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CAPACITY BUILDING IN TRADE AND ENVIRONMENT IN THE SUGAR/BIOETHANOL SECTOR IN BRAZIL

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INDEX

1. INTRODUCTION

Brazil is the world's largest sugar producer and exporter and also one of the lower cost producers. It has demonstrated rapid production and export growth over the last decades, despite lower world prices. As such, in 2004, Brazil contributed to 19% and 35% of global sugar production and exports, respectively.

Brazil is also the world's largest producer of bioethanol, producing 35% of the worldwide total in 2005, and is considered the only supplier capable of meeting the huge rise in import demand for bioethanol expected in the near future.

The production of both sugar and bioethanol gives Brazilian industry flexibility in responding to the changing profitability of sugar and bioethanol production. Almost 45% of Brazil's sugarcane is ground for sugar and 55% is used for bioethanol production.

Key environmental problems associated with sugarcane production include water consumption and pollution, changes in land uses, expansion of the cultivated area, leading to impacts in biodiversity, loss of habitats, landscape change and air pollution from pre-harvest burning.

Further trade liberalisation, both under the EU CAP reform on sugar and under the auspices of the Doha Round will lead to increased production in the most efficient sugar producing countries, with the largest increases expected to take place in Brazil. Indeed, it is projected that Brazilian sugar production and exports would increase by an average of 17% and 42% over the ten years following liberalisation as a result of a successful Doha Round, requiring an additional 450,000 hectares of land to be planted for sugarcane.

Moreover, the dramatic current expansion in the international bioethanol market is a factor that is also driving increased sugarcane production and bioethanol trade in Brazil. Although at present very little bioethanol enters international markets since the bulk of it is consumed domestically, trade is expected to expand dramatically, as many countries such as those in the EU and Japan, will not have the domestic capacity to supply their internal demand. At present Brazil is seen as the only reliable source to meet international demand.

This document analyses what have been, what are and what are likely to be the priority needs in terms of capacity building in trade and environment in the sugar and bioethanol sector in Brazil and whether existing or past programmes in trade and environment have met past and present needs or will be able to meet future needs. In order to achieve this the document is organised as follows. After this brief introduction, Chapter 2 characterises the sugar and bioethanol industry in Brazil, its production and trade patterns and future prospects. Chapter 3 identifies the key environmental issues associated with the sugar and bioethanol industry in Brazil and how these might be affected by further export-led expansion. Chapter 4 identifies and describes the most important capacity building programmes in the field of trade and environment in the sugar/bioethanol sector. Chapter 5 analyses and assesses those programmes in terms of their capacity to meet the environmental needs of the sector and identifies key lessons learned and future needs. Chapter 6 concludes.

The methodology consisted of a desk-research study complemented by interviews with key stakeholders from the sugar/bioethanol sector in Brazil.

2. THE SUGAR AND BIOETHANOL SECTOR IN BRAZIL

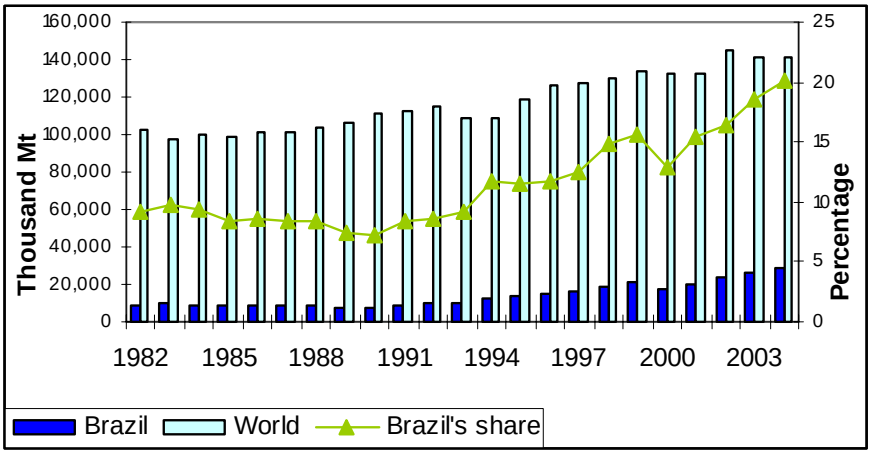
2.1. Characterization of the Sugar and Bioethanol Sector

Brazil is the largest sugar producing and exporting country. Sugarcane production in Brazil has expanded by more than 120% since 1982, reaching its peak in 2004 with 411 billion Mt. In 2003, Brazil produced 26.4 billion Mt and exported 13.3 billion Mt of sugar, corresponding to 19% and 32% of global sugar production and exports, respectively. Brazil is the main global exporter of bioethanol and the second largest producer after the US, supplying about 35% of world bioethanol production in 2005.

Brazil produces sugar and bioethanol from sugarcane. Sugarcane occupies 2.4% of cultivatable land in Brazil, amounting to nearly 5.6 million hectares.[1] Brazil's sugar exports made up 10% of total agricultural exports and nearly 3% of total Brazilian exports in 2003.[2] By producing sugar and bioethanol, Brazil saves around US$ 4.2 billion per year in foreign currency, US$ 2 billion of which come from sugar exports and US$ 2.2 billion from not importing the oil equivalent to the gasoline production.[3] The production of both sugar and bioethanol gives Brazilian industry flexibility in responding to the changing profitability of sugar and bioethanol production. In most cases, sugar and ethanol are produced in the same mills.[4] Almost 45% of Brazil's sugarcane is ground for sugar and 55% is used for bioethanol production.

In terms of employment, Brazil 's sugar and bioethanol agribusiness creates around 1 million direct jobs and shelters 60,000 growers who supply sugar cane. This activity has a strong presence in the economies of over 960 municipalities (around 17% of municipalities in the country) in a permanent, decentralized job creation and income generation process. [5]

Figure 1: Brazil's Sugar Production & Global Share



Source: Dufey et al 2005

Expansion in the sugar sector lies not only in an increase in cultivated land area – which increased from 2.6 million ha in the early 1980s to 5.6 million ha in 2003 - but also improved productivity, which rose from 57,000 kg/ha to 74,000 kg/ha over the

[1] UNICA (2004) *Brazil's Sugar and Ethanol - Energy and Environment Commodities*, União da Agroindústria Canavieira de São Paulo, available at: http://www.unica.com.br/i_pages/palestras.asp
[2] Estimated from FAOSTAT and Ministerio do Desenvolvimento, Industria e Comercio Exterior
[3] UNICA 2004
[4] Bolling C. and Suarez N. (2001) *The Brazilian sugar industry: recent developments*, in Sugar and Sweetener Situation & Outlook /SSS-232/September
[5] UNICA 2004

same period.[6] Sugarcane productivity has risen steadily at a 2.3% growth rate between 1975 and 2004, with yields now over 80 tons/hectare.[7]

The PROALCOOL - the powerful bioethanol intervention programme implemented in 1975 - has been another key factor behind the development of the sugar sector in Brazil. The PROALCOOL, introduced in 1975, regulated sugar and bioethanol production and exports basically by implementing a production quota and fixed purchasing price for bioethanol. In addition, it created huge domestic demand for its sugar market.[8] Box 1 provides details on the PROALCOOL programme.

Box 1: the PROALCOOL Programme

The PROALCOOL programme was launched by Brazil in 1975 and it still remains the world's largest commercial application of biomass for energy production and use. It involved co-operation between the government, farmers, alcohol producers and car manufacturers.

Prompted by the increase in oil prices, Brazil began to produce bioethanol from sugarcane in the 1970s. Production increased from 0.6 billion litres in 1975 to a peak of 13.7 billion litres in 1997. The task for the programme's first five years was to replace gasoline with 20 to 25 per cent blends of bioethanol. After the second oil crisis (1978-79), steps were taken to use hydrated "neat" bioethanol (96 per cent bioethanol and 4 per cent water). The investment required was funded through government soft loans. Tax reductions were also offered for bioethanol use. By December 1984, 17 per cent of Brazil's car fleet was using neat alcohol and this figure grew to more than 25 per cent by the late 1980s. A fall in oil prices and subsidy elimination led to market liberalisation in 1991. Supply shortages raised concerns about future availability and the share of neat bioethanol cars fell from almost 100 per cent of new cars sales in 1988 to less than 1 per cent by the mid-1990s.

In 2002 the Government began to revive the PROALCOOL Programme. This included a tax reduction on bioethanol powered car manufacturers and subsidies for purchasers of new bioethanol cars. Credits for the sugar industry were also introduced to cover storage costs to ensure future supply. At the heart of the programme is the ten-year deal with Germany. Germany is purchasing carbon credits as part of its Kyoto Protocol commitments and, in turn, helps Brazil subsidise taxi drivers and car hire companies by 1,000 *reais* per vehicle on the first 100,000 vehicles sold.

Sufficient and secure bioethanol supplies are key factors for the successful revival of the PROALCOOL programme and to rebuild consumer confidence in bioethanol-powered cars. To this end the Government developed and funded a programme to build up bioethanol stocks, paying for this by selling bioethanol during drawdown periods. About 500 million *reais* have been allocated to this programme since 2001. In addition, the Government asked the industry to produce an additional 1.5 billion litres in 2003/04 to maintain the maximum alcohol price at 60 per cent of the gasoline price.

Brazil is also strengthening its market through exports. As the world's largest and most efficient bioethanol producer, it is already supplying bioethanol to several countries and is negotiating with several others interested in buying bioethanol.

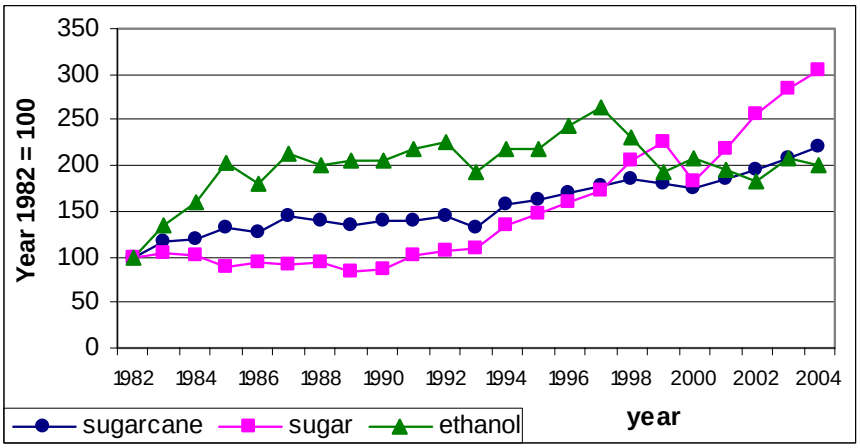
Source: Dufey, 2006

As seen in Figure 2, after years of relatively poor growth during the 1980s, sugar production has soared since the nineties, expanding by over 200% since 1982 and reaching a total of 28.4 billion Mt in 2004. Bioethanol production, on the other hand, showed a positive trend during the 1980s and mid-1990s and then started to decline,

[6] FAOSTAT statistics
[7] Martines-Filhi J. Burnquist H. and Vian C '*Bioenergy and the Rise of Sugarcane-based Ethanol in Brazil'*, Choices 2nd quarter 2006 –21(2)
[8] See section 8.1.4 for details on the Ethanol Programme

expanding by 80% overall between 1982 and 2002. The decrease of the late 1990s is mainly due to liberalisation of the bioethanol sector. As guaranteed prices and direct subsidies were phased out in the late 1990s, there was a significant shift from bioethanol to sugar production and exports. However, over the last five years or so bioethanol production has started to recover., due to both renewed domestic demand following the introduction of flex cars in Brazil and an expanding external biofuels market. In consequence, bioethanol production in Brazil reached 8.9 billion Mt in 2004.[9] The industry currently crushes 310 million Mt tons of sugarcane, from which 20 million Mt of sugar and 12.5 billion liters of alcohol are produced.[10]

Figure 2: Brazil's Production of Sugarcane, Sugar and Bioethanol



Source: Dufey et al, 2005

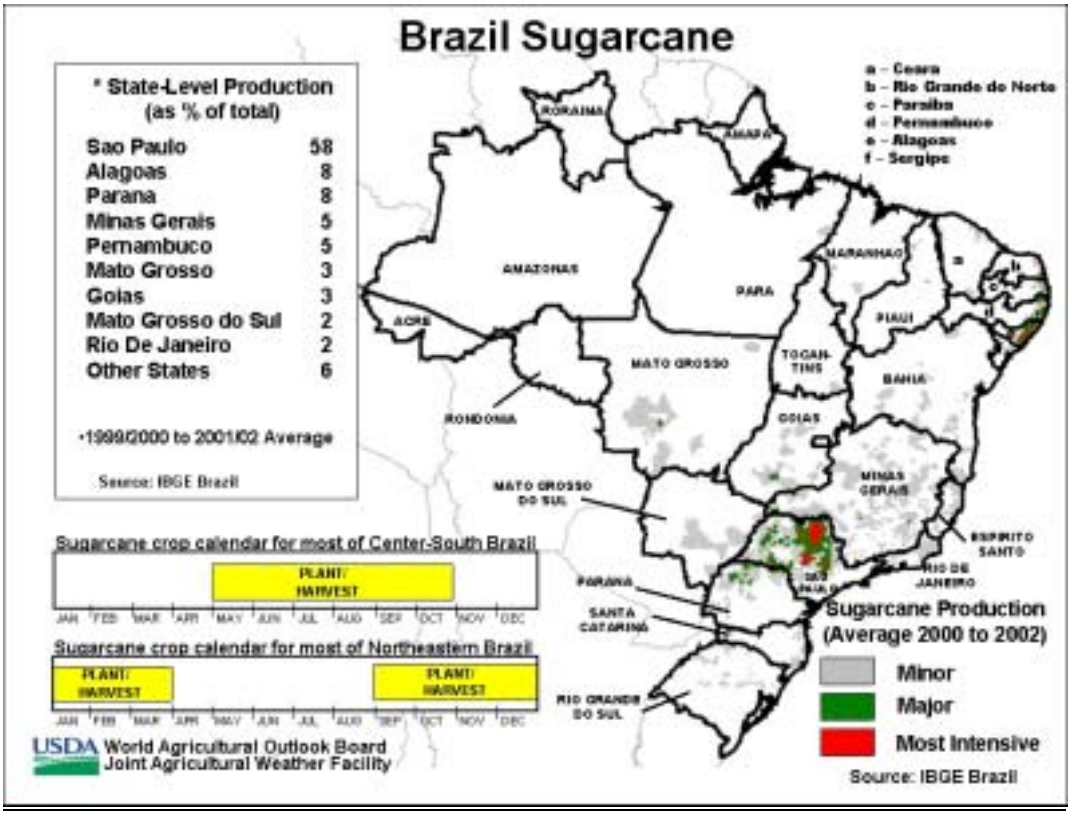
Brazil has two distinct sugar-producing regions: the northeastern region, the traditional sugar producer, and the central southern region, which has been gaining a prominent position since the launch of the PROALCOOL Programme in 1975 (see Figure 3). Indeed, the central southern region is dominated by the State of São Paulo, which now accounts for 60% of Brazil's sugarcane production. In 2005 the central southern region as a whole supplied 85% of the country's sugarcane, 83% of its sugar output, and 88% of its bioethanol.[11]

