Green Business in Brazil
A Study of Sugar and Ethanol

by

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ABSTRACT

Globally green business has witnessed tremendous growth and is seen as an alternative to fossil fuel and solution to global climate change. Among the green businesses, biofuel industry has witnessed a tremendous growth globally. Brazil is the leading producer of ethanol at 27 Billion liters in 2009, based sugarcane. This report discusses the history of ethanol in Brazil by providing the role played by the government in making the ethanol program successful; the challenges and impact faced by sugarcane ethanol; and the future sustainability of sugar and ethanol.

Ever since the spike in oil prices globally and the increasing concern about carbon emissions and global climate change, Brazil has pursued a policy of promoting biofuel industry based on sugarcane as a solution to energy independence and its international climate change commitments. The blossoming of ethanol industry can be traced to a number of public policy initiatives. The initiatives taken by the Brazilian government to enhance the productivity of sugarcane cultivation through large investment in R&D is one crucial factor. The enhanced production of ethanol was accompanied by the initial development of vehicle operating purely on ethanol in the 80's to the revolutionary introduction of the Flexible-Fuel vehicles (FFVs) which is capable of running on gasoline and ethanol or at any blending rates of both fuels. FFV to a large extent has contributed to the development and sustenance of biofuel industry in Brazil. However, many analysts have cast doubt about the sustainability of the Brazilian ethanol program as the government had recently suggested lowering the current ethanol to gasoline blending rate for fuel in Brazil from 25 to 20 percent. The system seems to be facing needs for change through better planning and consideration for internal consumers. If ethanol prices continue to rise due to demand-supply unbalances, carbon emission targets could be impacted due to potential switching to gasoline. Studies have indicated that when ethanol prices are above the 70 percent ceiling price of gasoline, then consumers will switch to gasoline.

Brazil is on its way to become one of the major petroleum producer and perhaps exporter. The future of sugarcane ethanol can be jeopardized if Brazil manages to tap into the potential oil reserves along the eastern coastline, which may cause an oversupply of cheaper petroleum base fuel causing lesser demand for ethanol, which can lead to producers switching back to sugar production.

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GLOSSARY

Units of Measure

Barrels of oil per day	bbl/d
Billions	B
US Dollars	Dollars or $
Gallons	US Gallons
Giga Watts	GW
Millions	M
Hectare	ha.
Hectare per year	ha/year
Kilograms	kg
Volume in cubic meter	m^3

CHAPTER 1.0 INTRODUCTION

Brazil is one of the fastest growing world economies in the last decade along with Russia, India and China. These four developing nations are commonly known as BRIC countries representing the 'new' global economic growth engines. Brazil is also the leading country in renewable energy source like biofuels. Biofuels industries are considered as a solution to our current dependency on fossil-fuel due to the escalating petroleum costs and a potential solution to global climate change (Pacala and Sokolow, 2004). Pressures to increase the use of renewable energy sources due to climate change concerns and to ensure energy independence have made countries searching for alternatives to fossil fuel source like biofuels. Globally biofuels production is mainly concentrated in Brazil, the USA and certain European Union (EU) countries.

Biofuels have credentials as "green business" since it has less carbon footprint compared to fossil-fuel and can be considered as a partial solution to global fossil fuel problems. The production of ethanol in US is based predominantly on corn while EU countries use rapeseed. In Brazil, ethanol is produced predominantly on sugarcane (UNEP, 2009). Internationally, the knock-on effects of growing biofuel crops have raised a lot of questions about the sustainability of the ethanol industry, in terms of arable crop land being used for fuel production and the use of fertlizers for biofuel crops which is an important contributor to greenhouse gas (GHG). In contrast, Brazil has earned a clean bill and acclaimed by international researchers and global communities for its strategy

to attain energy and food security balance without a lot of negative trade-offs (UNICA, 2009). Brazil has emerged as one of the most important economy in sugarcane ethanol industry with production rising from 11 M liters in 1990/91 to 27 M liters in 2008/9; an increase of 58 percent in production in less than two (2) decades (UNICA, 2009). There are currently nearly 300 sugar-ethanol mills in operation in Brazil, with 60 or more under construction. Brazil's ethanol is often held up as a model of sustainable biofuel production. In Brazil, all gasoline sold contains around 25 percent ethanol as per Brazilian federal government directive, as compared with 7 to 10 percent in North America and Europe (European Commission, 2004). Today, international and local oil companies have also invested in gasoline stations offering both gasoline-ethanol fuel blend and pure ethanol in Brazil. Although the Brazilian experience in regards to green business and biofuel is widely cited in international reports, there are no systematic study on Brazilian biofuel industry business structure, growth and trade-offs.

The present study contributes to the literature by studying green business experience of biofuel industry in Brazil, by examining the trade-offs involved in attaining energy, environmental soundness and food security. The study is organised as follows: Chapter 2 critically reviews the literature on this subject. Chapter 3 is devoted to an analysis of the history of ethanol in Brazil. Chapter 4 look at the challenges and impacts of ethanol production in Brazil. Chapter 5 examines the future of sugar ethanol in terms of production, demand trends and its consequences for energy independence, food prices and environmental impacts. Chapter 6 summarises the conclusion found through the preparation of this report.

CHAPTER 2.0 LITERATURE REVIEW

The literature on biofuel industry is recent but is growing more attention amongst researchers. This chapter briefly reviews the pros and cons of biofuel industry. This chapter is organised as follows: Section 1 defines the concept of bioenergy. Section 2 discusses the various types of biofuels and Section 3 discusses the Brazilian experience with biofuel sugarcane based.

SECTION 1.0 WHAT IS BIOENERGY?

Bioenergy is defined as the energy generated through biofuels that are produced from renewable sources of plant origin (Nass, Pereira and Ellis, 2007). More specificially, ethanol produced from sugar or starch derived from grains/biomass and biodiesel obtained from the processing of edible and non-edible vegetable oils can be used as fuel for powering automobiles. But the increasing attention of biofuels is on account of a number of environmental, social and economic reasons. First, the use of biofuels may lead to reduction in vehicular pollution and GHG emissions as it is established that emissions of sulphur dioxide (SO_2), carbon monoxide (CO) and other gasses are less in biofuels compared to gasoline. The economic benefit arising out of the development of biofuel sector in terms of increasing income and employment opportunities to rural areas is also highlighted (UNCTAD, 2006). Studies have also raised concerns about the environmental sustainability of biofuels production with overall GHG emissions based on life cycle analysis as it could pose threat to water and food supply (IEA, 2008; FAO, 2008)

SECTION 2.0 TYPES OF BIOFUEL

Currently there are broadly two types of biofuels:

- First generation biofuels
- Second generation biofuels.

The first generation biofuels are made from biomass consisting of sugar, starch, vegetable oils, animal starch or biodegradable output wastes from agriculture, industry, forestry and households using conventional technologies. Some examples of first generation biofuels include crops and seed from sugarcane, maize, oil seed crops and etc.

Second generation biofuel technologies are gaining more importance as the first generation biofuels cannot be produced beyond a certain threshold without threatening food security. Moreover, they are no cost competitive with existing fossil fuels. The second generation fuels are more sustainable, affordable and have greater environmental benefits. Examples of some second generation biofuels are fuels from crop waste, wood and solid waste.

SECTION 3.0 BRAZILIAN EXPERIENCE WITH BIOFUELS BASED ON SUGARCANE

The Brazilian Development Bank (BNDES, 2008) has published a study on the sustainability opf sugarcane based ethanol and found that the energy ratio and GHG emission of most biofuels are not encouraging except for sugarcane based ethanol. Sugarcane ethanol presents the highest energy ratio (9.3) and it can avoid 89 percent of GHG emissions when used as fuel for transportation.

In addition, ethanol mills in Brazil are sustainable and use the bagasse to generate power for ethanol and sugar production. The study also stressed the

importance of choosing the correct biofuel in terms of overall efficiencies and requirements. GHG emission reduction is one of the main reasons why sugarcane ethanol is more desirable. In 2003, the use of ethanol as an alternative to gasoline, and utilization of bagasse to power sugar and ethanol mills reduced CO_2 emissions by 27.5 M tonne and 5.7 M tonne in Brazil, respectively. In addition to the sustainability of sugarcane biofuel, the Brazilian government played an important role by encouraging the use of biofuel in the transportation sector by providing producers with subsidies and consumers a tax rebate. However, this scenario has changed in 1990 with a new set of rules for private companies to participate directly in the ethanol market. A number of institutions were created to implement, analyze policies related to ethanol activities, and to protect consumers in terms of quality, prices, and supply.

This study also stresses the role of research and development as one of the most important factors underlying the success of the ethanol program in Brazil. As a result, the productivity of sugarcane has rised by 2.3% yeilding over 80 tonnes/ha., thanks to better technology applied for pest control, improved management control, and greater soil selectivity.

