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# Biofuels trade and sustainable development:

# The case of Costa Rica

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## 1. Introduction

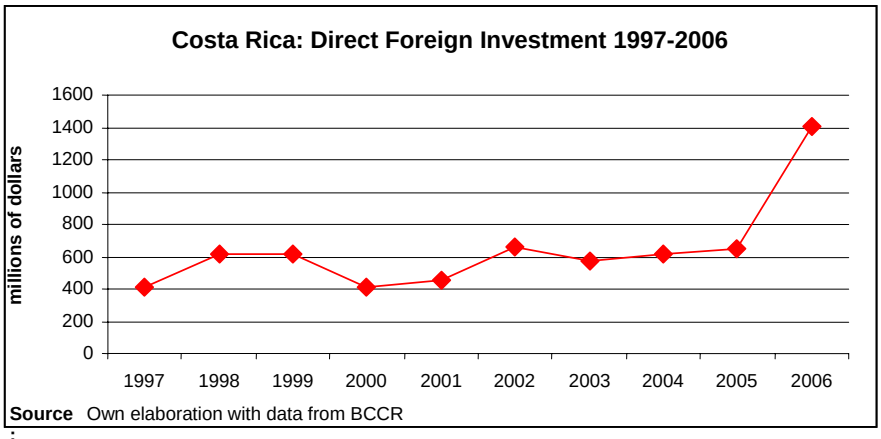
The significant rise in oil prices and uncertainty about the future behaviour of this product has given viability to alternative sources of energy which were not profitable in the past or did not have the right conditions for major development. What is the impact of increased bioethanol production on sustainable development? To what extent could the rise of bioethanol production affect food security or food cost? How could an increase in sugarcane cultivation affect the environment due to greater use of agro-chemicals, higher water demands and air pollution from fires? These concerns are at the heart of the definition of energy policies for a small non-oil producing country like Costa Rica, with high dependency on energy imports. Nevertheless, the country has the appropriate weather and soil conditions for the production of alternative sources of energy such as bioethanol from sugarcane. The present study analyses the accumulated experience in the bioethanol sector of Costa Rica, its lessons and constraints, and explores – starting from government policies and availability of natural, financial and institutional resources - how to develop the bioethanol sector, as well as the possible social, environmental and economic implications of such a decision.

The case study begins with a brief description of the Costa Rica's trade policy, followed by a section that sums up the country's experience with bioethanol production during the eighties. Then there is a review of the energy policies of the former and current administration, and the promotion of the bioethanol sector. Then follows an analysis of this sector in Costa Rica, contemplating production costs, trade trends and supply capacity, amongst other factors. The case study continues with a section analysing sustainability of the activity in its economic, social and environmental aspects, and finally the article ends with some conclusions.

## Costa Rican trade policy

Over the last two decades, Costa Rica has moved towards trade liberalization and is presently the most open economy in Central America, and one of the most open in Latin America. Besides adhering to GATT in 1990 and being a member of the WTO since its creation in 1995, Costa Rica has signed six trade agreements and fourteen bilateral investment agreements. At present, the average tariff is 6.5 per cent and the direct foreign investment has grown to 1,410.8 millions of US dollars in 2006 (see chart 1).

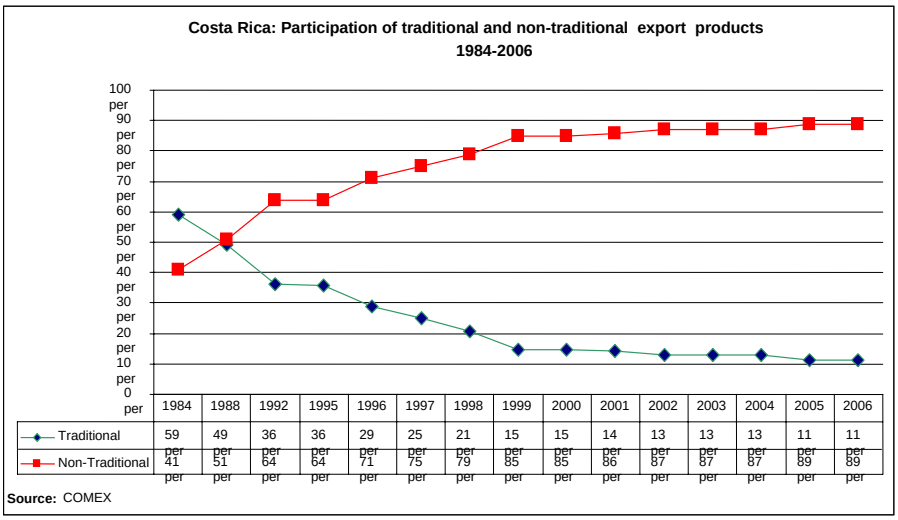
**Chart 1**




**Source** Own elaboration with data from BCCR

In 2006, the Costa Rican economy presented a growth rate of 8.2 per cent (over the period 2003-2007 the average annual growth rate was 6.2 per cent). It has an open unemployment rate of 4.6 per cent and poverty levels were at 16.5 per cent in 2007. Costa Rican export diversification is also significant; 3,796 products are currently exported with a change in its exports structure from 60 per cent traditional products in the 1980s to less than 15 per cent today. Non traditional products represented approximately 89 per cent of total exports in 2006 (see chart 2).

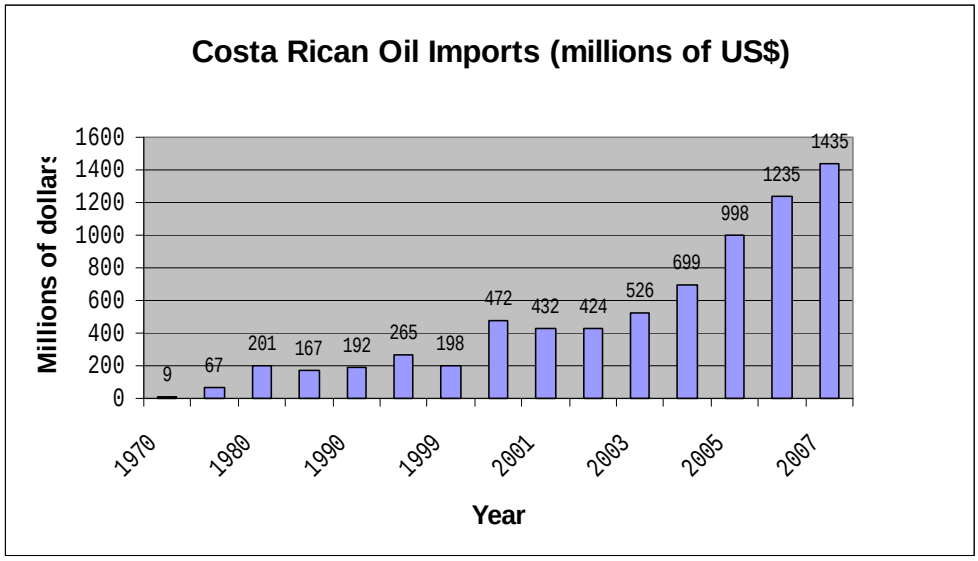
**Chart 2**



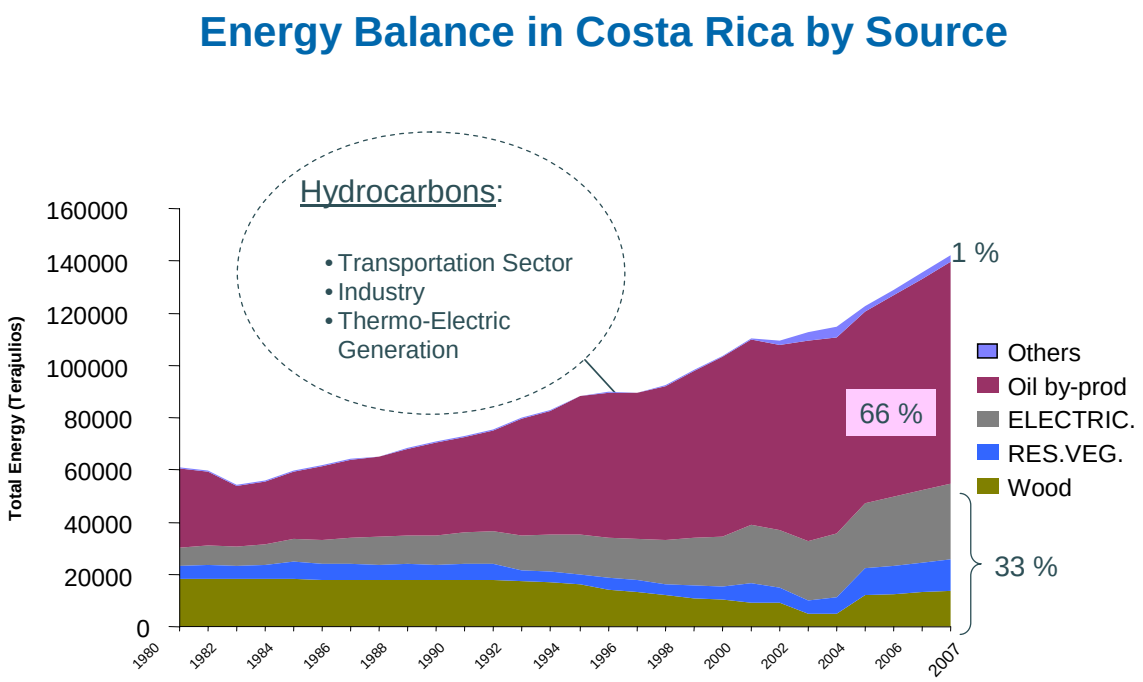

Costa Rica is part of the Central American Common Market, a trade integration created in the beginning of the sixties and undergoing a transformation towards an open regionalism since the nineties, in which trade liberalization has deepened amongst its members without increasing barriers to third parties.

Simultaneously, the country has been strengthening environmental regulations and institutions. Environmental protection is a constitutional right (Article 50, Political Constitution); it has had a Ministry of the Environment (*Ministerio del Ambiente*) since 1990 and several laws related to the environment, including: the National Law of Environment (1995), Law on Biodiversity (1998), and the Forestry Law (1996). Costa Rica has also signed fourteen multilateral environmental agreements. Twenty five per cent of its territory corresponds to protected areas and an Environmental Service Programme has allowed up to 51 per cent of national territory to be reforested. In 2007, the country was considered the top environmental destination in Latin America and tenth in the world according to a country ranking from Future Brand (La Nación, 13 November 2007), thus demonstrating how the country is taking advantage of its infrastructure and natural beauty.

