BNDES publishes book with unprecedented mapping of the ethanol sector

Brazil is one of the most advanced countries in technology and productivity in all stages of the sugarcane ethanol production chain. The Brazilian experience shows that sugarcane bioethanol has become one of the most important responses to the growing need to sustainably expand the use of renewable energy sources and enhance energy supply security, while reducing environmental impacts at the same time.

Sharing this experience and the lessons learned with the rest of the world – especially developing countries in tropical and subtropical zones – was the main reason why President Luiz Inácio Lula da Silva commissioned the Brazilian Development Bank (BNDES) and the Center for Strategic Studies and Management Science, Technology and Innovation (CGEE) to produce the book "Sugarcane Bioethanol: Energy for Sustainable Development". The entire work is also available at www.bioetanoldecana.org.

Similar interests also led to support from the Economic Commission for Latin America and the Caribbean (Cepal) and the Regional Office for Latin America and the Caribbean of the United Nations Food and Agriculture Organization (FAO).

Edited by specialist Professor Luiz Augusto Horta Nogueira, of Itajubá Federal University (Unifei) and based on research performed by almost 30 specialists, the book's main objective is to be a scientifically-based study to encourage international debate, and which envisions the construction of a global market for ethanol. It will also serve as a resource for the debates during the Brazilian government sponsored International Conference on Biofuels (http://www.biofuels2008.mre.gov.br/agenda-tentativa), to take place in São Paulo on November 17th–19th of 2008.

The work, the first to consolidate the sector's many aspects, with chapters unparalleled in the literature (e.g., Chapter 2 on bioethanol as a fuel and Chapter 8, on the global bioethanol market), describes the panorama of sugarcane and ethanol production – in Brazil and worldwide – as well as presenting ethanol as an energy commodity, and Brazil as the foremost supplier of products and solutions for the sector.

The text will serve as a basis for dialogue on sugarcane ethanol's potential, and the upper limits to production under good conditions, especially in tropical and subtropical countries.

The authors took into account the concern with analyzing current policies for the support and development of biofuels. This was done based on a careful analysis of its impacts in terms of changes in land use, investments standards, greenhouse gas emissions, trade pathways and food security.

Among the book's main conclusions:

– Sugarcane represents the second most important primary source and the most important source of renewable energy in the Brazilian energy matrix for bioethanol and bioelectricity (electric power generated from sugarcane bagasse).

– Sugarcane has clear advantages over other raw materials with respect to ethanol production. From an energy point of view, it yields up to seven times as much energy as corn as a raw material.

– The increase in the demand for sugarcane for biofuels production has no impact on food prices. In terms both of energy yields and its effect on food security, bioethanol production from sugarcane is superior to the alternatives.

– Sugarcane bioethanol production little affects the production of food, because its cultivation occupies relatively little space compared to land used for food. Worldwide, in order to produce about 50 billion liters per year, about 15 million hectares of land are required. This is the equivalent to 1% of the land in the world used for agriculture (about 1.5 billion hectares).

– Sugarcane bioethanol, produced under Brazilian conditions, is competitive with crude oil at around US$ 50 barrel – this is below current (November 2008) levels. The technology employed for its production is open and available.

– Sugarcane bioethanol production does not imply deforestation. The expansion of sugarcane plantations has occurred basically in areas previously occupied by low yield pastureland or crops destined for exportation, such as soy.

– Environmental impacts associated with sugarcane bioethanol production have, to a large degree, been attenuated, and are lower than those caused by the majority of crops.

– The use of sugarcane ethanol enables an 89% reduction in greenhouse gas emissions, which can significantly contribute to mitigating climate changes. In comparison, using corn as raw material enables a 38% reduction in greenhouse gas emissions; wheat, 19% to 47%; sugar beet, 35% to 56%, and cassava, 63%.

Under current conditions, for each million cubic meters of sugarcane bioethanol mixed with gasoline, about 1.9 million tons of CO_2 entering the atmosphere are avoided.

