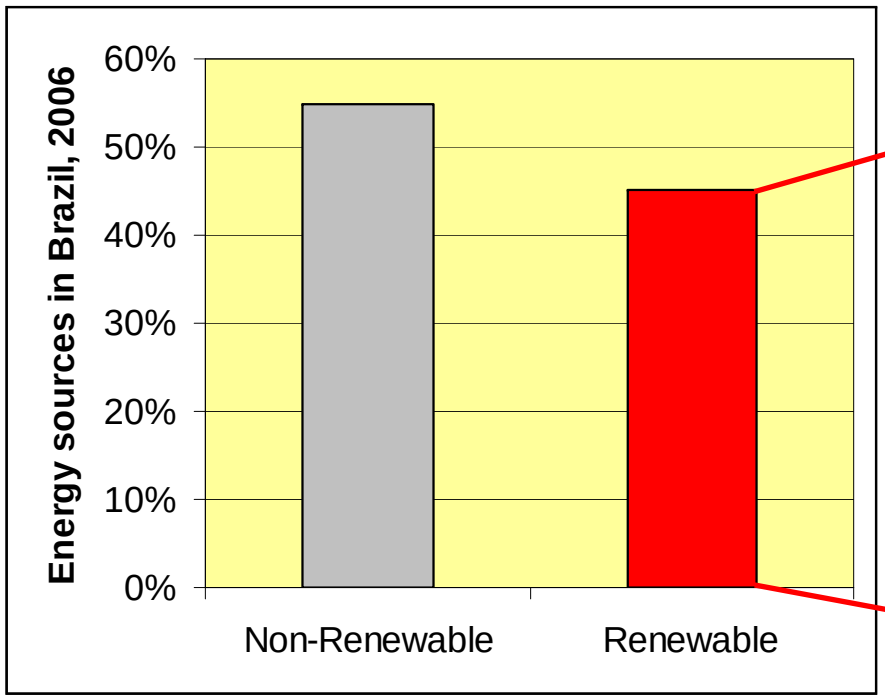
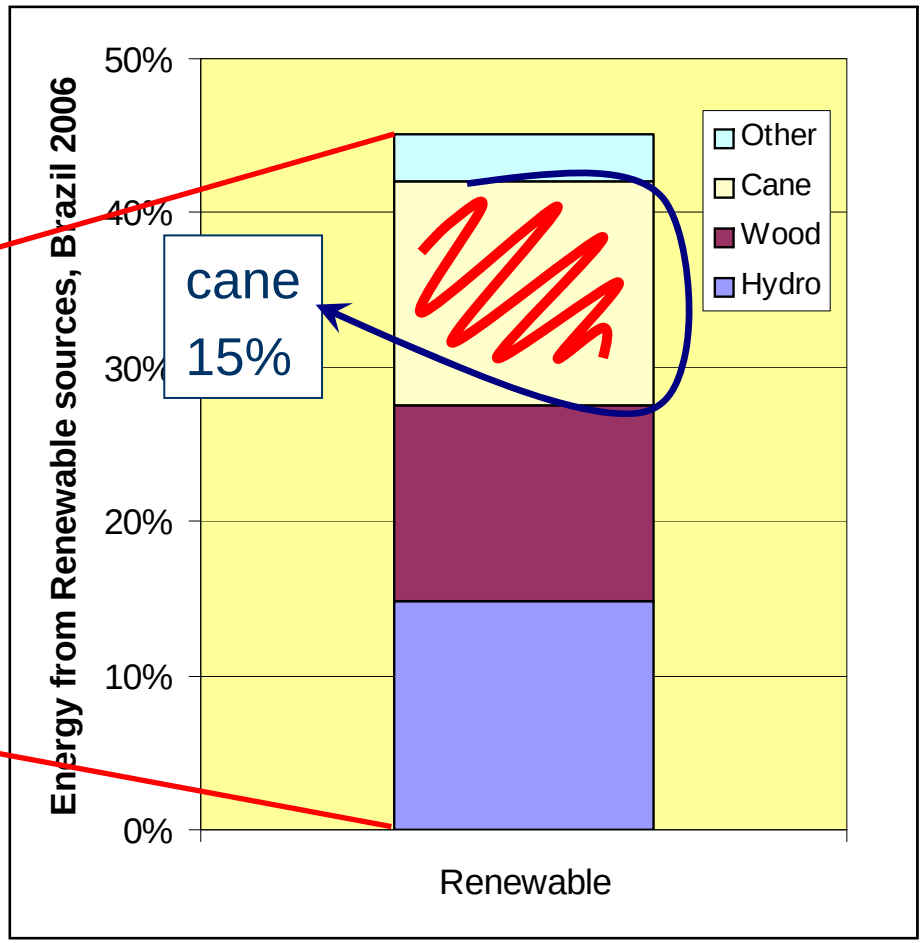
Bioenergy in Brazil and FAPESP's Bioenergy Research Strategy