Like all non-oil producing countries, Costa Rica has been affected by the sustained rise in oil prices, expected to go above US$100 per barrel by the end of the present year. Oil imports have increased from US$526 millions in 2003 to US$1,436 millions in 2007: a rise of 36.6 per cent in four years.




This figure is a little over 5.6 per cent of GNP, twice as much as in 2002. Over recent years, efforts have been made to diminish oil dependency. Energy balance in 2007 was distributed as shown in the following graphic.



## 2. Costa Rica's experience with bioethanol

### 2.1. Initial experience with Bioethanol in Costa Rica in the seventies and eighties

Interest for alternative sources of energy emerged in the 1970s as a result of the oil crisis that raised the issue of the sustainability of the global economy in the face of the possible exhaustion of non-renewable resources and a lack of alternative renewable sources. Daniel Oduber´s administration (1974-1978) faced the crash of the first international energy crisis. He gave a strong lead on government participation; it was the time of the "entrepreneur state", which was introduced to productive activities usually developed by the private sector. This policy was based on the assumption that the government would intervene in strategic sectors if there was no will or resources from the private sector. The Oduber administration (1974-1978) strengthened a state corporation that was established at the end of the Figueres administration (1970-1974): Corporación Costarricense para el Desarrollo (CODESA), an institution that also created a series of companies, such as the Central Azucarera Tempisque S.A. (CATSA), a company dedicated to sugarcane cultivation and industrialization.

Two other issues faced by Oduber´s administration were high coffee prices and, at the end of his administration, falling sugar prices. The former provided the necessary resources to develop a series of productive and cultural activities that brought dynamism to the economy and hence created a good image of the government[1]. The energy crisis and low sugar prices were an incentive for the government to look at Brazil and emulate actions related to ethanol production. Oduber´s administration established the 'Renewable Fuels Programme' as a way to face the oil price rise from the energy crisis. Complying with the Law of Technological Promotion and Development, in 1977 the government dictated basic guidelines to launch the national production and use of sugarcane based bioethanol. In 1987, a distillery for anhydride alcohol was installed in CATSA, with a double purpose: to face both the energy crisis and the low sugar prices which fell below production costs.

During the 1979-1980 sugarcane harvest, in the Carazo administration (1978-1982), 2.5 million litres of alcohol were produced. In the following two harvests (1980-1981 and 1981-1982), 2.1 million litres and 1.9 million litres were produced, respectively (Ruiz, 1987). In 1981, SEPSA[2], a dependency of the Agriculture and Cattle Ministry (*Ministerio de Agricultura y Ganadería* - MAG) published the document "Basic

[1] A Costa Rican president once said that the best government is good international coffee prices.
[2] *Secretaría Ejecutiva de Planificación Sectorial Agropecuaria* (Executive Secretariat of Agricultural Sectorial Planning)

Guidelines for a National Programme of Carburating Alcohol" (*Lineamientos Básicos para un Programa Nacional de Alcohol Carburante*).

In the second oil crisis, with the alcohol produced by CATSA, the government implemented a 20 per cent ethanol / 80 per cent gasoline mix, a product known as E20 and later called gasohol. This mix was sold in 33 gas stations in the Metropolitan Area between April 1981 and November 1982, then in 1983 its use stopped. In 1982, 4.1 million gallons of gasohol were consumed out of a total of 40.1 million gallons of petrol used in that year and in 1983, out of the same total petrol volume, 545,000 gallons of gasohol were consumed. In the following year, only the surplus of the preceding year was used.

Among the reasons that led to the failure of this national programme were: 1) it was an optional programme (i.e. not obligatory); 2) there was inadequate infrastructure in petrol stations; 3) consumers were not well informed on how to take care of their engines, which created insecurity over the effects the mix had on their vehicles (Chaves, 2003); 4) oil prices stabilised following the end of the oil crisis and; 5) the upcoming government showed little interest in continuing or strengthening the programme.

**2.2. Caribbean Basin Initiative**

Interest in the bioethanol sector was renewed when Costa Rica became a beneficiary of the Caribbean Basin Initiative (CBI) and the U.S. –within that initiative- promoted bioethanol production and exports. This brought diversification to the sugar industry and gave value added to its byproducts.

The Law for the Economic Recovery of the Caribbean was approved in August 1983 and became valid on January 1, 1984. The CBI is a unilateral concession by the government of the United States for tariff exoneration (almost all of them to zero tariffs) for a large part of the region's products, to promote "a stable political and economic climate in the Caribbean region." The main difference with the Generalized System of Preferences of 1974 is that in the GSP all products enter the list individually (for all beneficiary developing countries) following a study by the U.S. government. Obligatory exceptions are similar to those of the CBI; however, there are many products, especially agricultural ones that form part of the CBI but not of the GSP. The extension in CBI products is superior to that of the GSP. All products benefiting from the GSP are also part of the CBI, but the opposite is not the case. In the CBI there are no explicit mechanisms of graduation for countries or any reference to the competitive requirements.

As part of the initiative, duty-free status is granted to fuel ethanol under certain conditions. If produced from at least 45 per cent local feedstock (e.g. ethanol produced from sugarcane grown in the CBI beneficiary countries), ethanol may be imported duty-free.

If the local feedstock content is lower, limitations apply on the quantity of duty-free bioethanol. Nevertheless, up to 7 per cent of the U.S. market may be supplied duty-free by CBI bioethanol containing no local feedstock. In this case, hydrous ("wet") bioethanol produced in other countries can be shipped to a dehydration plant in a CBI country for reprocessing. After the ethanol is dehydrated, it is imported duty-free into the United States. Currently, imports of dehydrated ethanol under the CBI are far below the 7 per cent cap (approximately 3 per cent in 2005). In 2005, the cap was about 240 million gallons, whereas about 100 million gallons were imported under the CBI in that year (Yacobucci, 2006).

At the end of the 1984-1985 harvest, the CATSA distillery reopened following a four-year closure period. This CBI opportunity motivated LAICA and CATSA to join in 1984, to produce and export alcohol in 1985. This fact was preceded by a strong lobbying among sugarcane producers in the Costa Rican Congress to reform article 433 of the fiscal law, which had established, since 1885, the state's monopoly of the Fábrica Nacional de Licores (FANAL) for the elaboration of alcohol.

In 1984, the Taboga Sugarcane Mill was built, a new distillery that produced and exported alcohol. Initial outputs from the 1985-86 harvest were 898,683 litres of anhydride alcohol and 988,595 of hydrated alcohol. As a consequence of the preferences/quotas established by the CBI, in the same year LAICA built a dehydrating column in Punta Morales, associated with another rectifier plant to import and process low quality alcohol from the Caribbean and Europe, to re-export later to the U.S. Once again, the government became interested in ethanol production and proposed a strategy to be launched in 1988, giving enough time to make adjustments in petrol stations and inform consumers adequately. However, oil prices returned to normal, so the programme never took off.

### 2.3. Recent Costa Rican experiences with ethanol production

During the Pacheco administration (2002-2006) attention was paid again to biofuel. In the National Development Plan (*Plan Nacional de Desarrollo* –PND) 2002-2006, five core development issues were established, including harmony with nature, in which "satisfying hydrocarbon demand with an optimum product quality, reasonable prices and caring for environment" was defined as one of the main objectives. Among the policies to reach this goal, the following points were established:

- Research on development

- The use of clean technology
- Pilot projects in alternative fuel use

Strategic actions included research on biodiesel, liquefied gas, hydrogen, vegetable oil and alcohol. Another strategic action was reducing fossil fuel dependency through the execution -in the period 2002-2006- of at least one experimental project with biofuels.

Another important objective was declared in the IV National Energy Plan 2000-2015 - that of eliminating Methyl Terbutil Ether (MTBE) from fuel, beginning in 2005, and this was preceded by a strategy to oxygenate gas with ethanol or another environmentally and economically convenient product, which started in 2003.

In February 2003, the government emitted two executive decrees and formed two commissions: Decree No. 31,087 MAG-MINAE (the Ministry of Agriculture and the Ministry of the Environment) to create the Commission MAG-MINAE-RECOPE-LAICA (Ministry of Agriculture, Ministry of the Environment and Energy, Costa Rican Oil Refinery, Industrial Agricultural Association of Sugar Cane) to design a strategy for the development of carburating bioethanol, contemplating at least three aspects: to substitute MTBE, to commercialise gas mixed with bioethanol, and to determine the percentage of the mix. The other decree (No. 31,818 MAG-MINAE) established the commission to design the strategy for biodiesel development. However, the interposition of a resource of inconstitutionallity against article 7 of this decree (which forces the execution of the programme) made it impossible to apply the measure (GTZ 2006).

The Pacheco administration implemented a Regional Pilot Project using a mix of regular petrol with bioethanol in the central Pacific and northern zones of the country. This plan contemplated two aspects:

1) The use of the mixture 10/90 ethanol/gasoline with thirty vehicles from Refinadora Costarricense de Petróleo (Recope), monitoring their performance.
2) The management and logistics of the ethanol-gas, from the point of mixture in Recope to the point of sale in gas stations.

The scope of this plan was widened and the Barranca facility was chosen, supplying 64 gas stations in the Guanacaste province and central Pacific area, using a mix of 8 per cent bioethanol, covering the demand of approximately 66,000 vehicles and representing around 12 per cent of the national car market (GTZ 2006). There were two educational programs to be developed, in order to inform people of the plan and receive feedback: one in Puntarenas and the other one in Liberia (two provincial capitals). The pilot plan started operating in 2006 and its conclusion was expected in June 2007.

With the pilot plan with Recope vehicles, it was proven that a 10 per cent bioethanol in gasoline does not imply a diminished performance. The tests made on gas emissions with the E-10 mix were always under the established emission limits by the Ministry of Public Works and Transportation (MOPT) and hence confirmed that the 10 per cent mix did not represent performance or emission problems.

In the case of the Pilot Plan in Barranca, the initial reaction was a decrease in gasoline sales in gas stations. The consumers felt like guinea pigs; they got upset and threatened to sue Recope; there was a clear need for more information for the consumer and technical assistance for the gas stations. Additionally, initial press reactions were mainly negative, highlighting problems in vehicles and interviewing and expressing opinions of people with little knowledge on the matter.

