



# **Workshop on the Impact of New Technologies on the Sustainability of the Sugarcane /Bioethanol Production Cycle**

Poster Session for Research Group Presentations

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**ABSTRACTS**

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Centro de Ciência e Tecnologia do Bioetanol



# Workshop on the Impact of New Technologies on the Sustainability of the Sugarcane /Bioethanol Production Cycle

Ethanol from sugarcane: quest for real benefits for present and future generations



**Centro de Ciência e Tecnologia do Bioetanol**  
May 14-15th, 2009 – Campinas - SP, Brazil

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Antonio Bonomi

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Marcelo Pereira da Cunha



# Presentation

Biofuels have been presented as an alternative for oil products in the transport sector, motivated mainly by nations' energy security, the necessity of mitigation of greenhouse gases emissions and by the opportunity to induce rural development through biofuels production (i.e., jobs creation, better living conditions, and so forth).

Gradually, a consensus is being created that the production and consumption of biofuels should generate real benefits to humankind, either considering environmental or socio-economic aspects. It is desired that biofuels should minimize environmental impacts, both at local and global levels, and should bring socio-economic benefits to the social segments directly related to its production.

The debate towards sustainability of biofuels production and their use has reached a global dimension and Brazil has an important role to assume. Brazil is the worldwide leader in large-scale production of fuel ethanol from sugarcane and one of the few countries to have potential to significantly expand its production for export. However, it is the effective sustainability of the ethanol supply chain that may boost the Brazilian comparative advantages, which result from its long experience in producing this renewable fuel and favorable conditions regarding production factors.

The Bioethanol Science and Technology Center (Centro de Ciência e Tecnologia do Bioetanol - CTBE) must contribute for keeping Brazilian leadership regarding sustainable production of bioethanol from sugarcane, through state-of-the-art research, development, and innovation. Sustainability is an essential topic to guide CTBE's actions. Nowadays, CTBE focuses on the implementation of no-tillage farming of sugarcane, on the development of second-generation ethanol technology based on the biochemical route and on the development of a tool able to analyze new industrial technologies.




The Workshop on the Impact of New Technologies on the Sustainability of the Sugarcane/Bioethanol Production Cycle is one of the CTBE's activities to ensure the reduction of negative impacts and the enlargement of benefits related to the sustainability of the production and use of Brazilian ethanol. The main purposes of this event are listed below:

- (i) evaluation of essential aspects in the debate regarding sustainability of biofuels (with focus on the Brazilian ethanol production from sugarcane);
- (ii) identification of the state-of-the-art knowledge and Brazilian scientific and technical expertise;
- (iii) discussion of sustainability criteria and the methodologies for their evaluation, focusing on the new technologies for bioethanol production;
- (iv) discussion and possible definition of priorities and actions on RD&I to guarantee the effective sustainability along the ethanol supply chain.




In summary, this Workshop aims at identifying different points of view of the main bioethanol stakeholders in Brazil, presenting a preliminary CTBE's proposal on sustainability and finally helping CTBE to define a strategy on how to act, on this subject, as a National Laboratory.




# Program

# May 14th

 09:00  Opening Session  Marco A. P. Lima - CTBE  
Lúcia Melo - CGEE




## Morning Session - INSIGHTS ON SUSTAINABILITY

 09:30  Sustainability of Bioethanol:  
The Vision of CTBE  Arnaldo Walter - CTBE

 10:10  Global Opportunities for  
Sustainable Bioethanol  Marcelo Poppe - CGEE

 10:50  Coffee Break




 11:10  Insights on Sustainability: UNICA's  
Vision  Alfred Szwarc - UNICA

 11:50  Sugarcane in Brazil: Production,  
Research, Development and Sustainability  Jorge Luis Donzelli - CTC

 12:30  Lunch at ABTLuS Campus

## Afternoon Session - ONGOING PROJECTS



 13:30  The Employment and Sugar  
and Alcohol Sector  Danton Bini - Instituto de Economia Agrícola /  
Secretaria da Agricultura e Abastecimento - SP

 14:10  Biofuel Certification:  
The Green Ethanol Program  Oswaldo Lucon  
Secretaria do Meio Ambiente - SP

 14:50  Life Cycle Assessments  
for Bioethanol  Carlos A. Aragão de Carvalho Filho - Inmetro

## POSTER SESSION

 15:30  Oral Presentation of Posters Poster Abstract (1-3 minutes each Institution)

 16:20  Poster Session for Research Group Presentations Coffee break + Poster Exposition

