Chapter 9

An outlook for bioethanol fuel

Modern society is facing the worsening of environmental degradation while, at the same time, realizing that its reserves of natural resources, be they energy, water or metals are limited. In this context, energy plays a central role, compelling us to urgently rethink the foundations of an energy-supply model that is showing signs of depletion and seeks new resources which will allow continued socioeconomic development. Like a beacon amidst shortage, the sun, the underlying source of so many forms of energy and one of the few resources still underused by mankind, shines once again. Indeed, only a tiny fraction of the solar radiation reaching the Earth is currently captured through technological processes. There is although a huge potential for its use, but this requires the development of efficient and competitive technologies. Within this context, bioenergy has proven to be one of the best alternatives to capture and store solar energy, wherever idle land and favorable climate (sunlight, water and temperature) are matched by sufficent knowledge and an entrepreneurial spirit to apply it. In this light, it is worth recalling Henry Ford's visionary reflection published in 1934:

> I foresee the time when industry shall no longer denude the forests which require generations to mature, nor use up the mines which were ages in the making, but shall draw its raw material largely from the annual products of the fields. I am convinced that we shall be able to get out of the yearly crops most of the basic materials which we now get from forest and mine [Modern Mechanix (1934)].

Solar energy in the form of bioethanol, efficiently and sustainably produced, stands out among all available renewable energies to supply vehicle fuels. It is also able to meet pressing demands to reduce emissions of greenhouse gases, enhance air quality in large cities, and compete with conventional energies in terms of price. Additionally, it may provide a new dynamism for agroindutry in tropical countries with available land and a willingness to diversify away from concentrated and environmentally problematic energy sources, providing energy security and bringing new economic development.

The preceding chapters sought to demonstrate -- using the detail and reasoning that a document of this scope permits -- how the production of bioethanol from sugarcane, associated with the production of electric power, food and biomaterials, presents attractive returns and constitutes the best alternative to use labor, land, water and sunlight in the production of biofuels. This study also sought to demonstrate that this energy source still offers a great potential for improvement, developing its by-products and optimizig the agroindustrial processes. In the forthcoming years, production could exceed ten thousand liters of ethanol per hectare, with low exogenous energy requirements and emissions of greenhouse gases one-tenth of the amount generated using petroleum products with the same energy output.

The Brazilian experience in this field was accumulated over many decades, with its share of trial and error. Presently, it has hundreds of plants and millions of vehicles running normally, using fuel that a couple of months before was only water, carbon dioxide in the atmosphere and sunlight in sugarcane leaves. Therefore, Brazil can and must be a benchmark for other countries with similar conditions. Many countries could undertake efficient bioenergy pro-

grams, applying the Brazilian example to their characteristics, potential, and markets, but they apparently are reluctant, having doubts about the appeal of the solutions.

Similarly, many countries have tried to reduce their energy dependence, minimize their carbon emissions and enhance the air quality of their cities. However, they do not consider the use of bioethanol from sugarcane as an option, erecting barriers that protect alternatives that are not very efficient nor sustainable. Certainly, there is a lack of information and limited knowledge on the potential of bioethanol from sugarcane, even among energy and environmental decision makers. One of the main purposes of this book was to provide more comprehensive and objective information about this biofuel.

The most important points regarding bioethanol from sugarcane are emphasized below, well-documented and solidly based on decades of experience in Brazil with this type of biofuel. Together, these points demonstrate that bioethanol is a strategic and sustainable energy alternative, which can be replicated and adapted in countries with available land and suitable edaphoclimatic conditions:

1. Bioethanol can be used in vehicle engines, either pure or mixed with gasoline, delivering good performance and using the existing distribution and storage system for gasoline. In concentrations of up to 10%, the bioethanol effects on car fuel consumption are imperceptible and can be used in engines without requiring any modifications.

2. Bioethanol from sugarcane is produced with high efficiency in terms of the capture and conversion of solar energy (with an energy production/energy consumption ratio above 8). The productivity and yields achieved with current technology exceed all other biofuels, reaching 8000 l/ha plus generating significant energy surpluses, in the form of solid biofuels (bagasse and straw) and, principally, bioelectricity.

