

BIOFUEL POTENTIAL IN GUYANA



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Project Document

Biofuels potential in Guyana

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The report has been prepared by the international energy specialist and UN consultant, Prof. Augusto Horta Nogueira, under the coordination of Manlio F. Coviello, Economic Affairs Officer at ECLAC, who also acted as project manager.

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Abstract

Guyana depends on imported fuel to meet the needs of its transport sector. In recent years, prices of derivatives of petroleum have increased significantly, further widening the current account deficit. In 2005, fuel accounted for 29% of the value of imports of the country.

The technology of using ethanol mixed with gasoline in four-stroke cycle engines is well-known, and, does not require any changes in vehicles for levels of ethanol in the mixture up to 10%. This technology is used in many countries with vehicle fleets, similar to those of Guyana.

The sugarcane industry of Guyana constitutes one of the most important economic activities of the country and is one of the main sources of foreign exchange. However, it is subject to very significant market risks, associated with changes in the Sugar Protocol and the reduction of preferential prices on the market of the European Union.

A diversity of raw materials, sweet or starchy, may be considered for the production of ethanol. However, when considering costs, available technology and energy productivity, sugarcane (directly as juice or as molasses) presents the most attractive option. In time, other possibilities may be considered.

In the most conservative scenario (use of final molasses, producing 8.8 liters of ethanol per ton of processed sugarcane), it is estimated that 30.8 million liters of ethanol may be obtained annually from the sugarcane industry in Guyana. This would be nearly 3 times the anticipated demand of 11.5 million liters, if a mixture of gasoline with 10 % ethanol were to be used in Guyana's vehicles. If other raw materials with higher productivity (sugarcane juice or primary molasses) are considered, the available potential ethanol would increase proportionally.

In 2005, the export price of molasses was US\$ 83 per ton. Each ton of molasses can produce 260 liters of ethanol. This implies an estimated opportunity cost of US\$ 0.392 per liter of ethanol. This is lower than the US\$ 0.463 per liter that Guyana paid for its imported gasoline in 2005, indicating the competitiveness of the biofuel. Ethanol from molasses has consistently been price competitive in the past few years, even without consideration of positive externalities associated with it.

If Guyana were to utilize a mixture of gasoline with 10 % ethanol, a distillery producing 65 thousand liters of ethanol daily would be required to satisfy national demand. This would require an investment of approximately US\$ 6.5 million. It would result in a net earning of

approximately US\$ 800.000 and annual savings of US\$ 5.4 million on the energy import bill, at 2005 prices.

Present conditions of the energy and the agro-industrial sector of Guyana provide an excellent opportunity for the production and use of ethanol as a source of fuel in the country. Furthermore, in addition to price considerations, it is important to be able to produce locally part of the national energy demand, using available natural resources and proven technologies. This would also stimulate diversification in the sugarcane industry which is currently exposed to well known challenges. Moreover, the use of ethanol as a source of energy would have significant environmental advantages. All together, these conditions make a decidedly sufficient and robust case to promote the use of ethanol for energy security in Guyana.

The promotion of ethanol as a source of fuel in Guyana requires the collaboration of all institutions and stakeholders arriving at an operational mechanism for the introduction of ethanol within the energy sector. For such an initiative to be successful clear timelines should be established and commitments obtained. It should also include a component for building public awareness as well as involvement of the local science and technology community.

I. Introduction and background

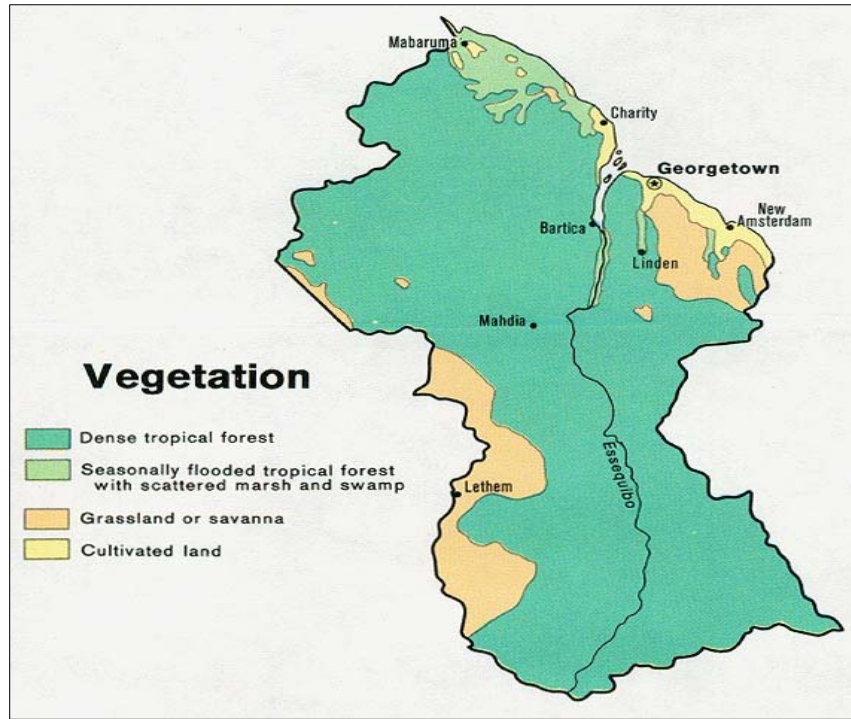
This outlook for the production and use of biofuels in Guyana is preceded by a brief look at the country's geographical and economic characteristics and an introduction to the energy situation and the objectives of the study.

Located on the Atlantic coast in the north of South America, Guyana has an area of 215,000 km² and a population of 752,000,¹ giving it a population density of fewer than four inhabitants per square kilometre. Most of the inhabitants are concentrated in coastal areas and are engaged in the main economic activities, which relate to the production and processing of agricultural crops such as sugar cane and rice, which are cultivated essentially on the coastal plains.

The interior consists basically of extensive forest formations, which cover more than 80% of the territory and sustain a sizeable timber industry. Guyana possesses substantial and diversified mineral resources and the bauxite industry plays a prominent role in the economy. Gross domestic product (GDP) was estimated at US\$ 624.3 million in 2005, corresponding to per capita income of US\$ 830 per year. Guyana's population and economic activity have not changed significantly in recent years.

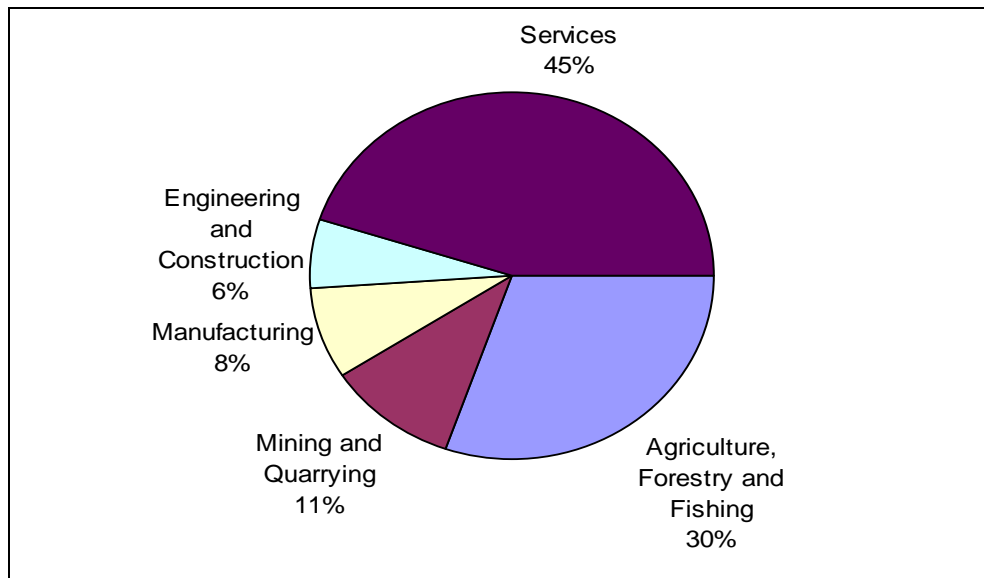
¹ Estimated data for the end of 2005, Bureau of Statistics of Guyana/UNICEF, Statistical Bulletin, January-March 2006.