These efforts have been accomplished by government actions and investments. In partnership with private companies and universities, the Government of Sao Paulo had assisted in the creation of a number of education institutions and universities dedicated to the research and development of technologies applied to the sugar-ethanol production. Sao Paulo is also home to one of the most important local university which has been responsible for almost half of all scientific researches on sugarcane ethanol conducted in the country. The

technological knowledge that the government had created has been extremely important for the development and growth of the industry in Brazil. The knowledge and experience acquired througout the years had contributted to higher quality technologies, greater efficiency, and better profits.

In contrast to the advantages of sugarcane ethanol, Zuurbier and de Vooren (2008) present a study where it implies that there are a few disadvantages linked to the increase in ethanol production. They stressed that sugarcane plantation area in Brazil has increased by 300,000 ha. from 2000 to 2007, with most of this expansion occurring in Sao Paulo. They suggested that the increase in ethanol production can represent a threat to food security and could affect the availability of arable land for food cultivation causing potential reduction in food supplies and an increase in food prices. In addition to food security, the expansion of sugarcane plantation can also cause deforestation and loss of natural habitat.

The Food and Agriculture Organization (FAO) study provides the definition of food security and identifies countries facing food shortages. They also list countries that are most affected by the rise of food prices (FAO, 2002). Based on this concept, the concern is not regarding whether farmers in Brazil are taking arable land from food to produce ethanol, but how the government will be able to sustain the internal consumption without jeopardizing sugar prices.

Mosera's study (2009) cites the increasing sugar prices as the cost of ethanol production in Brazil and discovered that the use of ethanol in the country is only advantageous when the ethanol price is 30 percent below gasoline. Among 28 Brazilian states, only two states have ethanol prices below the 30 percent threshold.

Brazilian ethanol and sugar mills have the flexibility to switch to either ethanol or sugar production depending on which is the product that brings more profit. The Brazilian market has the power to control prices internally and externally for those importing ethanol from the country. Based on the sugar prices acquired through Sugar Online (2010) and according to sugar specialists from the same source, Brazil can easily switch their sugarcane plant to produce more sugar to take advantage of the high sugar prices, and vice versa to produce more ethanol and reduce sugar production for similar reason. However the internal ethanol program and consumption that has been in placed for so many years could be jeopardize should the government decide to produce more sugar.

CHAPTER 3.0 THE FOUR HISTORIC PHASES OF ETHANOL INDUSTRY IN BRAZIL

Sugarcane in Brazil has an interesting history dating back to 16th century when it was first introduced in the state of Pernambuco. Sugar became one of the commodities exported by Portuguese settlers to Europe making Brazil the world major source of sugar until the 19th century when it was surpassed by coffee. In 2005, sugarcane was classified in Brazil as the 4th agricultural product after cattle, soybean and chicken (Nass, Pereira and Ellis, 2007). Sugarcane in Brazil is mostly produced into sugar, ethanol, cachaça (local rum) and other products. Brazilian sugarcane ethanol industry was triggered and catalyzed by the fluctuating high oil and sugar prices.

This chapter discusses the history of sugar and ethanol in Brazil and the main events which took place as part of the development of the ethanol industry. Section 1 describes the Pre-ProAlcohol Era which took place between 1930 to 1975. Section 2 describes the Pro-Alcohol Era between 1975 to 1985. Section 3 describes the Uncertanty Era which occured during 1988 to 1995. Section 4 reviews the history of the free market economy from 1995 up to today's market, followed by Section 6, summarizing and concluding findings from this chapter.

SECTION 1.0 PRE-PROALCOHOL ERA 1930-75'S

The Brazilian government's interest in ethanol began in 1931 with the formation of the Institute of Sugar and Alcohol (Instituto do Açúcar e do Álcool)

and legislation allowing blending of up to 40% (E-40) ethanol in gasoline with the intention to reduce oil import. The sugarcane industry was encouraged to produce as much ethanol as they could to decrease dependency of imported oil especially during World War II. Even back in the 1930's, Brazil had a huge imbalance of trade due to the importation and consumption of oil. Unfortunately, Brazil's attempts to decrease oil imports even with the addition of ethanol into gasoline were not successful during this period.

After the end of World War II, when cheaper oil was available, blending of ethanol into gasoline was used sporadically. This was mostly performed to take advantage of sugar surpluses until the 70's when the world faced its first oil crisis.

In the 1970's, high oil prices reached record high doubling Brazil's oil import payments by 1974. These payments were the prime driver for altering Brazil's political view by enhancing and supporting a stronger ethanol industry internally. During the 60's to 70's, the country experienced a strong economic growth under the military regime and they recognized the importance of maintaining the economic growth and the demand for energy to sustain the growth of the country. Superimposed on this was the powerful political clout of sugarcane growers and processors, who were seeking for an alternative market to sustain the highly fluctuating sugar market and prices. These pressures led to the creation of the National Alcohol Program in Nov. 14, 1974.

SECTION 2.0 PRO-ALCOHOL ERA 1975-1985

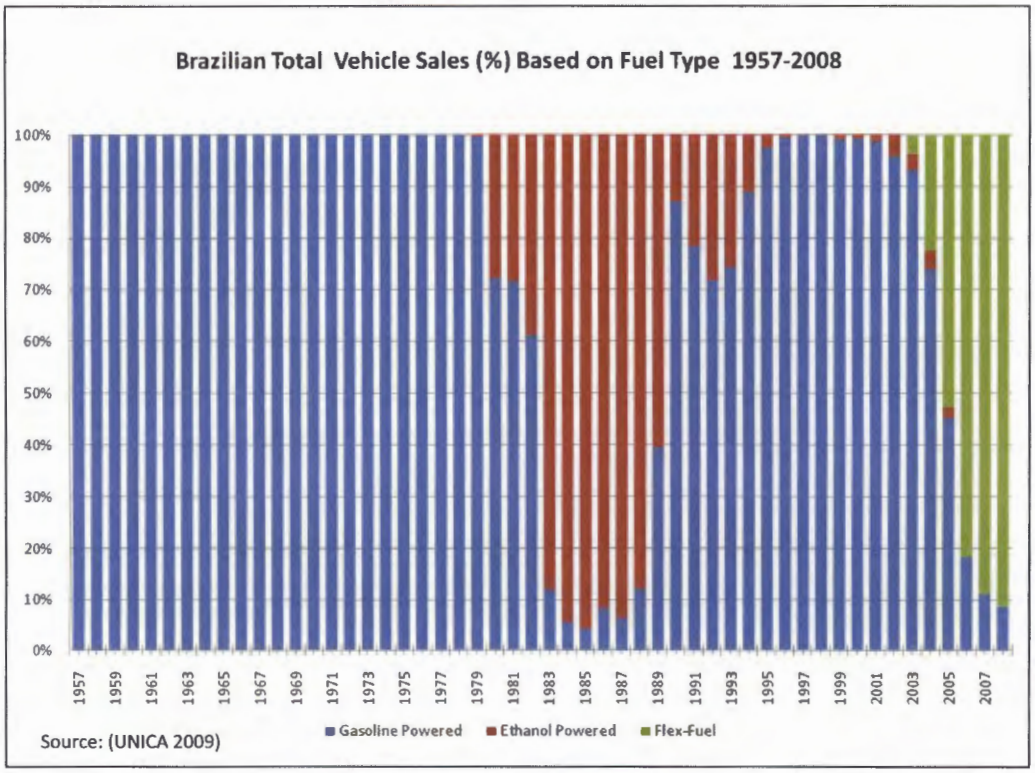
The success of Pro-Alcohol was contributed by stringent governmental controls on supply and demand, which were both stimulated and adjusted through a centralized control system. In 1975, the government established a five year

annual ethanol production targets of 3 B liters/year up to 1980 and more than doubling this value to 7 B liters/year from 1981-85.

This was achieved through the government's role in several programs to stimulate growth of infrastructure and research to increase production which includes:

- Low interest loan provided by state-owned bank, Banco do Brazil, at less than 25% annual percentage rate for the expansion of ethanol distilleries, plants and infrastructure which was highly successful in increasing ethanol production
- Price and production control by the government to regulate prices and production quotas were established to mitigate overproduction
- Ethanol producers were guaranteed by PETROBRAS, the state-owned oil company, that they will buy all the ethanol produced under the quota established by the government at a fixed price. This generated confidence to producers and encouraged growth within the industry
- Export control and sugar production quotas to reduce raw material competition between sugar and ethanol
- Heavy invesment in R & D to improve production efficiencies and reduce costs

Figure 3-1 Brazilian Total Vehicle Fuel Type Sales



By the late 70's, sugarcane growers, ethanol producers and sugar companies became wary of their industry's long term sustainability on high government dependency and formed the Cooperative of Sugar, Alcohol and Sugarcane Producers (Copersucar). The Copersucar Center of Technology (CTC) became the centralized location and coordinator for subsidized research in breeding, milling, and fermentation.

In 1979, the Otto-cycle engines operating on 100% alcohol was release into Brazil automotive market. To further encourage the ethanol industry, the government lower taxes on ethanol fuelled cars and in early 80's decreased licensing fees for ethanol fuelled cars in Brazil. By 1984, 96 percent of new cars sold in Brazil were ethanol fuelled (Figure 3-1, Shown in red bars).