However, with time there was a change in attitude from both the consumer and press. The consumers of this region accepted the product, although this was not the case at a national level. Since November 2006, there have been no complaints; press reports have been positive and have highlighted environmental and social benefits. The Pilot Plan has been followed up and the experience associated with global trends.

It is worth highlighting that national bioethanol was not used for this plan, because Recope opened it to international bidding and the contract was won by a Brazilian company. Recope made an investment of US$3 million to buy the bioethanol. The Pilot Plan has had an administrative cost of US$30,600.

**2.4. The Arias Sánchez administration (2006- 2010)**

The present administration has paid special attention to the energy sector. President Arias met the Vice-President of Brazil –José Alencar- the day after his inauguration and they agreed to exchange experience and unite efforts in biofuels, taking advantage of the vast experience Brazil has developed in this matter over the last two decades (BID 2006). Similarly, the president has said he is not going to give up on the possibility of finding oil in the country. The former administration did not permit the exploration of oil deposits in Costa Rica; they cancelled a concession to explore oil fields in the country to the Texas-based oil company Harken Energy.

In December 2005, the Meso American Integration Programme (PIEM in Spanish), launched a new initiative with Central American countries, Panama, Dominican Republic, Mexico, and Colombia, with the aim of achieving regional energy integration, strengthening markets of oil products, natural gas and electricity, and maximising the use of renewable sources and energy efficiency. This initiative was framed

within the Plan Puebla Panama (PPP) and the Central American Integration System (SICA) leadership. The plan included a project to build an oil refinery to supply the needs of the region, with the support of Mexico, who could finance part of it and give technological support. Honduras and Panama were included in the list of suggested countries to serve as site for the refinery. The Pacheco Administration did not submit Costa Rica. Immediately after Arias assumed leadership (2006), the country changed its position and proposed its name to be considered as site for the construction of the refinery. The refinery would have capacity to process at least 230,000 barrels of Mexican crude oil, known as "Mayan crude", daily. The value of the construction is estimated at between 3,000 and 4,000 million US dollars and is calculated to start functioning in four years (CEPAL 2006). No decision has been taken as yet. However, the government has not been idle; in the package of agreements that Arias brought from his visit to China as a result of the initial diplomatic relations between both countries, there is a cooperation agreement between the Chinese National Oil Corporation and the Costa Rican Oil Refinery (Refinadora Costarricense de Petróleo - Recope) to enlarge the national refinery and, in a first stage, move from processing 20,000 to 40,000 barrels daily, including technical support. These measures clearly demonstrate the present administration's interest in developing a broad energy policy that includes oil by-product markets as well as biofuels, and promotes a change in the structure of the energy market, which now is mainly managed by the state with little private participation.

Another decision Arias took was to derogate two technical commissions on ethanol and biodiesel, both created by the former administration. Instead, he established the National Biofuel Commission with decree DE- 33357- MAG-MINAE, to give integrated treatment to the biofuel issue and reorient former efforts developed by the previous commissions.

In the National Development Plan (PND) 2006-2010, this administration acknowledged the high dependency of the national energy matrix of oil imports, and proposed the following, among the national energy challenges: to reduce dependency on imported fuels; to take better advantage of renewable energy in the country; and to produce 100 per cent of the country's electricity from renewable energy sources[3].

Regarding biofuel goals, the objective is to develop a national industry by incorporating, during the present administration, agro-industrial production and biofuel consumption in a sustainable way on a national level.

The political commitment stipulated in the National Development Plan 2006-2010 is to promulgate legislation for the fuel industry to create an oil wholesale and retail market that helps develop the fuel

industry (including biofuels) in a sustainable investment context. Likewise, the goal is to have a prompt and adequate response to society's fuel needs in the context of today's world trends, mitigating greenhouse effect gas emission, and improving the environmental quality of fuels.

Arias´ government has just launched a national energy strategy with four components:

1. Energy strategy: the topic is energy security.
2. Environmental strategy: climate change; the programme to be carbon neutral by 2021.
3. Agricultural strategy: the topic is to reactivate agro, creating a national market for biofuels.
4. Social strategy: the emphasis is to use the biofuel market to reactivate the agro in areas of social vulnerability.

Some short and medium term actions determined by the present administration in the National Programme of Biofuels, launched in November 2007, are listed in the box below.

[3] In 2004, Costa Rica generated 99 per cent of its electricity from local renewable sources; 80 per cent hydroelectric, 16 per cent geothermal, 3 per cent wind and only 1 per cent fossil fuel combustion, making it by far one of the cleanest power sectors in the world.

# NATIONAL BIOFUELS PROGRAMME

## Strategic Actions for Fuel Development

### Short term actions (first six months)

1. Design and execution of a market strategy. Based on the results obtained from market analysis and consumer behaviour, work will be focused on a national communication programme with the objective to inform all the population about the fundamental basic elements of biofuel so their consumption will be positive and beneficial. Carried out by: RECOPE.

2. Validation of experiences in the national context. A research plan will be designed to determine the impact of biofuels on the performance and security of the vehicle and maintenance costs, among other aspects, in order to verify that biofuel consumption is not harmful to vehicles in the country. The research entity will be external, so that there is higher impact in communication in the population. (this is unclear) Carried out by: RECOPE.

3. Diagnosis of the system infrastructure. It is necessary to establish an inventory of infrastructure needs, including not only assets, but also technology, human resources, information systems, and organizational and budgetary design for the preparation of the actors that will facilitate the change. This diagnosise will be developed in an inclusive way, allowing the participants to reveal their own expectations and needs. Carried out by: RECOPE.

4. Strengthening of capacities of market components involved in production, trade and consumption of biofuels. A new form of consumption requires new patterns of behaviour. It implies negotiating the fundamental principles of interaction of the different market components. It is necessary to design a contracting framework through which the sustainability of the project can be guaranteed. Carried out by: RECOPE.

5. Budget projection of the investment for the purchase and trade of biofuel. Consumption restructuring implies budget restructuring by all the actors involved, who must prepare themselves financially to face new responsibilities and obligations. The national market has priority of purchase. Carried out by: RECOPE.

6. Generation of the legal framework for the operation. The generation and implementation of a Biofuel Decree is currently imperative. This will permit an orderly operation of the biofuel market in the country. The decree is a bridge to the Law of Biofuels, to be promoted in the mid-term. Carried out by: MINAE.

7. Design and implementation of the framework of knowledge management. It is necessary to develop Costa Rican technology, based on international experience, in order to develop agro-energetic crop cultivation. This will provide the necessary information for maximum effectiveness and efficiency of the biofuel programme.

## NATIONAL BIOFUELS PROGRAMME

## Strategic Actions for Fuel Development

**Medium and long term actions (one to four years)**

1. Development of the legal sustainability to produce, trade and consume biofuel. This will fundamentally be achieved with the promulgation of the Biofuels Law, which will include the experiences acquired in the process. Carried out by: MINAE.

2. Development of research and development in the area of biofuels. This intends to widen the management of knowledge, involving higher education institutions, promoting innovations and exporting technology and services as a way to finance scientific activity. Carried out by: MINAE, MAG and universities.

3. Increase the consumption of biofuels. The aim is to achieve a consumption level that represents, in the next three years, around 200 million litres of biofuel annually, promoting the re-conversion of all consumers and especially large ones. Carried out by: MINAE and RECOPE.

4. Minimize the risk of the producer. It is necessary too guarantee agro-energy crop cultivation that is profitable and efficient to the producer and the INS (National Institute of Insurance). The design should allow access to small producers, and promote local socio-economic development. Carried out by: MINAE, MAG, INS.

5. Generate alternatives of financial support. A fund will be set up for agro-energy projects, in a sustainable way and facilitating the insertion of small producers. Carried out by: MINAE.

6. Assist in the development of exports infrastructure. The country has the potential to trade its surplus on international markets, where demand is increasing. The state and actors involved should agree to develop port infrastructure for this purpose. Carried out by: RECOPE, MINAE.

## 3. The bioethanol sector

The sugar cane sector is quite well organized and has had its own legislation since 1940, led by the Liga Agrícola Industrial de la Caña de Azúcar (LAICA), founded in 1965 and constituting a non governmental entity under public legislation. The regulatory framework of the sector has been modified with time and the sector is currently regulated by the Organic Law of Agriculture and Sugarcane Industry, number 7818, promulgated in September 1988. The goals of the law are to maintain a fair regime regarding relations between the sugarcane producers and sugarcane mills, to guarantee rational and fair participation to each sector. Article 5 of the law gives LAICA the power to "trade alcohol, sugar, honey and other byproducts of the sugarcane industry whenever it is convenient, with national industry or any other".

Regarding sugarcane generation and technology transfer, there is the National Institute of Agricultural Technology (INTA in Spanish) of the Ministry of Agriculture, and in LAICA, there is the Office of Sugarcane Research and Development (DIECA in Spanish). LAICA has an ongoing research programme for new varieties that can adapt to different ecosystems in the country, which has identified 75 different varieties of sugarcane. The purpose of this research is for a better adaptation to different zones, more productivity and phytosanity, and ultimately resulting in some varieties bearing the LAICA name. (Pérez 2006)

### 3.1. Production trends

Sugar is the country's fourth agricultural export product, with 0.5 per cent participation in national exports. Almost 42 per cent of total production is exported and the main export markets are Canada (42.1 per cent), Russia (30.8 per cent) and the United States (25.6 per cent).

The cultivation area of sugarcane is approximately 51,000ha, primarily in the Guanacaste, central Pacific and Puntarenas regions.