**FIGURE 1
VEGETATION COVER IN GUYANA**



Source: Perry-Castañeda Library Map Collection, University of Texas at Austin

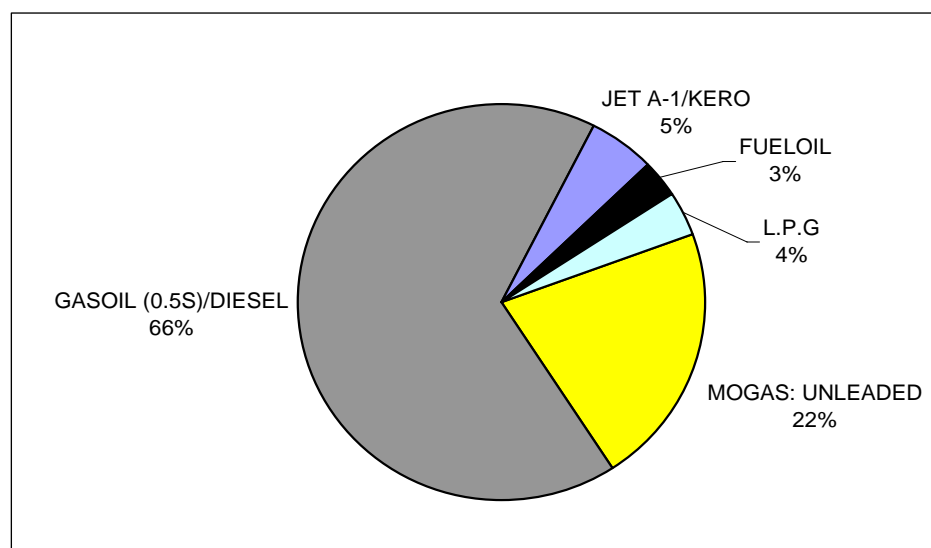
**FIGURE 2
COMPOSITION OF GUYANA'S GROSS NATIONAL PRODUCT**



Source: Bureau of Statistics of Guyana/UNICEF

According to the Latin American Energy Organization (OLADE), total end consumption of energy in Guyana stood at 759,000 tons oil equivalent in 2004, corresponding to an annual per capita consumption of one ton of petroleum, slightly above the average for the region.² In the same year, demand for petroleum derivatives for end uses amounted to 506,400 tons, approximately 67% of the country's energy matrix, distributed among the different petroleum products as shown in figure 3. Data from the Guyana Energy Agency for 2005 indicate that diesel accounts for 60% of the country's total fuel consumption,³ owing to its widespread use in the transport sector, in agricultural activities and for electricity generation. The country has a total installed capacity of 308 MW, consisting almost entirely of diesel-fired thermoelectric plants, which generated 914 GWh in 2004. It should be noted that Guyana, whose name means "land of many waters" in a local indigenous language, has a significant hydroelectric potential, with available capacity estimated at 7,600 MW.

FIGURE 3
COMPOSITION OF THE DEMAND FOR PETROLEUM PRODUCTS IN GUYANA



Source: Guyana Energy Agency, 2006

Guyana imports oil products from the Caribbean region to meet its fuel requirements, and its total bill for petroleum products absorbs substantial amounts of foreign exchange as shown in figure 4. In 2005, this expenditure accounted for 29% of the country's total import bill and was in excess of US\$ 220 million. In the past four years, the cost of these items has increased by more than 100%, with an obvious impact on the nation's economy. Imports of gasoline, the product which could potentially be replaced by ethanol fuel, were equivalent to 8.6% of GDP in 2005.⁴ The increasing number of vehicles in Guyana,⁵ shown in figure 5, is indicative of the growing motorization of the country and points to a continuing rise in the demand for fuel, with obvious implications for the economy in terms of the larger fuel import bill.

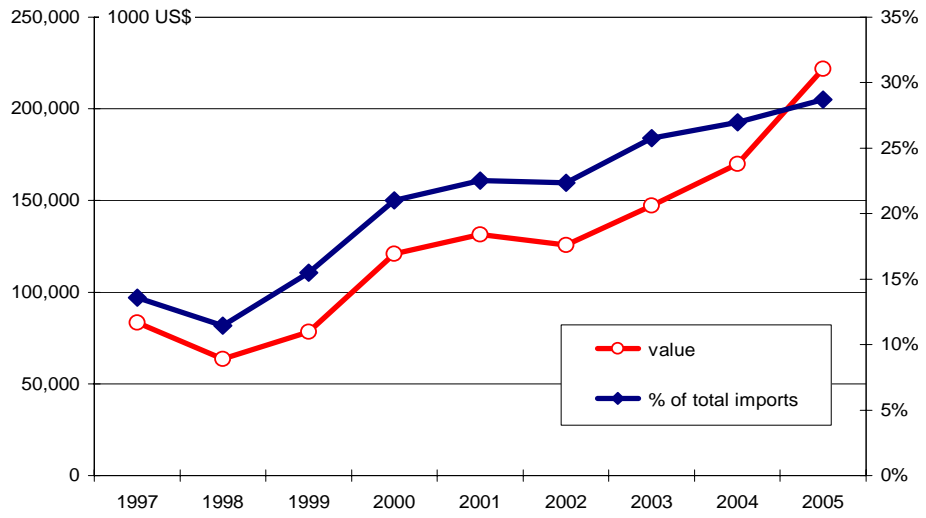
² Latin American Energy Organization (OLADE), Energy Statistics 2005, , SIEE, Energy-Economic Information System (SIEE), 2006.

³ Guyana Energy Agency, information collected by the author, June 2006.

⁴ Based on data provided by the Bureau of Statistics and the Guyana Energy Agency, June 2006.

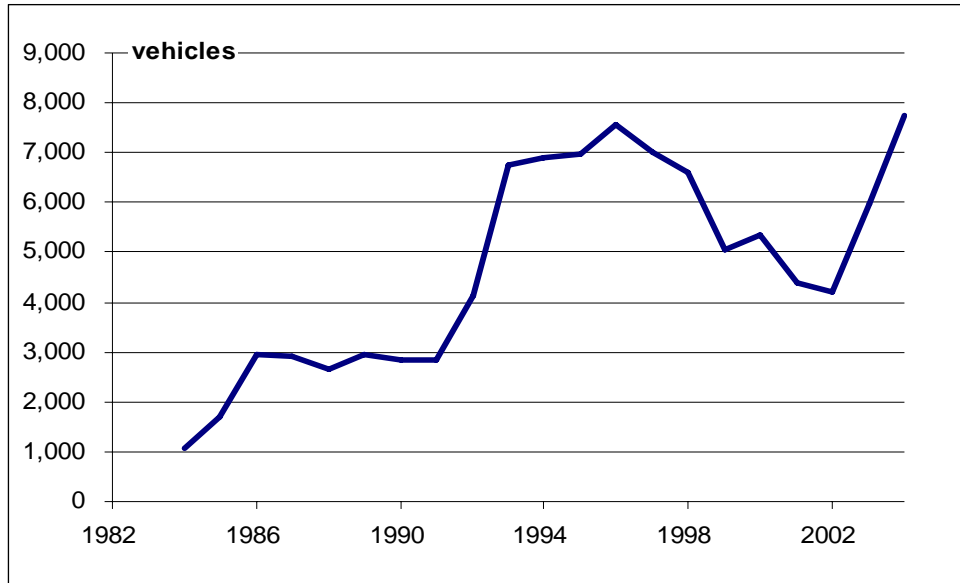
⁵ Data supplied by the Licence Revenue Office, cited in Bureau of Statistics of Guyana/UNICEF, *Statistical Bulletin*, January-March 2006.

FIGURE 4
IMPORTS OF PETROLEUM PRODUCTS IN GUYANA



Source: Guyana Energy Agency, 2006

FIGURE 5
VEHICLE REGISTRATION IN GUYANA



Source: Bureau of Statistics of Guyana/UNICEF, 2006

Guyana's sugar-cane industry is one of its major economic activities, contributing almost 15% of GNP and accounting for 40% of agricultural output. It provides direct employment to 20,000 people⁶ and close to 50,000 hectares are used for the growing of sugar cane. Established in Guyana more than three centuries ago, this industry is the biggest income generator and the main source of foreign exchange. Furthermore, it has the potential to produce and process agricultural goods, including for energy purposes.

An important change for Guyana's sugar industry, which exports a substantial proportion of its production, is the imminent entry into force of a new pricing system for exported sugar. Indeed, as will be discussed in greater detail below, starting in 2006, prices will be reduced progressively following the suspension of preferential terms of access to the European market. This new situation will be a serious blow to the industry's profitability, hence the need for the urgent establishment of a new operational framework for Guyana's sugar factories.

In view of the country's energy requirements and critical dependence in a context of rising prices, and given the obvious potential for biofuel production, a proposal has been put forward for the adoption of ethanol fuel in Guyana. Various initiatives in this direction have been reported in the press⁷ and the Government has discussed concrete ways of implementing these proposals for a national renewable fuel, notably by promoting the use of the country's natural resources and diversifying agro-industry, thereby reducing energy dependence. Clearly, there is a growing awareness in Guyana today of the need to introduce biofuels and to do so in such a way as to alleviate any problems that may arise and multiply the potential benefits.

At the request of the Government of Guyana, ECLAC decided to cooperate by promoting the preparation of this study, which is devoted essentially to exploring the country's potential to produce ethanol fuel on a sustainable basis for its own consumption. Similar studies were developed by ECLAC in other countries of the region,⁸ with a view to determining the potential for, and constraints on, the introduction of biofuels. Efforts were made to collaborate on the increasing number of government initiatives being implemented to promote ethanol.

The next section focuses on the basic concepts of bioenergy and presents an overview of bioenergy resources and potential in Guyana, based on the study of the potential demand for ethanol, which can be used in a proportion of up to 10% in gasoline blends. Chapter 4 contains an analysis of the sugar-cane industry, its present situation and the technical and financial requirements for producing ethanol; the existing capacity is determined and the potential for future output explored. An assessment is made of the feasibility of developing the production and use of ethanol in Guyana, based on estimates of potential demand and supply, prices and costs, the investment required and potential foreign exchange savings. Lastly, the relevant conclusions and recommendations are presented.

⁶ Guysuco News, July–August 2000, in M. Sharma, “Ethanol Production from Sugar Cane for Export and Use as a Gasoline Blend in Guyana”, Master's Degree Project, University of Calgary, 2002.

⁷ See, for example, “Ethanol Plant for Guyana”, *Business News*, 16 May 2006 [online] <http://www.cbc.bb/content/blogcategory/124/46/> and Guyana Online, “Ethanol Plant MoU signed”, 8 June 2006 [online] <http://www.guyanaonline.net/news/index.php>.