Bioethanol can be used in combustion engines, pure or blended with gasoline, with good performance and using the same distribution and storage systems as gasoline.

Sugarcane bioethanol: the Brazilian experience

Petroleum, natural gas and their derivatives represent 55% of global energy consumption. The World's reserves, however, cannot last more than a few decades. The dependability of the supply then becomes problematic for many countries. Further, fossil fuels are the main source of the gases which are causing climactic changes and global warming.

Bioethanol appears as a natural substitute for gasoline. In Brazil, ethanol produced from sugarcane currently comprises half of the gasoline that would be used if the ethanol did not exist. Its production is not subsidized, yet even so, its cost is competitive.

The sugarcane agribusiness (which includes sugarcane, sugar and bioethanol production) was worth close to R$ 41 billion in 2007. Thirty million tons of sugar and 17.5 billion liters of bioethanol were produced. Exports totaled 19 million tons of sugar (R$ 7 billion) and 3 billion liters of bioethanol (US$ 1.5 billion), representing 2.65% of Brazil's GDP. In addition, R$ 12 billion in taxes and fees were collected and annual investments of R$5 billion in new agroindustrial units were made.

Bioethanol and sugar production expansion in recent decades has occurred not only because of an increase in the size of the cultivated area, but also due to marked productivity increases in the agricultural and industrial phases, with annual increases of 1.4% and 1.6%, respectively. This process has resulted in an annual growth of 3.1% in bioethanol production per cultivated hectare over the course of 32 years.

Thanks to gains in productivity, the area currently dedicated to the cultivation of sugarcane for bioethanol production (close to 3.5 million hectares) represents only 38% of the land which would have been required to produce current yields using 1975 parameters (when the Proálcool program began). This noteworthy gain in productivity – which has led to a 2.6-fold increase in bioethanol yields – was obtained through the continuous adoption of new technologies.

The success of dual-fuel cars in Brazil, which use alcohol and gasoline, led to an increase in cane production from 88.92 million tons in the 1975/1976 harvest to 489.18 million tons in the 2007/2008 harvest. During the same period, ethanol production increased from 0.6 million cubic meters per day to 22.24 million cubic meters per day.

Despite the expansion, sugar cane occupies about 9% of Brazil's farmland, being the third most important crop in terms of land occupied, after soy and corn. In 2006, the area harvested was 6.12 million hectares, for a total planted area of 7.04 million hectares and total production of 457.98 million tons.

There are currently 330 mills in Brazil, with cane-processing capacities ranging between 600 thousand and 7 million tons per year. The 10 biggest mills are responsible for 15% of the total of raw material processed, whereas the 182 smallest units process half the sugarcane, a sign of low economic concentration.

An important aspect related to the recent growth in sugar alcohol production is the significant diversification in composition and origin of capital in the agroindustry. Originally based on family businesses, the sector has come to reflect an increasing number of mills controlled by Brazilian and foreign business groups.

Sustainability – The book contains a chapter on sugarcane production from the perspective of sustainability, defined as the possibility of bioenergy systems being able to sustain long term production. In this regard, it is possible to show how the sugarcane agroindustry in Brazil has evolved in a positive way.

Emissions of greenhouse gases are effectively mitigated by the production and use of bioethanol and bagasse, which substitute for fossil fuels. Additionally, emissions associated with preharvest burning of sugarcane tend to fall as a function of increased mechanical harvesting.

In Brazil, sugarcane planted for the production of fuels corresponds to a relatively minor area of farmland and national territory and does not imply deforestation. An important instrument for regulating the expansion of the bioethanol agroindustry in Brazil is the Sugarcane Agroecological Zoning which was developed by the federal government based on information from soil maps, climate maps, and environmental reserves.

The study defines areas and regions where large-scale sugarcane farming is not recommended, being usable as a resource to guide funding and infrastructure investment policies. According to the survey, the area which is available and appropriate for sugarcane (without the use of irrigation) surpasses 110 million hectares.

With regards to economic sustainability, sugarcane bioethanol is demonstrably competitive compared with conventional fuels in terms of international prices available to the producer in free markets, as well as final consumer prices, under Brazilian conditions.