The sector has 44 non-independent producers, comprising 16 sugarcane mills and 28 major producers of 5,000 tonnes each. They benefit from high technology, like laser land levelling, irrigation systems and mechanized cultivation. Independent sugarcane producers are small and total 10,761 in number. Mechanization level depends on the productive unit size. Ninety per cent of sugarcane delivery comes from productive units of less than 7ha. The sugar sector employs 30,000 workers in harvest time and 20,000 out of harvest season, which represents 11.7 per cent and 7.8 per cent of agriculture employment respectively. Due to a shortage of labour force, there is a trend to mechanise work as much as possible (Leal Fortuna, 2007).

| **Milling capacity in tonnes (t) of sugarcane** | |
|---|---|
| **Sugarcane mill** | **Installed capacity tonnes/day milling** |
| Taboga | 6,500 |
| CATSA | 6,300 |
| El Viejo | 6,200 |
| El Palmar | 4,500 |
| El General | 4,000 |
| Quebrada Azul | 3,000 |
| Victoria | 2,700 |
| Atirro | 2,300 |
| Juan Viñas | 1,700 |
| Ctjtris | 1,400 |
| Costa Rica | 1,200 |
| Argentina | 900 |
| Providencia | 800 |
| Santa Fe | 720 |
| Provenir | 700 |
| San Ramón | 680 |

Source: own elaboration

The national production of ethanol in the period 2003-2006 was estimated at 40-42 million litres per year. The production of bioethanol is carried out in three different locations: CATSA, Taboga Sugarcane Mill and LAICA, in Punta Morales. CATSA has a capacity of 200,000 litres of bioethanol per day, and Taboga has a capacity of 150,000 litres per day. Together these have a total capacity of 350,000 litres per day, or 42 million litres per harvest season. On the other side, LAICA has a dehydrating capacity of 110 million litres per season.

**Ethanol production capacity**

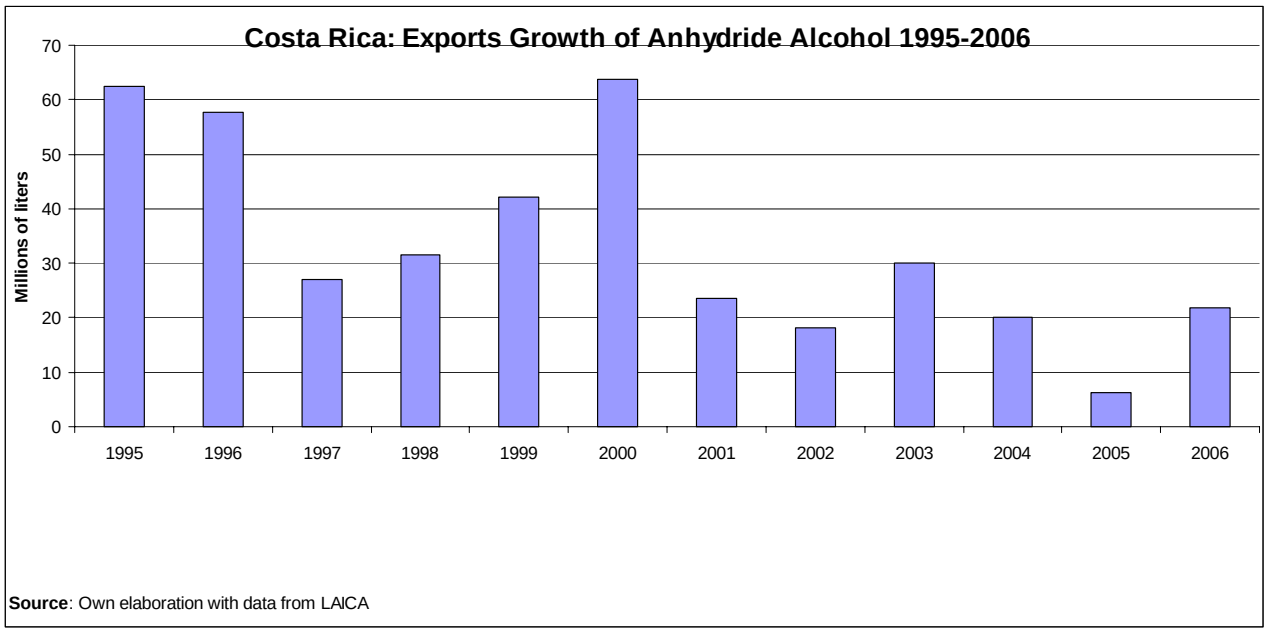
| Sugarcane mill | Installed capacity (alcohol litres/day) |
|---|---|
| CATSA | 200,000 |
| Taboga | 150,000 |

Source: LAICA

Basically what LAICA does is a 'maquila' process; they are supplied with imported hydrated alcohol, which is then processed and exported to the U.S. For the period 2001-2002, Costa Rica imported 1.28 million litres of hydrated alcohol from Europe. This volume was four times lower than that imported in the period 1999-2000. The imports proceeding from the European Union have diminished drastically because of the EU Regulations (BID)[4].

Despite the fact that in the country alcohol has been produced for 27 years and exported for 21 years, alcohol as carburant is still not part of the energetic matrix of the country. Motivated by the CBI, as a result of different attempts by previous administrations to produce carburating alcohol, the development of installed capacity has emphasized exports over national consumption. This incentive seems to continue because of U.S. interest in doubling the current demand to reach 28.4 million cubic metres by 2012, according to the Energy Bill recently approved by the Congress, the favourable conditions given by CAFTA extending the benefits of the CBI, and because of the rise in the demand of ethanol at a global level.

[4] Reform to the Common Agricultural Policy (CAP), September 2006. Directives: 2003/30/EC, 2003/96/EC. Regulations: (EC) 670/2003, (EC) 2336/2003, (EC) 1907/2006.




**Source**: Own elaboration with data from LAICA

One of the questions surrounding the decision to use bioethanol in a 10/90 bioethanol-gasoline mix in a generalized way is whether the country is capable of responding to national demand, given the current installed capacity and the possibilities of expansion.

Horta (2004) analysed the Central American region to determine the need for expansion of the cultivated area to supply projected national demand. He assumed a productivity level for the country of 75 tonnes of sugarcane per hectare, six litres of ethanol anhydride per tonne of processed sugarcane for sugar (molasses ethanol) and 75 litres of ethanol when the cane is destined directly to make biofuel (sugarcane juice ethanol). The scenario considers a mix of 10 per cent bioethanol in the gasoline and the use as raw material of 75 per cent of the available molasses, to be completed with straight sugarcane juice in the necessary measure to match the demand determined by the national gasoline market.

Using data available in 2004, he concluded that for Costa Rica, given a 10 per cent ethanol mix with gasoline, and considering the existing installed capacity to produce ethanol, there is a need to increase the current sugarcane production area by 26.5 per cent.

Horta (2004) also estimated the ethanol storage requirements in order to have the product available all year round. The estimations for a 100 day harvest demand storage between harvests of 61.3 thousand of cubic meters. Ethanol storage has its own costs and risks; however, it is necessary given the seasonal nature of the product and the need to guarantee the supply of ethanol between harvests. The

storage can be carried out either by producers or distributors, depending on their interests, availability and on how the country decides to tackle this matter.

Other problems that the country must face in order to develop the bioethanol industry are transportation and distribution. Production occurs in different places –currently Puntarenas and Guanacaste- , but it could also be in other areas like the northern zone if there were to be an expansion of cultivation. Recope would be in charge of the mixture in order to maintain homogeneity, so the bioethanol should be transported to their installations. Recope has four plants located throughout the national territory: Moín (294km), Barranca (110km), La Garita (36km), and El Alto de Ochomogo (20km). The transportation must be done in tanker trucks because ethanol cannot be exposed to water. In general, the storage, production and transportation of the mixture to distributors will require organization between the different actors and determination of costs that will eventually be internalized in the price of the final product.

Regarding the distribution of bioethanol to gas stations on a national level, Horta (2006) argues that Recope can use specialized pipelines to transport bioethanol, since Brazil has vast experience in this field and the contacts between both countries for technological support in this field already exist[5].

Another important topic is the implications of this activity for employment, especially regarding rural employment. Horta (2004) made employment estimates using two scenarios. One was where there was a high level of mechanisation and an estimated 160-day harvest with a productivity of 120,000 litres of bioethanol per day and a requirement of 455 direct workers per year. Another scenario was with a less mechanised sector, with a 100-day harvest needing 1,775 direct workers per year. Based on these scenarios and estimating a bioethanol demand of 84,500$m^3$, he concluded that a low level of mechanisation implied high labour demands (12,499 workers), while increased mechanisation brought lower labour demands (2,002 direct workers).

In order to estimate industrial employment he assumed an average requirement of 150 workers/year for distilleries, with a capacity for 120,000 litres/day and a harvest of 130 days. The estimation gave the result of 813 workers. When calculating indirect employment, the study assumed a figure of three indirect workers for each direct post, resulting in –in the case of high employment demands- a total of 13,311 direct employments, giving 39,934 indirect employment opportunities and a general total of 53,246. For the low employment scenario the general total comes to 11,260 employment positions. It

[5] During a first stage, in the second semester of 2008, Recope will acquire equipment for the reception, mixing and control of bioethanol in four locations.

is generally considered that as industry becomes more mechanized and increases efficiency, it shifts from the high demand scenario to the low demand one.

In the case of Costa Rica, the problem is the scarcity of labour force, and in general this labour comes from Nicaragua during the sugarcane harvesting period. From this point of view, the sector will tend towards mechanisation in order to minimise the shortage of labour force.

Horta (2006), in a later study using data from 2005 for Costa Rica, pointed out that with the country's current installed capacity (350,000 litres/day), 48 per cent of the previewed ethanol demand (to provide 900,000 million litres of fuel) could be covered, using a mixture of 10 per cent ethanol (90 million litres of anhydride ethanol per year).

**3.2. Production cost**

The determination of production costs for ethanol is a more difficult task than it would seem. Some of the reasons for this are: the variability in technologies, production routes, integration level of sugarcane production and information from producers who tend to inflate estimates. Also the sugarcane mills produce sugar and electricity, adopting arbitrary rules of cost distribution. Horta (2006) uses sugarcane production costs given by LAICA, which correspond to a determined zone of the country (Guanacaste). Assuming an exchange rate for the colón with respect to the dollar of 476.23 and an average productivity of 85 tonnes per hectare, the cost of the sugarcane is US$17.35 per tonne. This is a high cost compared to Brazil where the cost is around US$10 per tonne.

According to Horta (2006), assuming a production of direct ethanol from sugarcane juice, with productivities of 85 tonnes per hectare and 75 litres of ethanol per tonne of sugarcane, he defined three scenarios to estimate bioethanol cost. One was with a raw material cost of 40 per cent of the total cost of bioethanol, resulting in US$0.577/litre. A second one was with raw material at 50 per cent of the total cost of bioethanol, resulting in US$0.462/litre. The third option added the distillery and extraction processing costs (assuming Brazilian cost data of approximately US 0.075$/litre) to the unit cost of raw material (estimated at US$0.231/litre), resulting in a total of US$0.306/litre.