Carlos H. de Brito Cruz
Scientific Director
Fapesp

Energy sources in Brazil

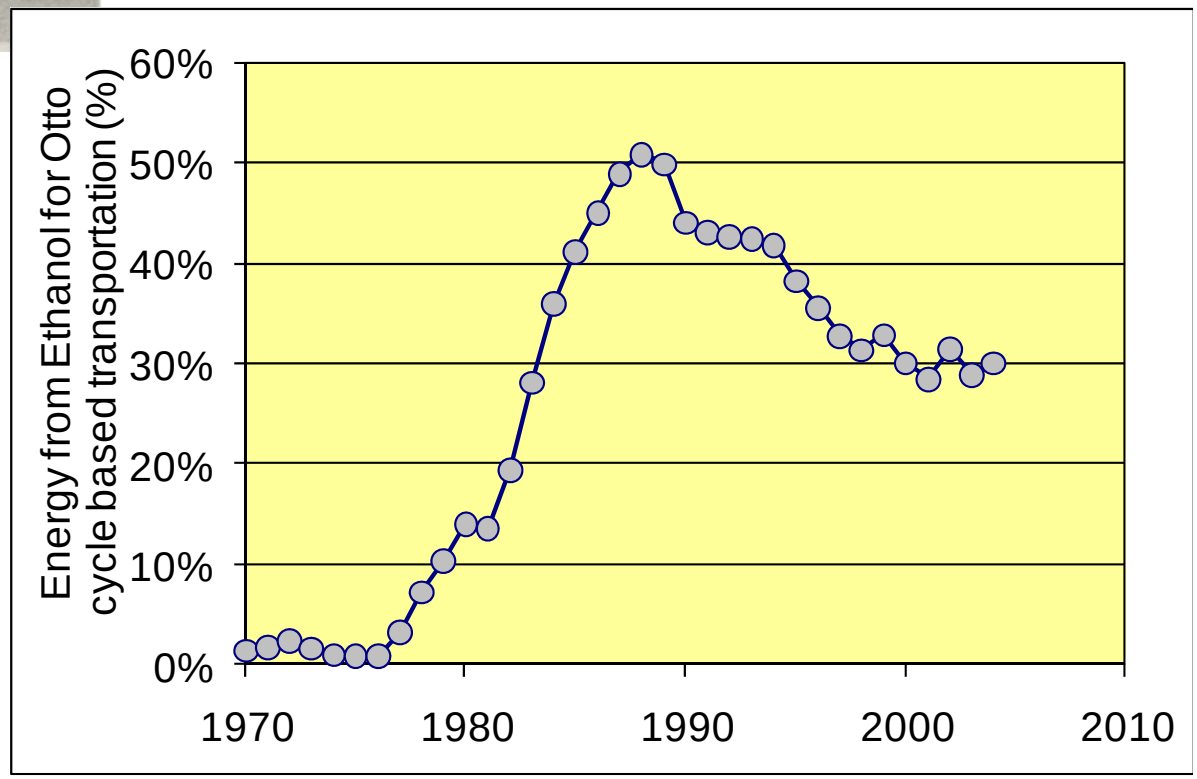




Ethanol in Brazil

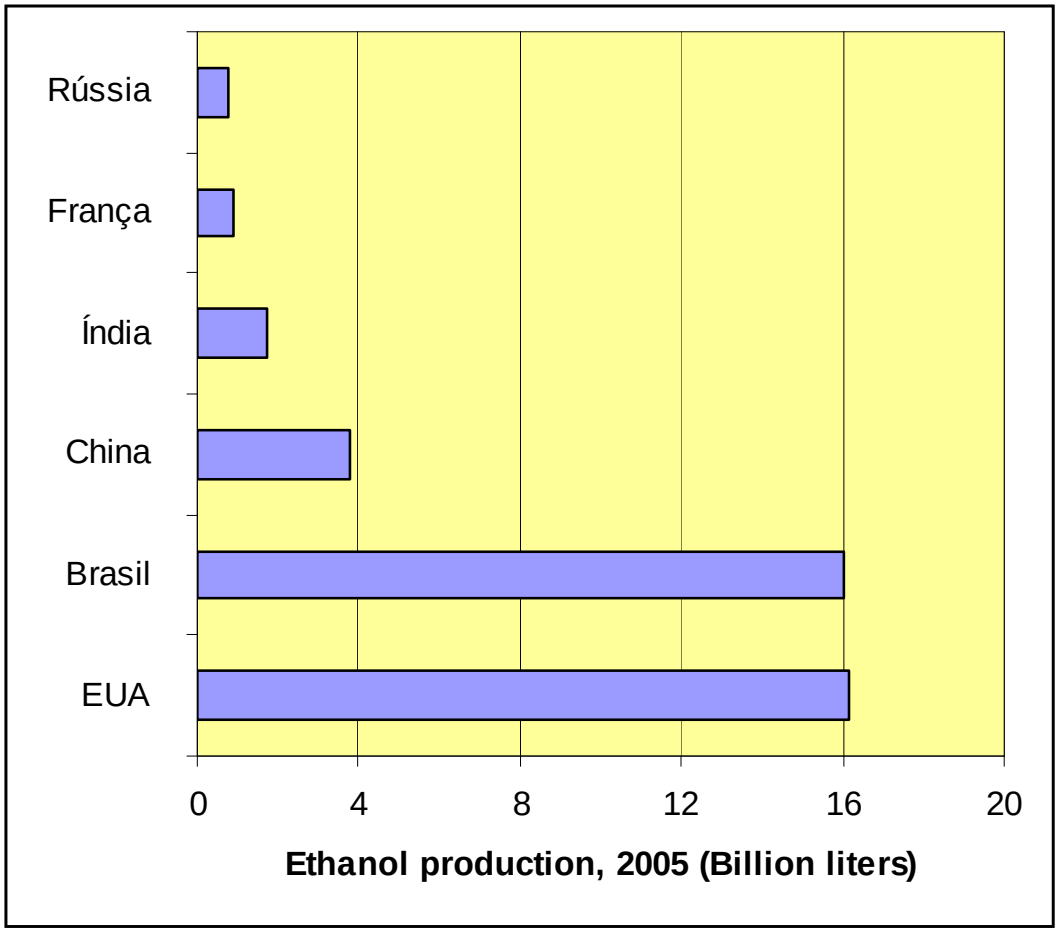
Sugarcane in Brazil: 1532

Mandated addition of Ethanol to fuel: 1929

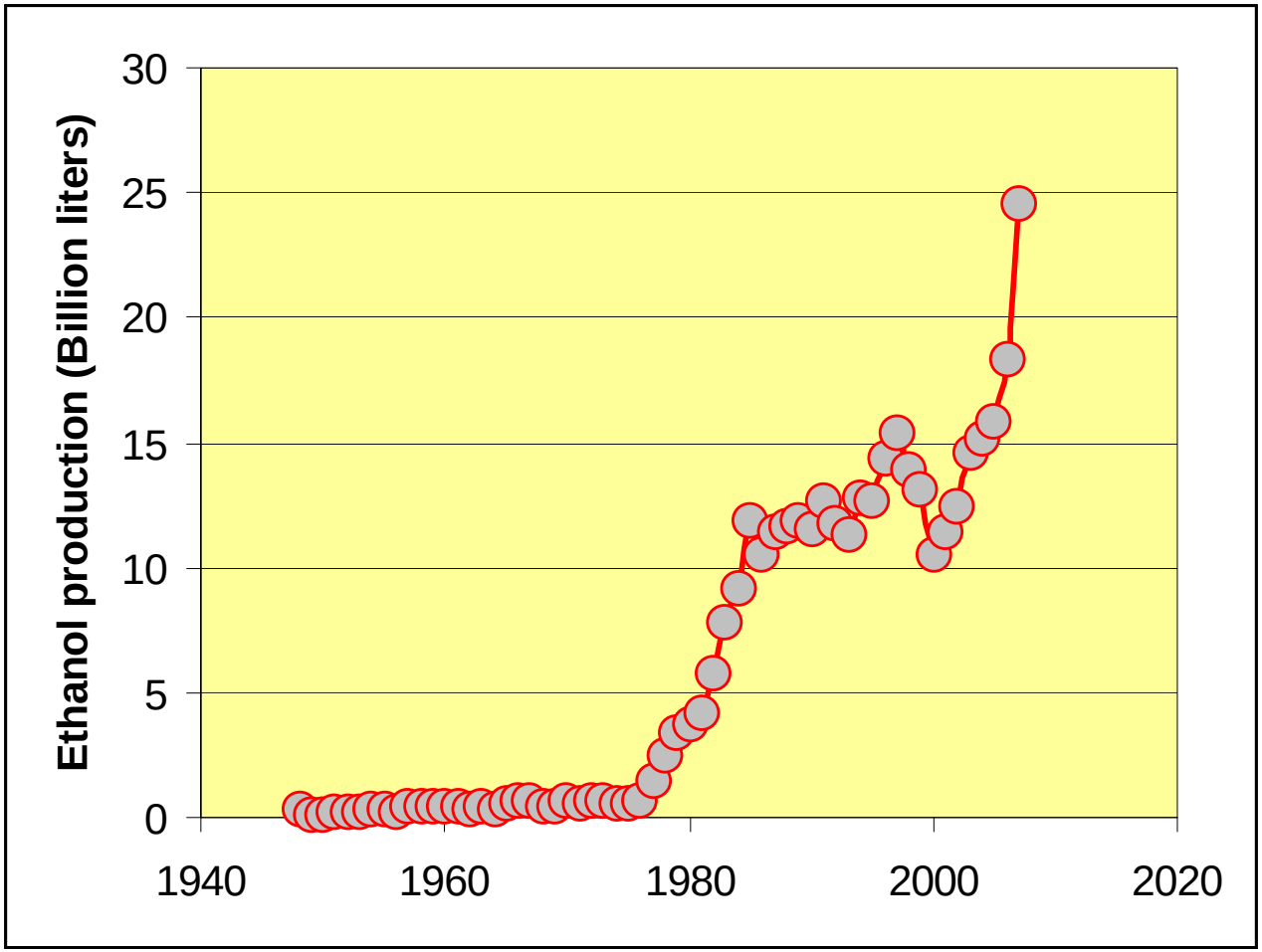


Ethanol: World Production

- Brasil is 2nd largest producer
- In 2005:
  - Brazil 35% (cane)
  - USA 35% (corn)
- Brazilian production
  - Sucrose: 1/3 of cane
  - Cellulose used for energy



