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PREFACE

SUGARCANE BIOENERGY IN BRAZIL:

SUSTAINABILITY, REDUCED EMISSIONS AND ENERGY SECURITY

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In 2007, sugarcane ethanol provided 16.3% of the energy for ground transportation (excluding railways) and 37.6% of the overall energy supplied via liquid fuel for Otto cycle engines in Brazil. This last figure was 51% in 1988.

In addition to the energy extracted and stored in ethanol, burning the sugarcane bagasse is used to generate heat for the mill. Bagasse has been increasingly used as raw material for generating electricity resold to distributors. In 2007, the total energy generated from sugarcane in Brazil reached 15.9% of all the energy generated in the country; this figure makes sugarcane the second major energy source in Brazil, second to petroleum and above hydroelectricity.

On top of having the world's lowest production costs, ethanol from sugarcane produced in Brazil has another important advantage: in the country's Center-South region, one unit of fossil energy is used for each 8-9 units of energy produced from sugarcane ethanol. Reduced carbon emissions are another benefit from sugarcane ethanol: for each cubic meter of sugarcane ethanol used as fuel, there is a reduction of 2.1 to 2.4 tons of CO_2 issued to the atmosphere.

Sugarcane landed in Brazil in 1532. In the "Brazilian model", sugar and ethanol are jointly produced, which has brought some technical benefits and a noticeable increase in the competitiveness of both products in the international market. Approximately 50% of the saccharose produced in Brazil from sugarcane is used for producing sugar; the other half being used to produce ethanol. Industrial and academic R&D helped to continuously increase ethanol productivity, especially during the past 33 years, at a rate of 3.2% per year. Increased productivity made possible to reduce the planted area by a factor of 2.6.

In 2007, the area planted with sugarcane for producing ethanol was 3.4 MHa, corresponding to 1% of the total cultivable area in Brazil. 63% of the ethanol produced in Brazil comes from the São Paulo state, which has the highest productivity, beyond 7,000 liters per hectare. Most of the expansion is taking place in the Center-West region of the country, in degraded grazing lands.

The world interest in biofuels, especially since 2004, created important opportunities for Brazil, while it also posed great challenges. It is worth noting that the world market for gasoline in 2002 was 1.17 trillion liters, so to supply a 10% demand of this energy it would be necessary to produce about 150 billion liters of ethanol fuel. This is equivalent to 10 times the Brazilian production.

Since 1975, with the start of the Proálcool Program, Brazil had been developing the use of biofuels, practically without any competition (and also without much interest from the rest of the world). High petroleum prices prevailing until 2008 and the growing attention to hazards from greenhouse gas emissions changed this comfortable, almost monopolistic, situation. On one hand, scientific breakthroughs led decision-makers in the US and Europe to believe that it will be possible to produce biofuels in an economically viable way by processing cellulose, using hydrolysis and/or gasification techniques. The price of petroleum, that reached US$ 120 per barrel in mid-2008 (though

it dropped since the beginning of the current economic world crisis) helped to strengthen this conviction, favorable to the feasibility of cellulosic ethanol. On the other hand, from the IPCC Scientific Report, published in 2008, stating that global warming has solid scientific grounds, it is therefore essential to take action to reduce the emission of greenhouse gases.

Since the Proalcool launch, Brazil had been the great, and practically the sole actor in this field. The scenario has changed: today, more developed countries decided to adopt the use of biofuels and they are investing into making this goal feasible, in terms of financial and corporate resources, as well as a significant part of their R&D capabilities. From 2007 on, Brazil lost its world's leadership in the production of ethanol to the United States. The American ethanol production is based on corn, which is less efficient than sugarcane in several aspects. The speed of technological advance tends to increase and the likely breakthroughs may result in significant changes, either positive or negative, for Brazil.

Simultaneously, in the new scenario, the likely increase of the world production of biofuels brought two relevant issues to the debate. The first is the increase being perceived as a potential competition factor for cultivable areas, which would raise the cost of food. Second, issues related to the sustainability of biofuel production were emphasized, especially those connected to studies on the Life Cycle Analysis.

All these recent changes stress the importance of research for acquiring new knowledge in the bioenergy area. Furthermore, they highlight the need for the research on biofuels in Brazil to shift level, from a relatively comfortable situation where external competition was virtually nonexistent into one where competition now includes the major scientific powers on this planet.

To face these challenges, action is required from the various parties involved in national science and technology policies. Fapesp, watchful on this subject, has been running debates since 2005 among the São Paulo state research community about bioenergy research. The approval of the project Guidelines for Public Policies for the Sugarcane Agriculture in the São Paulo State, led by Prof. Luís Augusto Barbosa Cortez, from Unicamp, within the Fapesp Research Program in Public Policies, was an important step in this direction.

The studies and the conclusions developed in this project are introduced herein. The job involved 18 workshops on specific themes and mobilized over 500 researchers.

The scientific and technological research agenda that came from this encompassing and systematic study shows the importance of studies associated to the sustainability of energy production from sugarcane. It also shows how possibilities for improved efficiency and productivity may result from scientific breakthroughs and the relevance of the interconnection between these challenges.

It is essential that Brazil and the São Paulo state take the necessary steps to intensify R&D activity in universities, institutes and companies regarding the issues covered herein. Brazil's leadership position in the use of bioenergy depends on that, especially when scientific progress points to a second generation of biofuels, based on processing sugars extracted from the cellulose in the biomass. For this purpose, Fapesp announced in 2008 its Research Program on Bioenergy, Fapesp's Bioen.

The Fapesp Research Program on Bioenergy, Bioen, aims at articulating R&D in this area, using academic and industrial laboratories and, in doing so, to expand and apply the knowledge in the fields related to ethanol production in Brazil. The Fapesp Research Program on Ethanol has a solid center to support academic research related to the exploration of these themes. It is expected that such exploratory activities generate new knowledge and qualify the necessary scientists and other professionals for advancing the industrial capabilities in ethanol-related technologies.

Additionally, the Fapesp Research Program on Ethanol establishes partnerships with industry for co-financing cooperative R&D activities between industrial and academic laboratories in universities and research institutes. For each of these collaborations, details and themes are specified according to the interest of private partners and in accordance to Fapesp's commitment to promote research in the São Paulo state. Other research

agencies from the federal government and other states were invited to participate in Fapesp's research program on ethanol: CNPq has already approved a co-financing regime, with significant resources from Pronex, which was used in the calls published in 2008. The Minas Gerais Research Support Foundation (Fundação de Amparo à Pesquisa de Minas Gerais – Fapemig) has already approved a cooperation agreement with Fapesp for co-financing R&D, for the collaboration between researchers from both states.

Fapesp's Bioen comprises five major divisions:

a) Sugarcane plant science and technology, including genomics, improvement and technologies for growing and harvesting sugarcane.
b) Industrial ethanol production technologies.
c) Ethanol applications for vehicles: Otto cycle engines and fuel cells.
d) Biorefinery technologies.
e) Overarching themes: social and economical impacts, environmental studies and land usage.

The first calls for research proposals were published by Fapesp in 2007 and 2008, jointly representing R$ 89 million in investments for the next four years. New calls will be issued this year.

Professor Cortez's and his team's work, presented herein, is a rich contribution from Fapesp's Bioen for the R&D development of bioenergy in Brazil. We hope it will stimulate the research community to continue searching for new scientific and technological challenges and that it means a milestone in overcoming them.