The challenge faced by the central government was to balance supply and to satisfy internal demand, while sustaining the country's economic growth. Inflation rates were rising in Brazil during this period and at the same time the government was investing heavily in ethanol production and the industry's infrastructures; where up to 80 percent of all the investment was from government subsidies and tax incentives.

A strategic approach made by the Brazilian government to further promote the ethanol industry was by making the ethanol available to Brazilians through the installation of ethanol pumps at all PETROBRAS gas stations nationwide (Figure 3-2) and the introduction of ethanol fuelled vehicles. Today, PETROBRAS has more than 6,000 gas stations in Brazil serving ethanol, gasoline and diesel.

Figure 3-2 Gasoline (G) and Ethanol (A) at PETROBRAS' Gas Station in Brazil

Source: http://en.wikipedia.org/wiki/Ethanol_fuel_in_Brazil

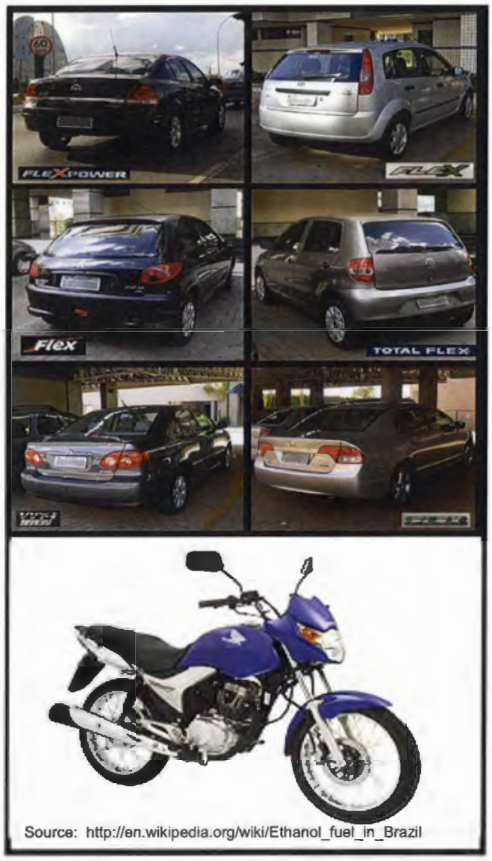
SECTION 3.0 UNCERTAINTIES DURING 1985 TO 1995

Throughout the 80', Brazil faced serious economic problems with inflation rate reaching 235% in 1985. The cost of running the ethanol program was increasingly high in the time when global oil prices were quite low. Ethanol production was increasingly expensive for the government because the industry was established purely on subsidies. Funding for ethanol R & D decreased slowing technological improvements and reducing efficiency. The government then set the guaranteed price of alcohol below production costs in 1986/87, causing burden on the ethanol industry. At the same time the sugar industry was more favourable with strengthening world sugar markets causing sales of ethanol-fuelled vehicles to plummet. These sales were spiralling further downward with the government elimination of lower tax rates for ethanol cars – clearly reflecting the lost of consumer confidence in 1995 (Figure 3-1).

By 1988, a new constitution was drafted phasing out all ethanol subsidies followed by the privatization of steel, mining, and energy sectors. The Pro-Alcohol program was officially terminated. Prior to this, the Copersucar cooperative had already strategically initiated programs to survive without government subsidies. This initiative was crucial for ethanol producers' survival especially in the central-south region where it already had significantly lower production costs, compare to the rest of the nation. With the lowering of sugar export quotas, the growers and processors could quickly switch from ethanol to sugar production, and increase sugar export. Ethanol blend in gasoline increased from E-10 to E-20, which protected the alcohol market from complete collapse. Since then ethanol

production increased by 30 fold with yield per ha. and production costs declined by 75 percent (Nass, Pereira and Ellis, 2007).

Figure 3-3 Flex-Fuelled Vehicles in Brazil



Source: http://en.wikipedia.org/wiki/Ethanol_fuel_in_Brazil

SECTION 4.0 FREE-MARKET ECONOMY: 1995 TO PRESENT

By early 90's, the inflation rate was brought under control and the regulation on the ethanol industry ended in 1999 except for the blending mandates. The government continued to support Copersucar. A grossly overestimated demand, high harvest rates, and high sugar prices led to overproduction of both sugarcane and alcohol in the late 1990s. The 1998/99 growing season was called the "super harvest" due to extraordinarily favourable climatic conditions for sugarcane production. The overproduction affected global sugar markets causing a decline in sugar prices. This led to 30% reduction in Brazilian sugarcane production in the following year, plummeting to 1985 levels. In early 2000's, oil prices began to rise making ethanol production marginally profitable again and competitive with gasoline prices. Interest in ethanol-fuelled cars was renewed but was still low compared with gasoline cars.

The development of Flexible-Fuel Vehicles (FFVs) in 2003, which are vehicles capable of running on gasoline, ethanol, or any combination of both fuels, renewed customers interest in ethanol enabling consumers to purchase fuels based on availability, cost and performance, making Brazil the leader in this technology as shown by the models of vehicles and motorcycle in Figure 3-3. FFV captured 20 percent of Brazilian market share during the first year of rising oil prices in early 2000's. By 2006, about 75 percent of all new cars manufactured in Brazil were FFVs at similar market price to gasoline power vehicles. Figure 3-1, graphically shows the ratio of ethanol to gasoline vehicle ratios where the green coloured bars represent FFV.

Today, ethanol has been promoted nationally and internationally for its positive energy balance which means that the energy contained in a tonne of ethanol is greater than the energy used to produce it (Nass, Pereira and Ellis, 2007). The outlook for ethanol production remains positive in Brazil due to the potential growth in sugarcane production, the competitive advantage of sugarcane ethanol for environmental concerns, and the long history and experience of ethanol and sugarcane industry. The ethanol program has been able to displace more than 280 B liters of gasoline and saved more than $65 B in cost of oil import in Brazil since 1975 (Moreira, 2006).

Besides being used for transportation, ethanol in Brazil is also used to produce the famous cachaça, rum, and others products. Ethanol production in Brazil had increased to almost 18 B liters in 2006, which is close to half the world's total production (REN21, 2008).

The fame of Brazilian sugarcane ethanol worldwide has made etahnol production increased to 58.14 percent since 1990/91 and reached a record in production of 27.5 B liters in 2008/9. Figure 3-4 shows the ethanol production and the percentage change.

Figure 3-4 Brazil's Ethanol Production 1990-2009

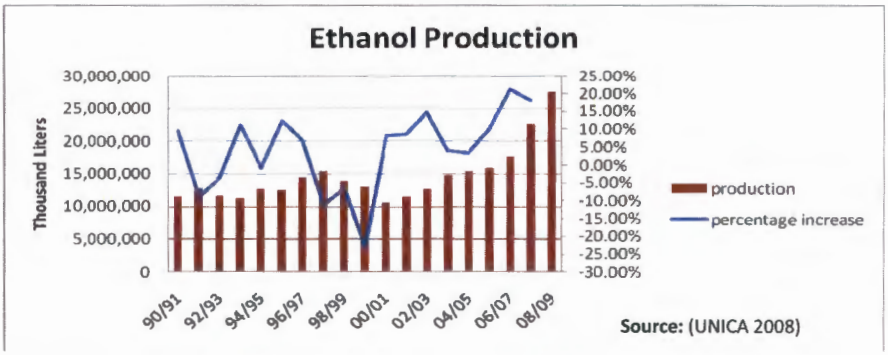


Figure 3-5 Brazil's Sugar Production 1990-2009

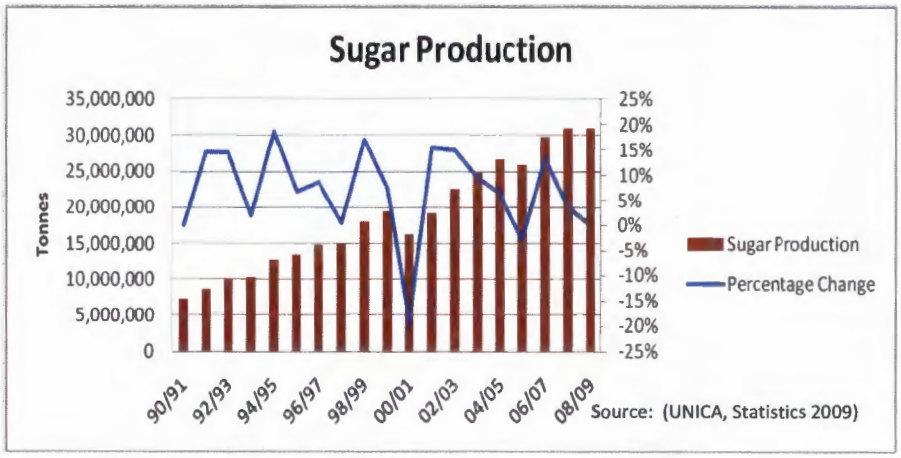
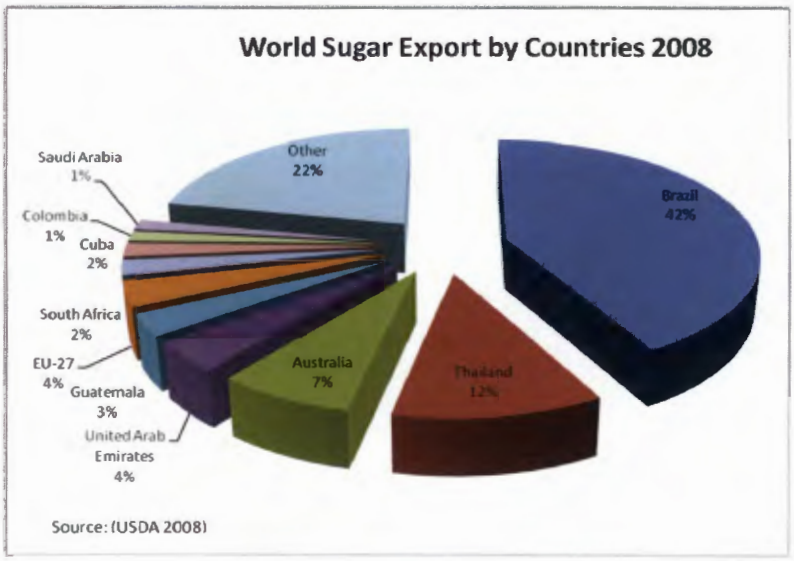