 19:30  Dinner

# Program

# May 15th



## Morning Session - STATE-OF-THE-ART OF THE KNOWLEDGE



08:50



Soil Carbon Stock Change



Carlos C. Cerri - Esalq / USP



09:30



Evaluation of GHG Emissions / Mitigation in Ethanol Production / Utilization



Isaías Macedo - NIPE / Unicamp



10:10



Coffee Break



10:30



Paradox: Mechanization and Social Inclusion



Márcia Azanha - Esalq / USP



11:10



Water Sugarcane Mills Usage



André Elia Neto - CTC



11:50



The Brazilian Land Use Model and its Applications for Ethanol Impacts



Laura Barcellos Antoniazzi - ICONE



12:30



Lunch at ABTLuS Campus



## Afternoon Session - STRATEGIES FOR IMPLEMENTATION



13:30



BIOEN: the FAPESP Research Program on Bioenergy



Carlos H. de Brito Cruz - FAPESP



14:10



BNDES and the Sustainability of Ethanol Sector



Arthur Yabe Milanez - BNDES



14:50



Sustainability of the Sugarcane / Bioethanol Production Cycle: A Strategic Priority at Embrapa



Robert Michael Boddey  
Embrapa Agrobiologia



15:30



Sugarcane Agroecological Zoning



Eduardo Assad - Embrapa  
Informática Agropecuária



16:10



Coffee Break



16:40



Workshop Report  
(Conclusion of the two day WS)



Manoel Regis Lima Verde  
Leal - CTBE



17:15



Debate with the Audience



17:30



Closing Remarks



Marco A. P. Lima - CTBE

# Summary

## Poster Session for Research Group Presentations

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- The Sweet and Bitter Sides of the Sugarcane. An Integrated sustainability Assessment for the Brazilian Ethanol Context.....06
- Pretreatment of the Vegetal Biomass for Ethanol and Other Products Integrated Production .....08
- Impactos Socioeconômicos e Ambientais e Construção de Cenários em Áreas Tradicionais e de Expansão da Cana-de-açúcar no N-Ne do Brasil ..... 10
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# Sustainability of Bioethanol: the Vision of CTBE

## **Authors:**

Arnaldo Walter, Manoel Régis Lima-Verde Leal, Antonio Bonomi, Mirna Ivonne Gaya Scandiffio and Marcelo Pereira da Cunha

*Centro de Ciência e Tecnologia do Bioetanol (CTBE)*

## **Abstract:**

Sustainability of biofuels has been seen as an essential condition for trading and, theoretically, a producer/country with better environmental and socio indicators can take commercial advantages in this market. Brazil has many adequate conditions for large-scale production of ethanol and could enlarge its competitive advantages improving its sustainability indicators. On the other hand, sustainability of ethanol should be a target in itself for Brazilians, as the whole society must get benefits from this economic activity. The talk will focus on the CTBE's vision regarding sustainability of ethanol production from sugarcane and also on presenting the preliminary proposal of action in this topic, as a national laboratory.

# Instituto de Economia Agrícola

## **Authors:**

Valquíria da Silva, Danton Leonel de Camargo Bini and Sergio Torquato Alves  
*Instituto de Economia Agrícola / Secretaria da Agricultura e Abastecimento-SP*

## **Abstract:**

**Mission:** To produce, adapt and transfer scientific knowledge and information in the field of economics applied to agricultural issues, aimed at sustainable development.

**Main Research and Study Themes:** Agricultural markets, Public policies, Regional development, Rural administration, Foreign trade, Environment, Socioeconomic relations, Statistics and Econometry, Bioenergy.

**Sustainability-Focused Actions:** Energetic Balance of Agricultural Crops (denyse@iea.sp.gov.br and castanho@iea.sp.gov.br) Technical Coefficient Matrices of Production Systems Program in Hydrographic Micro-Basins (GEF/ World Bank) The Agro-environmental Protocol (valsilva@iea.sp.gov.br and storquato@iea.sp.gov.br): Cooperation Protocol between São Paulo State Government and the Paulista Sugar and Alcohol Sector (Sugar and Alcohol Mills and South Central Brazil Sugar Cane Growers Organization) Core Indicators for the Agricultural Sector within the sustainability context: São Paulo State's Western Region Project of Restoration of Ciliary Forests - 5 components (GEF/ World Bank)

**Bioenergy Data Base:** [www.iea.sp.gov.br](http://www.iea.sp.gov.br)

# Monitoring and Minimizing GHG Emissions from Sugarcane Production: Ongoing Research at Embrapa Agrobiologia

## Authors:

Robert M. Boddey, Bruno J.R. Alves, Segundo Urquiaga, Luis Henrique de B. Soares, Veronica M. Reis and José Ivo Baldani