⁸ Economic Commission for Latin America and the Caribbean (ECLAC): Renewable Energy Potential in Jamaica (LC/W. 18), Santiago, 2005. (online) <http://www.eclac.cl/cgi-bin/getprod.asp?xml=/publicaciones/xml/3/24583/P24583.xml&xsl=/dmaah/tpl/p9f.xsl&base=/dmaah/tpl/top-bottom.xsl>. *Perspectivas de un Programa de Biocombustibles en América Central* (LC/MEX/L.606), Mexico City, March 2004. *Aspectos complementarios para la definición de un Programa de Bioetanol en América Central* (LC/MEX/R.857), Mexico City, May 2004.

An extensive programme of visits (reported on in Annex 1) was conducted in June 2006 in order to interview representatives of the Government of Guyana and other entities concerned with the production and use of ethanol and to collect relevant data and information. These visits and interviews provided a deep insight into the energy problem in the country and the potential of the sugar-cane industry.

Two fundamental references were used on the present study, the master's thesis of Mahendra Sharma⁹ and the study by Davis and others;¹⁰ these relatively recent studies discuss systematically the potential for using ethanol fuel in Guyana.

⁹ M. Sharma, "Ethanol Production from Sugar Cane for Export and Use as a Gasoline Blend in Guyana", Master's Degree Project, University of Calgary, 2002.

¹⁰ H. Davis, L. Stuart and P. Bhim, "Potential for fuel ethanol in the Guyana sugar industry", Proceedings of the twenty-fifth Congress of the International Society of Sugar Cane Technologists, Guatemala, 2005.

II. Bioenergy and biofuels in Guyana

This section reviews the concepts of bioenergy and biofuels and provides a brief list of bioenergy vectors in Guyana.

Bioenergy is based on the use of energy resources resulting from the conversion of solar energy into chemical energy through photosynthesis as occurs for example with wood, charcoal, ethanol and biodiesel. This was probably the first form of exogenous energy used in bonfires by early humans and which is now being considered in a new context, thanks to new technologies and requirements. While the extractive industries have a long history in the exploitation of energy resources and while oil and coal continues to play a dominant role, environmental and economic constraints are creating pressure for the introduction of renewable energies.

II.1 Sugar cane for liquid biofuels

Liquid biofuels have significant potential since they can be adapted to existing energy conversion systems, such as engines, and are economically feasible and socially and environmentally acceptable. Indeed, an intensive transition is taking place in national energy matrixes; ethanol and biodiesel produced on varying scales from raw materials ranging from sugar cane to African palm are progressively being introduced under widely varying conditions.

As regards the role of biofuels and particularly ethanol in the supply of fuels, the introduction of ethanol in gasoline blends deserves some comment. This technological option had been proposed as far back as the late nineteenth century by Henry Ford, who used pure ethanol in his early models. This fuel was first used on a large scale in Brazil, where a law was adopted in 1931 for the compulsory use of 5% ethanol in imported gasoline¹¹, thereby initiating a learning process that was the basis for the significant expansion observed in recent decades. Since the 1980s, Brazil has been using 25% ethanol in all gasoline sold, with demand currently standing at approximately 16 billion litres of ethanol and projected to increase to over 22 billion litres in

¹¹ Decree 19.717, Obrigatoriedade da adição de álcool à gasolina de procedência estrangeira (Obligatory addition of alcohol to gasoline from foreign sources), Rio de Janeiro, 20/2/1931.

2013,¹² based on current high growth rates. This estimate is corroborated by the fact that 40 new sugar factories are being constructed in Brazil. Similar programmes are being implemented in Colombia and Costa Rica, while various other countries are pressing ahead with legislation and regulatory frameworks to promote the use of biofuels. Among the industrialized countries, the United States has been developing a comprehensive programme for ethanol fuel extracted from corn and Europe has been promoting the production of biodiesel from canola, the target being for biofuels to satisfy 5.75% of energy demand for transport up to the year 2010.

The use of bioenergy in the form of biofuels necessarily means developing two quite different phases: the production of biomass for use as a raw material and its conversion into fuels suitable for use in internal combustion engines. Considering the production of ethanol for Otto cycle engines, a wide range of sweet, starchy or cellulose raw materials can be used; once converted into aqueous hexose solutions, these raw materials can be fermented and distilled to obtain the biofuel, which in turn can be used in blends of up to 10% in conventional motors or pure in specially modified engines. For diesel engines, oil-seed crops are more appropriate; once the oils or grease have been extracted, they must be processed by transesterization, yielding the biodiesel, which, provided it meets the necessary specifications, can be used directly in conventional diesel engines.

The success of biofuels development depends first and foremost on the proper selection of the raw material to be used in the production of a biofuel. In this regard, the choice of biofuel crops depends fundamentally on the following factors:

- Agro-industrial productivity, which combines agricultural productivity and industrial productivity and is evaluated in terms of litres of fuel per hectare;
- Technological availability, or the existence of known and accessible processes for converting the raw material into biofuels;
- The energy balance, which expresses the ratio of energy demand to production for a given raw material conversion process ;
- The availability of energy by-products that are capable of meeting the energy requirements of the conversion process;
- Environmental impact, at the level of agricultural and industrial production;
- Competition with food production;
- The level of knowledge and dissemination of crops in the context under consideration.

Using these criteria, a preliminary selection can be made from among the different crops that can be used for the production of ethanol. Starchy crops (products that clearly have food value and have a low energy yield) and corn (marginally attractive energy balance) can be ruled out or at least given lower priority.

Sugar cane stands out as a favourable alternative in Guyana, given the existence of export surpluses and the fact that it has been cultivated for centuries in the country and has an energy production/demand ratio of over 8, one of the highest available. Moreover, with the use of bagasse, the industrial processes can be self-sufficient and even generate a surplus. Bioenergy associated with this raw material will be studied in detail in the next section.

In addition to cane, a rapid survey is made of the main bioenergy resources available in Guyana, in order to provide a preliminary assessment of the conditions of these forms of

¹² I.C. Macedo and L.A. Horta Nogueira, *Biocombustíveis*, Strategic Affairs Group of the Office of the President of the Republic of Brazil, Brasília, 2005.

renewable energy in the country; the following section presents the energy potential associated with rice cultivation and the timber industry, two important activities in the country's economy and which produce high volumes of waste that can be used as an energy source.

II.2 Rice waste for cogeneration

Rice cultivation in Guyana, which occupies approximately 130,000 hectares, produced an estimated crop of 501,500 tons in 2004.¹³ In the same year, exports stood at 357,900 tons, accounting for over 70% of total production and inflows of approximately US\$ 54.5 million. Considering that rice-processing plants produce close to 0.22 kilograms of cellulose waste per kilogram of husked rice, it is estimated that approximately 110,300 tons of such residues (mainly husks) would be available. Assuming that the energy content of these wastes is 13.8 MJ/kg,¹⁴ the reserves may be estimated at 36,400 tons of oil equivalent or 11% of current diesel consumption in Guyana.

This potential biofuel, which is often wasted and causes environmental problems when not properly disposed of, could be used to produce electricity using conventional technologies. For example, in the rice-growing region in the south of Brazil, two thermo-electric plants totalling 6.4 MW and connected to the national grid were installed close to rice-processing mills to use the husks produced.¹⁵

II.3 Wood waste for cogeneration

As regards the bioenergy potential of Guyana's sawmills, whose total timber production in 2005 was approximately 1,347,000 cubic meters,¹⁶ the average density of the wood was assumed to be 600 kg/m³ and waste production (sawdust, wood shavings etc.) was estimated, conservatively, at approximately 200 kilograms per cubic meter or one third of processed wood. Estimating the heat potential at 13.8 MJ/kg, the result was an impressive figure of 1.55 million tons of oil equivalent for 2005, almost three times more than the country's current diesel consumption.

As in the case of the rice mills, these lignocellulose wastes can be used to produce electricity and for cogeneration. In this regard, Barama Company Limited, one of the main groups active in the forestry industry in Guyana, intends to set up a 3 MW plant using available waste.¹⁷

Of course, the above values are just preliminary estimates, but they indicate clearly the extent of knowledge of Guyana's bioenergy potential, mainly for electric power generation. It should be noted that irrespective of the production system, even when waste is being used, environmental factors must be respected, failing which bioenergy will always be inappropriate and undesirable.

¹³ FAO Statistical Databases (FAOSTAT) [online] www.faostat.fao.org, August 2006.

¹⁴ L.A.Horta Nogueira, L.A. and E.E. Silva, E.E., *Dendroenergia: fundamentos e aplicações*, Rio de Janeiro, Editora Interciencia, 2004.

¹⁵ Brazilian Electricity Regulatory Agency (ANEEL), Banco de Informações de Geração, [online] <http://www.aneel.gov.br/15.htm>.

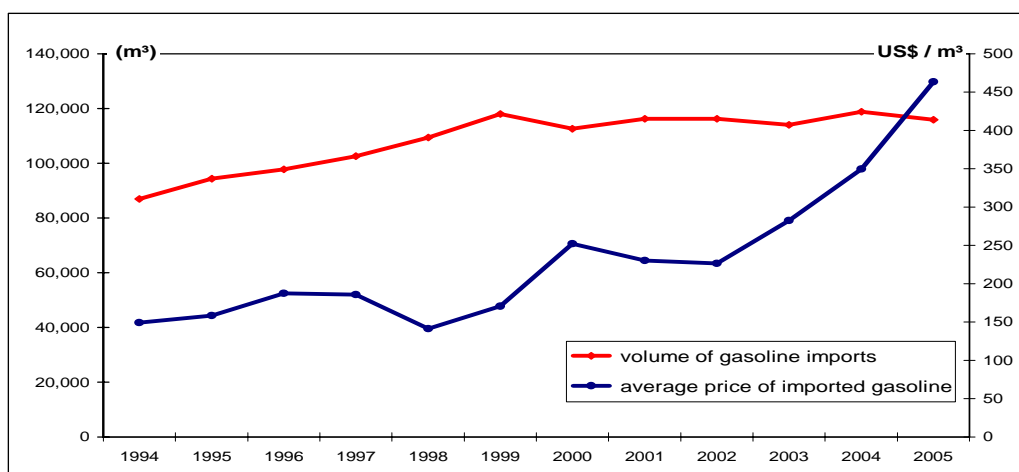
¹⁶ FAO Statistical Databases (FAOSTAT) [online] www.faostat.fao.org, August 2006

¹⁷ The Guyana Office for Investment, Go-Invest, Forest Products, [online] <http://www.goinvest.gov.gy/forestry.html>, September 2006.

