Theme # 1 – Induced Expansion of Biofuels Crops in Brazil

Present Situation and Perspectives on Bioethanol in Brazil

Rogério Cezar de Cerqueira Leite[1]
State University of Campinas – UNICAMP

Manoel Regis Lima Verde Leal[2]
Alternative Energies Center – CENEA

Luís Augusto Barbosa Cortez[3]
State University of Campinas – UNICAMP

1. Introduction

At the 2002 Dubrovnik Conference it was presented a paper "Worldwide Use of Ethanol: A Contribution for Economic and Environmental Sustainability" discussing what could be the role of ethanol for gasoline substitution. It was recognized that driven mainly by two factors (high oil prices and global warming) something had to be done to reduce emissions derived from fossil fuel burning. Bioethanol seems to be a good alternative, particularly when produced from sugarcane in Brazil. Brazil is responsible today for about 40% of the ethanol produced in the world and can play an interesting role to satisfy future demand of bioethanol.

Indeed, few countries have the necessary conditions to grow large extension of energy crops without jeopardizing its food production. Brazil occupies 851 million ha, the major part situated between the Equator and the Capricornium Tropic. The soil has in general good fertility, with also a good climatic condition for sugarcane without or minimum irrigation. We also know, after 30 years experience on fuel ethanol production and use, that Brazil has the necessary knowledge in this field. But the question that remains to be answered is: how much ethanol Brazil can produce? Based on this issue, a project was developed to evaluate the impacts of substituting 5 and 10% of the world demand of gasoline in the year 2025.

First, the future ethanol demand was sized, and estimated at 205 billion liters by 2025. Then, the areas considered under environment protection such as the Amazon, Pantanal, Atlantic Forest were excluded from the project. It was considered a technology pattern of a sugar cane production system with total mechanization, meaning that cane cutters will no longer exist in Brazil after the year 2025 when the environmental legislation phasing out cane burning will be fully implemented. Therefore, our project already incorporates only green cane harvesting. A survey was conducted by the Sugarcane Research Center (CTC) to map the available land for sugarcane in Brazil considering soil and climatic requirements.

1 Interdisciplinary Center for Energy Planning – NIPE; e-mail: cerqueiraleite@uol.com.br
2 Email: regis@cenea.org.br
3 School of Agricultural Engineering – FEAGRI Interdisciplinary Center for Energy Planning NIPE; e-mail: cortez@agr.unicamp.br

As far as the infra-structure is concern, a survey was conducted to identify all existing railroads, pipelines, waterways, and harbours that could better assist the necessary transportation of the ethanol. Then a standard distillery crushing 2 million tons of cane/year was considered because of its economics with present technology. Clusters of these distilleries (one typical cluster has 15 distilleries) were considered to select areas in the country which were mostly adequate to combine benefits of agriculture but also logistics.

The study results shows that with existing technology with 22 million ha (20% of which are considered as environment protection area) and today's ethanol yields it is possible to satisfy 5% of the future demand of ethanol in the year 2025. So Brazil would respond for half of the 10% target. With the introduction of new cane varieties and new technologies, such as hydrolysis and trash collection, it was estimated an improvement of overall productivity which will significantly reduce land requirements for sugarcane cultivation for ethanol in Brazil.

The socio-economic impacts in Brazil will be very beneficial in the country, helping to reduce and in some cases eliminate poverty, decrease regional disparities between South and Northeast and producing excess electricity equivalent to 15% of what is produced today what will help to boost the economy in the inner areas where it is mostly needed. This process is already been observed in Brazil where an unprecedented amount of domestic and foreign capital is booming the new business of bioethanol for exports.