*Embrapa Agrobiologia*

## Abstract:

Embrapa Agrobiologia has been engaged in research on the sugarcane crop form over 20 years. The main research theme was originally to understand the process, and quantify the inputs, of biological N<sub>2</sub> fixation (BNF) which has led to the successful production of a multi-bacterial inoculant at present under test in a national network of trials. The resulting economy of N fertilizer reduces GHG emissions associated with manufacture and application of the fertilizer. Long term trails on the impact on GHG from conversion to green-cane harvesting have also been published. Recently, GHG budgets have been published on the production cycle of ethanol from sugar cane. Actual objectives include the deepening of the basic understanding of sugar cane-associated N<sub>2</sub> fixation, and estimating GHG emissions from LUC and field applications of N fertilizer and vinasse.

# The Sweet and Bitter Sides of the Sugarcane. An Integrated Sustainability Assessment for the Brazilian Ethanol Context

## **Author:**

Tadeu F. Medeiros

*Escola de Engenharia de São Carlos - USP*

## **Abstract:**

The growing international discussion on the role of global warming and renewable energy boosts up once again the interest for bio-fuels. But there is, yet, a significant anxiety of the Brazilian society, as well as an international one, potential consumer of the Brazilian ethanol, about the present patterns of sugarcane cultivation and ethanol production impact balance. The current modus operandi of public policy formulation and implementation, based on punctual and setorized socioenvironmental impact assessment, limits and hides complex productive system functioning essential factors, as observed for the sugarcane ethanol context, enlarging ethanol production sustainability compromising risks. One of the knowledge gaps is exactly in the methodology design, that will make it possible to integrate the various sustainability elements, following principles of sustainability tailored to the sugarcane ethanol, as well as interiorize assessment process in the sociopolitical context of decision making in this theme. Therefore, the research project "The Sweet and bitter sides of the sugarcane. An integrated sustainability assessment for the Brazilian ethanol context" has the general aim of developing and applying an ISA methodology of sugarcane ethanol to the State of São Paulo. It is an exploratory research, and the research scientific means proposed are bibliographic research, workshop, DELPHI, seminars and case study. Two important results are the scientific discussion, with the engagement of stakeholders, about the concept of sustainability applied to ethanol context, and the proposition of a sugarcane ethanol ISA Methodology available for use by the governmental and nongovernmental institutions

actuating in the bioenergy area and also for institutions involved with the BIOEN Program.

**Participant Institutions:**

- NEPA - Núcleo de Pesquisa de Política Ambiental - Escola de Engenharia de São Carlos – USP
- ESALQ - Escola Superior de Agricultura - Luiz de Queiroz - USP
- EACH – Escola de Artes, Ciências e Humanidades - USP
- IEA – Instituto de Economia Agrícola – Secretaria da Agricultura e Abastecimento – Estado de São Paulo
- EMBRAPA – Empresa Brasileira de Pesquisa Agropecuária
- IMAFLORA - Instituto de Manejo e Certificação Florestal e Agrícola
- Leibniz-Centre for Agricultural Landscape Research (ZALF)
- University of Michigan - School of Natural Resources and Environment



# Pretreatment of the Vegetal Biomass for Ethanol and Other Products Integrated Production

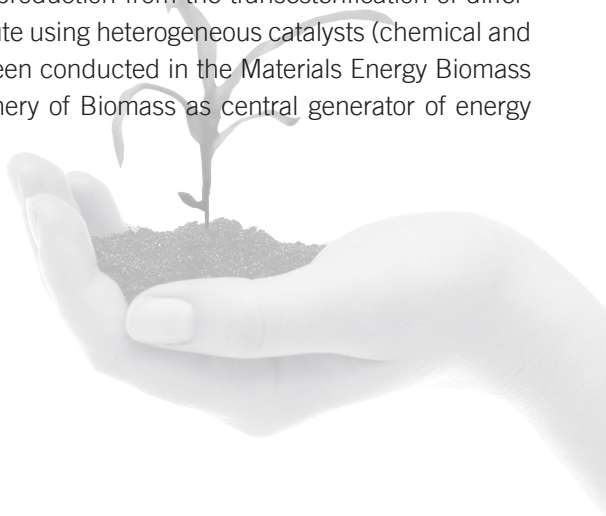
## **Authors:**

Maria das Graças de Almeida Felipe and Adilson Roberto Gonçalves  
*Escola de Engenharia de Lorena / Universidade de São Paulo*