III. Potential demand for ethanol fuel in Guyana

Bearing in mind that the proposal is to use a blend of 10% anhydrous ethanol in gasoline, the demand for ethanol for energy purposes is determined directly by gasoline consumption. According to data from the Guyana Energy Agency, national gasoline consumption totalled 115,900 cubic metres in 2005 and cost the country US\$ 53.7 million, signifying a unit cost of US\$ 0.463/litre. The limited demand for aviation gasoline was not taken into account in these estimates, although various aircraft engines are already approved for use with blends. Figure 6 shows the pattern of consumption and the C.I.F. price movements in recent years.¹⁸ As will be noted, consumption has remained practically unchanged at approximately 116 million litres, suggesting that the expansion reflected in figures 4 and 5 for total fuel consumption and the vehicle fleet must relate essentially to the use of diesel.

FIGURE 6
VARIATION IN THE CONSUMPTION AND CIF PRICE OF MOTOR GASOLINE IN GUYANA



Source: Guyana Energy Agency, June 2006

¹⁸ Based on data from the Guyana Energy Agency, June 2006.

The potential demand for ethanol for fuel purposes in Guyana under the conditions described may be estimated at approximately 11.6 million litres. A distillery operating 180 business days per year would therefore need to produce 65,000 litres per day.

Since there is practically no increase in fuel consumption with a blend of this composition, as demonstrated by experiments conducted recently by petroleum companies in Colombia and Costa Rica, ethanol may be considered to have the same value as gasoline.¹⁹ In other words, the substitution effect is direct and this level of ethanol consumption should enable Guyana to cut its gasoline consumption by the same volume, representing savings of US\$ 5.4 million at 2005 values.

In terms of *reduction of greenhouse gases*, it has been determined that for conventional technologies, every litre of anhydrous ethanol in the gasoline blend²⁰ results in an average reduction in emissions of 0.42 kg of CO₂ equivalent. Assuming that the conditions are the same as for Brazil, reductions in emissions could thus be estimated at about 4640 tons of CO₂ equivalent (i.e. 4640 Certified Emission Reductions, CER)

Depending on how these reductions are calculated, a relatively positive annual contribution could be obtained for the productive sector under the Clean Development Mechanism of the Kyoto Protocol. Assuming a conservative price of US\$5/ton of CO₂, a reduction in emissions would mean an additional input of US\$ 23.000 in the project cash-flow, per year.

¹⁹ Economic Commission for Latin America and the Caribbean (ECLAC), *Costos y precios para etanol en América central*, (Convenio CEPAL/República de Italia) (LC/MEX/L.716), Mexico City, 2006.

²⁰ I.C. Macedo, M.R. Leal and J.R. Silva, "Greenhouse gas emissions in the production and use of ethanol in Brazil: present situation (2002)", Secretariat of the Environment of the State of São Paulo, 2003.

IV. Potential supply of ethanol fuel in Guyana

The current situation of the Guyana sugar agro-industry is presented below, together with the alternatives for ethanol production, based on an assessment of its technical and economic benefits. A few brief remarks are also included on complementary issues relating to the increase in productivity of this activity in Guyana, through systems of cogeneration and agronomic development.

IV.1 The Guyana sugar industry

Guyana's tropical location, mean annual sunshine and temperature variation between 20° C and 33° C throughout the year, its flat topography and fertile soils and system of moderate winds are highly suitable for the cultivation of sugar cane. Perhaps the only specific difficulty is that the land is prone to flooding, so that drainage systems (based on gravity or pumps) are necessary and crops must be carefully planned around the two rainy seasons, the longer of which is between April and August and the second, between November and January.

Around 50,000 hectares are currently under cultivation with sugar cane in Guyana, providing 3.5 million tons of cane per year to 8 sugar estates, belonging to the Guyana Sugar Corporation Guysuco, whose sugar plantations occupy the coastal areas of the country as indicated in figure 7.²¹ The agricultural and industrial productivity indicators of these sugar factories are presented in figure 8,²² and the variations observed for each year are considered to be due to variations in rainfall, excessive amounts being the most prejudicial. On average for the last five years, the productivity was 75.8 tons/ha, varying between 64.2 tons/ha (2005) and 89.1 tons/ha (2002).

²¹ Guysuco, cited in M. Sharma, *op. cit.*

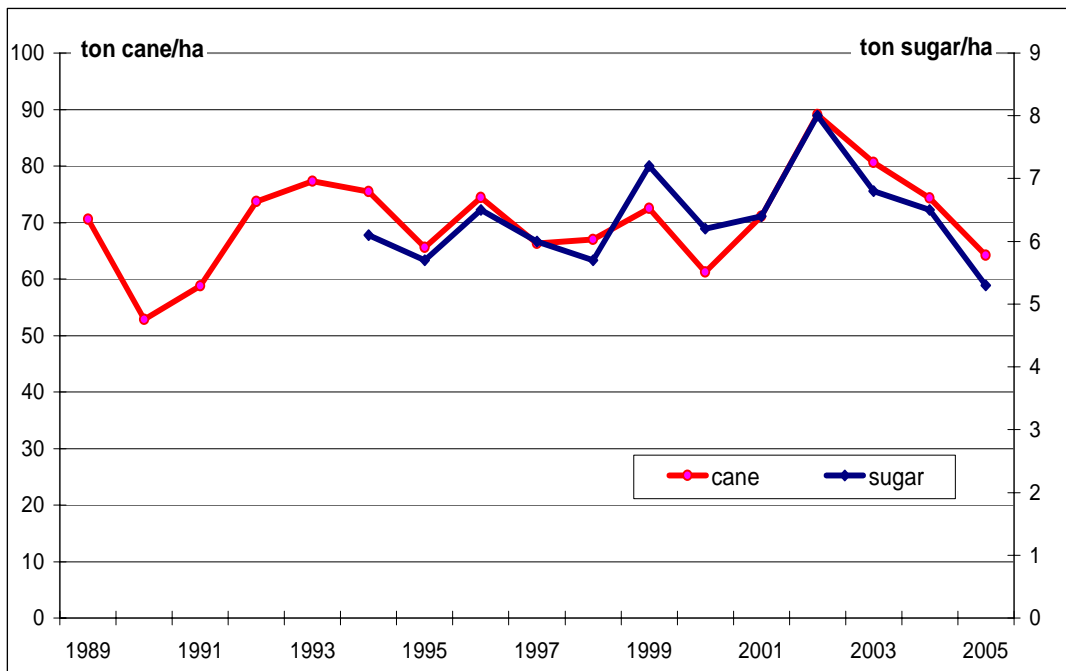
²² Based on data provided by Guysuco, cited in Bureau of Statistics of Guyana/UNICEF, *op. cit.*

**FIGURE 7
SUGAR FACTORIES IN GUYANA**



Source: Guysuco, 2006

**FIGURE 8
TRENDS IN AGRICULTURAL AND INDUSTRIAL PRODUCTIVITY OF THE SUGAR-CANE AGRO-INDUSTRY IN GUYANA**



Source: Guysuco, 2006

The average annual production of the sugar estates in Guyana in recent years was approximately 330 million tons. Of this total, close to 90% was exported, basically to the European Community and the United States, at preferential prices that are more attractive than those paid on the open market. This point is important and some explanation is due of how the international sugar market is organized.

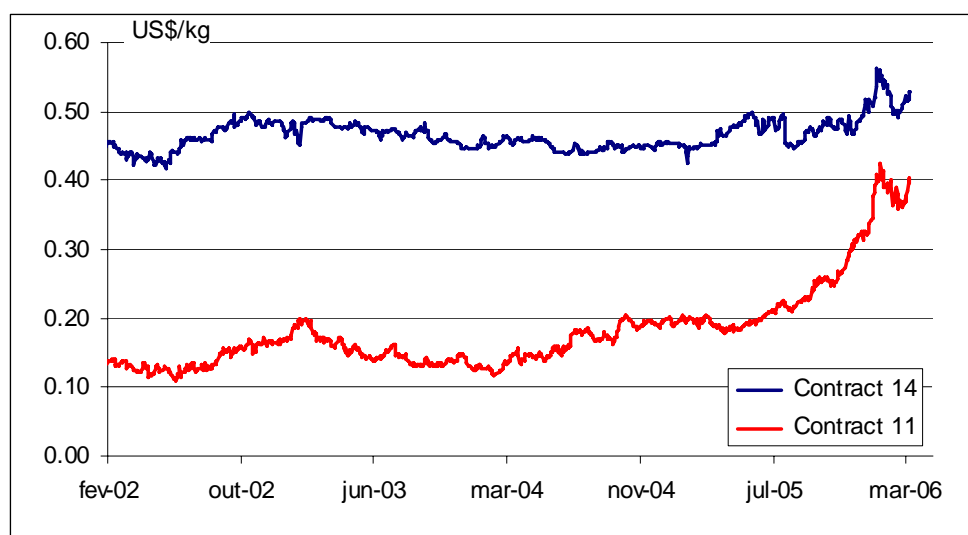
The prices paid for sugar differ significantly depending on the market concerned and two cases in particular deserve attention:

- Preferential contracts with the United States, under the quotas established by the United States Department of Agriculture, with prices determined by contracts No. 14 of the New York Board of Trade, NYBOT) and with Europe under the ACP (Africa, Caribbean and Pacific) agreements and Special Preferential Sugar Agreement (SPS), which are limited by quotas assigned to producer countries;
- Open-market or surplus contracts, which are based on the prices of No. 5 contracts of the London Stock Exchange or No. 11 contracts of the New York Stock Exchange.