Figure 3-6 World Sugar Export 2008



The increase in the Brazilian ethanol production is mainly contributed by the role played by the government establishing mandates to be independent of oil imports, promoting production, research, infrastructure through subsidies, ensuring producers sales of ethanol to state-owned oil company in the 70's, and the introduction of FFV at the turn of this century to rejuvenate internal market confidence and a good reflective of global demand for less GHG emissions.

On the other hand, sugar production in Brazil has increased by 76 percent since 1991. In the crop year of 2008/9 production jumped to a record of 31,049,206 M tonnes (Figure 3-5). The blue line in the figure represents the percentage change in production where it can be observed that production is not constant and dropped drastically in 2000/1 to negative 19.3 percent due to bad weather conditions in Brazil. The market immediately responded by increasing production (15.4 percent) in 2002/3; however that is followed by dropped of negative 2.8 percent in 2005/6, indicating fluctuating production rate due to various drivers – fuel prices, sugar demand and climatic conditions.

In 2008, Brazil had a market share of 42 percent of the world sugar export followed by Thailand and Australia (Figure 3-6). In the crop year of 1999 – 2000 Brazil exported over 11 M tonnes of sugar. From 1999 to 2009 Brazilian sugar export had a tremendous growth of 46.5 percent exporting over 24 M tonnes of sugar in 2009.

Brazil has been able to attend to both bioenergy and food production sectors simultaneously because of the production plants (Figure 3-7) capabilities to switch to either ethanol or sugar depending on the market demand. By 2006, the amount of sugar to ethanol production is almost equal at 45 percent and 55 percent respectively (Nass, Pereira and Ellis 2007). Figure 3-8 outlines the sugar to ethanol production ratio from 1948 to 2009 and in 2009 with the distribution of sugar to ethanol at 39 percent and 61 percent for ethanol. In 1980, the ethanol market had a significant expansion driven by government policies. From 1988 to 2000, the ethanol program suffered stagnation but the market started to rapidly recover and expand in the 2000's due to high internal demand.

The Table 3-1 summarizes the five different cycles the ethanol industry has gone through between the 1930's to today's market.

Figure 3-7 Costa Pinto Production Plant, Piracicaba, Sao Paulo

Figure 3-8 Sugar/Ethanol Distribution

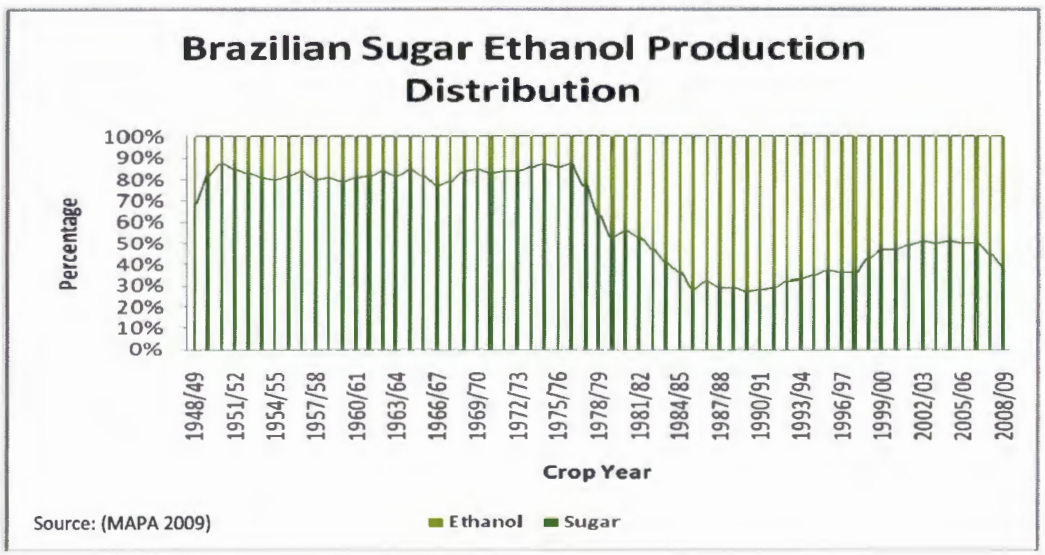


Table 3-1 Ethanol Industry in Brazil

Time Line	Description
Pre - ProAlcohol Era 1930-70's	• Formation of Institute of Sugar and Alcohol • Legislation allowing up to 40 percent ethanol blend to reduce oil import • Encouragement to produce ethanol • High oil prices, double Brazil's oil import payments • Political support on ethanol industry & Brazil economic growth • Ethanol an alternative to sustain industry during fluctuating sugar prices • Creation of National Alcohol Program – ProAlcohol (14 Nov. 1974)
ProAlcohol Era 1975 to 1985	• Production targets were set at 3 B liters in 1980 and 7 B liters by 1985 • Government incentives provided market confidence encouraged growth • Low interest loans for ethanol processing plant expansion infrastructure • Price regulation and production quotas to prevent over production • Petrobras purchase all ethanol produced under quota at a fixed price • Supply chain control imposed on export and production on sugar • Late 70's sugarcane growers became wary of subsidiaries dependency • Copersucar formed to coordinate ethanol research and development • Late 70's Otto-cycle engines operate on 100 percent (E-100) ethanol. • Brazil lower taxes on ethanol-fueled vehicles to encourage consumer use • 1980's decreased yearly license fees on ethanol cars • By 1984, 96 percent of all new cars sold in Brazil were ethanol fueled
Uncertainties: 1985 to 1995	• Inflation reached 235 percent in 1985 • Operating costs of ethanol program was high during low oil prices • Decreased funding for R&D and subsidiaries • Government fixed guaranteed price below production costs in 1986–1987 • Producers looked at more favorable strengthening world sugar markets • Ethanol car sales dropped • 1988 Brazilian new constitution phasing out ethanol subsidies • ProAlcohol was officially terminated • Copersucar cooperative initiated "subsidies-less survivor" programs significantly lowering production costs in Brazil's central-south region • Lower sugar export quotas allowing the switch from ethanol to sugar production, increased sugar exports making made Brazil a leader in the global sugar market. • Gasoline/Ethanol (Gasohol) blends increased from E-10 to E-20 protected the alcohol market from complete collapse.
Free-Market Economy: 1995 to Present	• Brazilian economy brought under control in the early 1990's • Ethanol regulations ended except for authority to gasohol blending rates • Government continued support research by Copersucar • Overestimated demand, high harvest rates, and high sugar prices led to overproduction of sugarcane and alcohol in the late 1990s • 1998–1999 sugarcane "Super harvest" caused decline sugar prices, leading to 30 percent reduction sugarcane production in 1999. Sugar and ethanol production plummeted to 1985 levels • Early 2000's, high oil prices rises made ethanol marginally profitable • Brazil developed flexible-fuel vehicles (FFV's), capturing 20 percent new-car market share in the first year of rising oil prices • 2006, 75 percent of new cars manufactured in Brazil were FFV's making Brazil the leader in FFV technology (IEA, 2006) • Brazil remains the world's largest producer of sugar • Brazil least oil dependent vehicle fleets in the world, the largest sugarcane and sugar producer and the second-largest ethanol producer

Source: (Nass, Pereira and Ellis, 2007)

SECTION 5.0 CONCLUSION

The development of ethanol industry in Brazil was driven by oil prices shock in 1973. The shock created strain in the balance of payments position of Brazil and efforts were made to mitigate the overall induced shock by high oil prices. One of the solutions to the balance of payments problem is to promote an alternative fuel source independent of oil, which is the production and use of sugarcane ethanol in Brazil since there were abundance of sugarcane in the country. The price of oil is independent on the national market but has profound influence on the Brazilian economy and influences the use of sugarcane for sugar and ethanol production.