## **Abstract:**

The Engineering School of Lorena – USP was part of the history of the development of the biofuels in the country with the first Pilot Plant prior to implementation of PROAL-COOL and in the obtainment of alcohol from cassava and integral use of vegetal biomass. Nowadays the necessity to reduce pollutant gaseous emissions has increased, consequently efforts have been done to use renewable raw materials in substitution to fossil fuels. In this context, researchers from EEL-USP have directed researches projects on the integrated use of vegetal biomass, including the sugarcane bagasse and straw in the different stages of the process of ethanol production, as pretreatment, hydrolysis and fermentation. The recent activities of the researchers group can be detached in several projects in development supported by FAPESP, CNPq, CAPES and FINEP. Among the different national and international projects developed in the Institution, the participation of researchers is detached in the coordination of the projects: Bioethanol (FINEP); Ethanol and xylitol biotechnological production and xylose crystallization from the hemicellulosic fraction of the sugarcane bagasse (FAPESP/Oxitenó); Ethanol bioproduction from xylose using lignocellulosic materials (FAPESP/Oxitenó); Sugars and glycols from the hydrolysis and delignification of sugarcane straw and bagasse and fast characterization of lignocellulosic materials (FAPESP/Oxitenó); Innovation in processes of detoxification of hemicellulosic hydrolysates of cane bagasse using functional membranes aiming the obtainment of products (xylitol) by biotechnological route (International Cooperation Brazil/United States-CNPq CNPq/National Science

agave bagasses for the obtainment of polymeric membranes (Bilateral Cooperation Brazil/Mexico – CNPq); Influence of the conditions of cane bagasse pretreatment with diluted sulfuric acid on the cellulose enzymatic saccharification (INCT/CNPq). There is also the participation of researchers in the project Public Politics Directions for the cane agro-industry of São Paulo State (FAPESP); Selection and biochemical-molecular characterization of clones of sugarcane and of lignocellulolytic microorganisms aiming the maximization of the saccharification and fermentation from the bagasse for the cellulosic alcohols production (MCT-CT AGRO/CT BIO). In the context of bioenergy, there are researches for the biodiesel production from the transesterification of different lipid raw materials through ethyl route using heterogeneous catalysts (chemical and biochemical). Researches have also been conducted in the Materials Energy Biomass Program – PROBEM, having the Refinery of Biomass as central generator of energy and raw materials from biomass.



# Impactos Socioeconômicos e Ambientais e Construção de Cenários em Áreas Tradicionais e de Expansão da Cana-de-açúcar no N-Ne do Brasil

## **Authors:**

Nilza P. Ramos; Eunice R. Batista; Ariovaldo Luchiari Jr; Edmar R. de Siqueira; José M. G. Ferraz; Marcos C. Neves; Otávio V. Balsadi; Antônio D. Santiago e Equipes  
*Embrapa*

## **Abstract:**

A inclusão da agroenergia nas prioridades governamentais brasileiras tem estimulado sobremaneira a expansão de cultivos agrícolas, tanto de cana-de-açúcar como de oleaginosas. Para o sucesso competitivo dessa expansão há necessidade de organização e planejamento dentro das cadeias produtivas considerando questões tais como: competição com alimentos, uso dos recursos naturais, mudanças climáticas e eficiência energética. Para atender a esta demanda a Embrapa vem desenvolvendo um projeto denominado “Impactos sócio-econômicos e ambientais e cenários futuros, para as áreas tradicionais e de expansão”, que se constitui em um dos Projetos Componentes do Projeto em Rede “Produção sustentável da cultura da cana-de-açúcar para bioenergia em regiões tradicionais e de expansão no N-NE do Brasil”. Este macroprojeto iniciou-se em 2006 e faz parte do tema “Grandes Desafios Nacionais”; envolvendo uma ampla equipe de pesquisadores distribuídos por várias Unidades da Embrapa. O objetivo geral é desenvolver sistemas produtivos sustentáveis para a cana-de-açúcar nas áreas tradicionais de cultivo e de expansão, utilizando como estratégia de ação a condução e integração de 6 projetos componentes cujos objetivos primordiais são: PC1- Gerir o projeto; PC2- Desenvolver materiais resistentes ou tolerantes a pragas e ao déficit hídrico; PC3- Otimizar a contribuição da fixação biológica de nitrogênio na nutrição da cultura; PC4- Identificar o potencial e as limitações de paisagens, principalmente em áreas de expansão, e auxiliar o desenvolvimento de sistemas de previsão de safras; PC5- Avaliar impactos sócio-econômico-ambientais e elaborar cenários futuros, para