The quotas are based on an import policy which allows countries to export limited quantities of a product tariff-free or subject to relatively low tariffs, but applies a higher tariff to all additional imports of this product.

Figure 9 shows the movement in sugar prices in contracts 14 and 11 of the New York Board of Trade in recent years. Quota volumes have remained constant, and account for decreasing percentages of exports; also the gap between prices paid under contract 14 and those under contract 11 has tended to become smaller.

FIGURE 9
MOVEMENT OF SUGAR PRICES ON THE NEW YORK BOARD OF TRADE



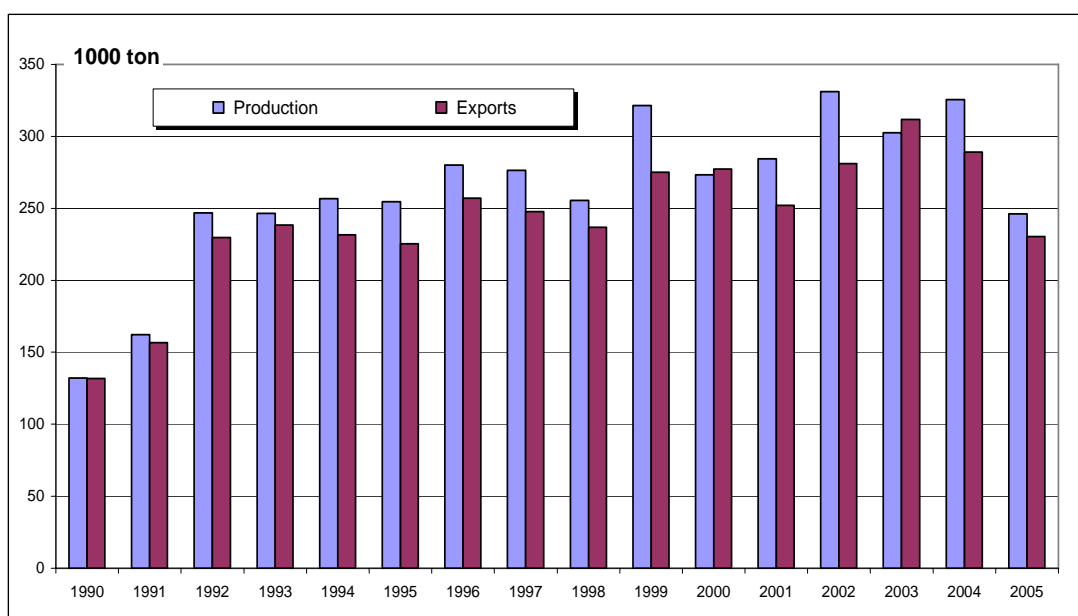
Source: New York Board of Trade, NYBOT

Guyana's access to consumer markets on preferential, zero-tariff or low-tariff terms is based on three international agreements: 1) The Caribbean Basin Initiative (CBI) signed with the United States (12,600 tons), 2) the ACP-EU Sugar Protocol (167,000 tons) and 3) the Special

Preferential Sugar Agreement (30,000 tons), corresponding in total to close to 210,000 tons, which include the quantity exported under preferential prices as well as non-quota volumes.

Figure 10 shows the performance of sugar production and exports in recent years. The wide variations observed are due mainly to the extreme weather conditions that prevailed in some years mainly as a result of the El Niño phenomenon. Nevertheless the country invariably exported between 85% and 100% of its sugar production. Exports from the sugar sector account for a very significant proportion of the country's total exports, since if exports of molasses and rum are included, sugar-sector exports in 2004 and 2005 represent 40% and 49% respectively of the country's total commodity exports.²³

FIGURE 10
VARIATIONS IN SUGAR PRODUCTION AND EXPORTS IN GUYANA



Source: Bureau of Statistics and Guyana Energy Agency, June 2006

The sugar-cane industry in Guyana has had to face new and daunting challenges in recent years, linked essentially to the prospect of a reduction in export quotas or preferential price margins, which will expose Guyana's production to a highly competitive and very volatile market. In 2005, the European Community, which currently purchases 60% of Guyana's sugar production, established a schedule for the progressive elimination of the quotas at preferential prices, and from July 2006 was due to reduce by 50% the price support existing within the framework of the ACP agreement. A further 25% cut is due to take effect in October 2008 and total withdrawal of European preferential tariffs from Guyana is to take place in 2009. Along with this process of quota reductions, the European Community is implementing a programme of productive restructuring for this agro-industry, in the belief that in the medium term it will be possible to improve its competitiveness.²⁴

²³ Figures based on data from the Bureau of Statistics and Guyana Energy Agency, June 2006.

²⁴ Guysuco, Guyana Sugar Corporation, information collected by the author, July 2006.

As a strategy for dealing with this new context, Guysuco is proposing to expand sugar production by 50%, diversifying the products of the cane-sugar industry, increasing the production of refined sugar, introducing the production of ethanol fuel and increasing electricity generation from bagasse, in short, by seeking to improve agro-industrial productivity and reduce costs.²⁵ Substantial resources would be needed; a credit application submitted to the World Bank by Guysuco in 2001 was rejected, and other restrictions were revealed in a study that suggested the closure of four sugar estates (Demerara Estates), with the loss of almost 9,000 jobs, almost half of the labour force employed in the sugar agro-industry in the country.²⁶

In view of Guyana's natural potential and socio-economic requirements, it is imperative for it to consider modernizing and possibly expanding its sugar-cane agro-industry. This could be done through the production of ethanol fuel, increased cogeneration and, generally speaking, by upgrading the production chain of sugar cane, which is a raw material with great potential.

IV.2 Possible choices for ethanol production: technical issues

The evaluation of the country's ethanol production potential, with an assessment of the present and future output of the sugar-cane industry, was conducted on the basis of the three technological scenarios shown in the table below, depending on the raw material. In all cases, production basically involves the following three stages:

- Preparation of a fermentable must (a sugar solution following heat treatment and pH adjustment, containing the yeast nutrient),
- Conventional fermentation in batch processes with refrigeration and two-stage fermentation with yeast recycling,
- Conventional distillation, with an initial alcohol concentration stage followed by dehydration through distillation with co-solvents or via molecular sieves.

TABLE 1
TECHNOLOGICAL SCENARIOS FOR ETHANOL PRODUCTION IN GUYANA

Scenario	Ethanol production (litre/ton)	Sugar production (litre/ton)
Exhausted molasses (poor syrup)	8.8	112
Rich molasses (rich syrup)	17.1	92
Cane juice	80	-

Source: Data elaborated by the authors based on Guysuco and Davis et alii.

As for sugar-cane supply, the 2004 output figure of 3.5 million tons was taken as representative. On that basis, ethanol could be produced at the levels shown in Table 2 below. Of course, if restrictions were placed on the availability of raw materials, perhaps to satisfy other needs such as drinks production or exports, ethanol output would be proportionately lower.

²⁵ H. Davis, L. Stuart and P. Bhim, op. cit.

²⁶ M. Sharma, op. cit.

TABLE 2
GUYANA'S ETHANOL PRODUCTION POTENTIAL

Scenario	Ethanol production (thousands of m ³ /year)
Exhausted molasses (poor syrup)	30.8
Rich molasses (rich syrup)	59.9
Cane juice	280.0

Source: Data elaborated by the authors based on Guysuco and Davis et alii.

In all the scenarios considered, the potential ethanol output is considerably higher than 11.6 million litres, which is the amount needed for a 10% ethanol-gasoline blend. A study which confirms these results took into account only the ethanol output of the four estates at which an end to sugar production has been suggested (Demerara Estates), using sugar-cane grown on 20,000 hectares and allowing an annual output of 90 million litres of the biofuel,²⁷ a volume much greater than the previously anticipated demand.

A more detailed study, conducted by experts from the Guyana Sugar Corporation (GUYSUCO) and presented at an international sugar-sector conference, looked at adapting and modernizing sugar mills as a means of facing the challenge of the shrinking market for sugar at preferential prices.²⁸ It looked at a mill located on the west coast of Demerara, which currently has the capacity to process 5,040 tons per day of cane, grown on 12,280 hectares of land located near the plant.

The study suggested resizing the plant to process 4,560 tons a day and made a comparative assessment of (a) sugar and molasses production, (b) production of sugar and of ethanol from exhausted molasses, and (c) production of sugar from raw cane juice, diverting the secondary juice and molasses for ethanol production. These alternatives are fairly similar to the scenarios proposed in Table 1, but where exhausted molasses was used for ethanol production, molasses from other mills would be added in order to raise output to the level needed to satisfy demand within Guyana. Increased cogeneration was also considered, with the production of excess power for the public grid. Table 3 summarizes the results of the study in terms of products, and the economic indicators are presented below.