During 2005, the northeastern region accounted for about 15% of sugarcane production, about 17% of sugar output, and about 12% of bioethanol output.[12] The states of Pernambuco and Alagoas dominate production, accounting for 80% of regional sugar and bioethanol production. Soil shows lower quality, topography is less apt and production is less mechanised than in the central southern region. All this means that the yields and costs are higher than in the central southern region, and the region is suffering a sustained reduction in its participation in the country's sugarcane production (it accounted for 23% of the country's sugarcane production in 1990).[13]

[9] Dufey et al 2005
[10] Pereira de Carvalho E. 2007 *'Homework'* , UNICA Article available at UNICA webpage: http://www.unica.com.br/i_pages/artigos_palavra.asp
[11] Data from UNICA, 2006-12-01
[12] Dufey at al, 2005.
[13] although the cost differential between both regions has been narrowing considerably

Production costs in the central southern region are also low in comparison to other countries, reflecting efforts to improve efficiency in all phases of the production process.[14]

Figure 3: Location of Sugarcane Production in Brazil



http://www.usda.gov/oce/waob/jawf/profiles/graphs/Brazil/BrazilSugarcane.gif

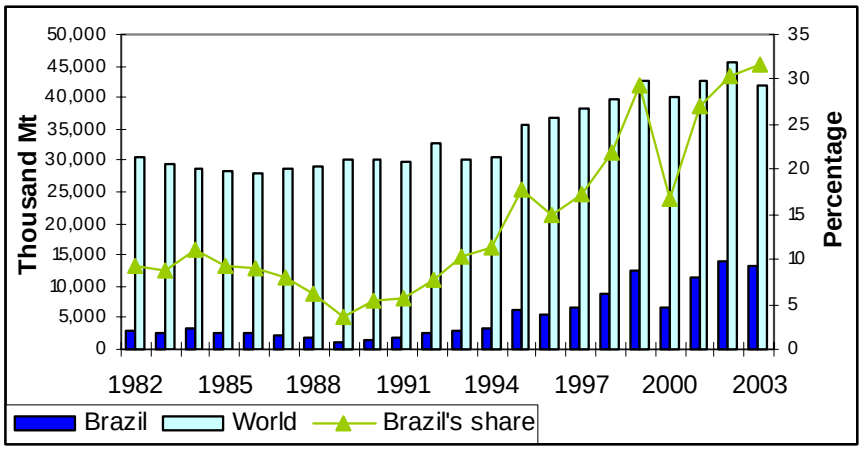
2.2. Sugar and Bioethanol Trade

Brazil has traditionally been a significant sugar exporter, accounting for 32% of global exports in 2003. As shown in Figure 4, sugar exports in Brazil have soared, particularly during the nineties, in line with production increases. Sugar exports have presented an almost four-fold increase over the last twenty years (375% between 1982 and 2003) reaching unprecedented levels in 2003 (13 billion Mt). This export increase can basically be explained by the liberalisation of the bioethanol sector, which encouraged a shift from bioethanol to sugar production and exports.

Brazilian sugar exports are well diversified. In 2002 they were sent to almost 100 different countries. Figure 5 shows Russia to be the main market for Brazilian sugar exports (17.7% of total sugar exports in 2002), followed by Egypt (7.7%), Romania (6.7%), the United Arab Emirates (6.1%), Iran (4.5%), Canada (4.5%) and Nigeria (4.3%). The EU25 receives less than 3% of Brazil's sugar exports.

[14] Bolling C. and Suarez N. (2001

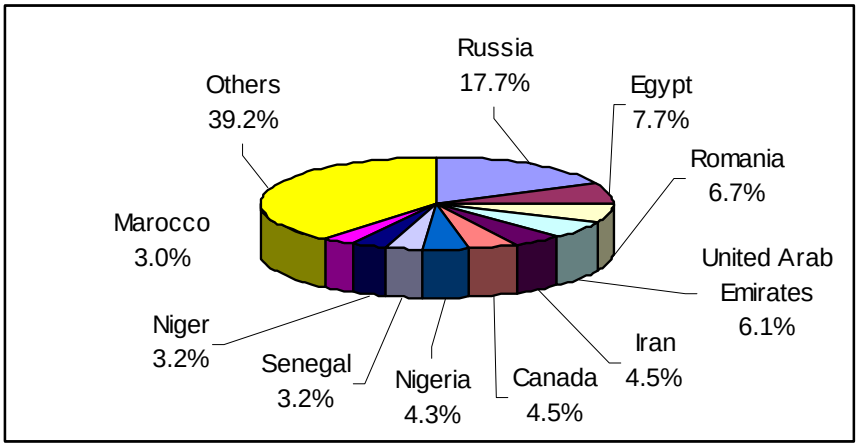
Figure 4: Brazil's Sugar Exports & Share of Global Exports



Source: Dufey at al 2005

The increase in production in the sugar industry over the last few decades has been mainly export-led. While about 15-20% of the overall sugar production was exported in the late 1980s, this figure has risen to about 55% in recent years.

Figure 5: Top 10 Destinations of Brazilian Sugar Exports, 2002

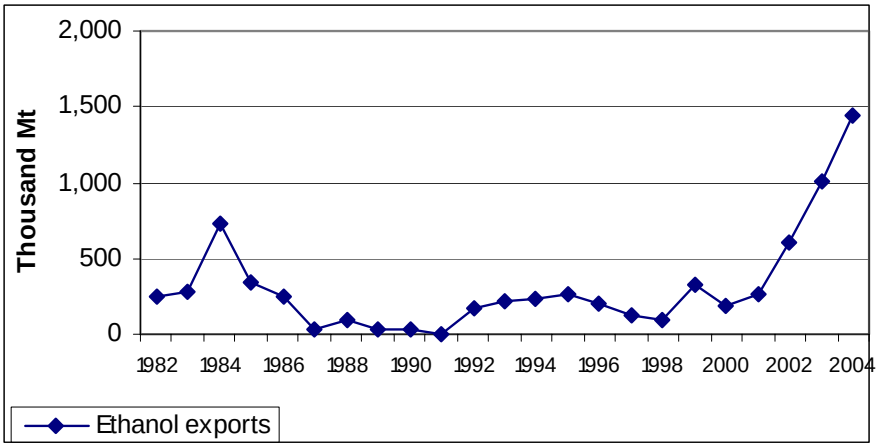


Source: Dufey at al 2005

With regard to bioethanol production, Brazil produced 14.5 billion litres in 2005, of which more than 2 billion litres were exported[15]. This makes Brazil the leading bioethanol exporter. Figure 6 shows the evolution of Brazil's bioethanol exports since 1990. Although bioethanol exports were insignificant until the second half of the nineties, they have soared over the last five years or so, supplying at present about 50 per cent of international bioethanol demand. The high oil prices, the ratification of the Kyoto Protocol and the increasing number of countries introducing biofuels into the blend of transportation fuels are among the main reasons for higher international demand.[16]

[15] Rodrigues D and Ortiz L 2006. 'Sustainability of ethanol from Brazil in the context of demanded biofuels imports by the Netherlands' available at:
[16] Dufey 2006

Figure 6: Brazil's Exports of Bioethanol



Source: Dufey et al, 2005

2.3. Future prospects for sugar and bioethanol production and trade in Brazil

Sugar and bioethanol production and exports in Brazil will continue expanding in coming years. Key issues driving future Brazilian exports of sugar and bioethanol include:

- *Multilateral Liberalisation of the Sugar Sector*

Sugar is one of the most distorted markets globally. About 80% of world production and 60% of world trade of sugar is at subsidised or protected prices.[17] Although both industrialised and developing countries protect their sugar industries, OECD countries such as the EU, Japan and the US have the most distorting policies to insulate their domestic producers from foreign competition. Only three major producers — Australia, Brazil, and Cuba — now operate at world market prices. [18]

Commitments achieved under the Uruguay Round of the World Trade Organization (WTO) and other trade agreements are forcing many countries to reform their sugar programmes. Additional pressure to liberalize this market comes from the 2005 WTO ruling that declared that the EU has been illegally exporting too much subsidised sugar. The ruling came after a complaint to the WTO in September 2002 by Brazil, Australia and Thailand and supported by twenty other countries, regarding the EU's sugar export subsidies.[19]

Several studies have attempted to quantify the impacts of liberalisation in the sugar sector. One of the most recent studies comes from Iowa State University.[20] The study predicts that the removal of trade distortions and domestic policies affecting production will induce a 3% average decrease in global sugar production by 2011-2012. While the most protected countries would experience import expansion or

[17] Source: Dufey et al, 2005
[18] WWF, 2004 , *WWF's position on reform of the EU sugar regime*, available at http://www.panda.org/about_wwf/what_we_do/freshwater/publications/index.cfm
[19] Early J and Early T 2006 '*Specific Environmental Effects of Trade Liberalisation: Sugar'* International Policy Council (IPC) Issue Brief 20, October
[20] Elobeid A. and Beghin J. 2005 '*Multilateral Trade and Agricultural Policy Reforms in Sugar Markets'* Working Paper 04-WP 356 September 2005 (Revised), Center for Agricultural and Rural Development, IOWA State University

export reduction, the most competitive producers such as Brazil, Australia and Cuba would see an increase in their export level and global export participation. For Brazil, production and exports would increase by an average of between 17% and 42% by 2011/12. Assuming that about 2.8 million hectares are now being harvested for sugar in Brazil (50% of sugarcane hectares), a 17% increase in production for sugar would require about 475,000 additional hectares.[21]

- *EU Sugar CAP Reform*

Linked to the above point, but of particular interest due to its impacts on the global sugar market, is the EU CAP reform. Indeed, the commitments achieved during the Uruguay Round, the 2005 WTO ruling against the EU sugar regime and the Everything But Arms (EBA) agreement, among other factors, have been putting strong pressure on the EU to reform its sugar regime. Indeed, since its implementation in 1968, the Sugar Common Market Organization (CMO) has allowed the EU to become the second largest producer and exporter of sugar.

In late 2005 the EU announced a final reform to the sugar regime that will take effect with the 2006-2007 crop season. As a consequence of the restructuring, the EU sugar output is expected to decline from 19 million tons in 2005 to 13 million tons in 2010.[22] As noted earlier, the most efficient sugar producing countries - notably Brazil and Australia - are expected to benefit the most from the reform.

- *Emergence of Global Biofuel markets*

The renewed global interest in biofuels has translated into an extremely rapid expansion of biofuel markets. Indeed, an increasing number of industrialised and developing countries are introducing policies to increase the proportion of biofuels within their energy portfolio. With the Kyoto Protocol's recent entry into force and the implementation of ambitious national targets for biofuels in many different countries, global biofuel production is expected to quadruple in the next 20 years, accounting for about 10 percent of world motor fuel.[23]

International trade in bioethanol is still small (less than 10% of global production), and Brazil supplies about 50% of the international demand. The strategic nature of the product and the existence of different policy goals associated with it imply that some degree of protectionism will prevail. However, trade is expected to increase dramatically[24] as several countries will not have the domestic capacity to supply their internal demand. Brazil is seen as one of the only suppliers capable of meeting the huge rise in import demand for bioethanol in the near future.[25]

Different studies predict increases in sugar and bioethanol production and trade in Brazil. The most relevant studies include:

- The Sao Paulo Cane Industry Union forecasts that bioethanol production in Brazil will increase by 8 -10 billion litres by 2012 to keep pace with domestic and international demand.[26] About US$ 100 billion are expected to be

[21] Early and Early 2006
[22] Early and Early 2006
[23] IEA, 2004.
[24] According to Ferreira Lenilson 2006, local analysts estimate global bioethanol trade will expand 600 percent by 2015
[25] Early and Early 2006
[26] Sao Paulo Cane Industry Union cited in Reuters 2005 ' Brazil Races to Keep Ahead of World Ethanol Demand' 16 of June; Neuhaus E., FBOMS – Brazilian Network of NGOs and Social Movements for the Environment and the Development. www.fboms.org.br – May 2006;

invested in about 100 new mills by 2012.[27] At that point total sugarcane milled would exceed 600 million tons (17 billion litres of bioethanol[28]), which means a 40% - 50% increase in the area planted or, alternatively, 2.5 – 3.0 million hectares. The effects of trade liberalisation should be encompassed in that estimate. This is about 5 - 6 times the additional 475,000 hectares needed to accommodate the increased production driven by trade liberalisation in the sector. [29]

- Smeets et al (2006) indicate the required land expansion for bioethanol production to be in the order of 3.5 – 4.0 million hectares by 2015, or 35 million litres of bioethanol.[30]
- Carvalho (2005) [31] forecasts that by 2010 - 2011, the demand for the sugar/bioethanol industry will require 560 million tons of sugarcane. This will be used as follows:
    - Total bioethanol demand will equate 27.6 million litres where 80% (22.1 million litres) will go to the domestic market and 20% (5.2 million litres) to exports.
    - Total demand for sugar will equate 35 million tons, where 31% (11 million tons) will be destined to the domestic market and 69% (24 million tons) to the export market.
- According to the 'Brazilian Agroenergy Plan 2006-2011'[32] released by the Government of Brazil, over the next eight years the additional demand for Brazilian sugar and bioethanol will total almost 200 million tons of sugarcane, or more than 50% of the current annual production. About 100 million tones (45%) would be for domestic demand and 120 million tones (55%) for the international market. The additional demand could be met by enlarging some units and setting up at least 60 new medium-size plants.