as áreas tradicionais e de expansão e PC6- Desenvolver alternativas tecnológicas, com ênfase em otimização da tecnologia de irrigação, do uso do nitrogênio e para controle biológico da broca gigante (*Castnia licus*). O Projeto Componente 5, apresenta caráter transversal em relação ao projeto como um todo, dada a natureza de seus objetivos primordiais que são a) obter um diagnóstico agro-sócio-econômico e fundiário da cultura da cana-de-açúcar no N-NE do Brasil, b) Avaliar impactos ambientais comparando-os entre os diferentes sistemas de manejo da cana-de-açúcar e c) a partir de estudos prospectivos, elaborar cenários prováveis da intensificação e expansão do cultivo da cana-de-açúcar no N-NE do Brasil. Em síntese, os resultados deste projeto deverão orientar o rumo das pesquisas relacionadas à intensificação tecnológica e à expansão das áreas cultivadas, auxiliando também na obtenção de respostas aos questionamentos da sociedade, identificando oportunidades e ameaças, subsidiando em última instância, a elaboração de políticas públicas voltadas ao desenvolvimento sustentável do setor sucroenergético na região estudada. Espera-se contribuir positivamente com o avanço de questões sócioambientais relacionadas com o uso da terra, manutenção da qualidade dos recursos naturais, certificação e rastreabilidade do produto, questões essas que, no longo prazo serão fundamentais para garantir a competitividade desta cadeia produtiva de tamanha importância para o agronegócio brasileiro.

# Medições e estimativas de emissões de gases do efeito estufa e fixação de carbono no setor sucroalcooleiro

## **Author:**

Marcelo V. Galdos

*Delta CO2*

## **Abstract:**

A Delta CO2 - Sustentabilidade Ambiental é uma empresa de assessoria e consultoria técnico-científica incubada na EsalqTec, incubadora de empresas da Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo. A empresa atua na área de sustentabilidade ambiental com enfoque no agronegócio. No setor sucroalcooleiro, a empresa tem prestado serviço à cadeia produtiva desenvolvendo pesquisas e levantamentos relacionados à emissão de gases do efeito estufa (CO<sub>2</sub>, CH<sub>4</sub> e N<sub>2</sub>O) e fixação de carbono. Utilizamos técnicas de mensuração e estimativa, incluindo amostragens de campo e análises laboratoriais, sistemas de informação geográfica, sensoriamento remoto e modelagem matemática.

A Delta CO2 oferece uma série de serviços:

1. Inventários de gases do efeito estufa, com base em protocolos internacionais;
2. Projetos de redução de emissões de gases do efeito estufa;
3. Medições de fluxos de gases do efeito estufa nos sistemas agrícolas;
4. Quantificação de fixação de carbono no solo e na biomassa;
5. Verificação, validação e certificação ambiental;
7. Assessoria tecnológica em fontes de energia renovável;
8. Avaliação do impacto ambiental de mudanças de uso da terra;
9. Projetos de elaboração de “footprint” de carbono de produtos;
10. Projetos de avaliação de ciclo de vida de produtos.

# Agricef Soluções Tecnológicas para Agricultura Ltda

## **Author:**

Domingos Guilherme P. Cerri  
*Agricef*

## **Abstract:**

A Agricef é uma empresa de base tecnológica que atua no setor agrícola provendo soluções inovadoras para as necessidades de produtores rurais e usinas de açúcar e álcool, com o objetivo de elevar o desempenho de seus empreendimentos. A Agricef nasceu na incubadora de empresas da UNICAMP e está localizada próxima ao Parque Científico e Tecnológico de Campinas, com uma área destinada a atividades administrativas, de estudos e projetos técnicos e de montagem de máquinas e equipamentos. A empresa destaca-se por utilizar tecnologias de ponta para construir soluções eficientes e confiáveis que atendam as demandas de uma agricultura diferenciada. Os produtos da Agricef estão preparados para operar nas condições exigidas pelos modernos empreendimentos agrícolas sem perder de vista os fatores sociais e ambientais que são a base da sustentabilidade. Os produtos da Agricef são voltados para atendimento de demandas não convencionais da área agrícola, incluindo:

### **Máquinas e Equipamentos**

- Auxílios mecânicos para colheita
- Dispositivos de instrumentação e controle

### **Agricultura de Precisão**

- Mapeamento de atributos do solo
- Mapeamento de produtividade
- Aplicação variável de insumos

### **Consultoria**

- Projeto de máquinas e equipamentos para fins específicos
- Otimização de processos de colheita
- Ensaios de desempenho de máquinas e equipamentos