TABLE 3
ALTERNATIVES FOR MODERNIZATION OF A SUGAR MILL IN GUYANA

Alternative	Sugar production (tons)	Molasses production (tons)	Ethanol production (thousands of litres)	Electric power generation (MWh)
Original situation	80,182	32,073	-	-
Sugar only	73,409	29,364	-	25,200
Sugar and ethanol from exhausted molasses	73,409	(14,098)	11,300	25,200
Sugar and ethanol from rich molasses	56,283	-	11,300	25,200

Source: Data elaborated by the authors based on Guysuco and Davis et alii.

²⁷ Ibid.

²⁸ H. Davis, L. Stuart and P. Bhim, op. cit.

An important aspect of ethanol production is the existence of a wastewater known as vinasse, of which 12 to 15 litres are produced for each litre of anhydrous ethanol. Vinasse, which has a high organic content and a reasonable level of potassium, is traditionally used in wastewater irrigation ("fertigation") systems in Brazil and Guatemala, with positive effects on the economic and environmental feasibility of agro-industry, since some of the nutrients from the sugar-cane harvest are returned to the soil.

It is essential, however, given the characteristics of sugar-cane growing in Guyana, where the cultivated plots are on drained land and almost always surrounded by canals, that the final disposal of vinasse is carefully considered in order to make use of its advantages and reduce the risk of environmental damage.

The importance of this is demonstrated by the fact that, for a daily output of 60,000 litres of ethanol, a distillery will produce between 720 and 900 cubic metres per day of vinasse.

IV.3 Possible choices for ethanol production: economic issues

In terms of the prospects for ethanol in Guyana, the most important economic considerations are the investments required and the biofuel production costs, which are discussed below.

The typical reference conditions for estimating the costs involved in plants for the production of ethanol from molasses assume the presence of distilleries with unit capacities of 150 cubic metres per day. For an effective harvest season of 180 days, this would result in annual output of 27 million litres, more than double the demand. Such plants cost about US\$ 15 million, giving a unit cost of US\$ 100 per litre of daily production capacity. Assuming that a distillery can be built with the same daily unit cost and that it meets the estimated demand for Guyana, meaning that it must produce 65,000 litres per day, the industrial investment needed would be some US\$ 6.5 million. This does not take account of the costs of the associated sugar industry which supplies the molasses used as the raw material.

For new projects in Latin America, the typical unit for direct production of ethanol from cane juice is an autonomous distillery with a capacity of 450 cubic metres per day, requiring industrial investment of US\$ 50 million, operating 180 working days per year, processing 1 million tons of cane per harvest, and with an annual output of 80,000 cubic metres of anhydrous ethanol. As in the previous example, the standard capacity is much higher than national demand; a smaller-scale unit therefore needs to be found, probably with a capacity of about 60 cubic metres per day, and perhaps operating with a slightly longer harvest.

Ethanol production costs essentially depend on the cost of raw materials, which make up about 65% of the final cost of the biofuel.²⁹ In the aforementioned GUYSUCO study on the modernization of sugar mills, a production cost of US\$ 0.246 per litre of ethanol was calculated, based on the assumption that molasses costs US\$ 45 a ton, the price observed at the time of the study.³⁰ The following table shows the breakdown of those costs.

²⁹ Economic Commission for Latin America and the Caribbean (ECLAC), *Costos y precios para etanol combustible en América Central (Convenio CEPAL/República de Italia)* (LC/MEX/L.716), Mexico City, 2006.

³⁰ H. Davis, L. Stuart and P. Bhim, op. cit.

TABLE 4
COST OF THE PRODUCTION OF ETHANOL FROM MOLASSES

Component	Estimated cost (US\$/litre)
Raw material (molasses)	0.1731
Energy (steam and electric power)	0.0196
Chemicals	0.0303
Wages	0.0097
Maintenance	0.0082
Other fixed costs	0.0051
Total	0.2461

Source: Data elaborated by the authors based on Guysuco and Davis et alii.

If molasses costs US\$ 83 a ton, the export value observed in 2005,³¹ with a productivity of 260 litres of ethanol per ton of molasses, the cost per litre of ethanol is estimated at about US\$ 0.392, assuming that the other cost components are constant.

For direct production of ethanol from cane juice, the cost horizon contained in GUYSUCO's Agriculture Improvement Plan was taken into account, assuming improved productivity and intensive mechanization.³² In that context, a price estimate of US\$ 16.00 per ton for sugar cane was used. On that assumption, together with a productivity of 80 litres per ton of cane, and assuming that raw materials make up 65% of total costs, the cost per litre of ethanol would be US\$ 0.308. If a price of US\$ 21.25 per ton is assumed, as in the 2002 study,³³ the same method of calculation would yield a price of US\$ 0.408 per litre of ethanol.

TABLE 5
UNIT SUGAR-CANE PRODUCTION COSTS FOR GUYSUCO, 2001

Activity	Cost (US\$)	percentage
Mechanical tillage	0.835	4.0
Field work	1.401	7.0
Cane planting	2.920	14.0
Ratoon cane	2.885	14.0
Harvesting	6.929	33.0
Field equipment	0.756	4.0
Water management	0.585	3.0
Field management	4.534	22.0
Total	20.848	100.0

Source: Data elaborated by the authors based on Guysuco and M. Sharma.

³¹ Based on information from Guysuco, cited in Bureau of Statistics of Guyana/UNICEF, *Statistical Bulletin*, January-March 2006.

³² H. Davis, L. Stuart and P. Bhim, op. cit.

³³ M. Sharma, op.cit.

Certain information on the costs of the sugar-cane agro-industry under the particular conditions that prevail in Guyana may be taken into account in any estimates on ethanol production. For example, the cost of creating new cane plantations is estimated at US\$ 2,931 per hectare, including all activities from the cleaning of the land and drainage to infrastructure works and earthworks.³⁴ Indeed, the growing of crops on low-lying and swampy land entails considerable costs. The values shown in Table 5 were calculated on the basis of the cost report presented by GUYSUCO in 2001,³⁵ taking into account the exchange rate (G\$ 182 = US\$ 1) and the observed sugar-cane output for the period (3.5 million tons)

To summarize production costs on the basis of the data presented, ethanol produced from molasses costs between US\$ 0.246 and US\$ 0.392 per litre, depending of course on the price of molasses.

As for direct production of ethanol from cane juice, costs per litre are estimated at between US\$ 0.308 and US\$ 0.408, basically depending on the cost of cane. It is interesting to note that in the scenarios considered above, ethanol can be produced without increasing the cane-growing area, since the quantities of molasses already available will suffice.

IV.4 Related issues

In addition to the technical and economic issues discussed above, some other matters related to ethanol production in the sugar-cane agro-industry deserve a brief look: job creation, mechanization and electric power cogeneration.

The agricultural activity involved in sugar-cane production is highly labour-intensive, mainly for harvesting. Some 20,000 people are in jobs directly connected to Guyana's sugar industry,³⁶ or 5,700 workers for every million tons of cane, which is close to the figure for north-eastern Brazil, with about 6,100 workers per million tons, and significantly higher than the number for south-eastern Brazil, 2,150 workers per million tons. In Brazil, which must not be very different from Guyana in that respect, 30% of the total were specialized workers (agriculture and industry); 10% had a certain level of training (tractor drivers, for example) and 60% were unskilled workers such as cane cutters.³⁷

Labour requirements for ethanol production can be estimated with reference to studies conducted in Central America: for high and low labour demand scenarios, respectively, figures of 14.8 and 3.8 workers per thousand litres per day of installed ethanol production capacity were calculated.³⁸ In the case of fuel ethanol production in Guyana, the volumes needed for a 10% ethanol-gasoline blend would call for a distillery which could produce 65,000 litres per day, and it is estimated that between 247 and 962 workers would be directly involved in ethanol production.

With the evolution of mechanized harvesting systems, they have been gradually introduced in regions where the land is sufficiently flat, as in Guyana. This has some important

³⁴ H. Davis, Guysuco, information collected by the author.

³⁵ M. Sharma, op.cit.

³⁶ Ibid.

³⁷ J.M.M. Borges, "The effect of labor and social issues of electricity sales in the Brazilian sugar cane industry", International Conference on Energy from Sugar Cane, Hawaii, 1991.

³⁸ Economic Commission for Latin America and the Caribbean (ECLAC), *Aspectos complementarios para la definición de un programa de bioetanol en América Central (LC/MEX/R.857)*, Mexico City, May 2004.

implications: first, falling demand for labour (it is estimated that every harvesting machine can do the work of 40 to 80 manual workers) which can be justified in light of labour supply difficulties and the need to cut down on unskilled jobs. Second, raw cane including the leaves and shoots can be harvested without burning, thereby increasing by some 30% the supply of solid biomass. Mechanized harvesting is progressing in Guyana and the cost of sugar cane is expected to fall.³⁹

For a rational use of sugar-cane bioenergy, bagasse and solid residues should to the extent possible be used for electric power generation by means of cogeneration systems, which produce heat for industrial processes and electrical and mechanical power for the cane grinders.

This is a fairly well-known technology using steam-driven thermal cycles, in which the boiler pressure determines efficiency and the amount of electric power available to meet the needs of the plant and possibly provide excess power to the public grid. With steam pressures of up to 21 bars, the internal needs of the agro-industrial plant are met, with about 12 kW of electric power and 15 kW in mechanical power for the preparation of the sugar cane and the extraction of the juice. For pressure levels between 42 and 80 bars, excess power of 40 kW y 80 kW respectively would be generated, and this only using the bagasse available from conventional cane harvesting.