Ethanol was highly subsidized by the government until 1999 when it became more market based attracting more investors from the private sector. Since then ethanol production increased by 30 fold with yield per ha. recording a leap to the industry largely facilitated through research and development which funded by the government and private sector in the past decades. As a result of government subsidies, the production costs has declined by 75 percent due to efficiency gains and technological improvements.

The ethanol industry received a boost with the introduction of FFVs in 2003 which has gained popularity amongst Brazilians. The large scale introduction of FFVs have increased the production of ethanol. Brazil has been able to attend to both bioenergy and food production needs simultaneously because of the sugar and ethanol plants capabilities to switch either to suagr or ethanol production depending on the market demand.

CHAPTER 4.0 CHALLENGES AND IMPACTS OF SUGARCANE ETHANOL

There is an increasing global recognition on Brazil for their advantages in sugarcane ethanol compared to other types of biofuels available in the market. These advantages include environmental, economic, and production process, are key factors to the success of the Brazilian ethanol industry. However at the same time, the Brazilian ethanol industry faces some challenges. This chapter analyses the impacts of high demand for sugarcane ethanol and its prospective impact on the Brazilian economy. The chapter is organized as follows: Section 1 briefly discusses the influence of weather condition on sugarcane plantation, its effects on ethanol and sugar production. Section 2 describes the issues of supply and demand of ethanol, and the impact on ethanol and sugar prices. Section 3 discusses the use of land for fuel instead of food production and how it could affect food security in Brazil.

SECTION 1.0 THE IMPACT OF THE WEATHER IN ETHANOL AND SUGAR PRODUCTION

The rainy season has been adversely impacting sugarcane harvest in Brazil since late September 2009 and it has been one of the important factor for shortages of sugarcane and high sugar prices in Brazil recently (Figure 4-1). This has also led to much speculative activity in this field due to uncertanties associated with weather conditions on sugarcane production. Market specialists from University of Sao Paulo are predicting that weather conditions will be more favorable for sugarcane plantation in 2010 which will provide better yield, bringing prices down

and will benefit domestic consumers and exporters (Moser, 2010). However, based on the experience with sugarcane harvesting in 2009, no one could predict whether this statement can be considered accurate.

In addition to the bad weather conditions, the recent global financial crisis, sugar and ethanol industry in the state of Sao Paulo was faced by adverse financial situations. The excess rain in the previous years, and high level of debt has contributed to high prices for suagr and ethanol. Brazilian analysts are predicting that the industry is far from financial recovery. Many sugarcane mills are still in default or experiencing high short term debt (Moser, 2010). A local ethanol and sugarcane plant in the Minas Gerais state had delayed employees' payment for the month of December in 2009 causing the plant to shutdown due to strike (Passos News, 2009). A resolution signed by the Brazilian National Agency of Petroleum, Natural Gas and Biofuel on Dec. 22, 2009, has established a new market for the biofuel industry where trading companies and commodities operating agencies are allowed to enter and participate in the Brazilian ethanol market. This is expected to bring more stability, price reduction, and control market fluctuation. Before this, the power over price was concentrated on the distributors where producers were only allowed to deal directly with distributors (Moser, 2010).

Figure 4-1 Sugarcane Field for Sugar/Ethanol Production

SECTION 2.0 THE IMPACT ON SUGAR AND ETHANOL PRICES

There is little doubt that the demand for sugar and ethanol grew internationally and sugarcane producers have been confronted by a difficult market situation where they have to choose to either produce ethanol or sugar; (a commodity that seems to be a profitable choice when prices are higher).

As a solution to high ethanol prices and supply shortages, Brazilian government had indicated that one of the measure is to decrease the blending mandate from E25 (25 percent ethanol and 75 percent gasoline) to E20. If this blending mandate is lowered it will automatically affects sugar and ethanol mills that are trying to catch up with their production. Inversely, if no action is taken by

local government, ethanol prices will rise, and consumers will search for a substitute by purchasing gasoline (Moser, 2010).

Consumers had already started reacting to high ethanol prices and switching to gasoline in many Brazilian states. According to an article published by local news on Jan 06, 2010 (UOL, 2010), it is more advantageous to use gasoline in 20 Brazilian States and only eight (8) of these states are benefiting from lower ethanol prices. The use of ethanol is only advantageous when the price is 30 percent below gasoline. The table below compares the price of ethanol to gasoline and provides the parity between these two. It is noticeable that among these eight states, two of them (Alagoas and Bahia) have reached the 30/70 percent price parity while the remaining states are closed to this value.

Table 4-1 Ethanol Price Comparison

Prices Comparison			
State	**Alcohol**	**Gasoline**	**Parity**
Alagoas	R$ 1,93	R$ 2,74	70%
Bahia	R$ 1,77	R$ 2,53	70%
Goiás	R$ 1,65	R$ 2,64	63%
Mato Grosso do Sul	R$ 1,60	R$ 2,78	58%
Paraná	R$ 1,68	R$ 2,54	66%
Pernambuco	R$ 1,76	R$ 2,64	67%
São Paulo	R$ 1,60	R$ 2,44	66%
Tocantins	R$ 1,81	R$ 2,75	66%
Source: (UOL, 2010)			

Similar to ethanol prices, the high sugar prices have also reached consumers' pocket in Brazil in the beginning of 2010. During a market research made on sugar price, it was discovered that 5 kg of sugar, were sold at $5.90 Brazilian Reais (R$) before and currently is at R$9,00 which is the equivalent of US$5.11. This affected bakery goods and sweets prices yielding a price increase of

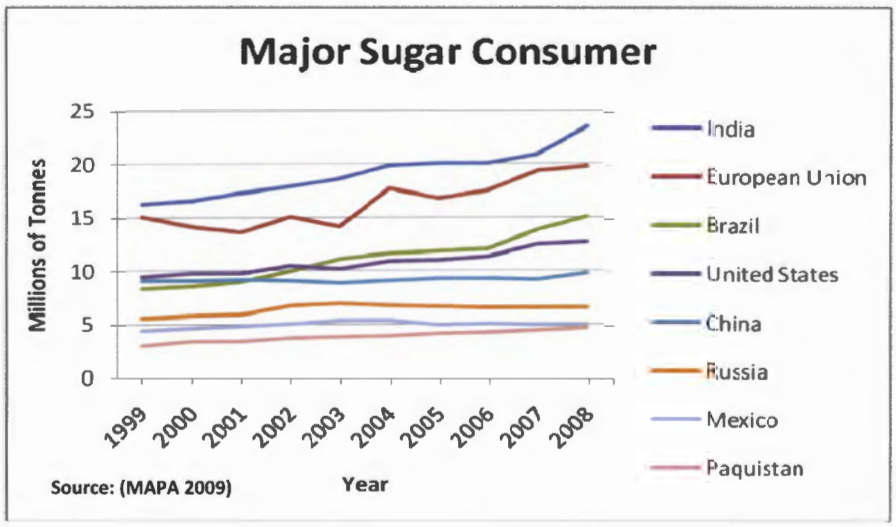
approximately 10 percent (Jatoba, 2010). Since Brazil is one of the world's sugar producer and exporter, consumers are now questioning the internal sugar market system and wondering if they will be able to continue consuming sugar as they were before. Many of these consumers have already mentioned that they have to either reduce their sugar consumption or look for sugar substitutes that offer a better price. The same occurred in Malaysia with the increase in sugar price of $0.20 Ringgit Malaysia (RM$) per kg reported by the local Malaysian News paper the New Straits Times on Jan. 1st, 2010.

Weather and climatic conditions are also contributors to the shortage in sugarcane yield and a factor governing sugar/ethanol prices. A bad monsoon rainfall in India during 2009 season had affected Indian sugar output compared to the previous year's production figures. According to a market report published by the International Sugar Organization in 2009, the sugar output for the current season will be 9 percent less than last year which will make India a major player in the sugar market imports (ISO2, 2009).

This coupled with high demand for ethanol is likely to catalyst producers to switch their production line, either to sugar or ethanol based on the product that provides a better return. This has adverse effects on sugar production during high oil prices when vehicle owners filled their tanks with ethanol when it is below the 70% parity.

Since India, EU and Brazil are the major sugar consumers at 23 M, 19 M 15 M tonne respectively in 2008; any crop production interruption due to climatic conditions will have positive impact on the supply demand and price of sugar and ethanol leading to a negative impact on food source (Figure 4-2).

Figure 4-2 World Major Consumer



SECTION 3.0 LAND USE

One of the implications of sugarcane ethanol is the use of land for feedstock fuel instead of food production. According to Zuurbier and de Vooren (2008), sugarcane plantation in Brazil had increase approximately 300,000 ha. from 2000 to 2007. Most of this expansion had occurred in Sao Paulo representing 70 percent increase in sugarcane plantation in Sao Paulo state (Figure 4-3). The same area is also expected to be expanded for future sugarcane plantation due to future ethanol demand. Sugarcane plantation is mainly concentrated in the South-East of Brazil because of favorable weather conditions and soil characteristics.