When examining the three possible scenarios, the first one showed high costs, double the Brazilian costs of about US$0.25/litre. The third scenario is unlikely to occur, since it was based on Brazilian costs (where there is higher productivity and benefits from economies of scale). The second option seems the most realistic because of the percentage of raw material and estimations supported by

national data. These estimates are made under the assumption that sugarcane juice is used directly, a situation that does not occur in Costa Rica, where production is based on molasses.

The dehydration of imported hydrated alcohol has been a profitable activity for further exporting of anhydride carburating ethanol to the U.S. market, due to prices in international markets and preferential conditions in the context of the Caribbean Basin Initiative (CBI). Hydrated alcohol is imported at US$0.17/litre and anhydride alcohol is exported at US$ 0.34/litre. Thus, for the sugarcane cutting season of 2001-2002, 1,283,000 litres of alcohol were imported from Europe and an almost identical volume was exported to the US, with a net profit of US$2,960,000.

Chaves (2003) makes a global revision of costs where a big dispersion can be perceived, and all values are significantly inferior to the ones estimated for Costa Rica.

| Country | Production cost in US$/litre |
|---|---|
| Australia | 0.145 |
| Brazil | 0.222 |
| Colombia | 0.24-0.30 |
| France | 0.386 |
| India | 0.261 |
| Mexico | 0.185 |
| Thailand | 0.152 |
| United States | 0.231-0.286 |

Source: own elaboration based on Chaves 2003

One would expect that as this industry consolidates, it will increase its productivity and improve its technology, and therefore costs will go down, but it would be difficult to achieve the same level of efficiency/costs as Brazil given, for example, the scale of production and if Costa Rica keeps producing bioethanol from molasses (Brazil produces biofuel from sugarcane and uses the bagasse for cogeneration).

### 3.3. Value Chain

Regarding bioethanol production and exports, there are two value chains: one based on national production of bioethanol and another based on bioethanol maquila. The former is supported by the distilleries CATSA

and Taboga, with a daily production capacity of 350 million litres, and fed by national producers 94.7 per cent of which are small scale. The second is bioethanol maquila, by Laica distillery in Punta Morales, which improves imported alcohol to export it to the U.S.

Bioethanol exports by sugar sector in harvest seasons 2000/01-2004/05

| Harvest | Gallons | Price/gallon FOB Punta Morales (US$) | Total income FOB (US$) |
|---|---|---|---|
| 2000/2001 | 6,228,651 | 1.3429 | 8,364,682 |
| 2001/2002 | 4,820,412 | 1.2646 | 6,096,124 |
| 2002/2003 | 7,928,883 | 1.2196 | 9,670,203 |
| 2003/2004 | 5,004,204 | 1.4447 | 7,229,483 |
| 2004/2005 * | 1,555,644 | 1.4447 | 2,247,439 |
| Average | 5,107,558.8 | 1.3433 | 6,721,586.2 |
| per cent Growth | -24,23 | 1,47 | -23.11 |

* Preliminary Values

Source: Laica

### 3.4. Trade trends

As mentioned at the beginning of this study, Costa Rica has had quite a proactive trade policy, and has successfully realized unilateral trade liberalization. It has signed trade agreements with six countries (plus CAFTA which is close to being ratified) and is currently negotiating an association agreement with the European Union together with the rest of Central America. The main purpose of these agreements is to consolidate more stable and predictable market access. Within these negotiations, the issues of sugar and bioethanol have had several treatments with quite predictable results. Sugar, as is well known, is a highly protected market.

Despite having exported bioethanol for 21 years, there has not been any clear trade policy with respect to the promotion of exports of bioethanol. In some administrations (see section on Costa Rican experiences) there have been some isolated efforts motivated mainly by the international oil crisis, but they have not been consistent and regarding exports there have not been other initiatives beyond the CBI proposal. This is not due to any internal market supply policy, because bioethanol is not part of the national energy matrix, but because the emphasis of the sugar sector has been on sugar production and its more traditional byproducts and bioethanol trade has not been seen as a market niche to be developed.

As already explained, the CBI allowed tariff-free entry of bioethanol into the U.S. for countries that would benefit from such initiative, provided that the origin rule be respected, which was 45 per cent of value added. However, it also allowed an imports quota with flexible value added requirements for member countries, giving the possibility of maquila to bioethanol to the U.S.

In the Harmonized System for Designation and Codification of Merchandise (HS) there is no specific tariff code for ethanol; for tariff effects this is accounted within the code 2207 that covers alcohol, both denaturalized (220720) and without denaturalization (220710). Both can be used for the production of biofuels.

The consolidated tariff of Costa Rica at the WTO for sugar is 45 per cent. With respect to the negotiations of the Doha round, specifically on environmental goods and services, the country has not yet stated a clear position with respect to treating bioethanol as an environmental or ecological good. The Brazilian proposal on that matter is relatively new and Costa Rica has not yet defined its position.

Regarding the Central American region, sugar is among a reduced list of sensitive products. Its production is fundamentally for local demand and the product is highly protected in all countries. Regarding bioethanol, there are recent regulations established for this product, defining its specificities and characteristics, and there is currently a tariff free trade.

CAFTA

Costa Rica has had to follow a difficult path to ratify the trade agreement with the U.S. After finishing the trade negotiations with the U.S. in January 2004, the Pacheco administration (2002-2006) delayed the submission of the agreement to the National Congress for its ratification, worried about the strong opposition from a sector of the population and conveniently leaving the decision to the new administration. The Arias administration (2006-2010), after several attempts and aware of the political damage that approval of the agreement in congress could represent, agreed to leave the approval to a national referendum, which finally occurred on October 7, 2007, with 51 per cent votes in favour against 48 per cent. At the present moment the congress is approving implementation laws that are a requirement for the agreement to be valid. The deadline for the approval of these laws is February 2008.

The agreement defines immediate free trade for bioethanol complying with the origin rule of the agreement, which consists of a national value added of 45 per cent. It also establishes a quota of 31 million gallons with a flexible origin rule that permits importing inputs including dehydrated and hydrated alcohol.

Of the six trade agreements signed by Costa Rica, sugar was excluded from three of them (Dominican Republic, CARICOM, Panama); in two of them (Mexico, Chile) quotas were established; and in one (Canada) an eight-year gradual opening market was defined before the total elimination of tariffs. In the case of CAFTA, which still has not been ratified, a quota was defined while in the EU, negotiations regarding the treatment of sugar are still underway.

With regard to bioethanol, in all cases -with the exception of Panama, who propose a ten-year gradual reduction- all agreements define a free tariff trade for bioethanol. This could be beneficial for bioethanol export promotion; however, this policy will be influenced by international prices, the supply of the country and the level of competitiveness of the sector.

With respect to bioethanol, in trade negotiations we can conclude that the signed trade agreements promote free trade of the product; however, this has not turned into effective trade between the signature countries. It could be that the change in the current international situation in relation to oil is creating the conditions to promote this trade; this remains to be seen.

### 3.5. Supply capacity

Right now bioethanol production is focused on satisfying export needs. There is no national consumption of bioethanol beyond the pilot plan, which is limited to a specific region of the country. Besides, bioethanol use in that project is imported from Brazil. If the country is interested in satisfying national demand with a 10/90 mix, it would have to increase the cultivation area of sugarcane by 26.5 per cent. Land would be available for such growth but it would depend on several factors. First, the use of the mix should be a generalized requirement. Then the government should decide how to supply the bioethanol demand. People might be willing to pay a higher price for the cost of local production in order to promote the bioethanol sector in the country. Or, there might be more interest in lowering the production cost of the mix and thus importing bioethanol for local consumption.

The decision of the government is not yet clear. On one hand, the National Biofuels Strategy will promote sugarcane production and bioethanol in depressed areas of the country to combat poverty, though for now there is no explanation as to how these policies will be put into action (purchase and distribution of lands, incentives for production, etc.). On the other hand, Recope is buying bioethanol through open, public, competitive biddings where international companies can participate, and giving priority to prices. The government does not seem to want to subsidise national companies and turn the development of the bioethanol sector into a fiscal burden for the country. National production could become competitive due to

transportation costs. The factors that will determine whether national production satisfies local consumption are: international sugar prices (especially the preferential ones), the international price of bioethanol, the oil price and the productivity of the sector. At present there is no clear policy stating that production must be for local or international consumption or both; it seems the decision will be determined by costs and prices of bioethanol and its inputs.

## 4. Sustainable development impacts of bioethanol

### 4.1. Economic sustainability

One of the concerns regarding the generalised use of ethanol in gasoline relates to supply. If Costa Rica wants to be self sufficient it has to develop storage capacity in the first place. This becomes more imperative because of the seasonal character of the raw material. Without discarding the possibility that the country can develop these capacities, it is timely to remember that today there is a complete dependency on hydrocarbon imports, and that the country is not in a position to guarantee any supply if facing an international eventuality. At an international level the biofuels market tends towards consolidation, and this will mean more stability, better technology and more producers and consumers. The country currently possesses an installed capacity that could, without much additional investment, supply almost 50 per cent of its biofuel demand using a 10 per cent mix, without increasing the area of sugar production. Assuming that this will be the situation in a short term, the country can import the necessary amount, as it has done with other products like rice where the internal production does not supply the internal demand, or as it has done in general with oil products. If necessary, the country could change the percentages of the mixture (to eight per cent, for instance) in such a way that it could increase supply capacity. What must be understood here is that being self-sufficient is not a necessary condition to generalize the use of the ethanol-gasoline mix. Besides, the country already has considerable experience with alcohol imports.

- **Currency savings due to oil imports substitution**

As mentioned above, oil import costs today represent more than 5.6 per cent of the GDP, a figure that has almost doubled in four years. The international trend is for rising oil prices; therefore we should expect this tendency to continue, at least in the mid-term. These price increases mean substitute products that were not profitable in the past have become so today. That is why it is the right moment for the country to develop these alternative products, to reduce oil dependency, improve the environment and stimulate new productive activities in the economy.

We must start from the fact that ethanol will not substitute petrol, but that it will be used as a mixture, and that in the short term this mixture must be 10/90.

However, it seems the benefits of using bioethanol are more directly connected with foreign currency savings and positive environmental impacts than the lowering of fuel prices, at least in the short term.