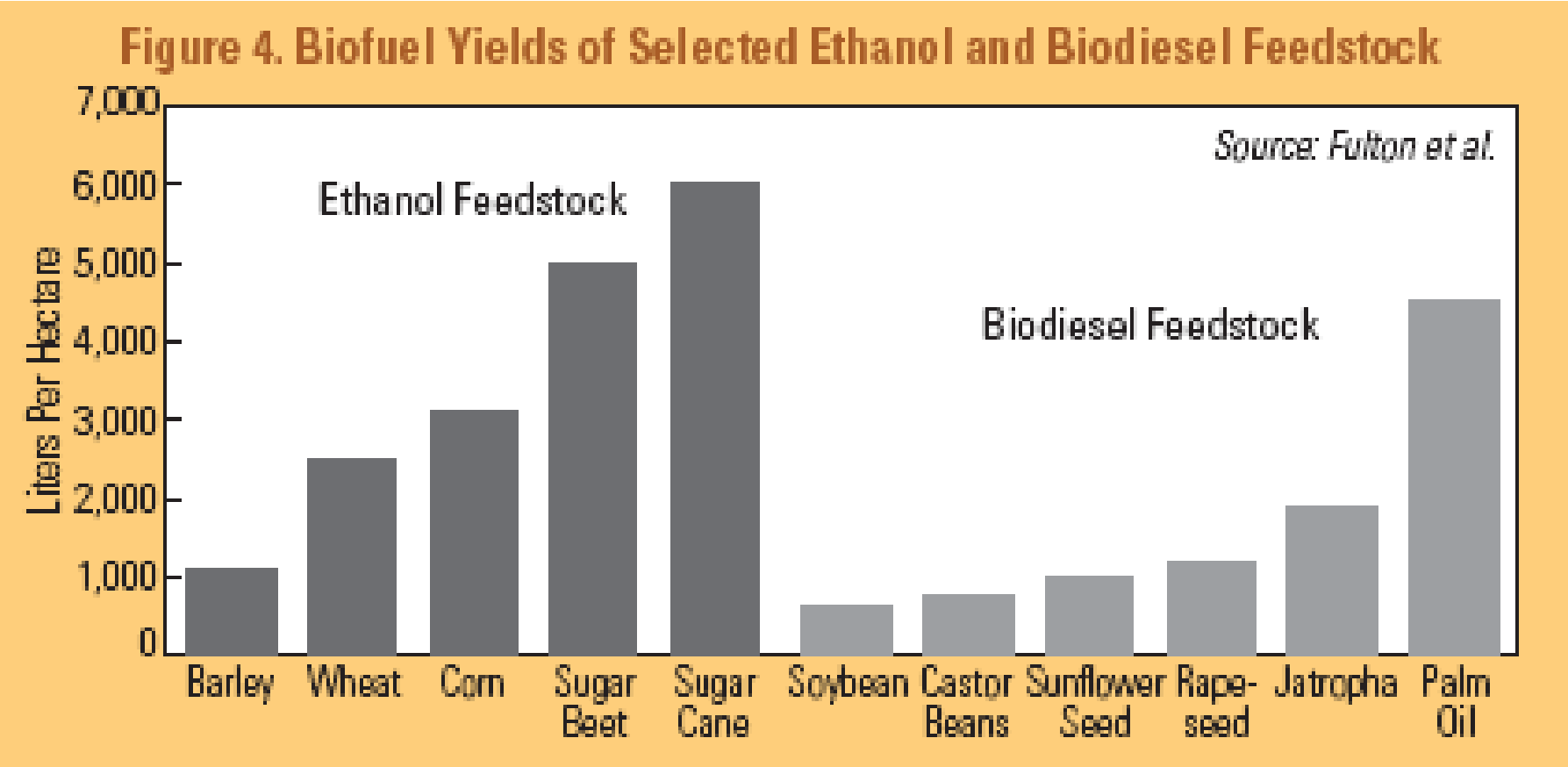
Brazil: Ethanol production 1948-2007



- 1975: Proalcool Program
- 2003: Flex-fuel vehicles
  - 90% of new vehicle sold are Flex
- Gasoline has 25% Ethanol added
  - No pure gasoline in Brazil

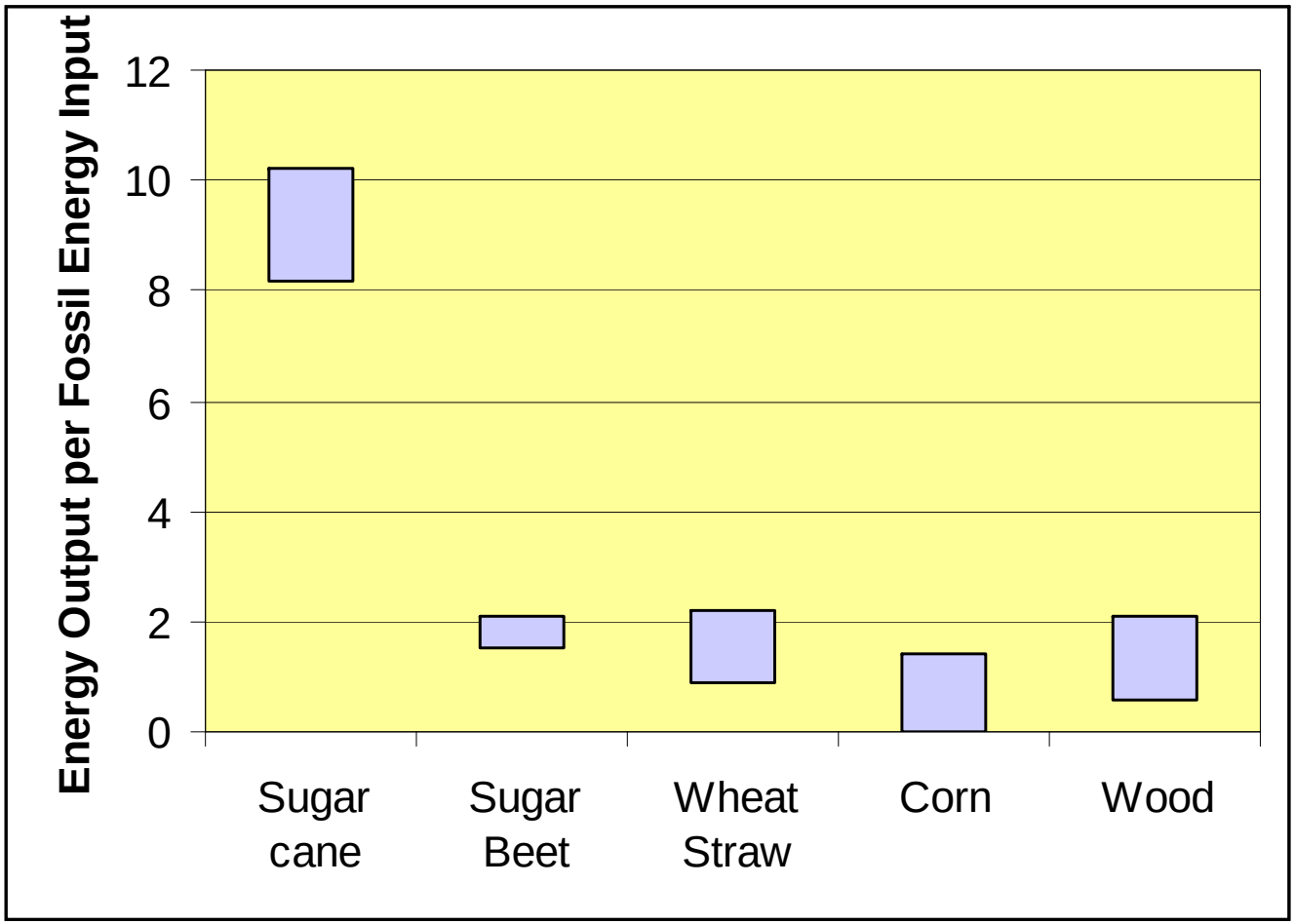
Gasoline is the ALTERNATIVE fuel in Brazil