3. Bioethanol from sugarcane, produced under Brazilian conditions, is competitive with gasoline derived from petroleum priced at or above US$ 45 per barrel, with production costs largely determined by the cost of raw materials. The technology adopted for its production is open and available and can be gradually introduced in the sugarcane agroindustry currently focused on sugar manufacturing.

4. The local environmental impact on water resources, soil and biodiversity deriving from the production of bioethanol from sugarcane, resulting, among others, from the use of agrochemicals, have been effectively reduced to tolerable levels, lower than for most agricultural crops.

5 The use of bioethanol produced from sugarcane reduces the emissions of greenhouse gases by almost 90%, contributing to minimize climate change. Currently, for every million cubic meters of sugarcane bioethanol mixed with gasoline, there is an emission reduction of around 1.9 million tons of CO_2 into the atmosphere.

6 The prospects for further technological advancements in the production of bioethanol from sugarcane are substantial. These include increases in yields and energy performance (including in the agricultural phase), diversification of feedstocks, and special focus on hydrolysis and gasification, to increase the production of bioethanol and bioelectricity. The proper development of bioenergy programs depends fully on their continuous interaction with sources of innovation.

7 Even though the increasing mechanization of the sugarcane harvest has reduced the need for manual labor, employment in the bioethanol agroindustrial sector is growing and is still high per unit of energy produced compared to other energy sources.

8 The production of bioethanol from sugarcane, as developed in Brazil, does hardly affect food production. Cropland planted with sugarcane is limited compared to areas planted with food crops or areas available for expanding agricultural activities.

9 The sugarcane bioethanol agroindustry is linked to many other economic sectors and spurs the development of different areas, such as services, agricultural and industrial equipment and logistics. Fostering scientific and technological development is a key element in this production chain, critical to ensure the use of environmentally friendly and highly efficient raw materials.

10 Considering the availability of unused lands or lands used for low-productivity cattle-raising activities, the production of bioethanol from sugarcane is very likely to increase, not only in Brazil, but also in other tropical-humid countries.

Given that the virtues of bioethanol produced from sugarcane are not widely known or appreciated, it is advisable that private and public decision-makers and opinion-leaders receive accurate information so that they can take informed decisions on this energy source. Bioethanol could play an important role in the energy matrix of many countries. Nevertheless, because of the innovation involved and diversity of competing bioenergy development paths, it is understandable that there are concerns, prejudices and lack of information.

The starting point to a deeper understanding of the potential and limitations of biofuels is to recognize the importance of the production context. Many misconceptions found in studies involving the prospects of bioethanol arise from the oversimplified view that there is a raw material and a product; however, as discussed in Chapter 3, bioethanol production from sugarcane cannot be compared to the production of ethanol from other crops, especially in relation to the most important criteria of sustainability.

An example of this limited understanding is the use of the term "second generation biofuels" to refer to biofuels produced by emerging technologies, especially based on lignocellulosic residues requiring enzymatic hydrolysis or gasification followed by Fischer-Tropsch processes, as discussed in Chapter 5. Several studies and reports suggest that these biofuels will be the redeemers of bioenergy viability (that could then be considered a modern and sustainable source of energy), as long as they are economically competitive, present a good ratio between the energy produced and the energy consumed in production, cause minimal environmental impact, have potential to mitigate climate change, do not adversely affect food production, fully utilizing the raw material. But presently, all these conditions have already been met by sugarcane bioethanol. There is therefore no need to await technologies still in the stage of development and whose costs -- projected to be competitive within 20 years -- are of the same order as present costs incurred by the sugarcane agroindustry in tropical countries [IEA (2005)]. New technologies for bioethanol are certainly worth developing; however, sugarcane-based bioethanol is an alternative that is readily available and meets desirable economic, energy and environmental criteria.