However, given the high cost of oil and its byproducts, the use of bioethanol becomes every day more profitable. Horta (2006) estimates parity costs. He calculates them for sugar producers, considering the different prices in the international markets. He estimates prices for molasses and sugar exports, both for the international surplus market and the U.S. preferential market. In the chart below there are parity costs for each product and market. Given these prices, the one with which it is most difficult to compete is the one that corresponds to sugar with the U.S. preferential market as destination. Afterwards Horta defines the parity price for bioethanol, based on the price of gasoline and MTBE that would be substituted by bioethanol. Using data from 2005, the price of regular gasoline is of US$0.47/litre and US$0.50/litre for super grade; the price of MTBE in Central America was calculated between US$0.43/litre and US$0.47/litre for that year. If we use scenario two from Horta´s estimation of the production cost (assuming 50 per cent of raw material as bioethanol cost), the price resulted in US$0.43/litre, thus making bioethanol use in the country profitable already. If we consider that gasoline prices have increased since then, it is clear that bioethanol use is profitable and that it can mean significant cost economy for the country.

**Parity prices of bioethanol in Costa Rica (2003/2004 harvest)**

| Reference | | Parity price (US$/litre) |
|---|---|---|
| **Product** | **Price (US$/kg)** | |
| Molasses external market FOB, surplus. | 0.044 | 0.131 |
| Molasses external market FOB, American quota. | 0.051 | 0.152 |
| Sugar external market FOB, surplus. | 0.170 | 0.284 |
| Sugar external market FOB, American quota. | 0.440 | 0.735 |

Source: Horta (2006)

- **Product Diversification**

Regarding the national producer, how are they affected by having an additional alternative for the use and sale of their product? The international sugarcane market is highly protected; in general countries manage to negotiate quotas, a limited access to different markets, and because it is a commodity, it has

an important price fluctuation. From this point of view, having an alternative use and thus a new destination market constitutes larger margins for manoeuvre and higher demand for the product, and consequently a more favourable situation towards the rise in the price with the subsequent incentives for the national producer.

- **Value added**

Another element to consider is the fact that ethanol production adds value to the production of sugarcane, and promotes and creates conditions for the development of an industry around ethanol and other byproducts.

Using the parity prices mentioned before, it can be seen that if the molasses and sugar producers substitute their production for the production of bioethanol the price received is much more than what they would get if they were to continue producing molasses or sugar for the surplus market. On the other hand, if distributors buy bioethanol at cost price compared with the cost of molasses or sugar production on the surplus market, they would also make significant savings, and thus there is a wide negotiation margin in which both may be favoured; and this is without considering the final consumer. The only case in which is more profitable to produce sugar is when it is destined for the U.S. preferential market.

- **Employment and income generation**

Horta (2004) assumes that to be able to supply the national demand of ethanol that the petrol mixture needs, production area must be increased by 26.5 per cent. According to weather conditions and current land use, it is possible to expand production without competing against other products and/or developing areas that are socially or economically depressed. In this way, the activity complements income generation instead of competing for basic products and vegetables. Because of the weather conditions that sugarcane requires, the products with which it could potentially compete for land use are pineapple, melon and rice. In this case the decision on what to produce will depend on access to markets, technologies, and how the productive chain is determined. From the institutional point of view there is enough legislation to avoid any irrational or irresponsible land use.

As mentioned before, assuming a low mechanised production, bioethanol production can generate 12,499 agricultural employments and 813 industrial ones, making a total of 13,311 direct employments, and 39,934 indirect employments, giving a grand total of 53,246. For a more mechanised production scenario the grand total of employments is 11,260, where 2002 are agricultural, 813 industrial and 8,445 indirect.

If we consider only the maquila process of bioethanol, the impact on employment is low, with benefits basically focused on the difference of imports and purchase prices of the U.S. and benefiting the industrial sector of bioethanol.

### 4.2. Environmental sustainability

The impact of bioethanol production upon the environment depends on whether bioethanol is produced locally in the country or is imported from countries with lower prices. At present, there is no local demand because there is no generalized use of a bioethanol-petrol mix and the small production is exported, so environmental impacts, if any, are very mild.

Sugar production and ethanol elaboration, like most productive activities, have an environmental impact (Randall 2006), and these lie in the land use (agricultural frontier expansion and related impacts on biodiversity), soil quality (fertilisers, erosive processes), water use (irrigation, competition with alternative uses, scarcity in some regions), water pollution (vinasse), air pollution (fires, boiler pollution) and GHG emissions. And like any other productive activity it must move towards cleaner, more sustainable production. This is not the current situation, even though for instance, fires are illegal. To a large extent, this reflects weaknesses in lack of compliance to legislation and poor effective environmental management in the country.

## Some environmental impacts of sugarcane production

| |
|---|
| Environmental impacts refer to the group of positive or negative effects that an existing or projected economic activity exerts on quality of life and the physical environment of a specific region. The environmental impact assessment starts with a diagnosis of the consequences produced by the sectors analyzed, on the soil, atmosphere, flora and fauna, amongst other aspects. |
| **Impacts on soil**: Sugarcane cultivation alters the physical and chemical properties of soil in several ways and through different processes. Due to the need for watering during the dry season and excessive rain during the rainy season, these lands are levelled before planting. This implies cutting hills, with the consequent elimination of important micro-flora and the change in the natural shape of the landscape. This impact is considered moderate.<br>Two activities with particularly negative impact on soil are weed control and fires. Pesticide residues are unlikely to degrade so they are deposited in the ground and remain there. Fires eliminate the vegetation cover and liberate certain nutrients that are consequently lost into the atmosphere. Chemical and organic fertilisers help improve soil properties, favouring vegetation cover and microorganisms. Watering and drainage also help keep a nutritional balance in the soil during critical periods of excess or lack of rain, so they both have a high positive impact on the environment. |
| **Erosion:** Weed control and fires generate a highly negative impact. Both activities eliminate the vegetation cover of the soil, thus encouraging both wind and water erosion. |
| **Compacting:** Due to the mechanization of the cutting and picking of the sugarcane, there is a compacting process which has to be reverted through ploughing each time new planting is carried out. Other things that help soil compression are weed control, fires (by eliminating vegetation cover) and watering. |
| **Salt in soil:** Activities that incorporate salt into the soil are: chemical fertilization (highly), weed control and watering. This generates a negative impact because the environment loses its productive capacity. |
| **Impact on superficial waters:** Weed control and chemical fertilization have a negative impact on superficial waters, which gets worse during rainy season. Pesticide and fertiliser residues are carried to rivers or natural sources of water through the irrigation processes, so water gets polluted with biocide agents or increases its nitrate concentration. Watering and sugarcane washing diminish water flow for other uses (human consumption, transportation, recreation) from the rivers used. |
| **Impact on underground waters:** Chemical fertilisation has a negative impact on subterranean waters given that liberated nitrates are often not absorbed by plants or organisms, so they get filtered into deeper layers of the earth until they reach the subterranean water bearing stratum. Watering channels are sometimes fed with waters under the earth layer through wells. |
| **Salt in water:** Chemical fertilization and fires generate a direct impact by adding salts to water. Watering has a negative impact because it transports such salts. |
| **Impacts on atmosphere:** The process that generates a major negative environmental impact on atmosphere is the burning of sugarcane, due to the liberation of carbon dioxide. Other activities with a negative impact on atmosphere are the milling or grinding, washing and centrifugation, all activities that belong to the industrialisation of sugar and generate noise. Organic fertilisation carries strong odours from decomposition. Weed control and artificial ripening imply pesticide emission, which has a mild negative impact on air quality from biocide action of the substances used. Sugarcane planting has a highly positive impact on atmosphere quality because of the plant's efficiency in fixing carbon dioxide, more effective than a natural forest. |
| **Impact on flora:** There is critical negative impact on weed control over bushes, herbs and pastures, given that this type of flora competes for space and nutrients with sugarcane. Fires have a critical negative impact over the same elements and over trees because they are eliminated if they are within the plantation. There is also a negative impact on the microflora from the cutting and picking, weed control and levelling. Several activities have a positive impact on flora, such as draining, land conservation practices, fertilization, and watering; these all widen and improve soil production capacity. |
| **Impact on fauna:** The major negative impact on fauna is generated by sugarcane firing, because it eliminates all animals and insects. Weed control and artificial ripening through agrochemicals produce a negative impact on fauna because these are toxic substances. Cutting and picking also eliminates some fauna in the plantation so they are negative. Sugarcane rat control generates a direct negative impact on this animal with a consequent indirect effect on other animals that feed or depend somehow on this one. Positive impacts on fauna include: soil conservation practices, watering, drainage and remanga. Increasing soil fertility and productivity, as well as water availability all year favour space and food availability for birds, insects and others. |
| **Solid residue elimination:** Organic fertilization and remanga represent solid residue elimination services in the process, which generates a positive impact on the environment. During the industrialisation process of sugar there are other processes in which solids are eliminated, like clarification, in which part of the sugarcane cachaza is returned to the fields to turn into an organic fertilizer. There are also the crystallisation and centrifugation processes where honey is produced as a by-product, then separated and stored before being used in other production processes. |
| **Elimination of liquid residues:** This occurs mainly through drainage and to a lesser extent through the watering system, which produces a positive impact on the environment. Organic fertilisation constitutes a liquid residue elimination service. In the stages of evaporation and crystallisation during the process of sugar industrialisation, the liquid residues are separated from sugarcane juice and eliminated, and those are used in the production of energy in sugarcane mills or in the drying of sugar. |
| **Poisoning:** The main negative environmental impact from poisoning comes from pesticides and to a less extent from rat control and chemical fertilisation. |
| **Food chain:** Sugarcane fires generate the worst negative impact on the food chain by breaking it at several points. They eliminate the vegetation cover of soil, animals and insects in it. This alters species situated in superior levels. Activities with severe negative impact are cutting and picking, rat control, insect control, and weed control. Activities that strengthen the food chain are drainage, soil conservation practices, organic fertilisation, remanga and planting. |

Source: Arce et al, 2004.

**Air pollution**

Observing the structure of the energy consumption by sources, it can be seen that oil represents 67 per cent, and transportation is the sector that consumes more than 50 per cent of the oil. Besides economic consequences, this has significant environmental implications because of the high air pollution due to an increase in vehicles: from 472,000 in 1998 to 830,000 in 2007 (La Nación, 2007). This is aggravated because the vehicle models are older than 1989, even though this tendency has been decreasing in recent years. A more environmental friendly mix like ethanol with gasoline would have significant impact on pollution.

Among the positive aspects for environment if ethanol is used as mix is the substitution of additives like Methyl Tertiary Butyl Ether (MTBE) and lead, which represent problems in use and undesirable emissions.