Biofuel yield per hectare

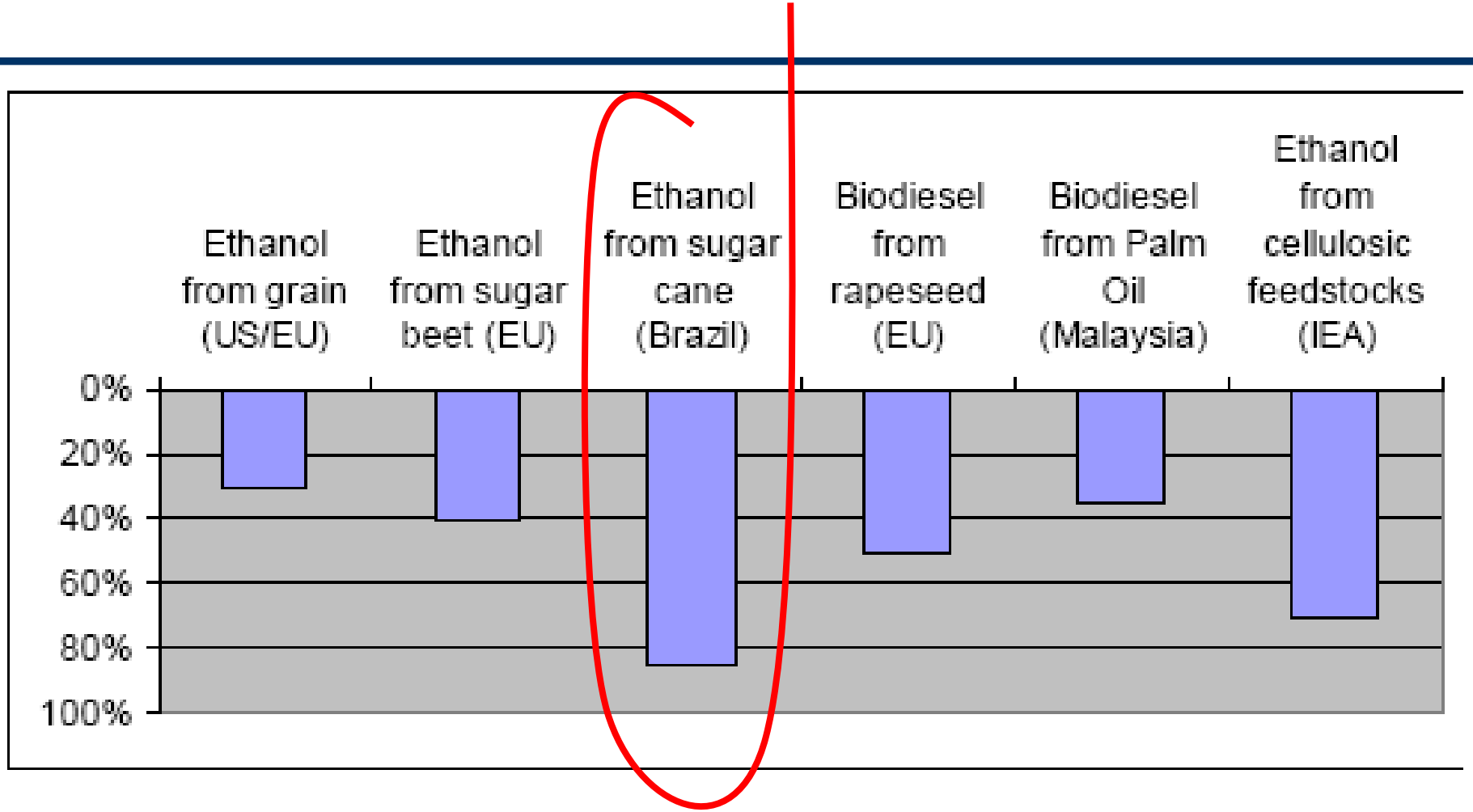


World Watch 2006, http://www.worldwatch.org/system/files/EBF008_1.pdf

Energy balance



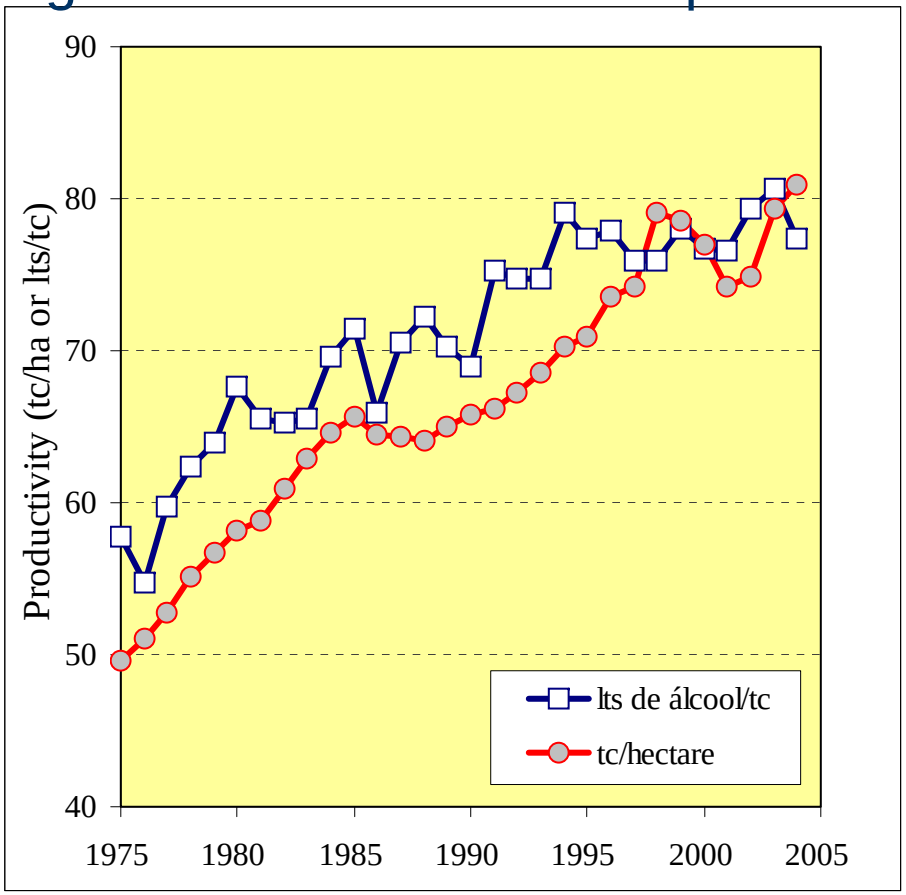
GHG reduction



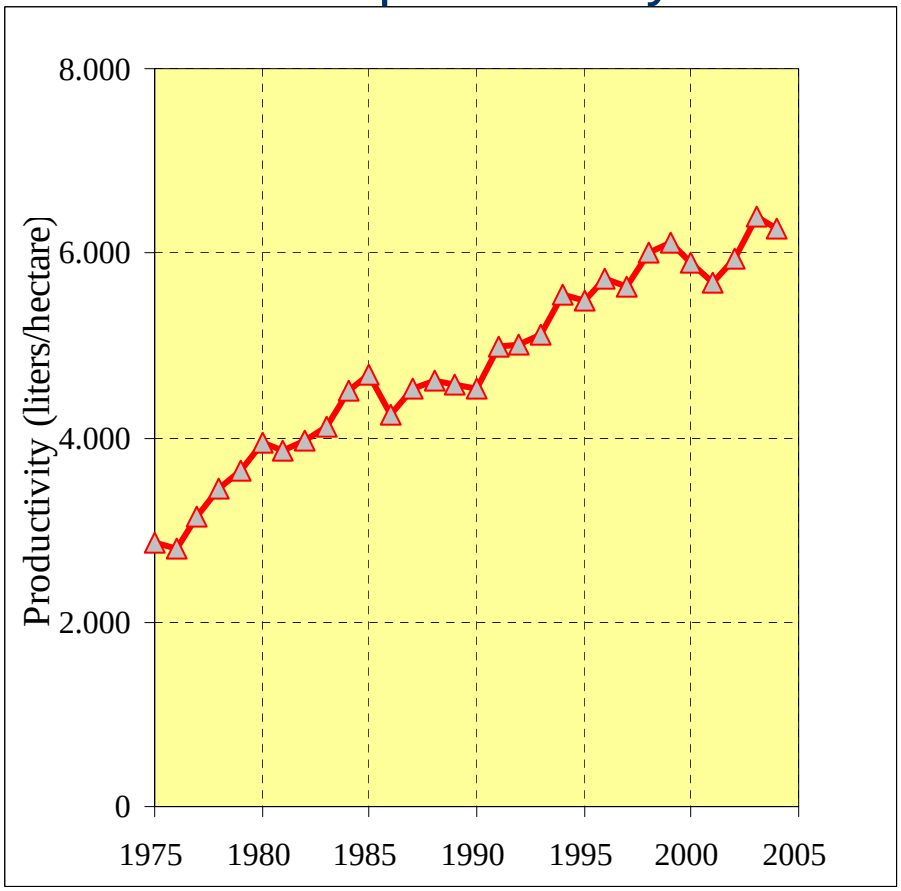