All the estimates agree that the bulk of the expansion is expected to take place in the central southern region of Brazil. The increased production would require taking land away from other crops as well as bringing new land into cultivation.[33]

All in all an important domestic and export-led expansion in the Brazilian sugar industry is expected to take place over coming years. Both international and national demand for bioethanol together with better market conditions for sugar trade are likely to be the main drivers of expansion, . The growth in trade is likely to significantly increase environmental pressure on the ecosystem.

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[27] Ferreira Lenilson 2006 'Brazil raising cane big time as ethanol gets Japan's attention' in Japan Times Wednesday December 6th

[28] Ferreira Lenilson 2006 'Brazil raising cane big time as ethanol gets Japan's attention' in Japan Times Wednesday December 6th

[29] Early and Early 2006

[30] Smeets E., Junginger M., Faaij A., Walter A. and Dolzan P. 2006 'Sustainability of Brazilian bio-ethanol' , Utrecht University and State University of Campinas, August

[31] Eduardo Pereira de Carvalho 2005 *'Industrial perspective on expansion of ethanol production capacity for export in Brazil'* UNICA– Power point Presentation at the Workshop & Business Forum on Sustainable biomass production for the world market, Campinas, Brazil, December 1, available at: http://www.bioenergytrade.org/downloads/carvalhonovdec05.pdf

[32] EMBRAPA 2006 'Brazilian Agroenergy Plan 2006-2011' Ministry of Agriculture, Livestock and Food Supply, Secretariat for Production and Agroenergy, Brasilia, DF: Embrapa Publishing House, 108pp

[33] Early and Early 2006

3. ENVIRONMENTAL PRIORITIES IN THE SUGAR AND BIOETHANOL SECTOR IN BRAZIL

3.1. Environmental impacts associated with Sugar / Bioethanol in Brazil

Brazil is an important user and exporter of sugar and bioethanol. A marked expansion in the production and export for both, but especially pronounced for bioethanol is expected to take place in coming years. The resulting increase in sugarcane monoculture and sugar and bioethanol production will therefore have numerous effects on the environment. The main environmental issues of concern include: agriculture frontier expansion and impacts on biodiversity due to changes in land use; impacts on air quality; impacts on global climate; impacts on water, soil quality and use of agrochemicals and a rise in the use of GMOs. Each of these issues is outlined below.[34]

- *Changes in land use: cultivated area expansion and impacts on biodiversity*

There are different views on the impacts on the expansion in the cultivated area and on biodiversity related to the new expansion phase in the sugarcane sector. Differences persist not only among the Brazilian government/industry and the environmental community, but also within different ministries of the Brazilian government.

According to Macedo (2005), the area currently occupied by sugarcane crops represents about 0.6% of the national territory and 2.4%[35] of the total cultivatable land. At least a further 12% of national territory is currently considered apt and available to support projected sugarcane expansion. The bulk of the expansion in sugarcane crops in the last thirty years has been concentrated in the central southern region of the country. Between 1992 and 2003, 94% of the sugarcane expansion in this region occurred in existing areas of agriculture or pastureland so only a small proportion of new agricultural borders were involved.[36] In the Sao Paulo region, which accounts for 60% of sugarcane production, the sugarcane crop has replaced cattle grazing and other agricultural activities (e.g. citrus crops). As a consequence, cattle production is moving to the central region of Brazil where the land is cheaper.[37] Land converted to agriculture in the sensitive area of the *Cerrado* savanna (which accounts for 25% of the national territory) has been used for cattle grazing and/or planted to soya, with only a small proportion for sugarcane.

According to Section 2.3, by 2013-2015 Brazil will need to increase sugarcane cultivation by something between 2.0 and 4.0 million hectares (from the 5.6 million hectares currently under cultivation) in order to meet the dramatic increase in domestic and foreign demand for bioethanol and sugar. The Brazilian Government (Ministry of Agriculture) and the sugarcane industry hold the view that there is sufficient unused agricultural land for the proposed increase in production (up to 90 million hectares of unused agricultural land in the *Cerrados*).[38] This means the expanded production would require something between 3% and 4% of this available agricultural land. The bulk of the growth in sugarcane in the next years is expected to

[34] Unless otherwise specified, this section draws from Macedo et al 2005 and xxx.
[35] UNICA 2004
[36] Macedo 2005
[37] Faiij 2006
[38] Costa I 2006 'Bioenergy – The Brazilian Success Experience' Power point presentation, Bioenergy World Forum, Verona 9 – 12 February 2006, available at: www.bioenergyworld.com/europe/2006/IMG/pdf/Thursday/Biodiesel_rogramme_for_Bahia_CEBI_ABEAMA.pdf

be concentrated in the western Sao Paulo region, the borders with Mato Grosso and in some areas within the state of Goias. [39]

However, others hold a different view. Pereira (2006)[40] shows that the accelerated expansion of the sector lit a warning signal in government environmental departments who now demand serious environmental impact studies and take more than two years to grant environmental licenses to new distilleries. The main concern of environmental departments is the creation of plantations, principally in the state of São Paulo where 40 new license requests were registered by August 2006. Moreover, the integrated use of spatial data and information (geo-referenced data) to show sugarcane growing expansion areas by the institutions/researchers associated with the sugarcane sector does not take into account the same concepts used in the maps of "ecological and economic zones" developed by the Ministry of Environment in a joint project with IBGE. Thus, the claim that the expansion of sugarcane monoculture has taken place mostly in degraded pasture areas and "*campos sujos*" is disputed. [41]

The Ministry of Environment has detected conflicts between areas apt for sugarcane crops (as defined by the Ministry of Agriculture) and areas and biomes that should be protected according to the Ministry of Environment. The expansion in the *Cerrados* and the lands closer to the *Pantanal* (highly suited to sugarcane plantations) are the main conflicting issues. Because it is a grass, sugarcane can also be grown in more fragile or marginal areas where other conventional crops are likely to fail or are too difficult to farm – such as steep slopes or in riparian areas or wetlands. These areas often possess a higher concentration of biodiversity.[42]

From the point of view of the Ministry of Environment, the sugarcane sector already has a historical debt to pay concerning environmental preservation and the sector's current activities in legally-protected areas show no substantial concern for protecting the other biomes or restoring the Atlantic Forest.[43] The *Cerrados* is a very sensitive area whose biome is highly threatened and could extend to the borders of the Amazon rainforest. Bioethanol production in Maranhão is also worrying because part of the territory of this state is Amazon rainforest.[44]

Overall, given the new phase of expansion that the sector is currently experiencing, new areas are expected to be turned over to sugarcane, including the *Cerrado* of Mato Grosso do Sul, Goiás and Minas Gerais. This could further increase the pressure on the already affected biodiversity.

Moreover, the substitution effect (sugarcane taking over existing pastureland or other crops) pushes the agricultural frontier to the northern lands and the shift of agricultural land into energy production and bio-based products has consequences on the other crops and the livestock industry (the food security issue) which are not well-studied. Thus, biodiversity impacts may come indirectly through the displacement of other crops that become less profitable so these may in turn advance into protected areas. The representatives of the sugarcane sector do not

[39] Macedo 2005
[40] Quoted by Rodrigues and Ortiz 2006
[41] Personal interview with the 'Working Group on Energy and Climate Change of the Secretaria de Qualidade Ambiental (SQA) of the Brazilian Ministry of Environment' January 2007
[42] Early et al 2006
[43] Personal interview with the 'Working Group on Energy and Climate Change of the Secretaria de Qualidade Ambiental (SQA) of the Brazilian Ministry of Environment' January 2007
[44] Rodrigues and Ortiz 2006

address these issues.[45] The substitution effect- related impacts are considered more significant than the direct effects of sugarcane expansion.

The related impacts of the required infrastructure also need to be taken into account. Petrobrás, for instance, has an ambitious infrastructure expansion plan to support increased bioethanol production in the states of São Paulo, Goiás and Mato Grosso do Sul for exportation. The project infrastructure basically comprises bioethanol pipes, whose construction impact is generally localized, but the implementation of this logistic matrix tends to accelerate the pressure to occupy lands located in natural habitats in the *Cerrado*.[46]

Although Brazilian environmental legislation is well advanced in terms of protection of sensitive areas (e.g. the Brazilian Forest Code includes effective legal reserve requirements for rural properties in 80% in the Amazon region, 35% in the savannas of the Amazonian *Cerrado* and 20% in all other regions), the lack of enforcement is a widespread problem. Enforcement of the national environmental legislation is a task that falls upon the individual states, where the regional governments are under pressure from powerful agribusiness lobbies not to implement legislation fully. Corruption is also an issue in some states. In practice, there is a permanent danger of a "race to the bottom" among producer regions. [47]

- *Impacts on local air quality*

The relationship between sector expansion and air quality is twofold. On the one hand, cane-burning and processing activity is likely to have a negative impact. The burning of sugarcane leaves and stalks is widely used to make harvesting easier, thus reducing the costs of manual harvesting and transportation. In Sao Paulo State, legislation has been passed to gradually prohibit cane-burning, with a schedule that takes both the technologies available and the expected unemployment into account, including immediate prohibition in risk areas. As a result, burning has gradually been reduced in Sao Paulo but the activity is still significant. It fell from being practised in 82% of the harvested area in 1997 to 63% in 2004. Sugarcane burning is projected to be completely phased out by 2031.

Sugarcane burning emits several gases including CO, CH_4, ozone, non-methane organic compounds and particle matter that are potentially damaging for human health. Several studies were conducted in Brazil during the 1980s and 1990s to identify the impacts of sugarcane burning on human health. While the study conducted by Macedo (2005) argue there is no direct link, several other studies found significant links with human health problems.[48] The latter has also been confirmed by practically all the stakeholders interviewed in the context of this research.

Legislation is implemented in São Paulo in which a sugarcane burning phasing out schedule is included, including detailed prescriptions how, where and when cane burning is allowed. Also a reporting requirement for cane produces is included in which cane producers are required to specify a sugarcane burning reduction schedule. Sugarcane burning is projected to be completely phased out in 2031.[49] Challenges towards effective implementation of the legislation include the trade-offs

[45] Personal interview with the 'Working Group on Energy and Climate Change of the Secretaria de Qualidade Ambiental (SQA) of the Brazilian Ministry of Environment' January 2007
[46] Rodrigues and Ortiz 2006
[47] Personal interview with the 'Working Group on Energy and Climate Change of the Secretaria de Qualidade Ambiental (SQA) of the Brazilian Ministry of Environment' January 2007
[48] See for example, Smeets et al, 2006
[49] Smeets et al 2006

in terms of rural employment. Elimination of sugarcane burning involves mechanization with the associated reduction in the sector's employment – notably employment of those lower-skilled workers. In addition, there is the urgent need to expand the coverage of the legislation to include other geographical areas, as at present, it incentivises companies to relocate in those States in which cane burning is still allowed.

On the other hand, a positive impact on air quality can be expected from domestic use of bioethanol since bioethanol replaces fuels that contribute more to air quality degradation and carbon emissions.

Overall, the impacts of increased sugarcane plantation on air quality would depend on what proportion of harvesting uses burning. Although a gradual decrease in the practice is expected over coming years (up until complete phase out by 2031), it will still have a significant impact, at least in the short term.[50]

- *Impacts on global climate*

At a global level, one of the main drivers behind the development of the bioethanol market that attracts international trade is its potential to reduce emissions of GHG gases compared to fossil fuels.

The link between sugar/bioethanol production and trade and GHG emissions is twofold: there are those GHG emissions linked to sugar-bioethanol production/trade and those linked to changes in land use.

The use of sugarcane bioethanol, associated with the bagasse, has become the first experience to bring positive results on a large scale.[51] Compared to both fossil fuels and other commercially available biofuels, sugarcane-based bioethanol produced in Brazil has the greatest GHG balance. IEA 2004 estimates that GHG emissions from sugarcane-based bioethanol in Brazil are 92% per cent lower than standard fuel, while wheat-based bioethanol points to reductions ranging from 19% to 47% and reductions from sugar beet-based bioethanol vary between 35% and 53%. Moreover, not only does the bagasse supply energy (thermal and electrical) for bioethanol production, it is also used in sugar production (replacing the fossil fuel that would be used in alternative production from sugar beets, or starch) and other industrial sectors (such as orange processing).[52] In 2003, Brazil avoided 5.7 million tonnes CO_2 equivalent due to the use of bagasse in sugar production.[53]

New developments in the sector such as the commercial application of lignocelulosic technology that will allow the use of bagasse for bioethanol production and the increased generation of electricity from bagasse will improve their GHG balance.