Fortunately, the understanding of the potential of bioethanol from sugarcane is increasing and, in some important forums, it is now distinguished from other biofuels as the most rational and viable option. Specifically, documents from International Organizations are increasingly clear in recognizing that fostering bioethanol production through inefficient means and the adoption of barriers to sugarcane ethanol imports by developed countries have actually increased the distortions in the markets for energy and agricultural goods.

A study by the Organization for Economic Co-operation and Development (OECD) on the impact of biofuels on agricultural markets, for example, states that:

reducing such barriers (including the creation of international standards for biofuels) would not only allow the developing countries to better sell their products, but also help importing countries to fulfill the environmental goals set out in the national biofuel policies, provided

that biofuels are produced in the exporting countries in an environmentally friendly manner [OECD (2007a)].

Other examples are the annual report of the International Monetary Fund, which shows how import barriers on efficient biofuels are harmful to all countries [IMF (2007)], as well as the bulletin of the World Bank's Energy Sector Management Assistance Program (ESMAP), which recommends the liberalization of international biofuel trade as a way to expand its energy and environmental efficiency [ESMAP (2007)].

By the same token, the United Nations Development Program (UNDP) clearly states in its Human Development Report 2007/2008 that:

International trade could play a much larger role in expanding markets for alternative fuels. Brazil is more efficient than either the European Union or the United States producing ethanol. Moreover, sugar-based ethanol is more efficient at cutting carbon emissions. The problem is that imports of Brazilian ethanol are restricted by high import tariffs. Removing these tariffs would generate gains not just for Brazil, but for also for climate change mitigation [UNDP (2007)].

The World Bank, in a document on solutions to the food supply crisis, signed by its President, expresses a similar opinion:

We need action in the US and Europe to ease subsidies, mandates and tariffs on biofuels from corn and oilseeds. The US's use of corn for ethanol has consumed more than 75 per cent of the increase in global corn production over the past three years. Policymakers should consider "safety valves" that ease these policies when prices are high. The choice does not have to be food or fuel. Cutting tariffs on ethanol imported into the US and European Union markets would encourage the output of more efficient sugarcane biofuels that do not compete directly with food production and expand opportunities for poorer countries, including in Africa [World Bank (2008)].

Developing global markets for bioethanol and expanding its benefits requires that this correct understanding of reality be transformed into effective measures.

Several measures need to be taken in order to create the markets discussed above and promote the development of biofuel production on a sustainable basis. These include the coordination and integration of national policies, and the preparation of feasibility studies which assess the opportunities for biofuel production, clearly identifying the challenges, adverse effects and advantages of each case. They also include, bolstering the knowledge of decision-makers, and promoting the articulation of trade policies and the struggle against climate change, according to the vision of a group of biofuel experts [Best et al. (2008)].

It is important to note that the modern sugarcane agroindustry still has important possibilities to diversify its products and increase energy resources, using technologies that are currently being developed or that are already being tested at the pilot level. Thus, they are increasingly moving towards becoming biorefineries, or production complexes capable of providing various types of bioenergy and biomaterials, including food and biodegradable plastics. Likewise, current agronomic studies aiming to preserve and diversify the germplasm base of sugarcane will expand from basic studies on the photosynthetic process, which still are on the frontier of knowledge, but show promising prospects to improve the energy and productive performance of this plant, that already is one of the most efficient converters of solar energy. The sugarcane agroindustry, indeed, is just starting to demonstrate its potential.

Certainly, there is much more to do and many challenges to overcome for the expansion of bioenergy systems, but the benefits will be equally large, since sustainable energy development is critical to consolidate a new relationship between nature and society. Based on this point of view the production and use of bioethanol from sugarcane offers a real potential to start building a new energy reality that is sustainable and which will make this agroindustry the lever for desirable social and economic transformations. The Brazilian model, improved over decades and with new possibilities of expanding with productivity and efficiency, is at the disposal of those countries that, due to their fuel needs, desire to competitively reduce their emissions of greenhouse gases and diversify their sources of energy, or which, given their climate, soil and people may successfully replicate the efficient production of biofuels for the use and benefit of all.