2. Historical Background of Ethanol Production in Brazil

Since Brazil became colony of Portugal sugarcane had a significant importance in the local economy. Sugar industry uses basic resources that are: land, sunshine and water. Those factors associated to the low demographic density created exceptional conditions for the production of sugar at low cost in Brazil. Then, since 1975, with the creation of the Proalcool, sugarcane started to be used to accomplish another objective: fuel ethanol production. But that was not really a novelty. Since a long time cane was used for the production of spirits and since the 30´ies, Getúlio Vargas would introduce the use of fuel alcohol in Brazil.

But from 1975 to 1979, in the first phase of the Proalcool Program, annexed distilleries were built using molasses as the raw material. This was a clever decision. It was possible to start the production with a low investment and produce anhydrous ethanol to be blended in the gasoline vehicles in proportions that varied up to E25. Particularly beyond 1979, ethanol started to have a growing importance in the Brazilian energy matrix. In that period were installed new autonomous distilleries (producing only ethanol) and also started the commercialization of E100 vehicles. These vehicles used hydrated ethanol.

That part of the history is known by many. We also know that the E100 vehicles responded for 90% of the sales in the 2ª half of the 80´ies and that in 1989 the ethanol shortage caused a supply crisis, jeopardizing the market for pure

ethanol cars. But if in one hand the ethanol market suffered an impact, the sugar production never cessed to grow. During the 90´ies the "Brazilian model" of producing sugar and alcohol was consolidated. In this period the sugarcane industry grew steadily and the E100 vehicle sales barely disappeared.

This was the picture until the beginning of the XXI century when the "flex fuel vehicle" was introduced giving a new impulse to the ethanol industry. Today the situation of the industry is very promising: Brazil produces sugar and ethanol in unprecedented low costs and high participation the world markets: 30%(45%??) for the sugar and 40% for the ethanol. The future perspective is also very promising, particularly for the ethanol industry because Brazil is the only major producing country that can produce significant volumes of ethanol for the world market.

3. Present Situation and Perspectives for Bioethanol

Brazil knows how to produce low cost ethanol, that is for sure! However, our experience was always oriented to satisfy the domestic market. At the moment we export around 20% of the annual production (reaching 3.5 billion liter out of 17 billion liter produced in 2006). Most of the exports is oriented to USA, Japan and India.

It is true that the foreign demand for fuel ethanol represents a relatively low risk. The drivers for this market are very strong: global warming is associated with fossil fuel burning, oil prices are relatively stable at high levels, and energy security is a strong consideration in geopolitical terms. In the other hand, ethanol from Brazil is indeed a very good possibility to abate CO_2 emissions and decrease oil consumption, and Brazil can become a supplier of liquid fuel helping to decentralize supply uncertainties.

However, to take advantage of this opportunity, we need to prepare a strategy to increase our participation in the future ethanol market. The strategy involving the capacity to produce large volumes of bioethanol and also considering the political, economic, and technical aspects. The present question is: will we have conditions to cope with the future demand and what should we do to satisfy it?

4. The Study Conducted at NIPE/UNICAMP for the Expansion of Bioethanol

The researchers of the Interdisciplinary Center for Energy Planning – NIPE at UNICAMP asked themselves the following question: what would be necessary for the country produce large quantities of fuel bioethanol aiming at the foreign market? Which would be the environmental, social, economic impacts and resulting policies from that macro action ? Do we have the necessary resources, such as land, people, natural conditions to face up to this challenge?

The Brazilian Government through the Center for Strategic Studies – CGEE commissioned a study to Prof. Rogério Cezar of Cerqueira Leite of the NIPE-UNICAMP who putted together a research group to analyze these impacts

aiming at formulate public policies to significantly expand the fuel ethanol production in Brazil.

First, the group did a survey on the availability of areas that were considered apt for sugarcane agriculture in Brazil. This study was carried out in partnership with the Center of Sugarcane Technology – CTC. Initially, the areas considered with important environmental restrictions, such the Amazon, Pantanal, Atlantic Forest were excluded from the study. Also were excluded forest and Indian reserves, and areas presenting technical difficulties, such as with slopes above 12% where the mechanization of the cane would be impracticable. In our study cane had to be harvested without burning and this implies mechanization since raw cane harvesting by hand becomes cost prohibitive.