# Research and Development Program in Biotechnology at the Sugar-Alcohol Sector of Brazilian Northeast by CETENE

## **Authors:**

Reis, A.L.S.; Lins, M.C.M.; Barros, A.C.B.; Souza, N.A.F.; Campelo, B.G.  
*Centro de Tecnologias Estratégicas do Nordeste (CETENE)*

## **Abstract:**

The Centro de Tecnologias Estratégicas do Nordeste (CETENE) was built as Research unit of Ministério da Ciência e Tecnologia (MCT) since 2005, bound to Instituto Nacional de Tecnologia, Its mission is develop, insert and improve technological innovations which have strategic character for a social and economic development of brazilian northeast, promoting cooperation based on networks and industrial sector northeastern in its three actions areas: Biotechnology, Nanotechnology and microelectronics.

Within the MCT's activities the CETENE's obligations are inserted in five programs: Technologies for agrobusiness and social Insertion – Biofábrica Governador Miguel Arraes, Technologies for Biofuels – Bioethanol and Biodiesel, Technology Support for industry, development and cooperation of networks and institutional strengthening.

The Bioethanol activities are carry out at Laboratório de Biocombustíveis and Biofábrica Governador Miguel Arraes as detailed below.

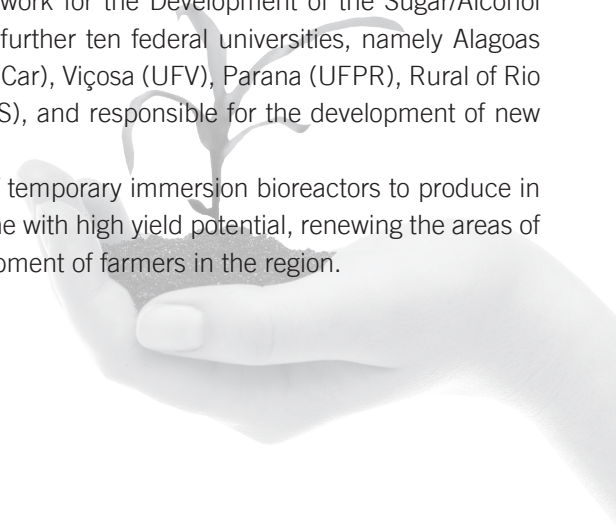
**Biofuels Laboratory:** The Laboratório de Biocombustíveis has main objective develop protocols using microorganisms of industrial interest able to produce enzymes on commercial scale aimed at obtaining of biofuels (bioethanol from lignocellulosics waste mainly from sugar-alcohol sector and biodiesel by enzymatic catalysis).

Today this nucleus has four selected filamentous fungus strains adapted to Bioethanol production and two filamentous fungus strains and one yeast strain for biodiesel production. The stage of development of technology in pilot scale. This goal will ac-

completed yet this year with the biorreactors for bioethanol and biodiesel production ending the great stage of research and technology field.

**Biofábrica Governador Miguel Arraes:** The Biofábrica of cane sugar CETENE has production capacity of up to 1.5 million plants per month and multiplies the most productive and adapted varieties for the Northeast region, well as promising clones for the production of ethanol. With the design of Cana meristem to the Northeast, farmers have access to varieties “RB” promising for the region, due to the partnership of CETENE with the Inter-University Network for the Development of the Sugar/Alcohol Sector (Ridesa), also composed of a further ten federal universities, namely Alagoas (UFAL), Goiás (UFG), Sao Carlos (UFSCar), Viçosa (UFV), Parana (UFPR), Rural of Rio de Janeiro (UFRRJ) and Sergipe (UFS), and responsible for the development of new varieties of the sugarcane.

The Biofábrica uses the technology of temporary immersion bioreactors to produce in vitro seedlings of varieties of sugar cane with high yield potential, renewing the areas of plantation, for socio-economic development of farmers in the region.



# Importance of Plant Physiology and Biochemistry for Sugarcane Sustainability

## **Authors:**

Brandrão, A.D.; Crivellari, A.C.; de Souza, A.P.; dos Santos, W.D.; Sousa, C.R. and Buckeridge, M.S.

*Departamento de Botânica do Instituto de Biociências da USP*

## **Abstract:**

Introduction: to achieve sustainability in the production of cellulosic ethanol regarding the industrial process and environmental impacts, it is necessary to understand aspects of the chemical structure of the feedstock used (bagasse and trash in the case of sugarcane) and also how sugarcane plants respond to environmental changes, including those related to the global climatic changes. This is important because these factors will affect the quality of feedstock in the near future.