Guyana's sugar factories currently total about 30 MW of installed electric-power generation capacity, about 10% of the total for the country. That power is basically used for the needs of the sugar industry and barely contributes any power supply to the national grid.⁴⁰ If 42-bar boilers were introduced (a relatively modest pressure level), assuming that 3.5 million tons of cane were processed annually, 1,400 GW could be generated per harvest using conventional processes, a supply 53% higher than the electric power requirements observed in 2005. Naturally, if a proportion of the residues currently left on the ground were included, or if higher pressure levels were used,⁴¹ that excess supply would be proportionally greater.

It should be noted, however, that the production of electric power using cogeneration systems in the sugar-cane industry must take place during the harvest period, which lasts a few months a year. Although power could be generated outside that period in exceptional cases, this would mean lower efficiency because of the lack of demand for thermal power from the industrial process. Unit investments for the electric power generation systems tend to be about US\$ 500 per kilowatt of installed capacity.

One last issue, of great importance for sustainable growth in this agro-industry, relates to the pattern of cane production, which may be of two kinds: the factory may grow its own sugar cane, or buy it from independent growers. The pattern in Guyana is a combination of the two, with private producers representing between 8% and 11% of the supply, as shown in Figure 11.⁴²

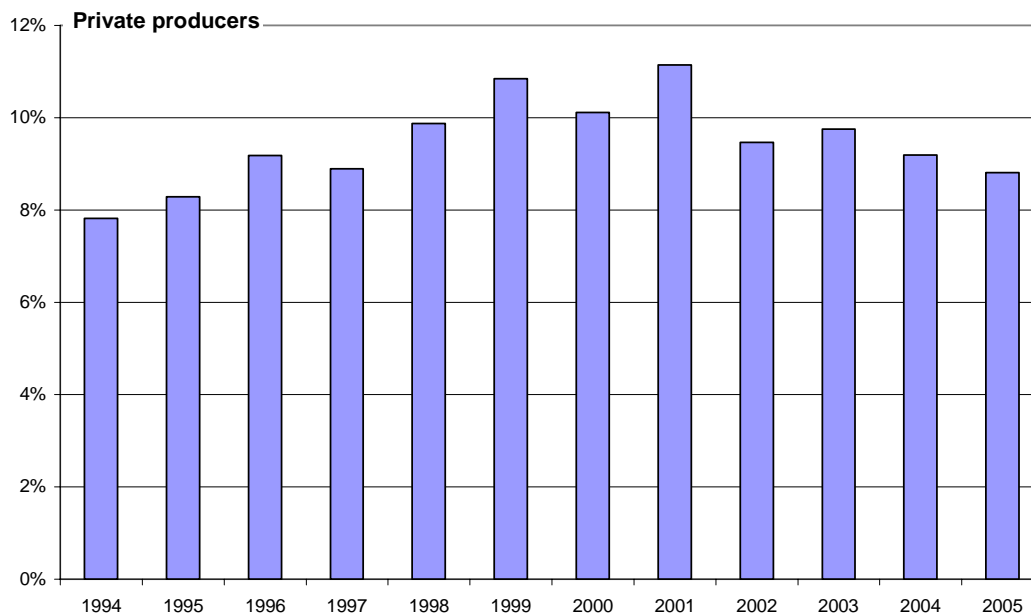
³⁹ H. Davis, L. Stuart and P. Bhim, *op. cit.*

⁴⁰ Information from Guysuco, 2006.

⁴¹ In most new factories in Brazil, boilers using 60-bar steam pressure are being used.

⁴² Based on information from Guysuco, cited in Bureau of Statistics of Guyana/UNICEF, *op. cit.*

FIGURE 11
SHARE OF PRIVATE SUGAR-CANE PRODUCERS IN GUYANA'S SUGAR AGRO-INDUSTRY



Source: Guysuco, 2006

Price formulas which facilitate fair negotiation between the parties can play a useful part in promoting growth in cane production, averting the distributive conflicts which may arise between private growers and rural factories. These formulas have been adopted in many countries and are based on proportionality criteria for the distribution of income from outputs (sugar and ethanol), ensuring that growers receive 60-70% of the sugar equivalent value delivered to the sugar estate's canal barge. It is definitely desirable that such rules should arise from agreements signed directly by the agents involved, that productivity and quality indicators should be recognized and that to the extent possible, this should be achieved without government involvement.

V. Competitiveness of ethanol production in Guyana

In assessing the competitiveness of the sugar-cane ethanol agro-industry, the context of opportunity costs and the indifference prices of its various products must be considered, in relation to conventional fuels and to non-energy products.

In the case of ethanol, it has been thoroughly proved that the performance of gasohol (gasoline blended with up to 10% of biofuel) is quite close to that of pure gasoline, and that the addition of ethanol makes practically no difference to fuel consumption. Thus, the use value of ethanol is equal to that of gasoline. The value to the consumer — the opportunity cost, in this case — of a litre of biofuel is equal to that of a litre of gasoline. This point is considered in greater detail in earlier studies.⁴³

From the producer's viewpoint, and taking a simplified view of the use of sugar cane, depending on the characteristics of the agro-industrial facilities, sugar (for the local market, for export on the free market or on the quota market at preferential prices), molasses for local use or for export, or ethanol biofuel can be alternative or complementary products. Producers will of course seek to maximize their income, within their production capacities and in the framework of trade agreements, which means developing production profiles for the different product types. For sugar, on average, it has been observed that it takes 1.67 kilograms of sucrose to produce a litre of ethanol, so an equation can be worked out for the indifference price of anhydrous ethanol, IPAE, as a function of the price of sugar, SugP:

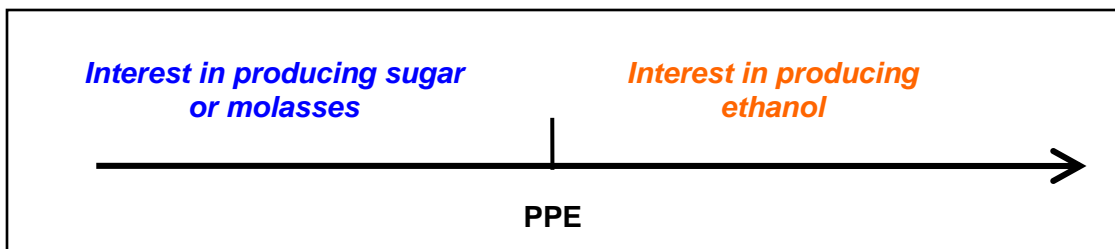
$$\text{IPAE (\$/litre)} = 1.67 * \text{sugP (\$/kg)} \quad (1)$$

Figure 12 summarizes the concept of parity prices of ethanol (PPE), which should be compared with the product's selling price in order to see whether market conditions are at least as attractive as those for sugar. Similarly, an indifference price point for ethanol can be worked out in relation to molasses, assuming the conversion of syrup with a sugar content of 56%, and where MolP is the price of molasses, which results in the following equation:

$$\text{IPAE (\$/litre)} = 2.98 * \text{MolP (\$/kg)} \quad (2)$$

⁴³ Economic Commission for Latin America and the Caribbean (ECLAC), *Costos y precios para etanol combustible en Centro América (Convenio CEPAL/República de Italia)* (LC/MEX/L.716), Mexico City, 2006.

FIGURE 12
INDIFFERENCE PRICE POINT FOR ETHANOL IN RELATION TO SUGAR

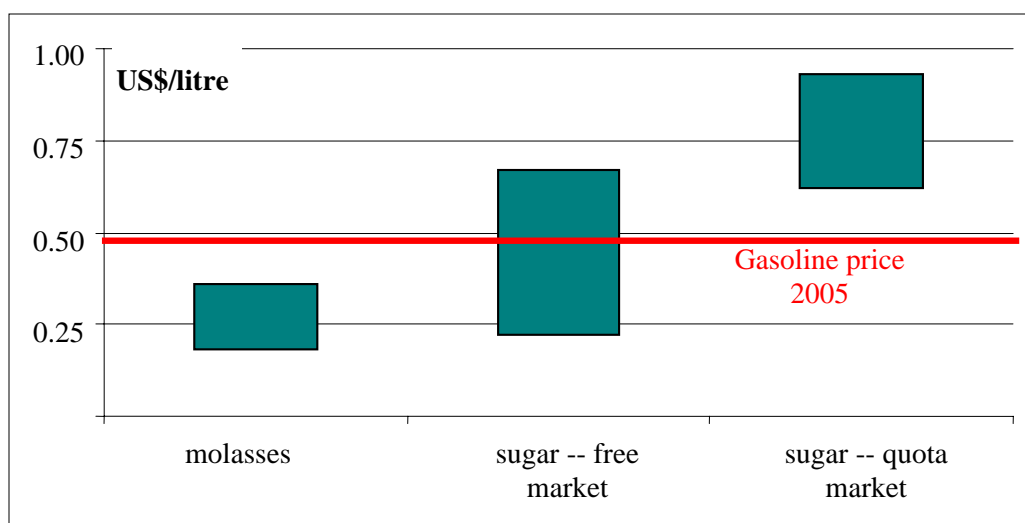


Source: elaborated by the authors

As mentioned above, there are various kinds of contracts for sugar products: parity prices for ethanol can be determined under the preferential or quota system or for open markets, for comparison with gasoline prices. It should be noted that the markets are highly volatile, meaning that analysis should take account of values observed over a certain period. Indifference prices for ethanol to be produced in Guyana can be calculated using the values shown in Figure 9 and the above equations. For preferential contracts, higher prices are paid for sugar, from US\$ 0.37 to US\$ 0.56 per kilogram, giving an indifference price for ethanol between US\$ 0.62 and US\$ 0.93 per litre, higher than the prices of Guyana's gasoline imports, which stood at US\$ 0.463 per litre in 2005.