Then, it was carried out a mapping of adequate soil and climate for the cultivation of sugarcane in Brazil. These information were crossed resulting in a map of different levels of productivity of sugarcane considering the present available knowledge about this crop.

To understand the potential few numbers are presented. The total area of Brazil is approximately 851 million hectares. Around 200 is occupied by pasture land and 60 millions for agricultural use. Of the 60 that is used for agriculture, 22 is used for soy, 12 for the corn and 6 for sugarcane. The remaining 20 are used for other cultures. In our study it is estimated that there is a potential of around 270 million ha for sugarcane in Brazil. This can potentially produce around 18.6 billion ton without irrigation or around 21 billion ton with survival irrigation (around 200 mm/year) using the presently available technology.

With these information in hands we defined 12 selected areas which were considered by reasons of productivity, location, logistics that would be able to be considered for a significant expansion of the fuel ethanol in Brazil. These areas, mostly located at the Brazilian cerrado can be found between the state of MS and the south of the MA. This region is quite diverse in occupation but has significant quantity of pasture land, with large areas of low productivity due to inadequate exploitation which conducted to soil degradation. The large regions North, South and large parts of the Southeast were excluded.

At the demand side, the future market of liquid fuels in the world was studied. More specifically the gasoline market for the year of 2025 was estimated. According to the projections of the National Energy Information Center (NEIC) it is estimated that 1.7 trillion of liters of gasoline will be consumed in that year. Therefore, considering the substitution of 10% by fuel ethanol it will be necessary around 204 billions of liters of ethanol and for 5% around 102 billions of liters, assuming that other countries will help Brazil to satisfy this future demand.

To make this production possible, and in order to organize the production, it is proposed the installation of standard distilleries. These distilleries present a typical output and could be multiplied in the areas selected. The size of these standard distilleries would be annual crushing capacity of 2 million tons of cane to produce 1 million liters/day of fuel ethanol. These are producing units

dedicated only to ethanol production, but , utilizing bagasse and part of the trash, they can generate important excesses of electric energy.

Therefore, "clusters" of 15 distilleries were defined. The clusters would justify the implementation of necessary infrastructure for ethanol transportation using ethanol pipelines. In our study a total of 12 areas were selected for the installation of 615 distilleries producing 104 billion liters of etanol. This production would require around 22 million ha for the cultivation cane, utilizing the presently available technology. Each one of these distilleries requires for its implementation around US$ 140 million (US$ 100 million for the industry and US$ 40 million for the agricultural equipment). The total investment would be around US$ 2.1 billion per cluster of 15 distilleries plus another US$ 500 million for the implementation of the cane field. Each cluster would produce 2.55 billion liters of ethanol/year and 1,200 GWh/year of electric energy.

Totalling up the macro values, for an estimated annual output for export in 2025 of 104 billion liters, it is required an investment of US$ 5 billion/year (for the distilleries and transport infrastructure). This results in an overall benefit of around US$ 31 billions in exports and generation of 5.3 millions jobs between direct, indirect and induced jobs. Beyond that it is produced electric energy equivalent to 15% of what was generated in 2004.

Another important result is the impact of this project in the interiorization of the development in Brazil. New cities will be implanted, with the necessary infrastructure of dwellings, schools, hospitals and services in general. It is, in fact, a large project of development and distribution of revenue for Brazil.

It is evident that there are not many investors in conditions to face up to the needs of this macro project for Brazil. Most likely the Brazilian Oil Co. - Petrobras and the National Bank for Economic Development - BNDES are the only few actors presenting the conditions to satisfy the demands of investment. However, it is probable that national investors (traditional or groups of venture capital) and international (that are already coming) can take responsibility for at least part of the demanded investment capital.