An analysis of the expected situation concerning emissions by 2010 provided by Macedo 2004 points out that the emissions avoided by the use of bioethanol would amount to 46.7 Mt CO_2 equivalent. Therefore, the additional decrease in emissions thanks to bioethanol use would amount to19.2 Mt CO_2 equivalent at 12.6 kg CO_2 eq./ ton of sugarcane. As a net result, the emissions avoided by the substitution of bioethanol for gasoline, and of surplus bagasse for fuel oil, minus the foregoing values amount to 2.6 tons CO_2 eq./m^3 of anhydrous bioethanol and 1.7 tons CO_2 eq./m^3 of hydrous bioethanol, for the mean values. For the mills featured in the

[50] Smeets et al 2006
[51] Macedo 2005
[52] Macedo 2005
[53] Macedo 2005

analysis, considering: increased mechanical harvesting of sugarcane (increasing the consumption of fossil fuels) and reduced sugarcane burning (reducing some methane and nitrous oxide emissions), with equivalents between bioethanol and gasoline changed for the various applications to include new compositions with the use of flex-fuel engines; and a production by 2010 of 34 million tons of sugar, 17.3 million m^3 of bioethanol, 535 Mt of sugar cane / crop.[54]

On the other hand, the GHG impacts from the change in land use induced by increased sugarcane plantations could also be significant and therefore requires further attention. Indeed, the evaluation of the emission of GHG from Brazil for the 1990-1994 period indicates change in the use of land and forests as the factor accounting for most emissions (75%), followed by energy (23%).[55] Indeed, the conversion of land from pastures to crops leads to a significant loss of soil organic carbon (SOC).. The implication of this is that if the additional land-use for sugarcane production leads (directly or indirectly) to conversion of pastures, the GHG emissions may be severe and could have a major impact on the overall GHG balance.[56]

Moreover, the burning of sugarcane to facilitate harvesting also contributes directly to GHG emissions. This practice, as noted in the point above, is expected to be substantially reduced in the future.

- *Impacts on water use*

Brazil has one of the highest levels of water availability in the world (14% of the surface waters and the equivalent of annual flow in underground aquifers) and the use of crop irrigation is very small (3.3 million hectares versus 227 million hectares in the world). Although sugarcane crops are mainly rain fed, the use of supplementary irrigation is increasing.[57] Efficient methods (subsurface dripping and other) are being evaluated.

The processing of sugarcane and particularly the conversion of sugarcane to bioethanol also utilise water. The levels of water extraction and release by industry have substantially decreased over the last decade, dropping from $5m^3$/ton of sugarcane collected in 1990 and 1997 to $1.83m^3$/ton in 2004 (sampling in Sao Paulo).[58] The level of water reuse is high and can be notably improved by optimising both the reuse and use of wastewater in ferti-irrigation. The fall in water use in recent years is due to both technical improvements and the implementation of legislation on water use.

The Ministry of the Environment acknowledges that a lot of progress has been made concerning water consumption and reuse by the sugarcane industry but points out that this is not general practice even in the São Paulo State. The ministry supports a "right price" for water to encourage resource conservation and more rational and cautious water use, especially regarding the issue of release to water bodies. The ministry highlights that other states are well behind São Paulo practices. There is particular concern shared among many local analysts about preserving the Guarani Aquifer whose recharge is located in the north of the State of São Paulo.[59]

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[54] Macedo, I.C. 2004:' "*Estimativa da redução adicional de emissões de gases de efeito estufa (GEE) com o aumento da produção de cana e derivados no Brasil; 2010*", Internal report, UNICA, São Paulo
[55] Macedo 2005.
[56] Smeets et al 2006
[57] Smeets et al 2006
[58] Macedo 2005
[59] Personal interview with the 'Working Group on Energy and Climate Change of the Secretaria de Qualidade Ambiental (SQA) of the Brazilian Ministry of Environment' January 2007

- *Impacts on water quality*

With regard to effluents, water pollution in the central southern region of Brazil is significant, especially where different water polluting sectors are present.[60] In the case of sugarcane, the two most significant types of pollutants are organic pollutants from bioethanol production and agrochemicals from sugarcane production. In the cycle of bioethanol industrial production, beginning with the cane itself, the principal effluent liquids that may sometimes be launched into water bodies are:[61]

- vinasse, a black residue of the distillation of cane syrup, fermented to extract bioethanol, which has high DBO and DQO;
- water from the cleaning of the fermentation vats, with a composition similar to vinasse but more diluted (around 20% of the consistency of vinasse);
- the water used for the cleaning of the cane before it is ground which contains high rates of sucrose, principally in the case of burn sugarcane and mineral vegetable material (adhered earth and rubble);
- water derived from barometric condensers and evaporators which contains sugars carried by tiny droplets;
- water from the removal of chemical encrustations (with soda or a solution of chloride acid) whose composition varies a lot but presents greater quantities of phosphates, silica, sulphates, carbonates and oxalates.

Of these, the most important volume to negatively affect the environment is vinasse because of its high rates of DBO and DQO and the volume produced, around 11 to 14 litres per litre of bioethanol.[62] Vinasse is hot and therefore requires cooling. In the mountainous areas of northeastern Brazil, the pumping cost and the cost of land to store vinasse were prohibitive, and it was therefore released into rivers, resulting in the pollution of rivers (and fish kills) during each harvest. Currently, vinasse is used for ferti-irrigation of cane crops, together with wastewaters (from floor washing, closed circuit purging and condensate remainders).[63] In the past, fertilization with vinasse has been associated with eutrofication problems when it runs off the fields and into the surrounding rivers.

Although the use of vinasse as fertiliser has been an important source of environmental degradation in the past (water use and pollution), legislation has recently been implemented to avoid the negative impacts of vinasse applications. However, as bioethanol production expands, the issue may require closer attention as the legislation does not require a complete nutrient balance. It is crucial to assess the environmental impacts of vinasse use and also enforcement of the legislation is rather weak. [64]

- *Impacts on soil quality*

The erosion process is the leading cause of agricultural soil degradation. Soil loss through erosion is a serious problem, depending on the kind of crop, the agricultural practices, the soil type and the rainfall pattern. Sugarcane in Brazil is recognised as having a limited impact on soil erosion compared to other crops. While the mean rate of soil loss for grains in Brazil is 24.5 ton / hectare a year, sugarcane has a rate of

[60] Faaij et al 2006
[61] CETESB 2002; PRODUÇÃO MAIS LIMPA (P+L) NO SETOR SUCROALCOOLEIRO; Câmara Ambiental do Setor Sucroalcooleiro - GT de P+L; in www.cetesb.sp.gov.br/Ambiente/camaras/texto_ca/documentos/procao_mais_limpa_sucroalcooleiro.pdf
[62] Rodrigues and Ortiz 2006
[63] Faaij et al 2006
[64] Faaij et al 2006

12.4 ton /hectare a year.[65] Moreover an assessment conducted over 11 years in the Sao Paulo region showed that sugarcane production had not significantly affected the thickness or the physicochemical composition of the soil in the area.[66]

Ferti-irrigation follows a technical standard in the São Paulo State, but this process covers just the crop areas closer to the mills (it covers around 30% of the crop area in the central southern region). The preservation and recovery of riverside woods, combined with appropriate soil preservation and handling are essential to ensuring adequate water supply. [67]

The practice of sugarcane burning contributes to soil erosion. Therefore, the introduction of mechanical harvesting helps control soil erosion. This technical improvement has enabled the harvesting to de done without burning in some areas. This technique also leaves considerable amounts of waste (organic matter) in the soil, which in turn reduces the need for soil preparation practices during the re-planting of the sugarcane sector. The use of this technique is expected to increase in the future.

- *Use of agrochemicals*

In Brazil, the level of consumption of insecticides, fungicides, acaricides and other pesticides in sugarcane crops is lower than for citrus fruits, corn, coffee and soybean crops and is also modest compared to other countries.[68] However, some concern may arise regarding their use considering the significant scale of sugarcane production, for instance, in Sao Paulo.[69] The use of mineral fertilisers is supplemented by the use of nutrient rich wastes from sugar and bioethanol production including vinasse and filter cake. Vinasse is rich in organic matter and potassium and relatively poor in nitrogen, calcium, phosphorus and magnesium. The use of vinasse as a fertiliser presents advantages and disadvantages. On the one hand, it reduces the need for mineral fertilisers, a rise in pH, an increased cation exchange capacity, increased availability of nutrients, improved soil structure, increased water retention and the development of soil micro-flora and fauna. Disadvantages include the risk of salinisation and nutrient leaching, although with no apparent negative impact on the soil or groundwater at doses lower than 300m^3/ha.[70] As noted before, the use of vinasse as fertiliser has been a significant source of environmental degradation (water use and pollution) in the past. New legislation aims to avoid the negative impacts of vinasse applications but more detailed attention is needed as the legislation does not require a complete nutrient balance which is crucial to evaluate the environmental impacts of vinasse use. Also, enforcement of the legislation is rather weak. [71]

On the other hand, sugarcane still uses more herbicides than coffee and corn, less herbicides than citrus fruits and the same amount as soyabeans. The consumption of fungicide is virtually nil, while that of insecticides is relatively low. At present it is not possible to totally eliminate herbicides especially because of the rising number of unusual pests. [72]

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[65] Donzelli J. 2005 'Soil used for sugar cane growing in Brazil; expansion trends' in Macedo, 2005
[66] Donzelli J. 2005 'Soil used for sugar cane growing in Brazil; expansion trends' in Macedo, 2005
[67] Personal interview with the 'Working Group on Energy and Climate Change of the Secretaria de Qualidade Ambiental (SQA) of the Brazilian Ministry of Environment' January 2007
[68] Macedo 2005
[69] Faiij et la, 2006
[70] Macedo 2005
[71] Faiij et la, 2006
[72] Macedo 2005

- *Use of GMOs*

Significant developments in sugarcane biotechnology have been taking place since 1997 in Brazil. Indeed, the Sugarcane Technology Center (CTC) pioneered the creation of transgenic sugarcane varieties in 1997 and has been very active in experimental planting of its findings. The government of Brazil granted a biosafety quality certificate to CTC the same year, enabling the Center to grow, in a restricted experimental area, varieties featuring resistance to herbicides, pests, diseases and flowering obtained through modern biotechnology techniques. Moreover, the CTC recently decoded the sugar DNA, which helped to select varieties that were more resistant to drought and pests and yielded more sugar content.[73] The genetic manipulation of sugarcane has guaranteed resistance to plagues with the substitution of the species adapted in cycles of 10 to 15 years and the usage of GMOs could reduce these deadlines. Stakeholders linked to the industry side argue this is the time to introduce new varieties into the market.

To date, genetic modifications have only been planted at the filed test site stage and the government has not issued any commercial authorizations. However, the sugarcane industry may soon attempt to get authorizations for commercial planting of transgenic varieties. [74]

Moreover, the biofuels market is expected to act as a key driver for GMO development. Indeed, given the need to improve both the economic efficiency and the energy efficiency of biofuels, biotechnologies are expected to play a key role in the development of the biofuel industry. Genetic improvement has been highlighted as the key to increased yields and environmental benefits of energy crops while reducing agricultural inputs. While genetic improvements of some feedstock (such as soya and corn) are more advanced, there has been less development for other energy crops such as sugarcane.

Although there is no available information on the environmental impacts of GMOs in the sugarcane industry, the experience from other sectors suggests it is a very sensitive issue. The main arguments against GM technologies relate to food safety concerns, and their impacts on biodiversity and on farmers' livelihoods. In Brazil GM-soy is already widespread in the South. In exports markets such as the EU, expansion of GMOs is heavily regulated and only 20 GM varieties - mostly corn and soya - have been approved for planting. GM crops for food and feed purposes that have been grown or imported must be labelled, but this is not the case for crops grown for energy production. [75]

4. Overall, the spread of GMOs in sugarcane may have pros and cons which require further investigation.

[73] Lunhow D. and Samor G. 'As Brazil fills up on ethanol, it weans off energy imports' The Wall Street Journal, 16 January 2006
[74] Macedo 2005
[75] Dufey 2006

4. KEY PROGRAMMES ON CAPACITY BUILDING IN TRADE AND ENVIRONMENT IN THE SUGAR AND BIOETHANOL INDUSTRY IN BRAZIL

According to the data provided by the 'WTO Trade Capacity Building Database' - Brazil received a total of US$ 7.3 million for capacity building in trade involving a total of 129 projects.[76] This makes Brazil the 10th largest recipient of capacity building support related to trade.[77] According to the same database, only seven of these projects (US$2.5 million) were classified under the 'Trade and Environment' category. However, none of these projects seems to be particularly relevant for the sugar/bioethanol sector. This suggests that third country governments and other traditional international agencies acting as funding institutions have not played any important role in the context of capacity building in trade and environment in the sugar and bioethanol sector in Brazil.

However, research conducted in the context of this document led to the identification of several programmes on capacity building in trade and environment for the Brazilian sugar and bioethanol sector. The agencies that have participated in the financing of these programmes include international organizations such as the World Bank and United Nations Development Programme (UNDP), the private sector, public sector and international NGOs.

These programmes can be grouped into: technical and financial assistance for R&D; information dissemination and awareness raising seminars; support for the development of standards and certification systems and; support for implementation and enforcement of the environmental legislation. The key programmes are described below.

4.1. World Bank Project - Alcohol and Biomass Energy Development Project

This project is the most quoted Technical Assistance project by the sugarcane producers in Brazil. The project was approved in May 1981 and closed in March 1987 and involved financing from the IBRD (International Bank for Reconstruction and Development or World Bank) for US$ 250 million. The project aimed to increase annual bioethanol production in Brazil to about 10.7 billion litres by the end of 1985, equivalent to 148,000 barrels per day of petroleum. Of this production, 9.2 billion litres would be used to replace 45% of Brazil's projected 1985 gasoline consumption, and the remainder would be used for chemical feedstock. The project consisted of three components:

- a production component comprising about 250 bioethanol units (distilleries and related agricultural facilities) expected to be approved by the Brazilian Government during 1981-83 and coming on-stream during 1983-85. These units would provide additional production capacity of about 5.6 billion litres, of which 95% was expected to be sugarcane-based and 5% cassava-based. This component would also include units to demonstrate the feasibility of new technology, such as bioethanol production from wood;
- a technology development component to support basic and applied agricultural and industrial research related to production and use of biomass energy;

[76] The 'WTO Trade Capacity Building Database' is one of the most extensive databases on trade related capacity building programmes. For more information on the database and details on Brazil's data please see http://tcbdb.wto.org/ben_country.asp?Requery=True&PageNum=1&ctry=16&maxyear=2007&sortorder=DESC&FeildName=&cat

[77] GHK 2006

- a monitoring and evaluation system to analyse the impact of the 'PROALCOOL Programme' on the agricultural, transport and industrial sectors, rural employment and the environment in order to identify any necessary corrective measures and facilitate planning.