Lines of research and scientific results: our research group at the Laboratory of Physiological Ecology of Plants (LAFIECO) focuses on the following lines of investigation: 1) understanding the chemistry and biochemistry of cell wall polysaccharides of sugarcane and other grasses that can be used for bioenergy. We also focus on the enzymes (mainly hydrolases) and their action on isolated polysaccharides. Results: we have already determined the chemical structure of polysaccharides in sugarcane cell walls. It is composed of cellulose, arabinoxylan, beta-glucan, mannan and pectins. Therefore, we already know what are the glycosidic linkages to be broken in order to produce fermentable sugars for bioethanol production. The oligosaccharide profiles have just started to be unveiled and with this we intend to reach a pattern that can be used to gauge feedstock quality and help to render uniformity actions of several labs throughout the country. We have started studies on the degradation of leaves in the field and in the plant in order to find how fungi attack rubbish materials in the field; 2) the hormonal control of sugar metabolism in sugarcane. Results: gibberellic acid controls

the production of sugars in seedlings of sugarcane and starts up vacuolization. It also changes cell walls composition slightly, what may open the way for new strategies to obtain cellulosic ethanol; 3) studies of secondary metabolism of sugarcane with the focus of controlling the addition of phenylpropanoids to hemicelluloses. Results: these compounds interfere with the attack of hydrolases to hemicelluloses and we found that under application of two chemical compounds directly to growing sugarcane plants, the access to wall by enzymes increased significantly. We named that “physiological pre-treatment”. This treatment is important because it has the potential to bypass for a while the use of transgenic methods in plants for production of cellulosic ethanol. These results also have an impact on lignin metabolism, as the phenylpropanoids are the primary substances used for lignin synthesis; 4) isolation of cell wall related enzymes from sugarcane and understanding of endogenous metabolism of the cell walls.

Results: we started these studies with xyloglucan endotransglycosylase (XTH), an enzyme whose encoding genes appear over or under repressed under several conditions imposed to the plants. We already have a collection of the gene family in sugarcane and intend to study tissue specific expression and find enzyme activity on isolated poly and oligosaccharides obtained in the research line 1; 5) growth and development of sugarcane plants under elevated CO<sub>2</sub> atmospheric concentration. Results: we found that sugarcane plants grow more and faster under doubled CO<sub>2</sub> concentration and that this leads to a higher production of sugars and changes in cell walls. Photosynthesis was shown to be increased and this is due to faster electron transport rate. We have already detected four genes related to this process and with these in hands, it is now possible to select new varieties with these properties or even design transgenic plants that display higher photosynthesis rates and higher productivity.

Focus on sustainability: LAFIECO also performs experiments with the responses of native species of the Atlantic Forest to the global climatic changes. Together with the knowledge already developed in São Paulo for regeneration of forests and reestablishment of biodiversity, we propose a strategy that we named as the “midway” in which the higher productivity of sugarcane, even if it has to be genetically transformed, can be associated to forest regeneration in order to decrease environmental impact and at the same time increase productivity of bioethanol from sugarcane.

# Development and optimization of the Production of 1st and 2nd Generation Bioethanol and Organic Acids from Sugarcane

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## **Abstract:**

In the last years, the Laboratory of Optimization, Design and Advanced Control (LOPCA) and the Laboratory of Fermentative and Enzymatic Process Engineering (LEPFE) has been developing a series of research projects focused on improving the productivity of existing ethanol generation (sugar cane molasses fermentation), the so-called First Generation Bioethanol, as well as proposing the study of manners of improving the Second Generation Bioethanol (from lignocellulosic biomass). The Laboratory of Optimization, Design and Advanced Control is also developing projects for the production of organic acids, such as lactic acid from molasses of sugar cane for subsequent production of solvents and biodegradable polymers. A bioethanol production from sugarcane bagasse based on an alkaline pretreatment has been intensively studied. This process is based on mild conditions of temperature and pressure, and results show that loss of cellulose during pretreatment is low and it is possible to obtain high concentrations of glucose using a low enzyme loading during the enzymatic hydrolysis step. The hydrolyzates are fermented using *Saccharomyces cerevisiae* yeast achieving ethanol yields similar to that obtained by fermentation of the glucose solution. Modeling of the hydrolysis reactor has been carried out using principles of Computational Flow Modeling and Chemical Reactor Engineering, in order to estimate the best operating conditions. Maximization of substrate concentration and conversion, enzyme re-utilization and minimization of reactor residence time and enzyme inhibition are the main goals. An alternative fermentation processes, the continuous extractive fermentation process