Nonetheless, considering the residual market price of sugar, with FOB prices fluctuating between US\$ 0.13 and US\$ 0.40 per kilogram, the indifference price of ethanol is between US\$ 0.22 and US\$ 0.67 per litre. On the basis of molasses prices in the Caribbean, which have stood between US\$ 60 and US\$ 120 per ton in recent years (in 2005 the export value of Guyanese molasses was US\$ 83 per ton), the parity prices of ethanol for molasses producers would lie between US\$ 0.18 and US\$ 0.36 per litre, significantly lower than the above prices, in parity with sugar. Figure 13 summarizes those values, drawing attention to the higher competitiveness of molasses-based ethanol.

FIGURE 13
PARITY VALUES FOR SUGAR-CANE ETHANOL



Source: elaborated by the authors

Thus, it can be stated that, given the conditions existing in Guyana, the production of sugar-cane ethanol to replace imported gasoline is attractive when molasses is used as the raw material. Direct production of ethanol from cane juice, which results in lower sugar output, would be dependent on current prices, which may or may not be favourable to ethanol. As already discussed in section 4 of this study, *the molasses supply in Guyana is highly favourable for ethanol biofuel production*: just 38% of the available supply of exhausted molasses would suffice to produce 11.5 million litres of ethanol, the amount needed for a 10% ethanol-gasoline blend in the country's entire gasoline consumption.

Another way to consider the economic feasibility of ethanol production would be to compare the necessary investment for production facilities with the saving that would result from the use of domestically-produced fuel.

These figures have already been presented above, in the context of the economic issues for ethanol production; an investment of about US\$6.5 million in a distillery, as against an annual saving of US\$5.4 million on imported gasoline (2005 prices), as detailed in section 3 above.

It is certainly an interesting opportunity, with a *payback period of less than 18 months*, an encouraging indicator for energy investments. Naturally, the above analyses did not include the significant implications of positive externalities such as growth in agriculture, reduced external dependency and job creation.

The situation in Guyana — which imports all the fuel needed for its transport sector, has a large sugar-cane output in relation to the numbers of motor vehicles, and is facing the challenges of seeking a new strategy for its sugar-cane industry — is really very favourable for the production of ethanol and its blending with gasoline for the domestic market. Another prospect, which could be equally favourable but requires more thorough study of economic factors and logistical costs, is the possibility of exporting ethanol to neighbouring countries or the European and United States market.

It is still a developing market affected by considerable protectionist barriers, but it has considerable growth potential. Guyana's strategic position and natural resources could be useful differentiating factors in the drawing of a new road map for the region's energy supply; nonetheless, the first step towards becoming a competitive exporter is to develop the local market for the product.

VI. Comments and conclusions

Bearing in mind the assessments described above, particularly in the last chapter, which *shows the promising feasibility of producing and using ethanol in Guyana*, some issues of a more institutional nature need to be looked at to help to define a flexible and effective procedure for gradual introduction of ethanol into the country's energy matrix.

First of all, it should be noted that the issue of *sugar-cane-based ethanol fuel in Guyana must be looked at differently from the other energy development* programmes available to the country in recent years. This energy technology is mature and well-mastered in Guyana itself, which has for centuries had its own sugar-cane agro-industry sector, which needs to be converted as a result of major changes in import markets. It must be understood that the production of ethanol fuel should not be restricted to an initial, tentative approach, since the potential already exists in the country.

In order to implement Guyana's ethanol production in a sustainable manner - with due recognition for its advantages and needs - the interests of potential actors must be coordinated and *an entity, such as an executive committee, must be set up to manage the process and act as an essential forum for sharing visions* and defining alternatives. This requires appropriate coordination of the business outlook, to be based essentially on the Guyana Sugar Corporation (GUYSUCO), independent producers and various areas of government, especially those concerned with energy, agriculture and the environment, to draw up an agenda containing feasible goals and time-frames and allocating responsibilities and tasks. If the desired agreement is achieved it should be possible within a few months to begin tests with domestically-produced fuel and design a plan for the gradual introduction of ethanol into Guyana's energy matrix.

The central task for the executive committee might be to set the starting date for the blending of ethanol with gasoline and the proportion of ethanol to be used initially, probably between 5% and 10%. The operational aspects of such a programme, such as the physical characteristics of the distributors' terminals or adjustments to the technical characteristics of gasoline in order to meet the specifications for blended fuel, should not be subject to collegial decision-making, because these are issues that are well known and have already been dealt with in a number of countries; there is no reason to allow them to delay the introduction of biofuel. Clearly, the executive committee's institutional status, and the monitoring of its work and the

results achieved, *must be given high priority within the Government* if its results are to be rapid and effective.

The economic viability of ethanol use, as assessed in this study, is of course based on the assumption that price variations will be favourable, a situation which may change. The future behaviour of prices for petroleum and sugar products, the main variables for that viability, cannot be predicted with total confidence. Nonetheless, the *opportunity to meet part of the country's energy demand with a local product* using available natural resources and proven technology, boosting an agricultural sector faced with clear short-term market problems, improving sustainability and producing a fuel which is increasingly in demand for its environmental advantages appears to be supported by strong arguments which are sufficient to justify moving forward confidently with ethanol production.

Another major argument in favour is that the outlook for crude oil prices undeniably shows a sustained upward trend, for reasons consistently founded upon the scale of oil reserves and the growth of demand. There would be little sense in failing to proceed with a programme of ethanol use on the assumption that oil prices might fall. There might in future be changes in price structures resulting from more positive Government action to protect the competitiveness of ethanol through mechanisms such as tax expenditure, but that seems unlikely in the foreseeable future.

In addition to providing a favourable environment by bringing about the *necessary inter-agency cooperation for implementing a programme of ethanol production* and use, two other important actions by the Government would be to promote technological development and public information. As is generally the case with biofuels, the proper development of ethanol depends a great deal on local conditions, particularly agricultural output, whose productivity and continuity is a direct function of crop varieties, which must be renewed constantly.

One important initiative, which is already supported by the Guyanese sugar-cane industry through the Sugar Association of the Caribbean (SAC), is the West Indies Central Sugar Cane Breeding Station (WICSCBS) in Barbados, which has since 1932 been promoting the constant renewal of sugar-cane plantations in Barbados, Belize, Guyana, Jamaica, St Kitts and Nevis, and Trinidad and Tobago.⁴⁴ Other areas for technical development could be the use of raw materials that have local potential, such as the sweet potato, for which there is clear interest in Guyana,⁴⁵ and the evaluation of how methods for the management of the industry's waste products, such as vinasse, affect conditions in the country. Obviously, the promotion of such activities depends on institutions such as the University of Guyana, the Institute of Applied Sciences and Technology (IAST) and the National Agricultural Research Institute (NARI).

As for public information, it must be recognized that attitudes towards ethanol on the part of gasoline users and society in general may be decisive for the outcome of an ethanol-use programme. *Careful advance planning must take place for publicizing the reasons, advantages and limitations of its use.* This must be given equal consideration, and creativity is needed in order to reduce the ever-present resistance to change and innovation. Useful measures to that end might include creating a fleet of demonstration vehicles or a control group of taxis, as ways of bringing gasoline/ethanol blends onto the market gradually. The positive experiences of Colombia and Costa Rica should be taken into account.

An issue which is outside this consultant's area of competence but must be given timely consideration is that of *new forms of financing for the expansion of Guyana's sugar-cane*

⁴⁴ For further detail, see <http://wicscbs.org/index.cfm>.

⁴⁵ Canadian investors have proposed to set up an ethanol plant in Guyana using sweet potatoes. A project is being developed in Canada to produce 150 million litres per year, using the same crop.

industry, including private funds and perhaps foreign investment. Such capital investments, which would of course be subject to Guyanese law, should be seen as a positive contribution; a suitable environment for investors must be created, with stable regulations, long-term contracts and minimal State involvement in price formation.

The final conclusion is that, in implementing a programme to promote the production and use of ethanol fuel in Guyana, *it is highly desirable that clear and feasible goals should be adopted so that agro-industry can receive a strong stimulus* and dependency on imported fuel can be reduced, with the resulting benefits for society as a whole. *Ethanol fuel must not be seen as a panacea* which will solve problems inherent to the socio-economic structure, but this growth opportunity must be seized in order to guide the evolution of agro-industry along desirable lines.

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Annex

Aerial photographs of sugar-cane plantations in Guyana

During the mission to Guyana in June 2006, and with support from GUYSUCO, an interesting flight was made over the sugar-cane growing areas between the Demerara River and the border with Surinam; that is where most of the country's sugar-cane plantations are. Since the area is fairly flat and close to sea level, drainage activities are essential; there is a network of canals between which the plantations are located, and this system is practically unique in all of Latin America.

The complexity inherent to this system explains the high cost of creating new plantations. It is also notable how the canals are used for moving the harvested sugar cane by canal barge to processing plants.

**FIGURE A1
BLAIRMONT SUGAR ESTATE**



**FIGURE A2
WALES SUGAR ESTATE**



**FIGURE A3
SKELDON SUGAR ESTATE**



**FIGURE A4
BARGES FOR TRANSPORT OF CANE**



**FIGURE A5
SUGAR-CANE PLANTATIONS IN GUYANA**