Doornbosch and Steenblik, OECD 2007

Increase in productivity through R&D

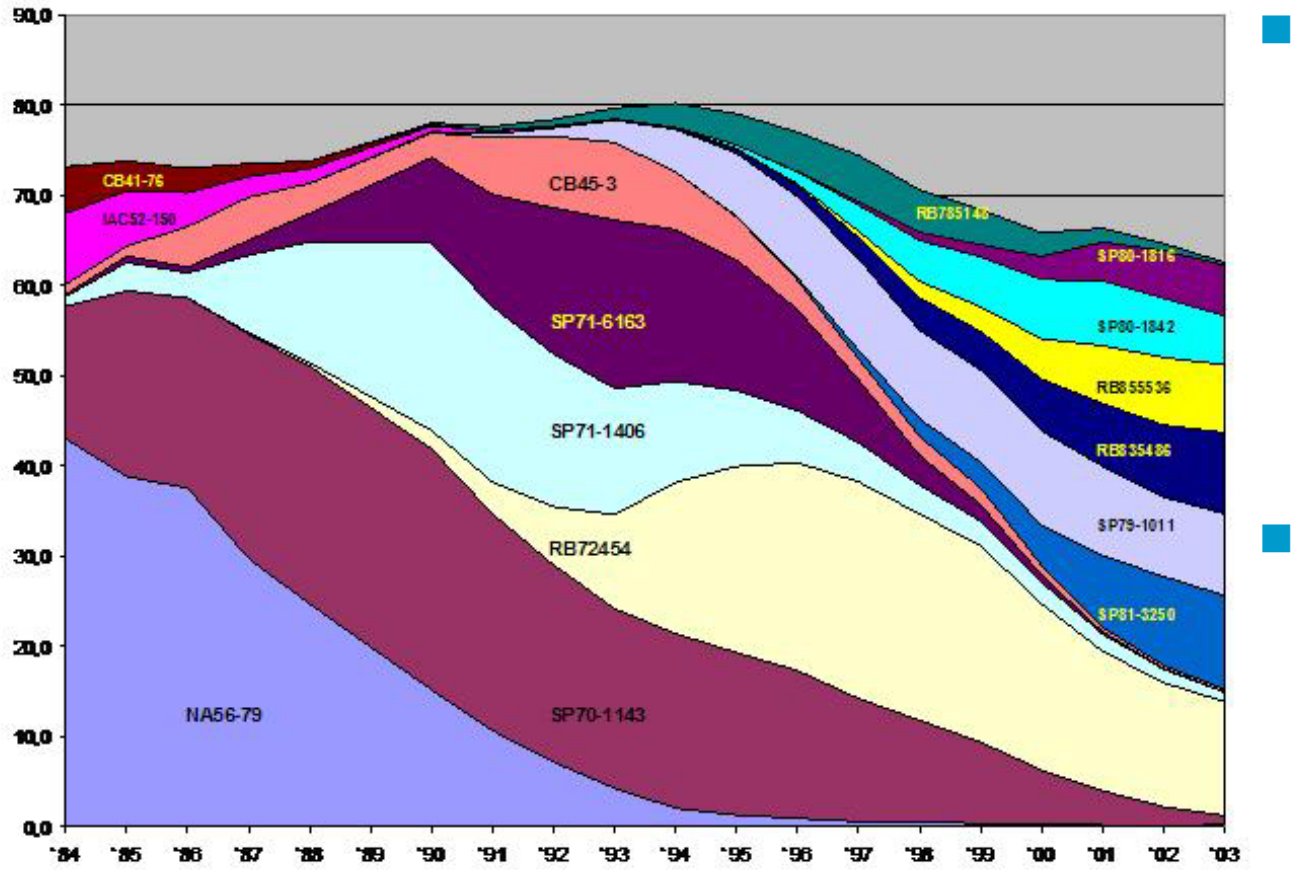
Agricultural and Industrial product.



Total productivity



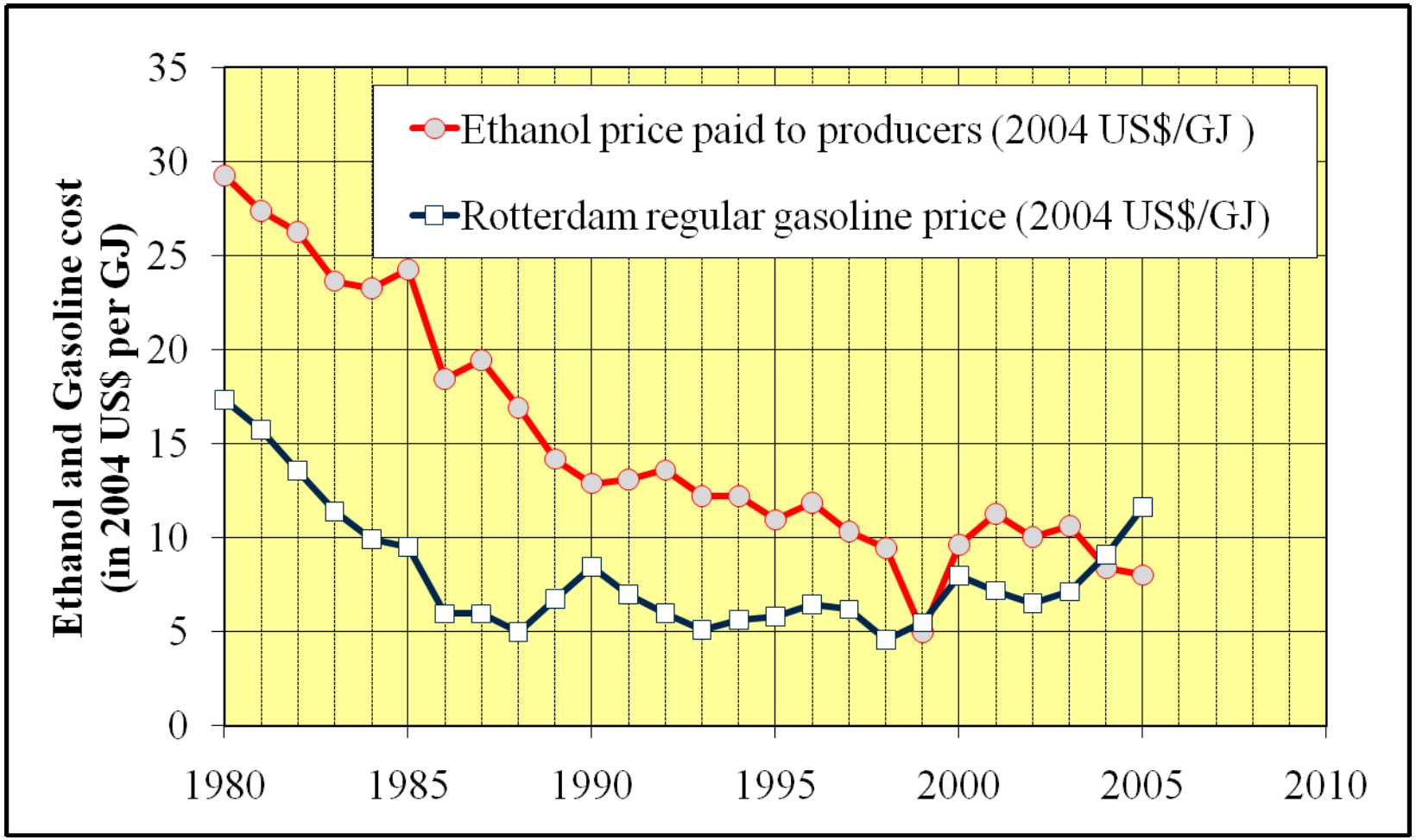
Number of Sugarcane varieties used in Brazil