The World Bank Archive identifies three documents that might be relevant for assessing the programme:

- *Alcohol and Biomass Energy Development Project* Dates: 1947 to 1998
- *Alcohol and Biomass Energy Development Project* Dates: 1980 to 1989
- *Brazil: Alcohol and Biomass Energy Development (Strongman) D*ates: 1980-06 to 1990-06.

Unfortunately due to the old date of the project, none of these documents were available from the World Bank. Moreover, interviews conducted with representatives from the Brazilian government and other key stakeholders show there is no readily institutional memory of the impacts of the project.

However, the increase in bioethanol yields can be linked to a long-term impact of the project. Indeed, a 1980 World Bank study on 'Alcohol Production from Biomass in the Developing Countries'[78] quotes the bioethanol yield (litres/ha) at that time in Brazil as 3,500 l/ha (p.16). Today this total is 6,800 l/ha. Increases in productivity and yields are associated with reduced pressures on the agricultural frontier.[79]

4.2. Biomass Power Generation: Sugarcane Bagasse and Trash UNDP Environmental Project BRA/96/G3180

The project objective is to investigate the possibility of promoting a significant reduction in atmospheric CO_2 accumulation by performing technical and economic analyses of the feasibility of the utilization of BIG-GT technology for power generation using bagasse and sugar cane trash as primary fuels.

The project proposal was prepared by Copersucar Technology Center (CTC) to Global Environmetnt Facility (GEF) and in July 1997 Copersucar and the United Nations Development Programme (UNDP) signed the contract that started the activities of Project BRA/96/G31 – Biomass Power Generation: Sugar Cane Bagasse and Trash. The project was approved in January 2002 and completed in June 2004. The project had an approved budget of US$ 3,750,000 from the GEF.[81]

The administrative organization of the project had UNDP as the Implementing Agency and the Ministry of Science and Technology (MCT) as the Executing Agency (representing the Brazilian Government). CTC was in charge of the project's technical coordination and execution of the vast majority of the activities and TPS Termiska Processer AB (TPS) was responsible for the gasification technology development and BIG-GT package detailing.

The '*Centro de Tecnologia Copersucar*' (CTC) is a cooperative of 36 sugar mill owners, responsible for 27% of the Brazilian sugar and bioethanol production. CTC

[78] World Bank, 1980. Alcohol production from Biomass in the Developing Countries. World Bank, 1818 H Street, Washington, U.S.A.
[79] Isaias Macedo, former Director of CTC, personal interview, December 2006
[80] For detailed information on the project see: Hassuani S., Lima Verde Leal M. and Macedo I. 2005 '*Biomass power generation Sugar cane bagasse and trash'* 1 st edition PNUD -Programa das Nações Unidas para o Desenvolvimento CTC -Centro de Tecnologia Canavieira, Piracicaba,Brazil
[81] For Project Documents see the original Project in:
http://www.pnud.org.br/projetos/meio_ambiente/visualiza.php?id07=97

is the largest R&D organization for sugarcane production and processing in the world; one of its strong characteristics is the agro-industrial integration under the same management. CTC prepared the proposal for GEF-UNDP, and has been working in correlated areas for several years. Its overall expenses on the subject in five years (including the three previous years) would be at least three times larger than the value of its contract in the proposed project.

The project's main objective was to evaluate and develop the required technology to use sugarcane residues, bagasse and trash as fuel for advanced cogeneration systems, such as a biomass integrated gasification gas turbine (BIG-GT), integrated with sugar/bioethanol mills. The project's immediate objectives were:

- Evaluation of sugarcane trash availability and quality.
- Evaluation of agronomic routes of unburned cane harvesting with trash recovery.
- Bagasse and trash atmospheric fluidized bed gasification tests.
- Integration of BIG-GT system with a typical mill.
- Identification and evaluation of environmental impacts.
- Project information dissemination.

Key results of the project were:

- Evaluation of sugarcane trash availability and quality
- Evaluation of agronomic routes of unburned cane harvesting with trash recovery
- Bagasse and trash atmospheric fluidized bed gasification tests
- Integration of BIG-GT system with a typical mill
- Identification and evaluation of environmental impacts

Several environmental benefits are expected from the project, stemming from the fact that studies indicate a significant margin for improvement in the use of renewable energies (bioethanol or surplus bagasse) in electricity generation and in the overall balance of CO_2 emission-absorption by the sugarcane agroindustry in Brazil. The estimated impacts of the project can be determined by calculating with a total of 315 million tons cane/year, from which 250 million tons are harvested unburned with part of the trash recovered and used for power generation using BIG-GT technology, and the remaining 65 million tons are harvested, burned and power generated by conventional systems (bagasse fired boilers and steam turbine generators). If this power generated using sugarcane residues is displacing generation from natural gas fired plants with 502 g CO_2 /kWh, the avoided CO_2 emissions will be 38 million tons of CO_2 equivalent per year in Brazil.

The initial focus of the project was at the institutional level, aiming to supplement existing know-how in CTC in the areas of sugarcane harvesting and other agricultural practices, transportation, sugarcane processing and conventional power generation, and by adding to knowledge on trash availability, quality and recovery, gasification technology and the environmental impacts of the sugarcane agroindustry and power generation. During project implementation the system level became predominant due to frequent and positive interface with policy makers and public meetings on cane burning and trash use issues. The interaction with several universities and research centres resulted in the development of research programmes related to the theme (energy from cane). Also, dissemination of information to the mills has created a favourable environment for starting to recover and use trash in conventional systems.

The dissemination of the project information was done in several ways. Eight newsletters were prepared and distributed according to a pre-established mailing list (Portuguese and English versions) and upon request from interested persons or

organizations. Publication of technical articles in important journals and presentations in national and international congresses, seminars and workshops were also used to disseminate the project information. The aim was to increase the awareness of the world sugarcane and power generation sectors about the potential of sugarcane residues and advanced power generation technologies, such as BIG-GT, to provide significant amounts of renewable energy in technical and economically feasible conditions.

Those involved in the project felt the initial project objectives and results were achieved and that the project had fulfilled the expectations of those who had planned and executed it. The potential of, and problems to be solved in, the use of advanced co-generation systems and the recovery and use of sugarcane trash, as a supplementary fuel to bagasse, are now well established and widely discussed. The private sector involvement in the project was also considered remarkable with the participation of Copersucar, TPS, sugar/bioethanol mills and equipment manufacturers in the project.

Moreover, the final budget of the project exceeded US$10 million since, in addition to the US$3.75 million coming from GEF, a further EURO 575,000 came from the European Commission DG XVII and SEK 3.5 million from the Swedish National Energy Administration (STEM). The balance of around US$ 5.3 million came from Copersucar and its affiliated mills.

4.3. Other Capacity Building Programmes of the *Centro de Tecnologia Canavieira* (CTC)

Copersucar (*Cooperativa de Produtores de Cana, Açúcar e Álcool do Estado de São Paulo Ltda*.), a private organization with no governmental participation, was founded on June 1st, 1959 with the main purpose of centralizing the trade of sugar and alcohol produced by its associate members. The increase in the number of producing units associated with Copersucar enabled consolidation of the trading system and made feasible the assistance and actions at all levels related to the productive process of each associate member.

In 1969 Copersucar started developing a sugarcane new variety programme that, together with the product analysis laboratory, formed the germ of Copersucar Technology Center - CTC, consolidated as such in 1979. The *Centro de Tecnologia Canavieira* (CTC) succeeded the Copersucar Technology Center in 2004.[82] Today, the new CTC, which is now open to new non-Copersucar associates, is one of the main and most complete research and development institutions on sugarcane agroindustrial technology in the world. A considerable amount of resources has been invested in sugarcane, sugar and alcohol technology research and development. There are now 126 associated members (mills and sugarcane suppliers).

CTC is located at Piracicaba in the State of São Paulo, with 12,800m^2 of constructed area and four agricultural experimental stations. It has an annual budget of approximately US$ 30 million/year and a staff of 500 specialists, including high and medium level technicians. The CTC invested about 1% of its total revenue back into research related to sugarcane and its final products through the 1980s and 1990s.[83]

According to CTC, the expansion experienced by the sugarcane sector is the result of new variety development, biological pest control introduction, improved management, and greater soil selectivity. The R&D programmes undertaken by the

[82] http://www.ctc.com.br/php/pagina.php?doc=home
[83] Martines-Filho et al, 2006

Copersucar Technology Center and current *Centro de Tecnologia Canavieira* (CTC)) have been instrumental in such improvements.

CTC programmes include: technology improvements for the use of healthy seedlings in order to control diseases and increase sugarcane plantation life spans; the use of minimum tillage techniques with implements developed by CTC; the utilization of liquid fertilizers and stillage/filter cake - production process residues; and weed control and biological elimination of pests.

CTC's research efforts also enabled the development of agricultural operation management systems, with the aid of computational resources such as the Agronomic Technical Control, the Integrated Production Control and the Mechanized Fleet Control. These help optimise the selection of the sugarcane variety, the machines and the mechanical operations for each area. The CTC also decoded the Sugar DNA, which helped to select varieties more resistant to drought and pests and with higher sugar content yields. Over the past 20 years the centre has developed some 140 varieties of sugar, which has helped lower growing costs by more than 1% a year.[84] Sugarcane varieties developed by CTC are cultivated in more than 50% of all Brazilian sugarcane areas, increasing agricultural productivity and characterizing an effective process of technology transfer and absorption. New sugarcane varieties developed by CTC have also had significant positive environmental impacts, for instance, increased productivity and new techniques suited to the central southern region lands helped avoid further pressures on the agricultural frontier.[85]

The technology developed by CTC enables enhanced yields up to 13% higher than existing average yields. The most significant advances are the developments in juice extraction and the continuous fermentation (3-vat) system for up to 1500m^3 bioethanol/day.

Improvements in equipment efficiency and operational procedures by CTC in the energy sector have also led to self-sufficiency in electric power and the organization of a bagasse surplus market. Indeed, in 1990/91 Copersucar, in a joint programme with Eletrobrás, investigated possibilities for increasing power production at the Brazilian sugar mills. Alternative concepts analysed included:

- Strict in-season co-generation, with variable bagasse surpluses (different process steam demands); use of higher steam pressures.
- Co-generation with condensing-extraction turbines (no bagasse surplus).
- Extended off-season operation, including the use of up to 70% of cane trash (not available today).
- Inclusion of stillage-derived fuels (methane or concentrated stillage).
- Use of a Biomass Gasification/Gas Turbine (BIG/GT) system, in cogeneration and combined-cycle mode (season) and Steam Injected Gas Turbine (STIG) mode (off-season; cane trash) (see project above).

Conventional bagasse-based co-generation systems at sugar mills in Brazil have been improved, leading from 60% self-sufficiency in electricity (in 1980) to 96% (in 1995); a high-pressure, high efficiency system is operating in a (commercial) demonstration unit, including environmental control (noise, particulate emission, odour).

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[84] Lunhow D. and Samor G. 2006 '*As Brazil fills up on ethanol, it weans off energy imports'* The Wall Street Journal, 16 January

[85] Isaias Macedo, former Director of CTC, personal interview, December 2006

Other environmental issues that have received considerable attention from the CTC programmes have been the control of emissions from sugarcane burning (which led to the introduction of new environmental legislation) and the development of a programme of nutrient recycling through the application of industrial wastes (i.e waste reduction) as vinasse and filtercake.[86] However, information on these specific programmes is not in the public domain.

4.4. The Corporate Social Responsibility Programme for the Sugar and Bioethanol Industry in São Paulo: UNICA and World Bank

UNICA is the São Paulo Sugar Cane Agroindustry Union (*União da Indústria Canavieira de São Paulo*) which represents sugarcane, sugar and alcohol businesses in the State of São Paulo. UNICA has more than 100 mills affiliated as members.

UNICA has played a key role in the development of the sugarcane industry and was, for example, an important player in the WTO case against the EU sugar subsidies.

UNICA has also recognised the need to support their member companies to strengthen their competitive position as well as to address some fundamental global issues such as irresponsible labour practices and operations with adverse environment impacts.

To this end, UNICA and the Business, Competitiveness and Development Programme of the World Bank Institute (WWBI) partnered to develop the capacity of local Brazilian businesses and their associations. Together, UNICA and WWBI aim to enhance firm level competitiveness, which is critical to lessening the *Custo Brazil* (the cost of production in Brazil). Both parties agreed to develop a capacity building programme specific to the region, with the WWBI team taking the lead in development.[87] The Competitiveness and Development (BCD) Programme was given the role of coordinating and designing the capacity building programme. Its role was to employ its wide experience in private sector development, capacity building and Corporate Social Responsibility (CSR). In addition, the BCD team provided training for UNICA 's local experts. Additionally, the BCD team developed an online course on Corporate Social Responsibility and Sustainable Development. UNICA contributed its local expertise and financial support for the training. UNICA's experts would later facilitate local capacity building sessions. UNICA also agreed to recruit participants, disseminate the course, facilitate the training sessions, and lastly, to host the certification event.

Content of the programme: the Face-to-Face sessions were organised around three sessions:

- Session One: introduction of the various issues explored in the sessions and the concept of CSR.
- Session two: this focused on local case studies.
- Session three: this was dedicated to discussing the challenges faced when socially responsible corporate strategies are implemented. Discussion concentrated on human resources, finance and technology as well as CSR and Sustainable Competitiveness.