The most concerning issue in the Brazilian ethanol expansion is the threat for food security. Even though some argue that Brazil is a large country with ample land for plantation, a rapid sugarcane expansion area can affect the availability of arable land for food cultivation which can potentially cause reduction in food supplies and increase in food prices. Similarly can be faced by India and other developing countries growing grains to produce biofuel. In Brazil

for example, the main grain crop area plantation had decreased by 0.9 M ha. in Sao Paulo State, while sugarcane planted area expanded by 1.7 M ha. in 2007.

Another concerning area that has grown rapidly and requires further study is soybean plantation which has potential for biodiesel production. The plantation area for soybeans in Brazil has increased from less than 10 M ha. in the 1980's to around 23 M ha. in 2008, corresponding to more than a third of all cropping land available in Brazil (Zuurbier and de Vooren, 2008).

Figure 4-4 presents the sugarcane plantation evolution since 1975 when the area designated for sugarcane was only 1.9 M ha. By 2008, sugarcane area plantation jumped to 8.92 M ha.

Figure 4-3 Areas of Environmentally Valuable Area and Sugarcane Plantation

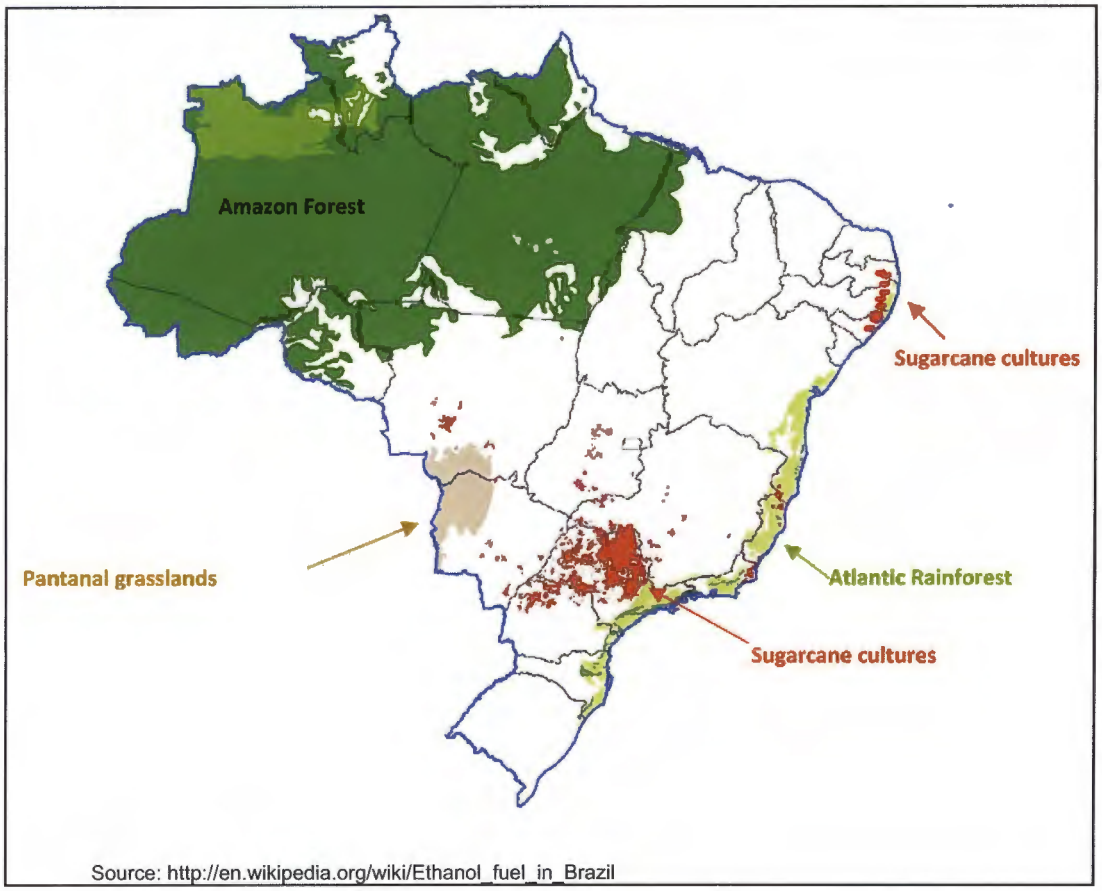
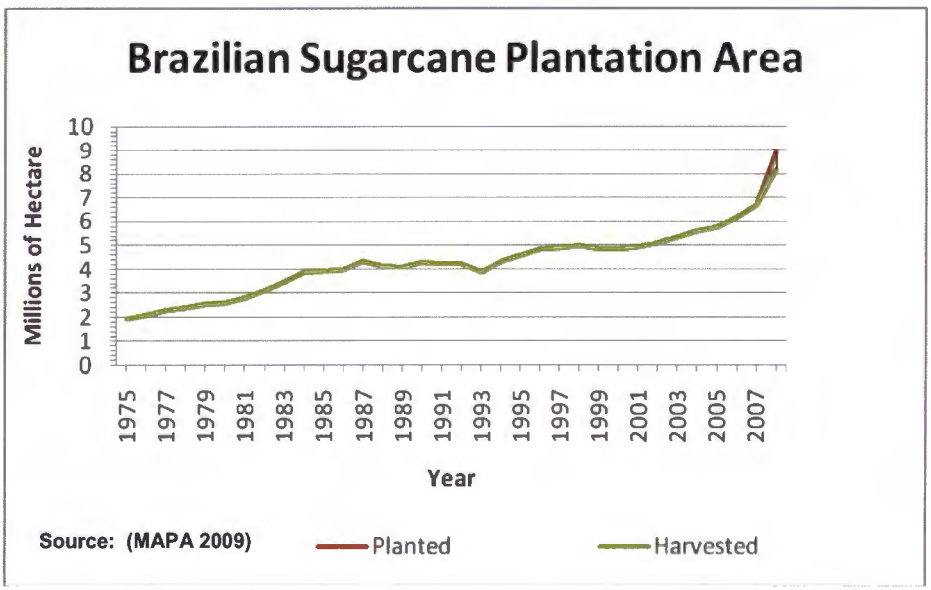


Figure 4-4 Brazil's Sugarcane Plantation Area



The sugarcane plantation is expected to continue growing in Brazil. The concern is whether sugarcane growers will respect the environment without expanding plantation areas to parts of the "Cerrado" areas where native vegetation and unprotected forest are. The Cerrado has attractive climatic conditions favorable to sugarcane plantation especially in the Amazon regions.

Summarizing, the key concerns and environmental issues surrounding sugarcane expansion are identified as potential loss of natural habitat and deforestation; land creation competition for food, feed and fuel production; water pollution, soil erosion and compaction; air pollution caused through burning of sugarcane before harvest (Figure 4-5) and further more the use of genetically modified sugarcane types, which will change the natural composition and chain of the sugarcane (Zuurbier and de Vooren, 2008).

Figure 4-5 The Burning of Sugarcane Prior to Harvesting

Source: (Personal File, 2009)

CHAPTER 5.0 THE FUTURE OF SUGAR AND ETHANOL

This chapter reviews the international demand of ethanol mainly propelled through government mandates. The chapter also analyses sugar and ethanol market in terms of sugar and ethanol projection; present and future challenges with a look at sugar and ethanol prices. It also analyses how the ethanol market can be affected due to shortages in sugarcane production in Brazil.

The chapter is organized as follow: Section 1 explores the international demand for ethanol and how it could benefit the Brazilian market. Section 2 reviews the future of sugar in regards to production according to the Brazilian government. Section 3 explores sugar prices in Brazil and in the world. Section 4 reviews the future of ethanol in regards to production according to the Brazilian government. Section 5 explores the internal ethanol prices in Brazil. Section 6 reviews the sustainability of sugarcane ethanol. Section 7 reviews the present and potential future challenges of ethanol and sugar in Brazil.

SECTION 1.0 INTERNATIONAL DEMAND FOR ETHANOL

In addition to the potential growth of ethanol in Brazil, other countries are also stipulating targets for blending ethanol into gasoline, which has a significant potential for Brazil's ethanol exports. Presently, at least 36 states or provinces and 17 countries had adhere to blending mandates, which requires blending of 10-15 percent ethanol (E10-E15) with gasoline or 2-5 percentage biodiesel (B2-B5) with diesel. In addition to the Brazilian blending mandates, many countries have

established biofuel target and plans, having an impact on biofuel demand and defining its production for the future. Table 5-1 Biofuel Blending Mandates summarizes the different blending mandates required by a few countries in the near future.

Countries like US, German and EU have established biofuel targets: By 2022, 20 percent of gasoline for transport vehicles in US will be biofuel; in 2007 the German government proposed a target of 17 percent total biofuel for transportation vehicles and the EU has implemented a policy that targets 10 percent of transport fuel from renewable sources by 2020 (UNEP, 2009).