In relation to production costs, the final cost of sugarcane bioethanol is somewhere between US$ 0.35 and US$ 0.40 per liter, significantly below barrel-of-oil equivalent prices of between US$ 50 to US$ 57. The mills currently being built and the new production frontiers should present lower costs still, as a function of the logistics investments in the new units.

The continued growth in agricultural and industrial productivity tends to stabilize or even reduce sugarcane bioethanol production costs in relative terms.

Job creation – The sustainability of sugarcane bioethanol production has also had a positive impact on job creation. In 2005 there were 982 thousand direct and formal workers involved in sugar-alcohol production and 4.1 million people who were dependent, one way or another, in the sugarcane agroindustry.

With respect to the quality of the jobs, information from the Brazilian National Household Sampling Survey (PNAD) indicated important improvements in several socioeconomic indicators, such as degree of formality, growth in income and benefits received by employees, marked reduction in child labor and increase in schooling levels.

It must be noted, however, that the labor involved in bioethanol production is generally heavy and the State must be permanently vigilant in strictly enforcing labor laws. This is an essential factor to inhibit any distortions to promote the progress of effective labor relations in this sector.

Even with the adoption of high productivity technologies, such as mechanical harvesting, bioethanol production continues to be a major generator of jobs of increasingly better quality and with a corresponding elevation in required skills and average pay. It is estimated that for each million cubic meters of annual production R$ 119 million are invested.

Ethanol and electric power – Bioelectricity, already produced for decades in the cane agroindustry, has used bagasse as a fuel in cogeneration systems, although this production has been limited to supplying the demands of the mill. The new investments have enabled an excess to be generated for the public grid, with increasing economic importance, and contributing to the power supply in many countries, such as Brazil.

In the 1980s, the boilers enabled a surplus to be produced of about 10 kWh/tc (Kilowatt hours per ton of cane processed). Today, the power produced by the majority of mills reaches close to 28 kWh/tc and can be as high as 72 kWh/tc in the most modern units. With the utilization of part of the cane harvesting and improvements in industrial processes, power surpluses could reach as much as 150 kWh/tc.

At the beginning of 2008, the installed capacity of sugar and bioethanol mills in Brazil was 3.1 GW, equivalent to the installed energy capacity of the Itaipu Hydroelectric Dam, with prospects of generating power, based on bagasse, for the public grid, reaching 15 GW by 2015, the equivalent to 15% of the installed potential of Brazil's power stations.

Bagasse-based power production is eligible for obtaining carbon credits, under the terms of the Clean Development Mechanism, as established by the Kyoto Protocol.

Food versus bioenergy

The natural resource base available on the planet is sufficient for the production of sustainable bioenergy in reasonable volumes. This is assuming that rational technologies are utilized such as sugarcane bioethanol. Due to its superior productivity differential indicators, the cultivation of cane for the production of fuels can hardly be associated with a food-supply or food-price crisis.

The authors believe it is important to underscore that the impacts of biofuels depend on their origin. The production of biofuels using low production processes, as seen in the United States and Europe, presents evident limitations, directly related to the production of food. Such a reality opens a window of opportunities for the rational and sustainable production of biofuels.

The production of ethanol in the United States, based mostly on corn, uses energy mostly coming from coal. One could say that ethanol made from corn is, in reality, coal converted into ethanol.

In Brazil, on the contrary, ethanol is produced almost entirely from solar energy. In other words, the effective reduction of greenhouse gases occurs with the production of sugarcane bioethanol, but not with corn bioethanol. The utilization of cane energy in Brazil has reduced carbon emissions by 13% across the entire energy sector.

The expansion of sugarcane and corn culture involves changes in soil use, which could imply greenhouse gas emissions if the expansion would result in deforestation. But in Brazil, this is not the case: expansion occurs on pasturelands.