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[86] Isaias Macedo, former Director of CTC, personal interview, December 2006

[87] For details on the programme, please see: '*Corporate Social Responsibility Program for the Sugar and Ethanol Industry in São Paulo, Brazil - Activity Report'* The International Bank for Reconstruction and Development, 38 pp, Washington DC, 2006

The Web -based course included six modules:

- CSR Main Concepts,
- Decision-Making Frameworks
- CSR Diamond
- Building Sustainable Competitiveness through CSR
- CSR and the Poor
- Coalition-Building and Action Plans

The programme trained approximately 2,500 participants over a period of 8 months. Participants included directors, managers and supervisors from various divisions, such as human resources, finance, production, technical, agricultural, marketing, accounting/auditing, commercial and legal departments. Recently, InWent and the German Chamber of Commerce in São Paulo joined the alliance, with the purpose of broadening the reach of the programme. Over the coming three years the partners will deliver the programme to several Mercosur countries, starting with Brazil and Argentina. The UNICA-WBI partnership encourages the vital role of the private sector in development and the significance of public-private partnerships.

In order to assess the effectiveness and quality of their efforts, both UNICA and WBI administered questionnaires for their respective components of the programme. This feedback will be used to shape future capacity building programmes.

Overall, although the interviews conducted for this research highlighted this programme as one of the relevant sustainable development programmes for the industry and UNICA, under the auspices of this CSR programme, emphasises its commitment to sustainable development and corporate social and environmental responsibility, the programme only focuses on economic and social aspects of sustainable development and does not address the environmental challenges associated with the sector.

4.5. Corporate Social Responsibility: The development of a social-environmental certification for the sugar and bioethanol sectors in Brazil by IMAFLORA

IMAFLORA – *Instituto de Manejo e Certificação Florestal e Agrícola* (Institute for Agriculture and Forest Management and Certification) – is a non-profit, non-governmental organization whose mission is to contribute to sustainable development by promoting agriculture and forest management that is environmentally appropriate, socially beneficial and economically viable. The main tools to encourage such good management are certification, training and capacity building, and support to the development of public policies. With headquarters in Piracicaba, Sao Paulo, IMAFLORA started its activities in 1995, during the intense debates concerning the protection of tropical forests, two years after the foundation of the FSC (Forest Stewardship Council), which deals with forest management certification.

IMAFLORA is a pioneer in a number of fields: it was the first certification body to certify a non-timber forest product within the Atlantic Forest region and the first to carry out certification of Community Forest Management. In order to improve the access of small and medium size community forest enterprises to certification, IMAFLORA has taken part in the SLIMF initiative set up by FSC, whose objective is to streamline and simplify the procedures for certification of small and low intensity managed forests. In addition, it has established its own Social Fund to partially subsidize certification of community forest management.

The Institute has five key programmes: Forest Certification Programme – PCF; Agriculture Certification Program – PCA; Certification Encouragement Program – PEC; Training and Capacity Building Program – PTC; and Support to the Development of Public Policies – PPP. In addition to these programs, IMAFLORA also supports initiatives within the theme Ethical and Solidarity Trade. Some of its main partners are: IMAZON – Institute for Man and Environment in the Amazon, FOE – Friends of the Earth – Brazilian Amazon, Rainforest Alliance, organizations that make up the ALFA Consortium (IEB – International Institute for Education in Brazil, TFF – Tropical Forest Foundation, Imazon, PESACRE – Group of Research and Extension in Agroforestry Systems of Acre, IPÊ – Ecological Research Institute, Florida University) and FACES – Forum for Supporting Ethical and Solidarity Trade (Friedrich Ebert Foundation, The Municipality of São Paulo, Agrarian Development Ministry, SERE Institute, SEBRAE –Small Business Support Service, Lyndolpho Silva Foundation, Viva Rio Foundation, World Vision).

The organizational structure of IMAFLORA consists of: Board of Directors, Auditing and Control Council, Consultative Council, Executive Secretariat, Departments and Technical and Administrative Teams, with a total of 45 persons, 25 of them with executive and administrative functions. In 2003, 32% of IMAFLORA's budget came from institutional funding, 14% from specific project funding and 53% from income from operational activities.

During its first eight years, IMAFLORA has been expanding and intensifying the understanding of its mission. In its early days, certification was the reason for IMAFLORA's existence but today, certification is seen as one strategy – albeit a central one – amongst others used to encourage good agriculture and forest management as a path towards sustainable development. In IMAFLORA there is a clear vision, shared by all the staff, of its mission that is the reference for evaluating the meaning and relevance of actions taken. The values related to sustainability that characterize what is socially beneficial, environmentally appropriate and economically viable are present and duly internalised. Its identity as an NGO that also acts as a Certification Body (CB), instead of being considered a problem, gives IMAFLORA market, technical and political credibility when dealing with a diverse array of clients, community groups and partners.

Although the bulk of IMAFLORA's work concentrates on forest management, some of its activities are also relevant to the sugar and bioethanol sector. Notably, the work carried out by the Agriculture Certification Program (PCA) constitutes one of the first attempts to introduce sustainability criteria in the sugarcane sector.

The PCA is part of the Sustainable Agriculture Network – SAN, established under the umbrella of the Rainforest Alliance, since IMAFLORA is its representative and partner in Brazil. PCA strives to make the social and environmental certification of agricultural practices a way to promote the social well-being of rural workers, producers and their families and also the conservation of natural ecosystems and their biodiversity.

Given IMAFLORA's experience in the environmental certification of the forestry sector, in March 1996 IMAFLORA decided to extend its activities to the agricultural sector and created a Programme for Environmental and Social Certification in the Agriculture in Brazil. The first step consisted of a three month feasibility study financed by the American NGO Rainforest Alliance. The focus of the study was on three agricultural products: sugarcane, coffee and oranges. Sugarcane was the crop chosen for the second phase of the project, which consisted of a pilot project on environmental and social certification. Sugarcane was selected due to its strategic

importance both for sugar and fuel production and also due to concerns about the associated social and environmental impacts.

The 'Sugarcane Environmental and Social Certification' project had the following goals:

- To define guidelines for environmental and social assessment, monitoring and certification.
- To define and implement an environmental and social certification system and create the institutional infrastructure and regulation for the operation of the system.
- To seek compatibility of the system with the main international initiatives in the agricultural system, notably IFOAM and Fair Trade.

The project involved partnerships with: the *Federação de Orgãos para Assistência Social e Educacional* (FASE), *Instituto Biodinâmico de Desenvolvimento Rural* (IBD), and collaboration from: *Empresa Brasileira de Pesquisa Agropecuária-Meio Ambiente* (EMBRAPA Meio Ambiente) – the environment research institute linked to the Ministry of Agriculture -, *Escola Superior de Agricultura Luiz de Queiroz* (ESALQ) (Agriculture High School Luiz de Queiroz), Deferal University of São Carlos (UFSCAR) and the University of Campinas (Uni-camp).

The first phase of the pilot project was financed by the Dutch Organization for International Development Cooperation (NOVIB). It involved two years spent reaching consensus among the key stakeholders regarding the key issues to be addressed and development of the guidelines. In order to achieve this, the project included the following activities:

- 2 workshops for the development of guidelines for environmental and social assessment, monitoring and certification of sugarcane;
- 2 meetings of the 'Working Group 7';
- 2 field tests and 2 public consultations by mail;
- a 'General Assembly'; and
- several meetings with key stakeholders.[88]

A total of 105 entities/people from industry, producers, workers, civil society, academia and government participated in the process. After four years of work, consensus regarding the guidelines was reached among the stakeholders, which was validated in a General Assembly in 1998. The result of the work was a methodology that was summarised and published in '8 pages, 12 guidelines and 30 criteria'.[89]

A second phase of the project consisted of an 'operational phase' in which a 'Certification Committee' was created. The goal of the Committee was to attract the interest of companies and foster demand for the adoption of the standard. However, this has not yet been implemented. A key drawback acting against the standard's implementation has been the lack of public sector support and a lack of interest from the industry given that there was no market demand any such standard. However,

[88] For details on each of the activities see Luís Fernando Guedes Pinto, 1999, '*CERTIFICAÇÃO AGRÍCOLA SOCIOAMBIENTAL:iniciativa piloto para a cana-de-açúcar*' 1 Laura de Santis Prada 2' Informações Econômicas, SP, v.29, n.5, May .

[89] http://www.sucre-ethique.org/Sao-Paulo-Issues-and-challenges,

the document and other material produced have been used by stakeholder discussions and academic research. [90]

Overall, one significant result of this programme was the formulation of parameters for the certification of the sugar/bioethanol industry, even though they have not yet been implemented. Moreover, there is optimism that the low demand for this type of certification will be reversed in the next few years notably driven by external demand and also if proper (economic) incentives are applied.[91]

4.6. Corporate Social Responsibility: Seminars promoted by the French NGO Ethical Sugar in Brazil*.*

The French NGO Ethical Sugar brings together trade unions, manufacturers and civil society within a sustainable development process in order to improve the social and environmental conditions of the sugar sector within the framework of a globalised economy.[92]

Ethical Sugar works towards sustainable development and proposes to promote social meetings and partnerships[93] between the stakeholders (civil society, companies and trade unions) from the north and the south of the country. The main aim of these meetings must be sustainable development, including respect for the environment and the social responsibility of companies, consumers and workers within the framework of a market regulated by democratic institutions.

Ethical Sugar's basic standpoints on trade and environment are found in its communication to WTO: *Ethical Sugar's Position and Position Concerning the Sugar Reform.*

The two key initiatives on trade and environment in the sugar industry in Brazil undertaken by Ethical Sugar are: the sectoral meeting 'Sugar Market Globalisation vs. Socio-Economic Rights Globalisation' and the sectoral meeting on 'Issues and Challenges Facing the Brazilian Sugar & Ethanol Industry of the 21st Century within a Globalised Sector'. [94]

- *Meeting on 'Economic Globalisation versus Globalisation of Social and Environmental Rights' - in June 2004* :

Whereas the UNCTAD XI meeting took place in São Paulo, Ethical Sugar organized a meeting - *Economic Globalisation versus Globalisation of Social and Environmental Rights'* - in Sao Paulo. The goal of the meeting was to discuss social, economical and environmental issues of the Brazilian sugar and alcohol market in the context of globalisation and to create synergies between the different actors that play a part in this rapidly growing sector, in order to build and secure sustainable development using tools of Corporate Social Responsibility.

The meeting was attended by some 45 stakeholders from the civil society sector and academia. Key aspects covered by the meeting included:

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[90] http://www.sucre-ethique.org/Sao-Paulo-Issues-and-challenges,
[91] Personal interview with Luis Fernando Guedes Pinto from IMAFLORA, February 2007

[92] See 'Sucre Ethique': http://www.sucre-ethique.org/
[93] Available at: www.wto.org/English/forums_e/ngo_e/posp55_ethical_sugar_e.doc
[94] Results from these two seminars are published at: http://www.sucre-ethique.org/Primeiro-seminario-cientifico?var_recherche=unctad and http://www.sucre-ethique.org/Sao-Paulo-Issues-and-challenges),

- Perspectives on the global sugar market including effects of the EU Sugar CAP reform in developing countries and;
- General environmental and social impacts associated with sugar and bioethanol production in Brazil.

- *'Issues and Challenges Facing the Brazilian Sugar & Ethanol Industry of the 21st Century within a Globalised Sector'.*- in São Paulo in May 2006

In view of the marked expansion that the sugarcane sector has experienced over recent years due to increased production and exports of sugar and bioethanol and the attraction of several transnational companies to the country (such as Cargill) and the opening up of a new cane area (Mato Grosso, Mato Grosso do Sul, Minas Gerais, etc.), Ethical Sugar felt it was imperative to think about sector growth in a sustainable and responsible way. In this context, they organized a second sectoral meeting – *'Issues and Challenges Facing the Brazilian Sugar & Ethanol Industry of the 21st Century within a Globalised Sector'' (Desafios da Indústria Sucroalcooleira Brasileira no Século 21)* - in São Paulo in May 2006. Key issues addressed by the meeting included:

- Brazilian sugarcane perspectives in a globalised sector (analysis of domestic and external markets, regulations, investments; land regulation and labour regulation);
- Social impacts of sugar and bioethanol production;
- Environmental impacts (sugarcane burning; sugarcane general environmental impacts; monoculture impacts on water discharge, land use and biodiversity; and water issues – pollution and improper use);
- Better management practices: (Ethos Institute's indicators of Corporate Social Responsibility[95] and specific action for the sugarcane sector; Socio-environmental Certification and Labelling; the Better Sugarcane Initiative (BSI)[96]).

Approximately 180 groups attended the second conference, belonging to various entities, including: companies (consultants, banks, communication agencies, millers, sugar and alimentary groups, representatives); trade–unions; NGOs: environmentalists (WWF, Earth's friends, etc.); social rights defenders (Reporter Brazil, Social Observatory, etc.); development organizations (OXFAM, FLO, etc); organic associations (AAO); universities: from various departments (sociology, engineering, geography, health, economics); government representatives (Agriculture and Environment); public and private foundations; and journalists.

One of the great merits of Ethical Sugar's second seminar was to create a methodology for the meeting under the spectrum of 'scientific neutrality'. One of its Brazilian business partners, UNICA, published a book - *Sugarcane's Energy*, edited by Isaias Macedo - which intended to analyse the socio-environmental impacts of this culture, but according to some other Brazilian partners, it only partially achieved this, completely ignoring the question of social impacts in terms of health or occupational safety. Moreover, the book also argues that sugarcane burning has no impact on health or atmospheric pollution (see section 3.1 on impacts on local air quality).

[95] According to Mariana Kohler Pereira, Head of UniEthos - the research and capacity building branch of Institute Ethos- , 28 mills associated with UNICA (it has more than 100 mills affiliated as members) have applied the Ethos Social Responsibility Indicators in 2006. It was the first agribusiness sector to apply Ethos methodology on CSR. The results of this exercise are confidential.

[96] See subsection 4.8

Given the conflicting viewpoints, this neutrality was seen as the only way to bring together all the stakeholders in the sector. Corporate Social Responsibility definitely does not seek to create a strategic asset for the companies, but rather, to support the social dialogue as well as solutions in terms of better practices. Yet, a diagnostic is essential in order to design and implement such practices.

Ethical Sugar decided that promoting the dialogue between academic researchers and financial companies or decision makers was of primary importance to accomplishing a more balanced diagnostic. Secondly, trade unions should also be included because they are the traditional social dialogue promoters.