Table 5-1 Biofuel Blending Mandates

Biofuels Blending Mandates	
Country	**Mandate**
Australia	E2 in New South Wales, increasing to E10 by 2011; E5 in Queensland by 2010
Argentina	E5 and B5 by 2010
Bolivia	B2.5 by 2007 and B20 by 2015
Brazil	E22 to E25 existing (slight variation over time); B2 by 2008 and B5 by 2013
Canada	E5 by 2010 and B2 by 2012; E7.5 in Saskatchewan and Manitoba; E5 by 2007 in Ontario
China	E10 in 9 provinces
Colombia	E10 existing; B5 by 2008
Dominican Republic	E15 and B2 by 2015
Germany	E2 and B4.4 by 2007; B5.75 by 2010
India	E10 in 13 states/territories
Italy	E1 and B1
Malaysia	B5 by 2008
New Zealand	3.4 percent total biofuels by 2012 (ethanol or biodiesel or combination)
Paraguay	B1 by 2007, B3 by 2008, and B5 by 2009
Peru	B5 and E7.8 by 2010 nationally; starting regionally by 2006 (ethanol) and 2008 (biodiesel)
Philippines	B1 and E5 by 2008; B2 and E10 by 2011
South Africa	E8-E10 and B2-B5 (proposed)
Thailand	E10 by 2007; 3 percent biodiesel share by 2011
United Kingdom	E2.5/B2.5 by 2008; E5/B5 by 2010
United States	Nationally, 130 billion liters/year by 2022 (36 billion gallons); E10 in Iowa, Hawaii, Missouri, and Montana; E20 in Minnesota; B5 in New Mexico; E2 and B2 in Louisiana and Washington State; Pennsylvania 3.4 billion liters/year biofuels by 2017 (0.9 billion gallons)
Uruguay	E5 by 2014; B2 from 2008-2011 and B5 by 2012
Source: REN21 (2008)	

These blending targets represent a positive step within global communities to meeting GHG emission and can provide positive economic return to ethanol producing countries such as Brazil.

SECTION 2.0 SUGAR FUTURE PROJECTION

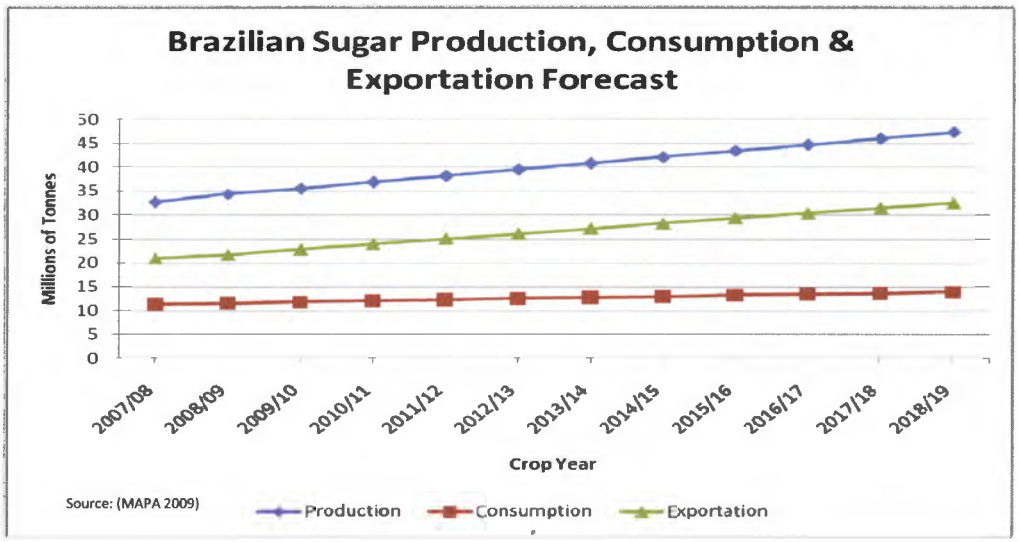
The Brazilian government announced in 2008 that sugar production in Brazil has been projected to continually increase, maintaining the country as the world leader in sugar production and exporter for the decade. The projection is to increase sugar production from 31 M tonnes in 2008/9 to 47 M tonnes in 2017/18. By 2018 the government is expecting a 20 percent increase in sugarcane production (MAPA, 2009), while the projection of sugar export and production by 2018/19 is 33 M and 64 M tonnes, respectively (Figure 5-1).

The steady growth in world population has been one of the factor for such high sugar projection. Internally, the population of Brazil has grown by 51 M to approximately 180 M habitants in 55 years from 1950 to 2005. The population increase corresponds to over 2 percent/year. The internal Brazilian demand for sugar based on the projection from the figure below is 22.3 percent higher in 2019. The exportation of sugar, however is predicted to be 55.4 percent higher by 2019.

Sugar production in Brazil has been affected by weather adversities and this has impacted various crop cycles. The production has been fluctuating since crop production in 1990/91. Due to strong internal market the Brazilian government has been able to maintain a relatively high sugar production. However, sugarcane harvesting and recovery process faced challenges in the country due to heavy rain falls since the middle of 2009. According to Brazilian

Sugarcane Industry Association (UNICA), the amount of sugarcane crushed in 2009 is 10 percent lower compared to same period a year ago where only 30.2 M tonnes were crushed. UNICA reported that rain has greatly affected the amount of sucrose per tonnes of cane: the concentration of sucrose averaged 128.6 kg per tonnes of cane is down 20 kg or 13 percent compared to same period last year (Sugar Online, 2010).

Figure 5-1 Brazil's Sugar Production, Consumption & Exportation



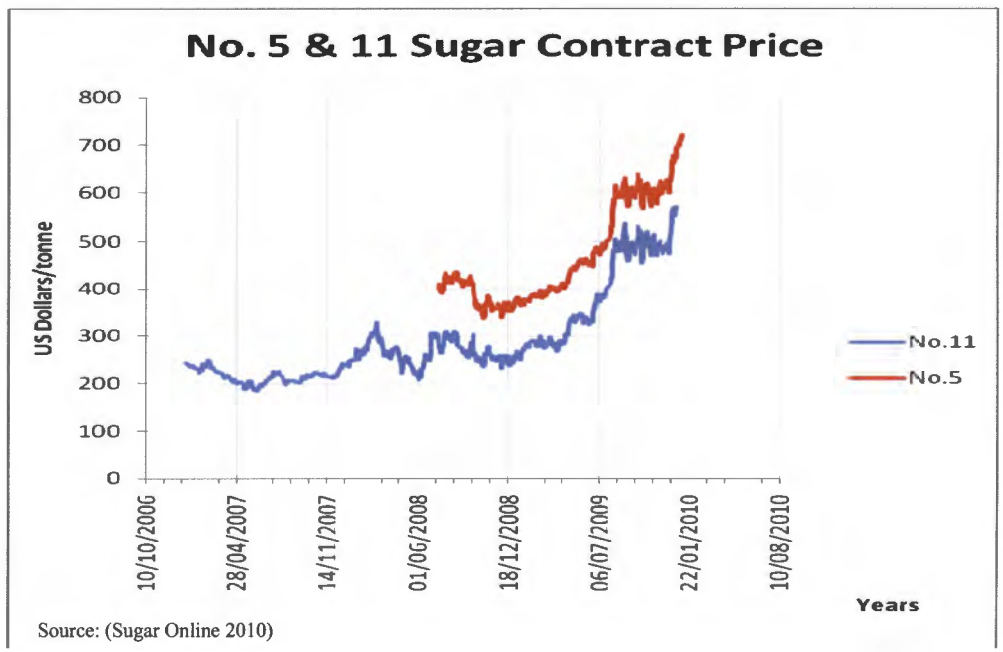
SECTION 3.0 SUGAR PRICES

The speculations in the sugar market have been shaping sugar prices over the last few months. The future of raw sugar reached 29 year high in the last days of December 2009. A weaker dollar and strong demand in Asia countries made white sugar reach its peak price of 128 percent in 2009. Financial institutions are predicting a massive buy stoppage if sugar prices reach 28 cents per lb (Sugar Online, 2010).

Figure 5-2 shows the behavior of sugar prices since late 2006 where the red line represents Contract no. 5 for white sugar prices traded in London at the London Futures Exchange (LIFFE). It can be noted that sugar prices had increased significantly since July 2008 when the price of sugar was at US$400/tonne. On January 1st of 2010 the price jumped to over US$700/tonnes representing almost 50 percent price increase.

The blue line refers to contract no. 11 which is raw sugar traded in New York at the Intercontinental Exchange (ICE). It can be noted that raw sugar prices had also increased with the same trend as contract no. 5. On January 08, 2007 sugar prices were being traded at US$245/tonne and on Dec 22, 2009 this price jumped to US$570/tonne.