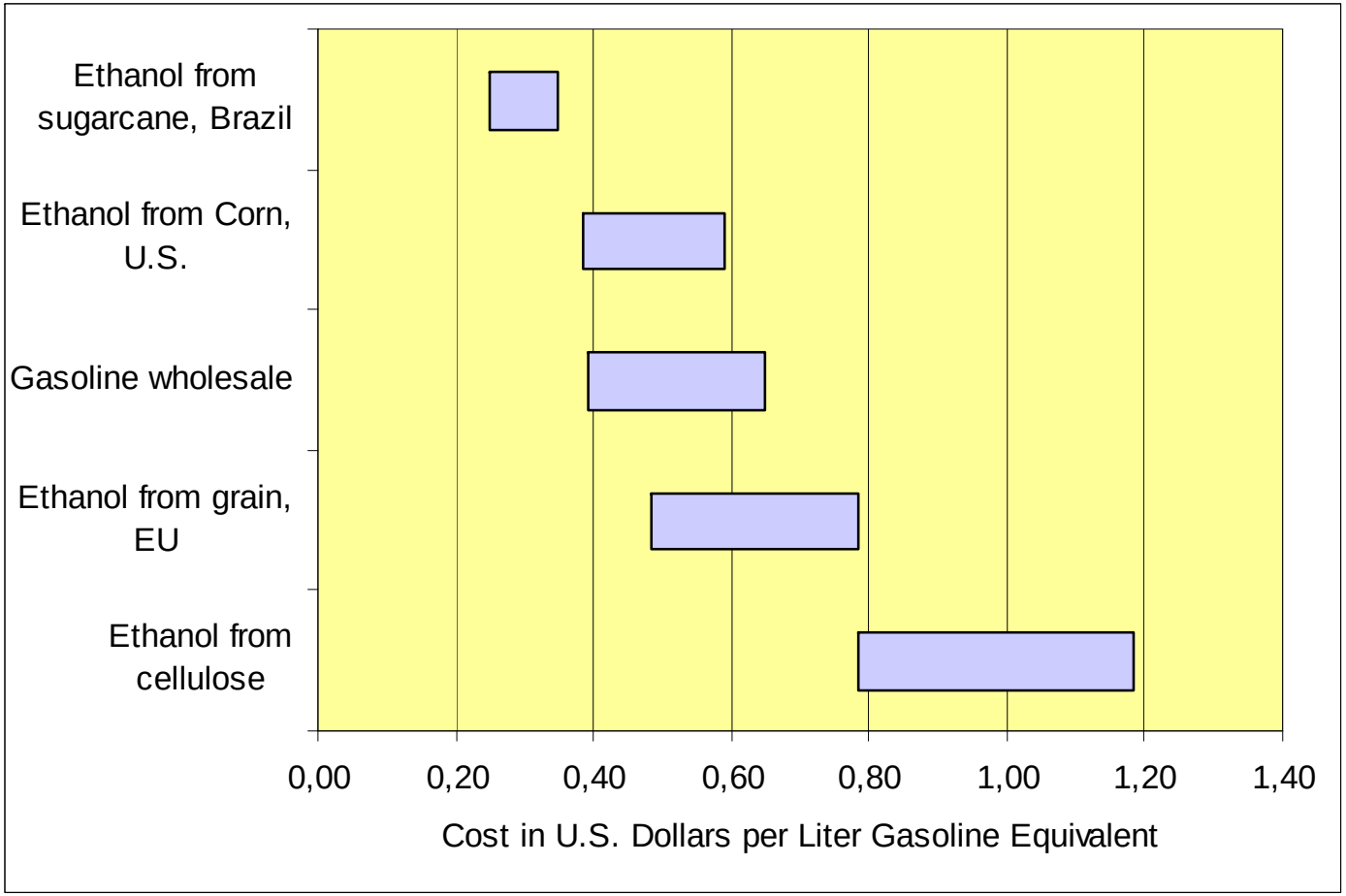
1984 1994 2003

- Developed by 3 research organizations
  - CTC
  - Ridesa
  - IAC
- Plus private companies
  - Alellyx
  - Canaviallis

Ethanol costs x Gasoline



Biofuels costs



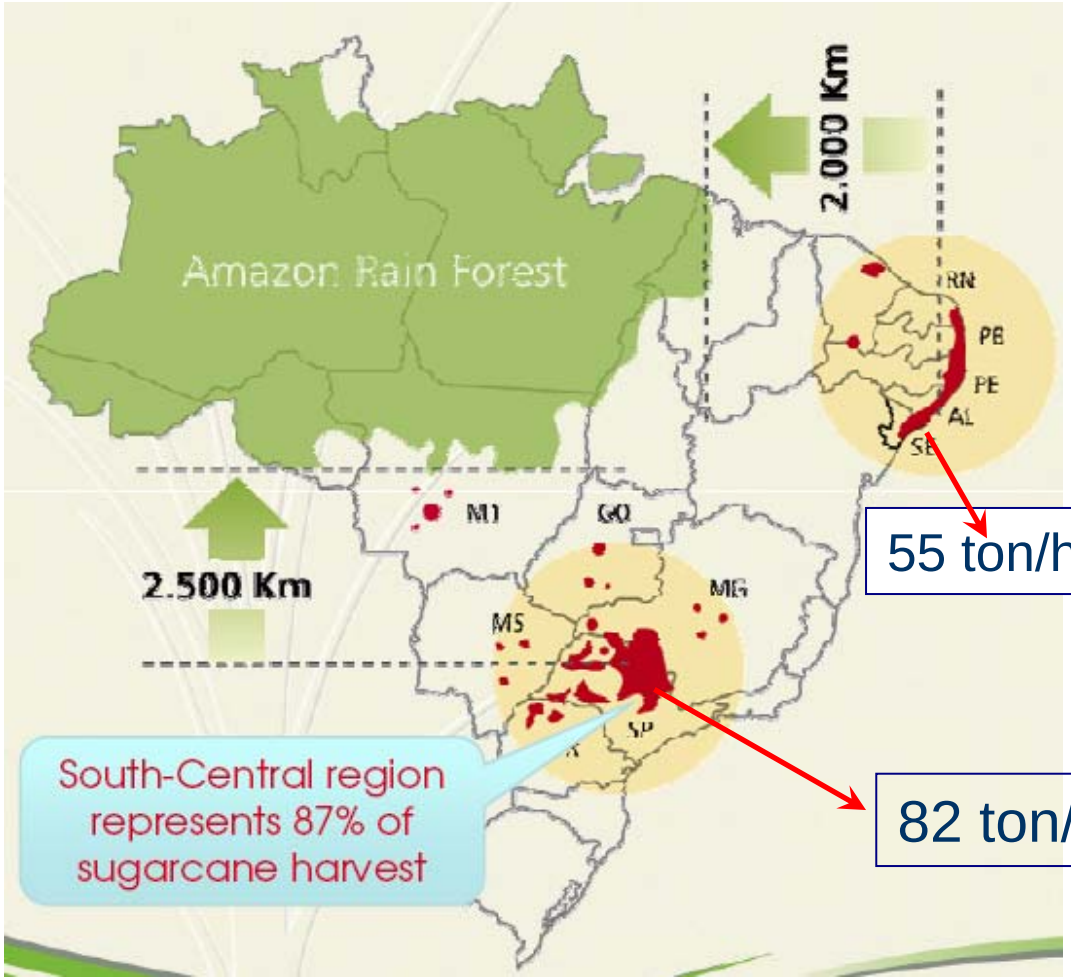
World Watch 2006, http://www.worldwatch.org/system/files/EBF008_1.pdf

Brazil: 1% of arable land displaces 50% 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%