Next steps include the organization of modest "workshops" (approximately 20 people) on precise subjects and with only the key people, who would represent in the same proportion the institutions present during the seminar. The subjects will be selected from among the most problematic statements detected during the seminar, for example: The "Maturador" (Dupont de Nemour), transition towards prohibition of sugarcane burning and towards mechanization, subcontracting of labour, etc. Their goal will be to identify and promote best practice.

The Ethical Sugar in Brazil wants to take a large part in the WWF Brazilian Best Sugar Initiative (BSI) implementation, particularly in its social aspects (see subsection 4.8 on the BSI).

4.7. Organic Sugar: Sao Francisco Sugar Mill

In 1986, Sao Francisco Sugar Mill (Usina São Francisco) set up Green Cane Project, mainly aimed at developing a self-sustainable sugarcane production system, based on the ecological and conservation potential of this culture.

From soil preparation to industrial procedures, the most advanced technology available was integrated into the project, while still relying on the antique and traditional techniques of natural harvest. As a consequence of this initiative, in October 1997 Sao Francisco Sugar Mill was awarded the organic producer certificate.

Sao Francisco Sugar Mill relies on a 7,500-hectare area to harvest sugarcane and is fully certificated to carry out organic production. To fulfil the Usina's organic raw material requirements, 6,000 hectares from 11 farms located in Sao Francisco Sugar Mill, belonging to the same holding, were also converted and completely certificated for the organic system. As a result, the 13,500 hectares of certificated sugarcane brakes enable Sao Francisco to organically industrialize all of its crop. It has a production capacity of 80,000 hectares, of which 20,000 hectares are exported.[97] This makes Sao Francisco Sugar Mill the biggest organic agriculture project not only in Brazil but globally.

The project overcame several obstacles that potentially complicated the large-scale implementation of this kind of agriculture. Sao Francisco Sugar Mill's industrial park allegedly makes use of the most up-to-date production techniques, placing an emphasis on environmentally secure production procedures that are compatible with the preservation of neighbouring ecosystems.

[97] Planeta Organico '*Planeta Organic Visita'* Interview to Daniel Bertoli available at: http://www.planetaorganico.com.br/native1.htm

Native vegetation has increased from 5% to 14% since the project's implementation thanks to a native forest reforestation programme running since 1986.[98] In addition, the project works towards the protection of wildlife, which means that hunting and fishing are forbidden. There is also a fire prevention programme for native forest and the reforested areas.[99] Moreover, São Francisco Sugar Mill has not burnt sugarcane since 1995.[100]

More generally speaking, organic certification has appeared as a market demand, with greater technological and environmental impacts concerning agricultural soil, water use, air quality and biodiversity. This project played a pioneering role and introduced new ideas and concepts. But the organic area is still quite restricted and the certification has contributed very little to improving social circumstances or the regulations' systemic issues. The relationship between the agribusiness and the NGOs has not benefited much from the certification processes so far and mutual trust is still lacking.[101]

4.8. Better Sugar Initiative (BSI)

World Wildlife Fund (WWF) is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring sustainable use of renewable natural resources
- promoting the reduction of pollution and wasteful consumption.

Through its *Sustainable Sugar Initiative*, WWF is developing techniques and practices to reduce the environmental impact of sugar farming and helping sugar farmers to implement these in the field. WWF received IFC initial financing for the BSI activities.

The Better Sugarcane Initiative (BSI) is a multi-stakeholder collaboration whose mission is to promote measurable improvements in the key environmental and social impacts of sugarcane production and primary processing. The BSI involves progressive sugarcane retailers, investors, traders, producers and NGOs who are committed to developing internationally-applicable baselines that define sustainable sugarcane.

The BSI' Steering Committee is based around the world and includes Jason Clay from WWF and Olivier Genevieve from Ethical Sugar. Other stakeholders involved include Isaias Macedo and representatives from UNICA and WWF-Brazil. [102]

The BSI recognises the wide range of geographically variable issues connected with sugarcane production and primary processing. In order to effectively address the key impacts, the BSI initially focuses on the most significant issues in sugarcane

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[98] Planeta Organico '*Planeta Organic Visita'* Interview to Daniel Bertoli available at: http://www.planetaorganico.com.br/native1.htm

[99] Planeta Organico '*Planeta Organic Visita'* Interview to Daniel Bertoli available at: http://www.planetaorganico.com.br/native1.htm

[100] Daniel Bertoli Gonçalves, consultant to Fasolim Consultancy, Personal Interview, February 2007

[101] Luis Fernando Guedes Pinto from IMAFLORA, Personal interview, February 2007

[102] Richard Perkins, Agriculture and Rural Development Freshwater Team WWF-UK, personal communication, February 2007

production and primary processing. In the case of Brazil these include: soil degradation; water use; effluents (in water, air and soil); and habitat loss and degradation.[103]

To achieve this, the BSI is committed to engaging stakeholders in a constructive dialogue to define, develop and encourage the adoption and implementation of practical and verifiable performance-based measures and baselines for sugarcane production and primary processing on a global scale.

The end result of BSI will be a set of standards which can be used by companies and investors across the globe as sourcing and investment screens and by producers to enhance the long-term sustainability of production. In the context of Brazil, they are currently drafting the principles of consultation. [104]

Overall, implementation of the BSI is only just starting in Brazil and therefore it is too early to assess impacts.

4.9. Enforcing Environmental Legislation – The work of the Environmental Chambers of the Sugar Cane and Alcohol Sector of CETESB

CETESB (*Companhia de Tecnologia de Saneamento Ambiental*) is a public agency in charge of controlling, enforcing, monitoring and evaluating all human activities that might pollute soil, water and air in the state of São Paulo.[105] Its main aim is to preserve and improve the quality of these resources.

The Environmental Chambers (there are six of them) are collegiate bodies that act as a regular forum to bring together the productive sector and the public bodies in charge of the environmental regulation. One of these chambers is the Environmental Chamber for Sugar Cane and Alcohol, created in 2002 and based in Ribeirão Preto, Sao Paulo. The Chairman is the Chairman of UNICA (see point 4.4) and the Executive Secretary is appointed by CETESB. The members are representatives from the industry, labour groups, consultants, universities and other research centres and government (state, but not local).

The objectives of the Environmental Chamber for Sugar Cane and Alcohol are:

- to implement and improve strategic instruments for environmental management;
- to collect information from the public and private sector pointing towards the sustainable development of the State of Sao Paulo;
- to promote partnerships with the private sector to implement public policies towards environmental management; and
- to support CETESB's strategic planning.

Key activities of the Environmental Chamber for Sugar Cane and Alcohol include:

- to assess and propose innovations and improvements in standards, procedures and environmental regulations;
- to elaborate sectoral management plans aiming at the rational and economic use of natural resources; environmentally-friendly production methods;

[103] Richard Perkins, Agriculture and Rural Development FreshwaterTeam WWF-UK, personal communication, February 2007
[104] Richard Perkins, Agriculture and Rural Development FreshwaterTeam WWF-UK, personal communication, February 2007
[105] See CETESB web page: http://www.cetesb.sp.gov.br/

prevention and control of accidents; improvement of the health and safety conditions for workers; motivation and capacity building of human resources; and to enhance communication with the external public.

At present there are three Working Groups at the Environmental Chamber for Sugar Cane and Alcohol focusing on the following issues:

- the environmental impacts of the agro-industry activities on ground water
- Cleaner Production and technological change
- regulatory, socio-economic and environmental impacts of sugarcane burning.

With the Technical Groups' working support, the Chamber registered significant progress on environmental issues related to:

- Resolution SMA 14/2005 – Criteria and Procedures for Previous Environmental Permits of Sugar and Ethanol Mills and Sugar Mills;
- Technical Standard P4.231/2005 - Criteria and Technical Procedures for Applying Vinasse on the Agriculture Soil. Although this technical regulation for applying vinasse is still under consideration for further improvements, it shows the Environmental Chamber's efforts in assuring environmental improvements in the sector.[106]
- Guidelines for the implementation of regulation 11.241 on the gradual banishment of sugarcane burning in the State of São Paulo, regulated by the Decree 47700/2003. At present this regulation has been accomplished by the private sector and enforced by the public Environmental Office in charge of its control and supervision in the State of São Paulo, although it still remains a very controversial issue. [107]

5. ASSESSMENT OF THE PROGRAMMES VIS A VIS ENVIRONMENTAL NEEDS OF THE SECTOR

5.1. Programmes Assessment

- **Type of CBTA programmes**

Key programmes on capacity building in trade and environment in the sugar and bioethanol sector in Brazil include: technical and financial assistance for the development of bioethanol and biomass energy (e.g. the project supported by the World Bank in the 1980s) and also programmes targeting a reduction of emissions and effluents (e.g. the project supported by GEF); capacity building also comes under the form of support for research and development (R&D) (e.g. several programmes led by CTC for the development of sugar varieties, technological improvements and for the reduction of sugarcane burning and wastes); programmes aimed at information dissemination and awareness raising (e.g. numerous seminars linking sugar/bioethanol production and trade and the environment or sustainable development in general); support for the development of organic or environmental-social standards, certification/labelling initiatives (e.g. IMAFLORA) and; support in the implementation of environmental legislation (e.g. CETESB).

[106] Interview to Marco Antonio Sanchez Artuzo representative of CETESB at the Environmental Chamber of the Sugar Cane–Alcohol Sector in São Paulo.
[107] Interview to Marco Antonio Sanchez Artuzo representative of CETESB at the Environmental Chamber of the Sugar Cane–Alcohol Sector in São Paulo.

- **Type of Donors**

A vast range of stakeholders has participated in the financing of programmes on capacity building in trade and environment in the sugar/bioethanol sector in Brazil. These range from international organizations such as World Bank and the GEF, to the private sector – notably the sugarcane industry, international NGOs and the Brazilian Government. On the other hand, none of the selected programmes have been financed by third country governments.

In general, international cooperation (both from international institutions and third country governments) for capacity building in the sugar/bioethanol sector has been poor because the sector has not been a priority for international donors. As a result, capacity building in the sector has been primarily endogenous.[108] However, international cooperation in the sector may increase as the sector becomes more and more important for international donors. Key issues currently attracting attention from international donors include: the long experience of Brazil with bioethanol production and the novelty of this market at the international level; the environmental and social effects of bioethanol production both locally and globally, and the potential for South-South cooperation.

- **Implementing Agencies of the Capacity Building Programmes**

The implementing agencies of the programmes have been, to a large extent, national entities including R&D institutions linked to the industry such as CTC, but also Brazilian universities. There are also cases of partnerships between Brazilian and international/foreign institutions (e.g. the CTC/UNDP or the WB/UNICA) and also private-public partnerships (e.g. CETESB's Environmental Chamber). In other cases (e.g. the seminars conducted by 'Ethical Sugar' or the ongoing 'Better Sugar Initiative') the programmes have primarily been led by foreign institutions.

- **Relevance of CBTA programmes for the environmental priorities of the sector**

In general the capacity building programmes were found relevant in terms of the intended environmental issue they were targeting, although stakeholders' perspectives on the relevance of the programmes vary. There are significant differences in terms of the scope of the programmes and the type of environmental issue they aim at addressing.

Programmes led by the R&D institution, CTC, tend to be 'issue-specific' in the sense that they focus on specific environmental aspects associated with sugar/bioethanol. For instance they concentrate on technical support for CO_2 reductions in the use of bagasse and sugarcane waste for power generation; reductions in sugarcane burning or in the generation of waste and effluents. In some cases the programmes were not targeting environmental improvement (e.g. they were targeting increases in productivity) but the overall impact of the programme led to an indirect environmental benefit (e.g. increase in yields which may reduce pressure on the agricultural frontier). UNDP have also been involved in the CTC programmes (e.g. programme for CO_2 reduction through biomass power generation). Overall, stakeholders deemed the CTC experience to be highly effective. They highlighted the continuous technological innovation and the ownership of the CTC programmes as the key factor of success in capacity building in the Brazilian case. In addition, the important agglomeration economies for the sugarcane agribusiness in the São Paulo State

[108] Interview with Angelo Bressan, Director of the Department of Sugarcane and Agroenergy, DCAA/SPAE of the Brazilian Ministry of Agriculture, Livestock and Food Supply, February 2007

(positive externalities) have been recognised as another crucial factor behind the success of the programmes, since they have allowed technological knowledge spillover beyond CTC´s boundaries. They also identified other institutions that have had an important role in this spillover, notably the network of institutions including the State Universities (especially the *Escola Superior de Agricultura "Luiz de Queiroz"* from USP in Piracicaba[109], the State agricultural institutes and labs (especially the *Instituto Agronomico de Campinas*)[110], and other private organizations (e.g., IDEA de Ribeirão Preto)[111], thus creating a solid network of specialized knowledge in the sugarcane agribusiness activities.

The capacity building programmes related to standards and certification processes e.g. the Sao Francisco Mill organic scheme or environmental-social certification standards linked to IMAFLORA are rather holistic in their approach as they are simultaneously targeting several of the key environmental challenges faced by the sector. However, the focus of these programmes is on the impacts in situ (local impacts) and therefore they fall short of addressing global issues such as the expansion of the agricultural frontier. Other issues hindering the effectiveness of these programmes have been the lack of industry support (e.g. for the certification criteria led by IMAFLORA) and the low level of trust among stakeholders: '*The relationship between the agribusiness and the NGOs has not benefited much from the certification processes so far and mutual trust remains to be built*[112]*.*

In this context, it is also worth mentioning that, at present, there are several initiatives towards the development for the environmental/social certification of biofuels. These are mainly driven by northern institutions, notably countries' governments (e.g. EU, Netherlands, UK) or by international NGOs worried about the sustainable development impacts of biofuels international trade. There is an special interest on biofuels/feedstock from countries such as Brazil and Indonesia/Malaysia. A key certification criterion to be included in these initiatives is the carbon balance of the biofuels. The position of the government of Brazil vis a vis these initiatives is reflected in its response to the EU Review of the Biofuels Directive. In its response, the government of Brazil acknowledges the need to include local impacts within the certification criteria but also highlights the importance of the carbon balance of the products as a way of challenging the sustainability of biofuels produced in industrialised countries: '*Climate change is arguably the greatest and most urgent environmental challenge facing mankind today. Therefore, any environmental certification scheme should address not only local environmental impacts but also the net contribution of any specific biofuel to greenhouse gas emission reduction. A set of requirements that only assesses local environmental impacts (as the structure of subquestions 4.1 and 4.2 might suggest) could lead to the absurd situation that biofuels with very low or even negative carbon balance may qualify as environmentally sound*'. [113]

Generally speaking, several concerns have been raised regarding certification programmes when they are led by the interest of foreign institutions without meaningful participation of a Brazilian counterpart. Concerns prevail over whether these constitute unnecessary barriers to trade; there are questions about the relevance of the programmes to deal with the local environmental conditions and; there are concerns regarding the ownership and content of these programmes.