**GHG emissions**

According to studies, with the substitution of fossil energy for sugarcane byproducts there are 2.6kg of $CO^2$ less per litre of anhydride ethanol produced. Considering a mixture of 10 per cent ethanol in Costa Rican petrol with an ethanol demand of 90 million litres anhydride ethanol per year, an estimated 234,000 tonnes of $CO^2$ or 63,800 tonnes of carbon could be avoided. Also, a study estimates that considering an avoided tonne of carbon at a conservative price of US$5, in the scope of the Kyoto Protocol and the valid mechanisms of carbon trade, Costa Rica could obtain US$320,000 each year from the use of gasohol with 10 per cent ethanol (Horta 2006).

**Impact on agricultural frontier/land use**

With respect to the use of land, promotion of monocultivations and all the problems that can be related to this type of crop, to a large extent this will depend on the country's strategy. Chaves (2007), using data from the Ministry of Planning, argues that there is in the country a significant area of land with potential for farming, despite the area dedicated to forestry and forest, estimated to be 37 per cent of the national total. Besides, adds Chaves, other lands could be added that are currently underused as pastures and activities of very low productivity. The current government visualizes the production of ethanol as a way to reactivate agriculture and develop it in zones where there is more poverty and social limitations. All this must consider the limitations of labour force that can be a restrictive variable for any expansion beyond certain limits of the production.

Another aspect that could act in favour of the development of ethanol production is the fact that the country has enough legislation to promote adequate land use. Among these laws we can mention the following:

The Forestry Law (7575) from 1996
The Law of Use, Management and Conservation of Land (7779) from 1998
The General Law of Health (5395) from 1973
The Organic Law of Environment (7554) from 1995

Chaves (2006) mentions that one hectare of sugarcane captures approximately 19 tonnes of atmospheric $CO^2$.

In the National Development Plan the present administration clearly states its vision of environmental policy. It acknowledges that environmental management in the country has been contradictory or inconsistent, so we see big achievements, such as the Environmental Services Programme (ESP) and its impact in reforesting the country which went from 21 per cent forest in 1986 to 51 per cent at present. On the other hand, Costa Rica has the most polluted hydroelectric watershed in the Central American isthmus.

The government says that there is no incompatibility between economic growth and the promotion of environmental sustainability. It sustains on the contrary that both are imperative in the search for human development, which is the ultimate objective of the political proposal of the 2006-2010 administration. "Costa Rica needs urgently to accelerate its economic growth to reduce poverty, but not just any economic growth. We aim to be a country that bets on clean industries based on knowledge, more than in a predator use of natural resources, whose economic rationality in the long term is very arguable. To put it in outlined terms: if our economic growth is to be economically sustainable in the long run, we should be concerned with making it environmentally sustainable in the short term. The ultimate goal of environmental policy is human development, which is the growth of options for people. This is why conservation is not enough; it is necessary to ensure the use of natural resources; a sustainable use, certainly, but use in the end." (PND 2007)

The present administration has launched a programme of neutral carbon emission, that is, the carbon emissions must be compensated with activities or programmes that bring about carbon capture. From that point of view, an ethanol production programme could help achieve this goal. The mixture of ethanol with petrol is less polluting than petrol alone, so better air quality is being promoted.

However, these environmental problems do not necessarily have to be this way. The Brazilian experience is a good example of efforts to make sugarcane activity more sustainable. The Brazilian sugarcane industry has minimised the use of agrochemicals in recent years. Schemes include: recycling materials and vinasse to use as fertilisers; fighting plagues like the Broca with biological methods; reducing sugarcane fires with the aim of eliminating these by 2021, agricultural zonification, and land classification. The environmental impacts of ethanol production can be controlled or mitigated by establishing possible goals and promoting technological change and the development of new knowledge (Horta 2006).

### 4.3. Social Sustainability

One of the goals of the biofuels strategy of the current government is to strengthen the agricultural sector by means of the promotion of biofuels and hence reactivate socially depressed areas. It is not clear how they will implement the policies, so it is somewhat early to speak of social impact. What is worth highlighting is that the administration combines economic aspects with the social and environmental ones in the definition of the strategy. An interesting trend in the sugar sector in the last few years has been the increase in small producers. According to Laica, between the 2000 and 2005 harvests there was a significant increase in producers (97.2 per cent). The segment which grew most in this group was that with a production of less than 250 tonnes. Laica attributes this to the security and confidence of the organization of the sector. This emphasizes the important role of the small producer in the sector.

Among the actions of the government there is the creation of a development bank that can assume activities or projects that demand –in the short term- a larger financial risk than commercial banks will accept. Another initiative is the establishing of a programme with funds for small and medium entrepreneurs, to promote this kind of productive unit and help them prepare for the opening of markets implicit in the signing of trade agreements so they can also take advantage of access to these important markets.

Regarding food security, it could be strengthened by creating conditions to generate income through employment or profits to allow the purchase of products of the basic shopping basket.

The option of sugar production for ethanol also means creating more opportunities for the rural sector. According to Horta, even though employment generation is not necessarily that considerable, it is meaningful if you see it with respect to the economically active population in the rural area.

The production of sugarcane can at the same time serve as a basis to develop programmes in the framework of the Kyoto Protocol, where cleaner production is privileged.

**5. The role of the state**

In Costa Rica there is a state monopoly in imports, processing and distribution on a wholesale level for oil byproducts. As mentioned before, up until 1985 there was a state monopoly on the elaboration of alcohol with the Fábrica Nacional de Licores. An important tradition can be perceived regarding the intervention of the state in these sectors. How should the country face production and distribution of biofuels?

One of the objectives of the present administration is to create an open market where there is state participation as well as private sector involvement in the fuel market, including biofuel. For this to be possible, important changes must be brought about in the organization and institutions of the energy sector. Such changes are not impossible but do require time to implement.

At the moment it seems that the best incentive the state can give to biofuel market development is by enforcing and generalising the use of the ethanol/petrol mix, and today this is true only at the level of a pilot plan. Another of the tasks in which the state can play an important role is in the education and information on the implications, benefits and precautions surrounding the use of the mix. A third way to promote the ethanol sector is by supporting agro industry technological development associated with ethanol production.

Regarding the determination of biofuel prices there should be a careful analysis to see which is the best road to take for the country in this matter. It could be the possibility of letting the market forces determine the price based on the opportunity prices (a price which makes it indifferent to produce ethanol or another product) when faced with the prices of international markets, and also considering the opportunity prices compared to other sugarcane products. Also the price could be determined by the government starting with the costs of agro industry production, or reference prices (parametric formula) (Horta 2006).

Among the concerns for the promotion of the bioethanol sector, there are social and environmental impacts that the activity could carry. These could be mitigated if there are the adequate legal and institutional conditions to address the different challenges of the development of the sector. In the

environmental arena, even though the country has solid legislation and important institutions, there are reasonable doubts about the capacity of the government to enforce this legislation and develop an environmental management that guarantees milder impacts on the environment. Some of the difficulties Central American countries faced when signing the trade agreement with the U.S. was that it made them commit to comply with fulfilment of their own legislation, with trade sanctions and fines if they failed to enforce these laws. Central American governments did not want this to be included in the agreement, and in the end they had to accept it, but asked for an environmental cooperation agreement that would help them with financing and technical support to improve legislation enforcement. Costa Rica is one of the countries in a better condition to enforce legislation in the region, but is still a long way from achieving this satisfactorily. Therefore, if bioethanol production were to be promoted, concern about compliance with environmental legislation would be an issue.

Regarding social impact, the most important concern, which remained clear during the referendum discussions on the trade agreement with the U.S., is the theme of poverty and social inequality. There has been a tendency in recent years for the gap between the poor and rich to get larger while extreme poverty remains steady; for the last 20 years, around 20 per cent of the population has been living below the poverty line, with the exception of this year, when the figure dropped to 16.5 per cent. In the face of this, people ask who really benefits from trade agreements and economic liberalisation. To this end, the government and country must define a social (education, health, etc.) investment policy that promotes more benefits for the majority and thus counteracts the tendency towards concentration of wealth. The country has tradition and strong institutions in the social field, but there must be clear and explicit policies established in this sector, specifically to avoid undesirable social impacts from an activity like bioethanol production.

## 6. Conclusion

Acknowledging the heavy burden of the oil cost for the national economy and considering that this tendency is very unlikely to change in the mid term, it is worth weighing the benefits of promoting alternative sources of energy, particularly bioethanol. The trading experience on bioethanol and its installed capacity at the moment is a good starting point to launch a strategy in this field.

Bioethanol is not currently part of the national energy matrix, but given international oil prices, national bioethanol production and consumption is already profitable. The great majority of studies point out the favourable conditions Costa Rica has to promote the bioethanol sector, as well as the economic, social and environmental benefits it could bring. However, just like any other activity this one has implications in different areas, and thus a well planned strategy is required in order to minimize possible negative impacts. The first great actor in this project would be the state, who should establish the normative and institutional framework for the development of such activity. In the case of Costa Rica, the first steps are just being taken in this field. This contemplates aspects like: generalisation of the use of the mix, price fixing mechanism, and the way in which Recope (the state corporation) and the private sector participate. On the other hand there are sugarcane producers and sugarcane mills, which must improve productivity, develop friendlier practices with environment, as well as promote the participation of small and medium size producers. And perhaps what is more important are the lessons from former experiences; that a sustained national information campaign must be developed to inform consumers about the benefits of introducing the biofuel mix and also to minimise worries or concerns over how vehicles will be affected and any maintenance details. An adequate strategy could allow the country: to reduce dependency on oil imports with the consequent cost savings; to reactivate the agricultural sector; and promote a better distribution of income via employment and opportunities for medium and small producers. Possible environmental dangers that the activity may bring can be minimised if the government and productive sector assume their responsibility and there is adequate promotion of clean technologies, research and development.

Brazil is a good example of a country that has made a development bet on this ethanol sector and after two decades is receiving the benefits, which can even be further increased. Therefore, the development of the bioethanol sector must be seen as a mid term project where benefits will not necessarily be perceived immediately. The activity is a challenge for the country but there are the necessary institutions, human resources and a favourable international climate that all serve to increase the probability of success. If done adequately, in the long term positive results will be perceived in the environmental, economic and social arenas.