5. The Impact of New Technologies on Required Resources for Bioethanol Production

In the 2ª part of the project already commissioned by the CGEE to the group of the NIPE-UNICAMP it is being investigated in more detail the impact of the new technologies. These are especially: the genetic improvement (conventional and genomics), the trash collection and the hydrolysis of the fibers and corresponding ethanol production.

When we consider expansion of the ethanol production from 17 billion to 105 billion liters to satisfy the substitution of 5% of the world demand of gasoline, a special attention needs to be devoted to: efforts to decreasing production costs and to increase production sustainability. Today sugarcane to ethanol in Brazil presents excellent overall figures when productivity (6,000 liters of

ethanol/ha.year), production costs (ranging from 25-30 cents of US$/liter) and renewable/fossil energy ratio (8-9).

However, more long term effort should be devoted to guarantee this competitiveness. The present cane-ethanol industry is changing its primary objective that was to produce low cost sugar and ethanol to another more ambitious objective that will be the production of low cost-sustainable energy. That will certainly require more investment in R&D and the construction of a sustainable “cane to energy” industry.

First of all, more efforts should be devoted to the raw material. Around 70% of the ethanol production costs is the raw material. Genetic improvement of sugarcane is absolutely essential to guarantee production at low cost and adequate to new producing areas. In the last decades the programmes developed by CTC, Ridesa group and Center Cana from the Agronomic Institute of Campinas – IAC have guaranteed an improvement in the order of 1.6% per year in cane productivity. It is higly recommended to expand the improvement programmes for the new areas (cerrado) where most of the expansion will probably take place.

Then it is absolutely imperative to use the entire resources produced by the sugarcane. A new production system has to be developed and implemented not only to make raw cane harvesting economical but also trash collection a common practice. Trash collection will allow a more abundant availability of fibers in the industry rendering possible the production of surplus electric energy in the first moment and ethanol by hydrolysis in a second moment.

Hydrolysis is a technology that can represent a true "break-through" in the ethanol production. It is the technology that will create the basis for the second generation of bioethanol. Several countries and particularly the USA are working hard to develop this important technology. Brazil has several research groups is in this race. The Brazilian Ministry of Science and Technology – MCT finances has created the Bioethanol Research Group, with the participation of several institutions in Brazil, with the objective to conduct R&D for the bioethanol from hydrolysis.

Already we have a clear indication that the new technologies will be able to have a favourable impact on the needs of land, reduction of environmental impacts and improvement of the economic and social impacts. Those constitute the most important potential limiting factors for the adoption of a large scale project for the production of fuel bioethanol.

6. Conclusions

The first decade of the XXI century is being dominated by the discussion involving the greenhouse effect and correspondent global warming. This preoccupation is another important element in the discussion of the last three decades since the first oil crisis when it became evident that oil supplies were not forever.

In the same period (since 1975) Brazil launched an ambitious programme to substitute gasoline. Oil was 80% imported and weighing heavy in the Brazil balance of payments. During the last decades Brazil learned significantly to produce a low cost ethanol and sugar. In these two products Brazil become a world leader and a reference.

Now a new opportunity is being presented: can we help to substitute large amounts of gasoline helping the world to decrease global warming and oil dependence? A study is being conducted at NIPE/UNICAMP with the objective of answering this question. A first phase of this study has been concluded showing the feasibility and benefits for Brazil.

In the second phase of the study, in progress, it is analyzed the introduction of new technologies to enhance ethanol production. Mainly three technologies are considered key for the second generation of bioethanol: genetic improvement, green cane harvesting with trash collection and hydrolysis. It is highly emphasized the importance of cost reduction and improvement of sustainability indicators through the utilization of whole cane.

In order to make these technological progresses an important investment is required for R&D in Brazil. It is considered today a consensus in Brazil that we may lose our competitiveness if major investments in R&D are not made in the country.