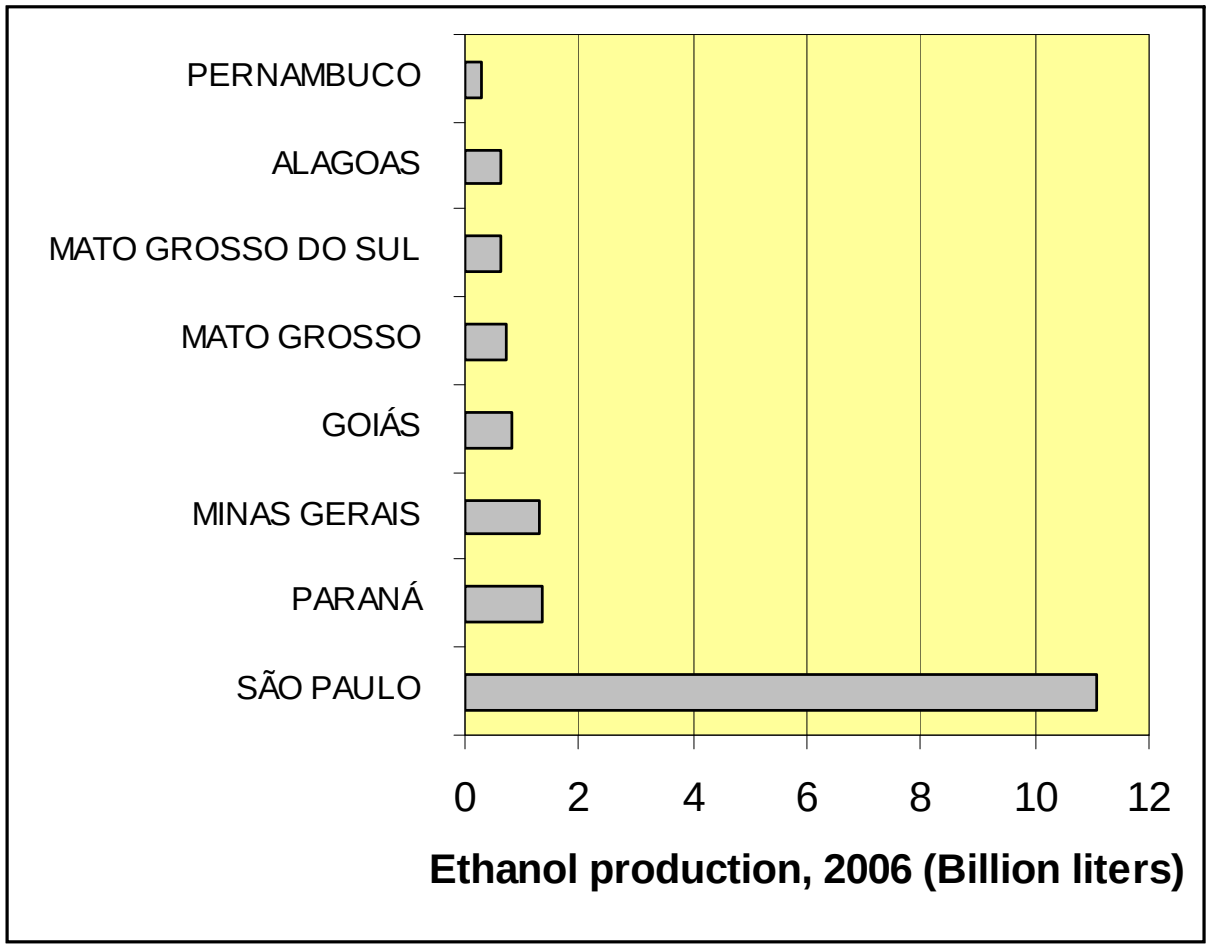
Source: UNICA

Where does Brazil plant Sugarcane?



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

Brazilian Ethanol production, by State

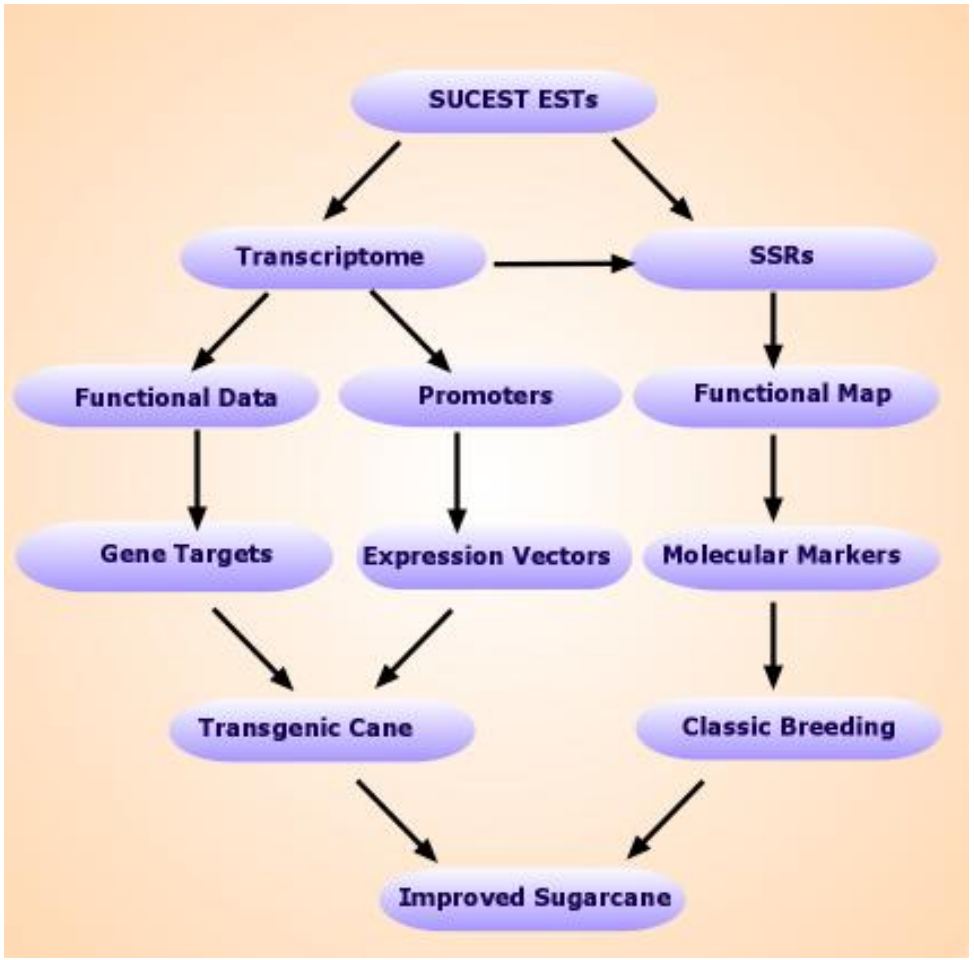


- São Paulo
  - 62% of Brazilian Ethanol
- Makes the State 2nd to the U.S.
- São Paulo hosts most of the R&D in sugarcane and ethanol in Brazil
  - IAC, CTC, CTBE, Ridesa, USP, Unicamp, Unesp, UFSCAR

Programa FAPESP BIOEN

- Mobilizar a comunidade de pesquisa em São Paulo para os desafios da Bioenergia
- Desafios
  - Produtividade,
  - Processos industriais,
  - Alcoolquímica,
  - Motores
  - impactos – sociais, ambientais, econômicos
- Usar a base existente

FAPESP: SUCEST Program



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

FAPESP Genome Program
SUCEST
The Sugar Cane EST Project

SUCEST Project
FAPESP, 1999 - 2004

Genome Research

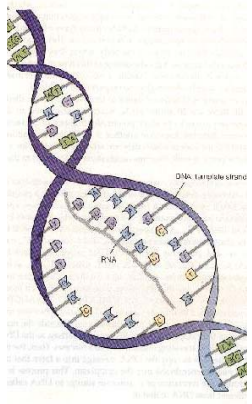
13:2725–2735 ©2003 by Cold Spring Harbor Laboratory Press ISSN 1088-9051/03 $5.00; www.genome.org

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

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

50 labs

200 researchers



238000 ESTs

43000 Transcripts

SUCEST-FUN Project

BMC Genomics

BioMed Central

Research article

Open Access

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

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

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

Received: 18 August 2006

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Int J Plant Genomics. 2008; 2008: 458732.

Published online 2007 December 16. doi: 10.1155/2008/458732.

PMCID: PMC2216073

Sugarcane Functional Genomics: Gene Discovery for Agronomic Trait Development

M. Menossi,[1] M. C. Silva-Filho,[2] M. Vincentz,[1] M.-A. Van-Sluys,[3] and G. M. Souza[4*]

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

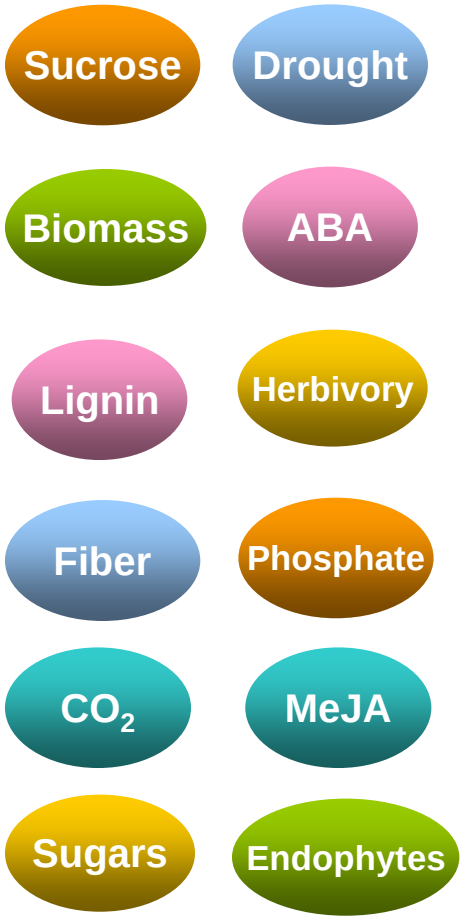
By

F.S. PAPINI-TERZI[1*], J.M. FELIX[2*], F.R. ROCHA[1], A.J. WACLAWOVSKY[1], E.C. ULIAN[3], S. M. CHABREGAS[3], M.C. FALCO[3], M.Y. NISHIYAMA-JR[1], R.Z.N. VÊNCIO[4], R. VICENTINI[2], M. MENOSSI[2] and G.M. SOUZA[1]

