandro Roberto Marana	IQ	USP	Development Of Beta-Glycosidases Designed To Improve The Efficiency Of Noncomplexed Cellulase Systems
APR	Cecilia Laluce	IQAr	Unesp	Ethanol Production From Sugar-Cane-Bagasse: Enzymatic Pre-Treatments, Microbiological Assays To Evaluate Toxicity And Tolerance To Hydrolysates At Increaseing Temperatures
APR	Celina Lopes Duarte	IPEN	SDSP	Pre-tratamento do bagaco de cana para hidrolise acida ou enzimatica da celulose utilizando o processo de oxidacao avancada por radiacao ionizante para producao de biocombustivel etanol
APIP	Regina Helena Geribello Priolli	FORP	USP	Association Analysis Using Ssr And Snp Loci To Find Qtl For Seed Oil

# Processes II: in cooperation with industry

Modal.	Chamada	Interessado	Unidade	Entidade	Título
PITE	Braskem 03/08	Carlos Frederico Martins Menck	ICB	USP	Desenvolvimento de Estratégias para Transformação do Glicerol Via Rotas Biotecnológica e Química
PITE	Braskem 03/08	Luiz Henrique Capparelli Mattoso	CNPDIA	Embrapa	Obtenção, Caracterização e Modificação Química de Nanofibras de Origem Renovável para Sua Utilização Como Reforço de Resinas Poliolefinicas
PITE	Braskem 03/08	Rubens Maciel Filho	FEQ	USP	Desenvolvimento de Rotas para Obtenção de Ácido Acrílico e Ácido Propiônico Por Processo Fermentativo a Partir de Açúcares
PITE	Oxitenos 1	Adilson Roberto Gonçalves	EEL	USP	Açúcares e Glicóis a Partir da Hidrólise e Deslignificação de Bagaço e Palha de Cana de Açúcar e Caracterização Rápida de Materiais Lignocelulósicos
PITE	Oxitenos 1	Alfredo Eduardo Maiorano	IPT	SDSP	Estudo do Processo de Hidrólise Enzimática do Bagaço de Cana de Açúcar para Obtenção de Açúcares
PITE	Oxitenos 1	Antonio Aprigio da Silva Curvelo	IQSC	USP	Desenvolvimento de Metodologia Analítica e Deslignificação Organossolve Aplicados Ao Bagaço e a Palha da Cana-De-Açúcar
PITE	Oxitenos 1	Daniela Zanchet	LNLS	ABTLUS	Obtenção de Glicóis de Interesse Industrial a Partir de Derivados de Biomassa: Desenvolvimento de Catalisadores Heterogêneos para Hidrogenólise do Glicerol
PITE	Oxitenos 1	Inês Conceição Roberto	EEL	USP	Bioprodução de Etanol a Partir de Xilose Empregando Materiais Lignocelulósicos
PITE	Oxitenos 1	Maria Das Graças de Almeida Felipe	EEL	USP	Produção Biotecnológica de Etanol e Xilitol e Cristalização da Xilose a Partir da Fração Hemicelulósica do Bagaço de Cana de Açúcar
PITE	Oxitenos 1	Vera Regina Leopoldo Constantino	IQ	USP	Hidrogenólise de Glicerol a Etilglicol e Propilenoglicol Catalisada Por Materiais Bifuncionais Contendo Metais de Transição

# Demonstration Plant for Acid Hydrolisis: FAPESP - Dedini

- Project started in 2002
- Dedini-Fapesp proprietary process
- Demonstration plant
  - 5,000 liters per day
  - Mixed with input for fermentation



Planta DHR



# *Impacts: selected projects as of May, 2009*

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<b>Modal.</b>	<b>Interessado</b>	<b>Unidade</b>	<b>Entid</b>	<b>Título</b>
APTem	Andre Meloni Nassar	ICONE	ICONE	Simulating Land Use And Agriculture Expansion In Brazil: Food, Energy, Agro-Industrial And Environmental Impacts
APTem	Paulo Furquim de Azevedo	EESP	FGV	International Bioenergy Market: Assessing Institutional Structures
PITE	Leda Coltro	ITAL	SAASP	Indicadores Ambientais para Polímeros de Fonte Renovável a Partir de Estudos de Acv

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# ***BIOEN: research portfolio***

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<b>Division</b>	<b>Value</b>
Plant Research	27.038.940,12
Processes	16.221.275,25
Impacts	427.725,60
<b>Total</b>	<b>43.687.940,97</b>

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# ***BIOEN Workshops***

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- Bioenergy – Aug, 2009
- Genome Sequencing – Aug, 2008
- Cellulosic Ethanol – Sep, 2009
- Photosynthesis – Feb, 2009
- Sugarcane improvement – Mar, 2009
- Soil Carbon – Jun, 2009

# State of São Paulo Bioenergy R&D – BIOEN

- Academic Basic and Applied Research
  - Advancement of knowledge – US\$ 24M (2008) + 2009,..
    - Plus US\$ 140 M (10 years) for a Statewide Research Center
  - Young Investigator Awards – US\$ 6 M (2008) + 2009..
    - Open to foreign scientists who want to come to Brazil
- Joint industry-university research (5 years)

Company	Subject	Value by industry
Oxiteno	Lignocellulosic materials	US\$ 3,000,000
Braskem	Alcohol-chemistry	US\$ 25,000,000
Dedini	Processes	US\$ 50,000,000