## 7. Acronyms

| | |
|---|---|
| BCCR | Banco Central de Costa Rica |
| BID | Banco Internacional de Desarrollo |
| CAFTA | Central American Free Trade Agreement |
| CARICOM | Caribbean Community |
| CATSA | Central Azucarera Tempisque Sociedad Anónima. |
| CBI | Caribbean Basin Initiative |
| CEDARENA | Centro de Derecho Ambiental y Recursos Natural |
| CEPAL | Comisión Económica para América Latina y el Caribe (ECLAC) |
| CINPE | Centro Internacional en Política Económica para el Desarrollo Sostenible |
| CODESA | Corporación Costarricense de Desarrollo |
| COMEX | Comercio Exterior |
| DIECA | Dirección de Investigación y Extensión de la Caña de Azúcar |
| ECLAC | Economic Commission for Latin America and the Caribbean (CEPAL) |
| ESP | Environmental Service Programme |
| EU | European Union |
| FANAL | Fábrica Nacional de Licores |
| FOB | Free On Board |
| GATT | General Agreement on Tariffs and Trade |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gas |
| GSP | Generalized System of Preferences |
| GTZ | German Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit) |
| HA | Hectares |
| HS | Harmonized System (Code) |
| IICA | Inter-American Institute for Cooperation on Agriculture |
| INS | Instituto Nacional de Seguros |
| INTA | Instituto Nacional de Tecnología Agropecuaria (Instituto Nacional de Innovación y Transferencia en Tecnología Agropecuaria) |
| LAICA | Liga Agrícola Industrial de la Caña de Azúcar, Sociedad Anónima |
| MAG | Ministerio de Agricultura y Ganadería |
| MERCOMUN | Mercado Común Centroamericano |
| MINAE | Ministerio de Ambiente y Energía |
| MOPT | Ministerio de Obras Públicas y Transportes |
| MT | Metric Tons |
| MTBE | Methyl Tertiary Butyl Ether |
| OEA | Organización de Estados Americanos |
| PIB DGP | Producto Interno Bruto |
| PIEM | Programa de Integración Energética Mesoamericana |
| PND | Plan Nacional de Desarrollo |
| PNE | Plan Nacional de Energía |
| PPP | Plan Puebla Panamá |
| RECOPE | Refinadora Costarricense de Petróleo |
| SEPSA | Secretaría Ejecutiva de Planificación Sectorial Agropecuaria |
| SICA | Sistema de Integración Centroamericana |
| UDSMA | Unidad de Desarrollo Sostenible y Medio Ambiente (de la OEA) |
| WTO | World Trade Organization |

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## 9. Annex

### Data for Costa Rica from Horta´s study

### Basic data for the perspective study for ethanol

| | Planted area (thousands of ha) | Agricultural productivity (tonne cane/ha) | Processed cane (thousands of tonnes) | Gasoline demand (thousands of cubic meters) |
|---|---|---|---|---|
| Costa Rica | 48.0 | 72.3 | 3,472 | 845 |

### Ethanol demand and supply

| | Ethanol demand (thousands of m3) | Availability of ethanol from molasses (thousands of m3) | Requirement of ethanol from direct juice (thousands of m3) | Fraction of the attended demand by ethanol from molasses (per cent) |
|---|---|---|---|---|
| Costa Rica | 84.5 | 15.6 | 68.9 | 18.5 |

### Additional sugarcane requirements

| | Additional sugarcane required (thousands of tons) | Additional planted area with (thousands of ha) | Increment in area with sugarcane (per cent) |
|---|---|---|---|
| Costa Rica | 918.3 | 12.7 | 26.5 |

### Production capacity and minimum requirements of storage according to the extension of the harvest

| | Annual demand of ethanol in thousands of m3 | Ethanol production capacity | | Storage between harvests | |
|---|---|---|---|---|---|
| | | 100 days (m3/day ) | 200 days (m3/diay) | 100 days (thousands of m3) | 200 days (thousands of m3) |
| Costa Rica | 84.5 | 845 | 423 | 61.3 | 38.2 |

### Generation of agriculture employment in an ethanol programme

| | Ethanol demand (thousands of m3) | Demand of labour force | |
|---|---|---|---|
| | | High | Low |
| | | Workers | |
| Costa Rica | 84.5 | 12,499 | 2002 |

**Employments generated in an ethanol programme**
**Scenario with high demand of labour force**

| | Direct labour force | | | Indirect labour force | General total |
|---|---|---|---|---|---|
| | Agricultural | Industrial | Total | | |
| Costa Rica | 12,499 | 813 | 13,311 | 39,934 | 53,246 |

**Employment generated from an ethanol programme**
**Scenario for low demand of labour**

| | Direct employment | | | Indirect employment | General total |
|---|---|---|---|---|---|
| | Agricultural | Industrial | Total | | |
| Costa Rica | 2002 | 813 | 2815 | 8445 | 11260 |

**Estimated consumption of gasoline and ethanol in Costa Rica**

| Year | Regular | Super | Total 1 | Ethanol 2 |
|---|---|---|---|---|
| 2005 | 131,6 | 106,5 | 238,1 | 23,81 |
| 2006 | 136,8 | 110,2 | 246,9 | 24,69 |
| 2007 | 142,1 | 111,7 | 253,8 | 25,38 |
| 2008 | 147,7 | 114,0 | 261,7 | 26,17 |
| 2009 | 153,5 | 115,0 | 268,5 | 26,85 |
| 2010 | 159,5 | 116,5 | 276,0 | 27,60 |

1. Average estimation from RECOPE given in millions of gallons.
2. It was estimated assuming a substitution of 10 per cent in millions of gallons.

**LAICA**
**Anhydride alcohol exports by harvest in Costa Rica**

| Harvest | Gallons | Price/gallon FOB Punta Morales | Total income FOB |
|---|---|---|---|
| 1995-1996 | 15,262,529 | $ 1.1592 | 17,692,245 |
| 1996-1997 | 7,145,703 | $ 1.2589 | 8,995,448 |
| 1997-1998 | 8,338,931 | $ 1.0226 | 8,527,499 |
| 1998-1999 | 11,144,934 | $ 1.0390 | 11,579,769 |
| 1999-2000 | 16,822,091 | $ 1.1012 | 18,525,048 |
| 2000-2001 | 6,228,651 | $ 1.3429 | 8,364,682 |
| 2001-2002 | 4,820,412 | $ 1.2646 | 6,096,124 |
| 2002-2003 | 7,928,883 | $ 1.2196 | 9,670,203 |
| 2003-2004 | 5,004,204 | $ 1.4447 | 7,229,483 |
| 2004-2005 | 1,555,644 | $ 1.8768 | 2,919,586 |
| 2006-2007 | 5,448,666 | $ 2.4133 | 13,150,072 |

Alcohol calculated based on 100 per cent purity to 60 per cent F (15.56 C)
Since 2004-2005 harvest, price per gallon and income based on CIF
http://www.laica.co.cr/docs/Zafra2006/index.swf

| Production of ethanol in Costa Rica | |
|---|---|
| **Ethanol production harvests** | |
| 1979-80 | 2.5 million litres |
| 1980-1981 | 2.1 million litres |
| 1981-1982 | 0.09 million litres |
| 1983 | 545,000 gallons of gasoline mixed with ethanol in 20 per cent |
| 1982 | 4.1 million gallons of Gasohol |
| 1983 | the mix was almost eliminated |

**Capacity for land use in Costa Rica per region in hectares**

| Class | Chorotega | Central Pacific | Huetar Atlantic | Huetar North | Central | Brunca | Total |
|---|---|---|---|---|---|---|---|
| I | 0 | 0 | 16,636.8 | 0 | 0 | 0 | 16,636.8 |
| II | 147,401.0 | 56,133.0 | 72,788.3 | 52,665.2 | 7,894.5 | 78,574.2 | 415,456.2 |
| III | 89,532.5 | 98,974.1 | 91,267.7 | 251,785.5 | 77,002.0 | 52,034.4 | 660,596.2 |
| IV | 181,987.0 | 24,378.0 | 71,743.7 | 194,356.3 | 161,669.5 | 188,866.9 | 823,001.4 |
| V | 972.7 | 0 | 55,219.6 | 615.9 | 0 | 11,359.0 | 68,167.2 |
| VI | 195,763.9 | 8,323.5 | 52,645.0 | 263,813.9 | 137,949.0 | 146,875.2 | 805,370.5 |
| VII | 263,342.1 | 151,926.8 | 56,412.7 | 69,351.1 | 161,627.3 | 127,288.2 | 829,948.2 |
| VIII | 138,110.6 | 52,060.4 | 503,708.0 | 146,568.5 | 315,451.9 | 322,728.6 | 1,478,628.0 |
| TOTAL | 1,017,10.,8 | 391,795.8 | 920,421.8 | 979,156.4 | 861,594.2 | 927,726.5 | 5,097,804.5 |

## Costa Rica: State of the negotiations for products like sugar and ethanol in the Free Trade Agreements

| | FTA Mexico-Costa Rica | FTA Dominican Republic-Costa Rica | FTA Chile-Costa Rica | FTA Canada-Costa Rica | FTA CARICOM-Costa Rica | FTA Panama-Costa Rica | CAFTA | Association Agreement Central America-EU |
|---|---|---|---|---|---|---|---|---|
| **Sugar** | An exports quota was established for 70,000 MT | Excluded | Excluded However, in 2004 an exports contingent was established of 1,500 MT tariff free | Free tariff contingents were established for refined sugar. In the case of access to Canada, this country gave to Costa Rica an initial quota of 20,000 MT, which will be incremented progressively until reaching 40,000 MT in the eighth year of the agreement. From then on, Canada will eliminate the imports tariffs for the refined sugar exports from Costa Rica. | Excluded | Excluded | Exports without tariffs from Costa Rica to the US, currently of 15,000 tons and to be incremented with another 13,000 MT annually, with an annual growth of 2%, for crude and refined sugar. The quota includes 2,000 annual tons of organic sugar | Currently the MFN tariff is between 33.9 €/100 kg/net y 41.9 €/100 kg/net |
| **Ethylic Alcohol** | 0% tariff | 0% tariff | 0% tariff | 0% tariff | 0% tariff | It will have a gradual deduction in 10 years | Zero tariff for CAFTA norm of origin. The US accepted receiving 31 millions of gallons per year without charging tariffs | Currently a 0% tariff is applied to all code, The specific MFN tariff for alcohol Corresponds to19.2 euros per hectolitre (hl) |

**Source:** Own elaboration with information from COMEX