DNA Research 12, 27–38 (2005)

Transcription Profiling of Signal Transduction-Related Genes in Sugarcane Tissues

Flávia Stal Papini-Terzi,[1,†] Flávia Riso Rocha,[1,†] Ricardo Zorzetto Nicoliello Vêncio,[2] Kátia Cristina Oliveira,[1] Juliana de Maria Felix,[3,4] Renato Vicentini,[4] Cristiane de Souza Rocha,[4] Ana Carolina Quirino Simões,[1] Eugênio César Ulian,[5] Sônia Marli Zingaretti di Mauro,[6] Aline Maria Da Silva,[1] Carlos Alberto de Bragança Pereira,[2] Marcelo Menossi,[3,4] and Gláucia Mendes Souza[1,*]



FAPESP

Maps and Markers

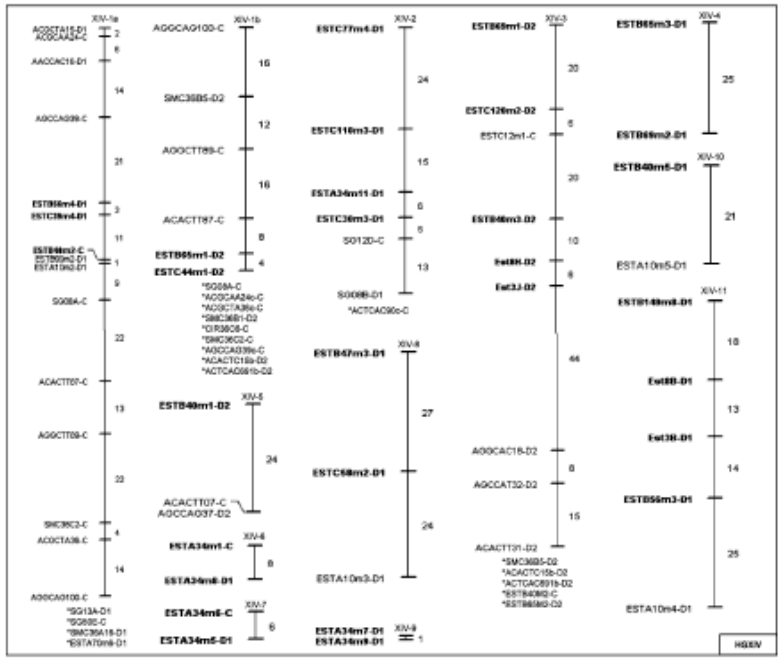
Mol Breeding (2007) 20:189–208
DOI 10.1007/s11032-007-9082-1

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

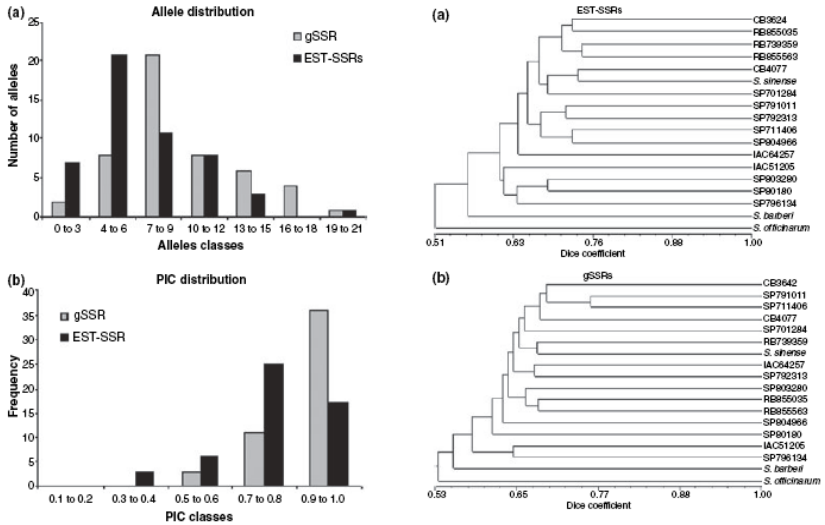
Development of an integrated genetic map of a sugarcane (*Saccharum* spp.) commercial cross, based on a maximum-likelihood approach for estimation of linkage and linkage phases

Hereditas 144: 78–79 (2007)

OneMap: software for genetic mapping in outcrossing species

G. R. A. MARGARIDO[1], A. P. SOUZA[2] and A. A. F. GARCIA[1]

[1]*Department of Genetics, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo (USP), Piracicaba, São Paulo, Brazil*
[2]*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

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

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

SUCEST: Gene Discovery and Functional Genomics

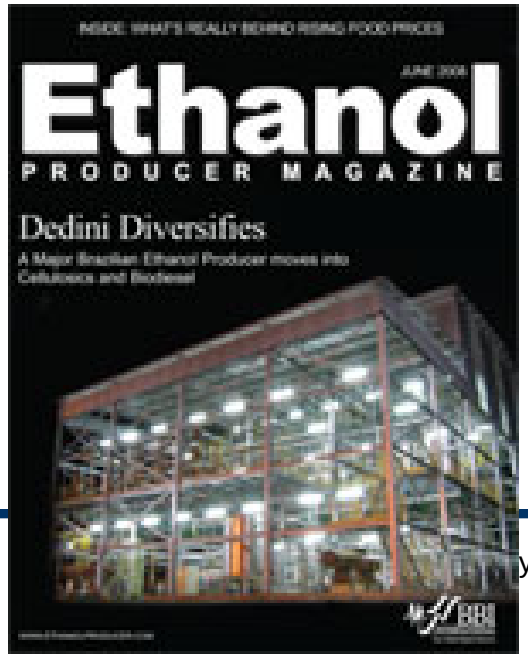
- Genes associated to traits of interest
- In association with planters R&D center
  - Sugarcane Transcriptome Project (University of São Paulo, USP)
    - Over 1,000 trait genes (sucrose, herbivory, drought, nutritional responses) identified through genomics tools applied to the study of the Brazilian 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

Biotechnology + Breeding knowledge

- Target genes which migh help in
  - Increasing yield, and
  - Expansion to pasture land (subject to extended drought season)
  - Easing the need for expansion of planted area
- The SUCEST-FUN Database
  - an integrated database for sequences, expression data, markers, germplasm and transgenics characteristics

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

Road Map Tecnológico

- Projeto do Programa Políticas Públicas
  - Unicamp e APTA
  - 01/08/2006 a 31/07/2008
- 13 Workshops
  - Position Papers
  - >100 participants
- Presentation later today

13 Road map Workshops

Tecnologia Agrícola 1	Controle Biológico e Pragas	ESALQ/USP
Tecnologia Agrícola 2	Modelagem, Nutrição Vegetal e Fertirrigação	ESALQ/USP
Tecnologia Agrícola 3	Melhoramento Genético e Genoma da Cana	IAC/APTA
Tecnologia Agrícola 4	Colheita, Transporte, Recuperação da Palha	CTC
Tecnologia Industrial 1	Limpeza, Extração e Tratamento	CTC
Tecnologia Industrial 2	Fabricação do Açúcar	UFSCar
Tecnologia Industrial 3	Fabricação do Etanol	FAENQUIL
Tecnologia Industrial 4	Processo de Energia e Cogeração	UNICAMP
Tecnologias Inovativas 1	Hidrólise	IPT
Tecnologias Inovativas 2	Alcoolquímica e Sucroquímica	UNICAMP
Tecnologias Inovativas 3	Automação e Controles	EMBRAPA
Ambiente Externo	Sustentabilidade Ambiental, Social e Econômica	IEA/APTA
Ambiente Interno	Gerenciamento da Agroindústria Canavieira e Infra-estrutura	Unesp

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

1. Improvements in the feedstock: building a better cane plant for energy
2. Production of Ethanol and other products: hydrolysis, pyrolisis, 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

FAPESP's BIOEN

- Academic Basic and Applied Research
  - Advancement of knowledge: Thematic/Pronex
    - R$ 20 + R18 milhões
  - Regular Grants and Young Investigator Awards
    - R$ 5 + R$ 5 milhões
  - Fapesp-Fapemig agreement
    - R$ 3 + R$ 2 milhões
- Joint industry-university research

Company	Subject	Value
Oxiteno	Lignocellulosic materials	R$ 6,000,000
Braskem	Alcohol-chemistry	R$ 50,000,000
Dedini	Processes	R$ 100,000,000