for bioethanol production, has been investigated. Experimental investigation of kinetics, modeling, simulation and optimization of this process has been carried out. The studied configuration consists of three connected equipments: bioreactor, flash vessel for ethanol removal and a hollow fiber membrane for cells recycling. This configuration presents higher productivity, low vinasse generation and less utility use (steam) when compared to conventional fermentation processes. In the product purification step, distillation and dehydration processes have been studied through computer simulation using Hysys and Aspen Plus. Several process configurations have been studied aiming decrease of ethanol losses and energy consumption on column reboilers. The main improvements are the multiple effect distillation, which allows thermal integration between column reboilers and condensers; the use of alternative solvents in extractive distillation, such as glycerol; detailed study of the azeotropic distillation process with cyclohexane. Simulation of bioethanol production processes from sugarcane and sugarcane bagasse have been carried out as well, using the process simulator Hysys. The Organosolv process with dilute acid hydrolysis on three steps was used for conversion of sugarcane bagasse into ethanol. The whole process was simulated, including sugar extraction, juice treatment, hydrolysis, fermentation, distillation and dehydration. The development of software sensors based on Artificial Neural Networks to infer concentrations of cell biomass, bioethanol and substrate from secondary measurements has been investigated. The developed system is based on an array of primary sensor, a communication module and a monitoring and data acquisition subsystem. This integrated framework provides a real-time monitoring solution, which is one of the most important aspects of the decision making in the strategies of optimization and control of bioprocesses. Lactic acid production process from sugarcane molasses has been developed using bacterial contaminant of the alcoholic fermentation. Through this process was possible obtain high yield of lactic acid. The product obtained will be purified, esterified and dehydrated for subsequent production of solvents and biodegradable polymers. Models for all steps of the process are being developed in order to optimize the conditions of the process as well as provide solutions compatible with their applications.

# CENBIO: Brazilian Reference Center on Biomass

## **Authors:**

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## **Abstract:**

The Brazilian Reference Center on Biomass (CENBIO), founded in 1996, is a research group in bioenergy located at the São Paulo University, in the Electrotechnics and Energy Institute (IEE).

CENBIO was established with the main goal of promoting the development of research activities and the disclosure of scientific, technologic and economic information to make feasible the use of biomass as an efficient energy source in Brazil.

In order to achieve these goals, for over ten years, CENBIO has been focused on the development of studies and projects aiming at the use of biomass, and promoting the interchange among Brazilian and foreign institutions of technical information and economic, social and environmental results of biomass technologies uses for energetic ends.

CENBIO has tradition in the production of studies and dissemination of data related to the use of biomass in Brazil. Furthermore, a major focus of the center is the discussion of environmental, social and economic sustainability of biomass. The main projects related to bioenergy sustainability are: Gnesd – Global network on energy for sustainable development; Potential for Sustainable Production of 2nd Generation Biofuels (IEA); Biotop – Biofuels Assessment on Technical Opportunities and Research Needs for Latin America; Best - Bioethanol for Sustainable Transport.

# A Sustainability Analysis of the Brazilian Bio-ethanol

## **Authors:**

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## **Abstract:**

The poster summarizes results of the project, Analysis of Environmental and Social Impacts of Bio-ethanol Production in Brazil, developed in 2008 with the support of the British Embassy in Brasília, and of the Department for Environment, Food and Rural Affairs (Defra), British Government.

The main target of the project was the evaluation of the sustainability of ethanol production in Brazil. The focus has been on GHG emissions, land use change and socio-economic impacts at the level the production takes place.

The poster will present the analysis based on indicators of welfare in municipalities with and without sugarcane production, considering the most important producer sugarcane states (São Paulo, Paraná, Minas Gerais, Goiás, Mato Grosso, Mato Grosso do Sul, Alagoas and Pernambuco). Eleven indicators were taken from the Human Development Atlas (1991 and 2000), published by IBGE. Complementary analysis include three indicators of FIRJAN, for 2005.

# Measuring Success of a New Ethanol Technology: Sustainability Assessment of PPDP Results

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## **Abstract:**

Ethanol production from sugarcane in Brazil has many economic and environmental advantages regarding biofuels produced from other raw material and in other countries. However, developments in this industry are essential (e.g., ethanol production through hydrolysis of sugarcane bagasse and trash) both to keep production costs at a low level and to improve sustainability. In order to measure the stage of development and the level of success attained by a new ethanol production technology a “virtual biorefinery” will be constructed applying mathematical modeling and simulation tools to evaluate the economical and environmental impacts of the bioethanol produced from sugarcane through the standard production chain (1st generation) and, for example, a proposed new technology developed to produce ethanol using lignocellulosic residues (2nd generation).