Acknowledgments

This research was financed by the Center for Strategic Studies – CGEE and coordinated by Rogério Cezar de Cerqueira Leite with the participation of the following researchers: Adriano Viana Ensinas, André Tosi Furtado, Arnaldo César da Silva Walter, Carlos Eduardo Vaz Rossell, Francisco Rosillo-Calle, Gilberto de Matino Jannuzzi, Gislaine Zainaghi, José Antonio Scaramucci, José Humberto Nicola, Luís Augusto Barbosa Cortez, Manoel Sobral Jr., Manoel Regis Lima Verde Leal, Marcelo Pereira Cunha, Mirna Ivonne Gaya Scandiffio, Oscar Antonio Braunbeck, Sérgio Bajay and other students and researchers from UNICAMP.

References

BRAUNBECK, O.; MACEDO, I.; CORTEZ, L. - “Increasing the Available Biomass from Sugarcane for Energy Conversion” International Workshop Implementation Strategies for Biomass Utilization in Europe and Developing Countries. Sweden, 19-21 November 2001

LEITE, R.C.C. (Coordinator) “Estudo sobre as possibilidades e impactos da produção de grandes quantidades de etanol visando à substituição parcial de gasolina no Mundo” First Phase Final Report December 2005:
http://www.cgee.org.br/prospeccao/doc_arq/prod/registro/pdf/regdoc2162.pdf

LEITE, R.C.C. “Energia para o Brasil – um modelo de sobrevivência” 134p Editora Expressão e Cultura, Rio de Janeiro.

CORTEZ, L.A.B.; GRIFFIN, M.; SCANDIFFIO, M.G., SCARAMUCCI, J.A. - “Worldwide Use of Ethanol: a Contribution for Economic and Environmental Sustainability” SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS Proceedings Dubrovnik, Croacia, 2-7 July 2002

CORTEZ, L.A.B.; GUERRA, S.M.G. e LAMPARELLI, R.A. -"An Overall Evaluation of the Alcohol Programme in Brazil after 15 Years of Existence" IX International Symposium on Alcohol Fuels. Florence, Italy November 1991

CORTEZ, L.A.B. -"O Programa Brasileiro de Álcool Combustível 20 Anos Depois" III Congreso Nacional de Energia, at La Serena, Chile 17 - 19 April 1996

GUERRA, S.M.G. and CORTEZ, L.A.B. - "Biomass Energy - A Historical Trend in Brazil" Proceedings of the World Renewable Energy Congress, Reading, UK, 13 - 18 September 1992

CORTEZ, L.A.C. “Um Balanço de 30 Anos do Proalcool” apresentado no evento “Etanol Combustível: balanço e perspectivas – evento comemorativo dos 30 anos de criação do Proalcool” 16 e 17/11/2005 at UNICAMP: http://www.nipeunicamp.org.br/proalcool/Palestras/16/proalcool30%5B1%5D-Cortez.ppt

MACEDO, I. C.(Coordinator) “A Energia da Cana-de-Açúcar” UNICA, 237 p. http://www.portalunica.com.br/portalunica/?Secao=referência&SubSecao=publicações&SubSubSecao=livros

RAMALHO, E.L.; CORTEZ, L. - “PROALCOOL e a Crise do Setor Sucroalcooleiro” Congresso Brasileiro de Energia – Proceedings from CBE, vol. 3, pp. 1390-1396, Rio de Janeiro, RJ, 1999

ROSILLO-CALLE, F. e CORTEZ, L.A.B. - “Towards PROALCOOL II - A Review of the Brazilian Bioethanol Programme”. Published by Biomass & Bioenergy, 14 (2) 115-124, 1998

WALTER, A.; CORTEZ, L. “An Historical Overview of the Brazilian Bioethanol Program” published by Renewable Energy for Development –Stockholm Environment Institute/Newsletter of the Energy Programme, 11(1) 2-4 July 1999