[109] See http://www.esalq.usp.br/english/history.html
[110] see: http://www.iac.sp.gov.br/
[111] see: http://www.ideaonline.com.br/home/
[112] Guedes Pinto Executive Secretary of Imaflora
[113] Brazilian official position stated on environmental certification in the REVIEW OF THE EU BIOFUELS DIRECTIVE – PUBLIC CONSULTATION EXERCISE (Responses and comments by the Brazilian Government). Brussels, 10 July 2006

Several stakeholders linked to the industry, academia and government in the sugar/bioethanol sector have shown themselves openly hostile to any standards/certification processes that do not have ownership from Brazilian counterparts. They have pointed out the importance of national expertise and previous experience in the formulation of parameters for the certification for the sugar/bioethanol industry (linked to IMAFLORA, for instance) even though they have not yet been used. On the other hand, given that environmental/social schemes are mainly driven by external demand, some stakeholders see international cooperation on these issues as inevitable. However they also highlight the relevance to include a Brazilian counterpart.

The seminars promoted by French NGO Ethical Sugar are another example of programmes that show a more holistic approach in terms of the trade-environment issues they are covering. Indeed, the seminars' agendas included all the general issues concerning sugar/bioethanol global trade, market information and environmental consequences. However, it is difficult to measure how these impacts are being addressed by the programmes as these are only 'one shot initiatives' rather aimed at creating awareness on the issues. On the other hand, some stakeholders showed caution towards programmes led by foreign institutions as they are viewed as being strongly associated with protectionist sugar/ethanol interests in their countries of origin. Thus, building mutual confidence has been highlighted an urgent task in this field.

The UNICA/World Bank CSR Programme for the Sugar and Bioethanol Industry, on the other hand, only focuses on economic and social aspects of CSR and therefore does not address any of the environmental impacts of the sector.

The World Bank programme on Alcohol and Biomass Energy Development was one of the most quoted technical assistance projects by the sugarcane producers. One of the programme's intended activities was the implementation of a monitoring and evaluation system of the agricultural, transport and industry, employment and the environmental impacts of the 'PROALCOOL Programme'. However very little is known about the actual environmental implications of the programme as there is no available information on the programme at the World Bank and there is no readily available institutional memory from the Brazilian side. Indeed, the lack of available information for assessing the relevance programmes has been a drawback that has appeared in the context of almost all the selected programmes.

The programme linked to the CETESB public-private Environmental Chamber aims to improve implementation and enforcement of environmental legislation. The different activities of the Working Group also constitute an example of a capacity building programme that is simultaneously targeting several of the key environmental challenges confronting the sector. Actors involved in the programme acknowledge there have been improvements linked to the work of the Environmental Chamber (notably on implementation of the regulation for applying vinasse and on sugarcane burning) but there are also considerable challenges ahead.

All in all, stakeholders' perceptions of the programmes are wide-ranging. These views range from those who consider there has been no relevant capacity building programmes on trade and environment in the sector, through those who acknowledge the existence of capacity building programmes but have reservations on their actual relevance, to those who believe the experiences with capacity building programmes have been very successful.

- **Key Limitations of Capacity Building Programmes and Future Needs**

The programmes present several limitations. These mainly refer to issues related to the sugar/bioethanol trade-environment debate that are not being covered by the programmes as well as issues of ownership and confidence among the stakeholders. More specifically these include:

- *Expansion of the cultivated area and its systemics impacts in temrs of biodiversity and GHG emissions*: the expansion of the cultivated areaand its related impacts on biodiversity and GHG emissions has only been addressed marginally and indirectly by some of the programmes, for instance, when they aim at increasing the productivity of the sector. Indeed, none of the analysed programmes has been specially designed for targeting the issue. Chapter 3 identifies the expansion of the cultivated area as one of the key environmental issues confronting the sector and therefore more capacity building on the issue is needed.
- *Indirect impacts*: the current focus of the selected programmes is on those environmental impacts that are directly linked with increased sugar/bioethanol production. However, the new phase of expansion facing the sugar/bioethanol sector is predicted to lead to a displacement of those agricultural activities that will become less profitable. The relocation of these activities might take place in environmentally sensitive areas and therefore the related environmental impacts need to be monitored and addressed.
- *The trade link*: the vast majority of the selected programmes focus on the production side of the trade-environment equation i.e. on those environmental impacts associated with the production process. Very little effort has been made to address the trade aspects of the relationship. Effort has been made to provide capacity building on issues such as the challenging of the EU sugar regime at the WTO (notably by the sugarcane industry) and there is also considerable focus on market intelligence in the biofuels sector. Efforts are also being done in increasing the use of Kyoto Protocol's Clean Development Mechanism.[114] However there are other trade issues in which the environmental dimension is very relevant and there is a gap in terms of capacity building. One of these aspects is, for example, negotiations on environmental goods and services (EGS) which are currently underway at the WTO. Issues such as a better understanding of the sustainable development implications of including organic sugar or bioethanol within a list of EGS for trade liberalisation are crucial. EGS has been an important topic under the current Doha Round and it is likely to become an even more prominent topic as long as the biofuels issue permeates the WTO debate. Another topic deserving more capacity building efforts relates to the trade implications of environmental/social certification, lifecycle analysis and production and process methods (PPMs). This topic was already a sticking point in the debate even before the creation of the WTO in 1995 and very little progress

[114] According to UNICA the private sector's efforts will be aimed at: breaking down protectionist barriers for sugar and alcohol in the international market, to create commodity markets for sugar and ethanol, increasing production and sales of alcohol vehicles in the domestic market, and increasing the participation of fuel alcohol and electric energy cogeneration from sugarcane bagasse in the Brazilian energy matrix. Concrete actions include: actions at the WTO against the EU, use of the Kyoto Protocol's clean development mechanism (CDM) resources, among many others. Other important steps are: inventory financing for seasonal alcohol (warrants), since production occurs during 6 months and sales take place during 12 months; by contract with exporter companies consign part of the alcohol production to fill spaces that open in the international market, purchase guarantee, and a regulatory value for electric energy generated from sugarcane waste. See http://www.unica.com.br/i_pages/artigos_palavra.asp

has been made since then. Developing countries have strong views on this topic as they regard it as a means of discriminating against their exports.

- *GMOs:* Stakeholders linked to the industry side argue that more capacity building efforts for the development of GM varieties in the sector are needed (at present only CTC is conducting research on this and they are in an experimental phase). However as Chapter 3 highlighted, GMO is a very sensitive issue and therefore capacity building is also needed for an understanding of the different environmental (and social) implications associated with the introduction of GMO varieties in the sugarcane sector. The trade implications of the introduction of GMOs are also relevant and would need to be covered. These include addressing market access issues, as some markets (notably the EU) are opposed to the use of GMOs. Moreover it also requires understanding of regulatory aspects of international trade of GMOs, for example, the linkages between Multilateral Environmental Agreements (MEAs) - notably the Cartagena Protocol on Biosafety adopted under the framework of the Convention of Biological Diversity which regulates trade of GMOs - and the WTO rules. The relationship between MEAs and WTO trade provision is one of the aspects being covered by the current Doha Round at the WTO.[115]
- *Environmental legislation*: Chapter 3 highlights the issue that poor implementation and lack of enforcement of the environmental regulation is one of the key challenges to be overcome by the sector in order to improve many of the environmental problems confronted by the sugar/bioethanol sector in Brazil. At present, only the CETESB programmehas been found as targeting this issue. All the stakeholders interviewed in the context of this research mentioned the need of better enforcement of the environmental regulation as a high priority. Given its importance and the sheer scale of the challenge, therefore, more capacity building efforts in this field are urgently needed.
- *Social issues*: The vast majority of stakeholders interviewed in the context of this research mentioned the social aspects linked to the sugar/bioethanol sector as the most significant challenge facing the sector. One social aspect likely to become more and more prominent is the rural unemployment resulting from the mechanization of sugarcane harvesting (linked to the planned reductions in sugarcane burning). Thus, important capacity building efforts have been identified in the training and relocation of the non-skilled labour force employed in the sector. The business model, with enormous concentration of land and capital highlights the need for a better inclusion of small-scale producers. .
- *The ownership of the programmes*: stakeholders have stressed the importance of ownership as a key factor behind the success of the capacity building programmes. While ownership has been identified in the context of the industry-led capacity building programmes (notably CTC), lack of ownership or poor levels of ownership were mentioned in the context of some of the programmes linked to foreign institutions.
- *Confidence and support among stakeholders*: the need to build mutual trust/confidence and support among the stakeholders has also been highlighted as a key factor in increasing the effectiveness of the capacity building programmes. More specifically, this implies both the need for increased confidence between the industry and civil society sector and increased public support for some of the initiatives.

[115] See WTO 2001

5.2. Lessons learned from the Capacity Building Programmes

The previous sections highlight several lessons that can be drawn from the Brazilian experience with the capacity building in trade and environment programmes. These can be summarised as follows:

- Key programmes on capacity building in trade and environment in the sugar and bioethanol sector in Brazil include: technical and financial assistance for R&D; information dissemination and awareness raising campaigns; support for the development of standards and certification systems and; support for implementation/enforcement of the environmental legislation.
- A wide range of stakeholders have participated in the financing and execution of the programmes including international organizations such as World Bank, GEF and UNDP, the private sector, public sector and international NGOs. There is a lack of participation from third country governments.
- There are important differences in terms of the scope of the programmes and the type of environmental issue they aim to address. While some programmes address one specific issue, others aim to tackle many of the key environmental issues facing the sector.
- The vast majority of the capacity building programmes were found relevant in terms of the intended environmental issue they were addressing, although stakeholders' perspectives on the relevance of the programmes vary.
- In some cases the programmes were specifically designed for achieving environmental goals while, in other cases, the environmental impacts are linked to a collateral effect.
- The lack of information or institutional memory regarding some of the programmes has been a major drawback when assessing their effectiveness.
- More capacity building efforts are need in terms of: the coverage of environmental impacts (including 'global' issues such as expansion of the cultivation area and impacts on global climate; indirect impacts, GMOs, and implementation and enforcement of environmental regulation) but also in addressing the trade aspects linked to the sector.
- Social issues have been highlighted as the most important challenge facing the sector.
- Ownership of the programmes, confidence among different stakeholders and public support have been highlighted as key factors for improving the relevance and effectiveness of the programmes.
- There are important opportunities for South-South cooperation which have not been exploited yet.

6. CONCLUSIONS AND RECOMMENDATIONS

Brazil is the largest sugar producing and exporting country. Brazil is also the second largest bioethanol producer and the main global exporter. The external market has been a key driver for the expansion in the sugar industry that has taken place over the last two decades. Further trade liberalisation, notably under the EU CAP reform on sugar but particularly relating to expansion of the global biofuels market will be the key factor driving the new expansion phase of the sector.

The expected increase in sugarcane monoculture, sugar and bioethanol production is likely to place considerable added environmental pressure on the ecosystem. Key environmental issues of concern in the sugar/bioethanol sector include: land clearance and biodiversity impacts due to expansion of the cultivated area; impacts on air quality; impacts on global climate; impacts on water supply and availability; impacts on soil quality; increases in the use of agrochemicals and a rise in the use of GMOs.

Although environmental legislation addressing many of the aforementioned issues has been passed in Brazil, its implementation and enforcement is weak and this therefore arises as one of the key challenges confronting the sector in order to improve its environmental footprint.

Capacity building in trade and environment in the sugar/bioethanol sector in Brazil can be grouped into: technical and financial assistance for R&D; information dissemination and awareness raising campaigns; support for the development of standards and certification systems and; support for implementation and enforcement of the environmental legislation and; South South cooperation. The agencies that have participated in the financing of these programmes include international organizations such as the World Bank and the GEF, the private sector, the public sector and international NGOs. International cooperation (both from international institutions and third country governments) for capacity building in the sector is poor because the sector has not been a priority for international donors. As a result, capacity building in the sector has been primarily endogenous. However, international cooperation in the sector may increase as the sector is becoming more and more relevant for international donors.

The majority of the identified capacity building programmes were found relevant in terms of the intended environmental issue they were addressing. However there are important differences in terms of the scope of the programmes and the type of environmental issue they were targeting. While some programmes address one specific issue, others simultaneously target several of the environmental issues confronting the sector. While the majority of the programmes were designed to specifically target environmental goals, in a few cases the associated environmental impacts came as an indirect result. Moreover, the lack of available information regarding many of these programmes also acted as an obstable for assessing the programmes' relevance.

Several lessons learned and future needs have been identified from the analysis of the programmes. These relate to aspects of the sugar/bioethanol trade-environment debate that are not being properly covered, such as: expansion of agricultural frontiers and the related impacts on biodiversity and GHG emissions; indirect impacts related to the sector expansion; GMO introduction; implementation and enforcement of environmental regulation. The need to embrace the trade side of the trade-environment equation and social aspects is also important.

Information availability and institutional memory regarding the programmes is another area that needs to be improved.

Finally the ownership of the programmes, the need for increased confidence among different stakeholders and increased public support have been highlighted as key factors for improving the relevance and effectiveness of the programmes.

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