In Eastern Europe, ethanol produced from corn and sugar beets is also used. In these countries, the cost of fuel is two to four times higher than in Brazil, and internal subsidies and customs barriers protect the local industry, impeding the importation of ethanol from Brazil. This has created resistance in groups who associate ethanol with a false dilemma, that of producing food versus fuels.

The book calls attention to the protectionist practices of industrialized countries with respect to food prices, with serious implications in at least two aspects: a) maintaining protectionist prices for the farmers of these countries, with tariff barriers which impede the access to agricultural products from developing countries in industrialized markets; b) the fall in prices, caused by the surpluses of subsidized production, which results in imbalances in world markets for agricultural goods and harm to the food production structure of the majority of low income countries.

Currently, only 1% of arable land in the world is used for the production of liquid biofuels, with prospects of reaching 3% or 4% in 2030. The numbers demonstrate that, structurally, it is not the limited availability of arable land that harms food security and restricts the possibilities of biofuels production.

In parallel fashion, according to the book, the current crisis in the food markets is not caused by a lack of food production. World food production has been increasing systematically and the per person supply has increased 24% in the last 40 years, rising from 2360 to 2803 calories per day per capita. Within the same period the world population has grown from 3 billion to 6 billion people.

Sugarcane is one of the most important crops in the world, occupying more than 20 million hectares and producing about 1.3 billion tons in

2006/2007. Brazil stands out in the statistics on areas planted with close to 7 million hectares, the equivalent to 42% of total sugarcane produced.

Corn, the other raw material important for the production of bioethanol, is cultivated in all continents and occupies approximately 147 million hectares, from which about 725 million tons were produced in 2004. In 2006, U.S. corn production surpassed 267 million tons of grain, for a harvested area of a little over 28 million hectares; almost 20% of the production was earmarked for bioethanol.

Perspectives for a worldwide biofuel market

For year 2010, projected global bioethanol demand will be 101 billion liters, compared to a supply of 88 billion liters. This outlook should be in balance by 2015, when supply should reach 162 billion liters and demand should level off at 150 billion liters, being distributed heterogeneously across regions.

As a fundamental condition to developing production potential and the global bioethanol market in the coming years, policies oriented to the promotion of biofuels have been proposed and implemented in several countries. An analysis of these policies shows that increasing energy security and mitigating climate change are among the most important factors that drive biofuel programs in most of the countries.

The future of bioethanol fuel

Bioenergy represents one of the best alternatives for capturing and storing solar energy, one of the few natural resources underutilized by humanity, assuming that free land, suitable climate and knowledge are available. It is capable of meeting the urgent demands for reduced greenhouse gas emissions, improving the air quality in cities and competing pricewise with conventional energy sources.

Additionally, this pathway can provide a new agroindustrial dynamic for tropical countries with available land, and the will to overcome environmental problems in the area of energy, bringing with it, new prospects for economic growth.

The Brazilian experience in this field can and should be seen as a reference. Several countries have sought to reduce their energy dependence, reduce their carbon emissions and improve air quality in their cities. However, they have still not included sugarcane bioethanol in the range of alternatives, raising barriers that protect inefficient and unsustainable solutions.

New uses – An extensive field of applications for sugarcane – and in particular, bioethanol – is the production of a diverse range of polymers, whether as inputs for the conventional petrochemical industry or the so-called ethanol-chemoindustry. The new technology will enable the use of more advanced processes, such as the manufacture of biodegradable plastics, currently being developed in Brazil.

Sugar and bioethanol mills appear more and more within the context of the so-called biorefineries – similar to the current oil refineries, but located in new bases, renewable, and environmentally more healthy.

The sugarcane agroindustry presents great possibilities for diversification of its products and increases in available energy, whether in the direction of biorefineries (production complexes capable of supplying bioenergy and a range of biomaterials), or whether by reinforcing the base of genetic resources (including studies at the level of photosynthetic processing). The sugarcane agroindustry is just beginning to show its potential.

The Brazilian model, fine-tuned over decades and with the potential for expanded productivity and efficiency, is at the disposal of those countries that seek to competitively reduce their emissions of greenhouse gases and diversify their energy supply sources.