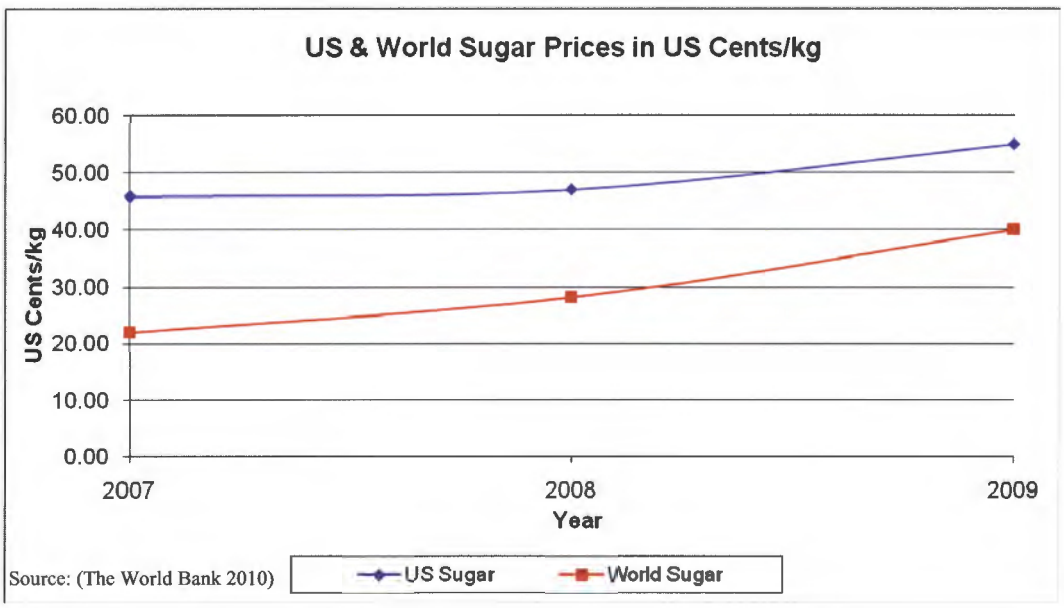
Figure 5-2 Sugar Contract Price (No. 5 & 11)



Source: (Sugar Online 2010)

Using a different measurement method, the World Bank had also been constantly monitoring sugar prices and had lately posted on commodity prices related to 2007, 2008 and 2009 years. Figure 5-3 provides annual average sugar prices in US cents per kilo for the same number of years mentioned above and it can be observed that both US and World sugar prices have been increasing steadily for the last three years. The annual average world sugar prices in cents for 2007, 2008, and 2009 were US$0.22, US$0.28, and US$0.40 respectively, representing a 30% increase in prices in 2009. For US, sugar prices were respectively US$0.46, US$0.47, and US$0.55 in 2007, 2008 and 2009 with a 15% increase also in 2009.

Figure 5-3 US & World Sugar Prices in US Cents/kg



Source: (The World Bank 2010)

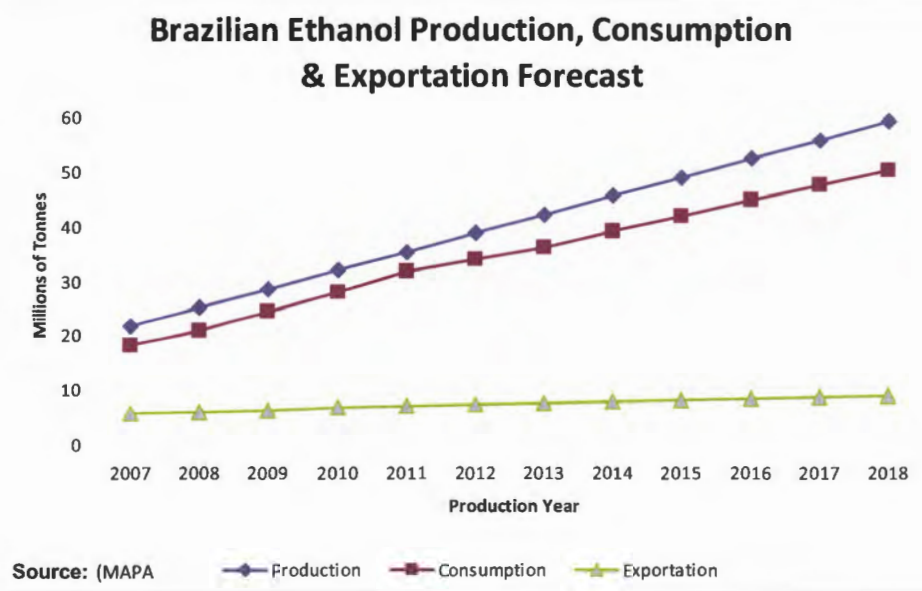
The increase in sugar consumption, projection and prices is highly correlated based on demand and supply. Even though some analysts claimed that there are vast arable land available for plantation of sugarcane to meet demand for sugar,

much less is known if the sugarcane plantation can meet up with the demand of both sugar and ethanol demand globally. The sugar and ethanol demands can be predicted fairly accurately but the challenge in the future is to be able to predict the affects of weather conditions on the sugarcane crops. The following sections will look at the projection of ethanol and it prices in the Brazilian market.

SECTION 4.0 ETHANOL PROJECTION

The ethanol production, consumption and export are projected to increase due to internal demand in Brazil with the introduction of FFV. The production of ethanol for 2018/19 is projected to be at 58.8 B liters, which is projected to double the 2007/8 figures (Figure 5-4).

Figure 5-4 Brazil's Ethanol Production, Consumption & Export Forecast



Source: (MAPA

The internal demand is projected to be at 50 B liters and the export is at 8.8 B liters by 2018. As it can be observed from the figure below, most ethanol

produced in Brazil is intended for internal consumption, highlighting the government's continual support for oil independence. Based on analysts by 2017, 73.6 percent of all cars sold in Brazil are projected to be FFV type (MAPA (b), 2009). These FFVs have been greatly embraced by consumers because of its ability to switch to either pure ethanol or blended gasoline depending on availability and price at the pumps.

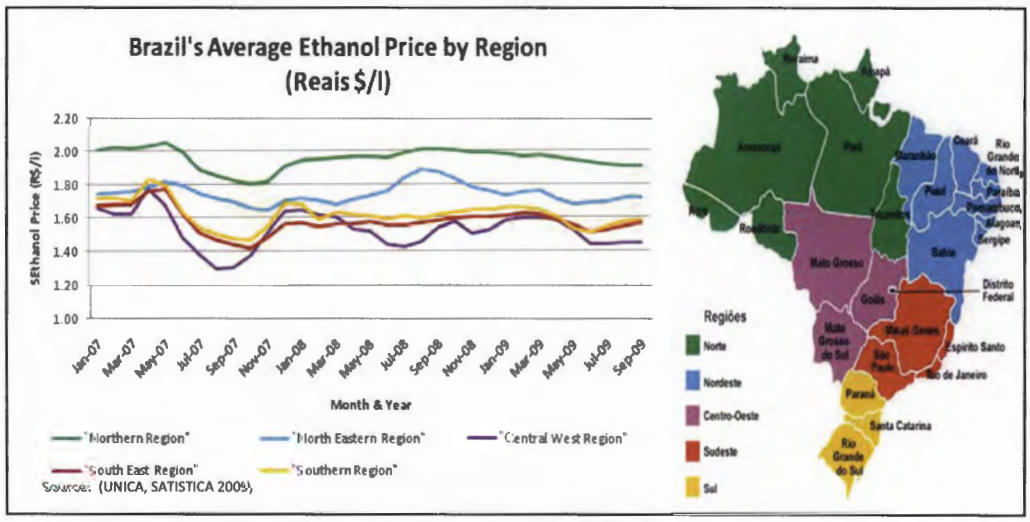
SECTION 5.0 INTERNAL ETHANOL PRICE

The internal ethanol price in Brazil varies depending on the region and is presented in the figure below in Brazilian Reais, by state. The North Regions can be observed to have the highest ethanol prices for all the gas stations. One of the reasons for the discrepancy in high prices is because this is the non-ethanol producers region and most of its fuels are transported from the Southern regions where Brazil's ethanol production plantsa and oil refineries are concentrated. Other factors governing the ethanol price in Brazil are weather conditions affecting sugarcane crop, the high demand for sugar and the price of oil. When transportation costs are included at the pump, this made ethanol less attractive compared to petroleum based fuel in the Northern regions. The remaining regions are relative close in terms of retail prices and the Center-West has the lowest price mainly because of Copersucar, the national sugar cooperative implemented a program in the mid 80-90's called "subsidies-less survivor" which was responsible for lowering production costs in this region (Nass, Pereira and Ellis, 2007).

The future of ethanol seems to be uncertain since demand for sugar have been increasing and Brazilian mills are more interested in taking advantage of this opportunity and switching to sugar production. As a result, ethanol prices have

been increasing due to supply shortages and higher internal demand. By the beginning of August 2009, the price of anhydrous ethanol (blended to gasoline) rose by 38 percent compared to July, while hydrate ethanol (used in FFV) jumped to 30 percent by beginning of September. Due to high prices in hydrate ethanol, consumers are switching to gasoline in several states. Gasoline becomes more viable for consumers when the price of ethanol is more than 70 percent the price of gasoline.

Figure 5-5 Average Ethanol Price by Region



SECTION 6.0 THE SUSTAINABILITY OF SUGARCANE ETHANOL

The historic presence of sugarcane in Brazil and the experience the country have acquired througout the years with the ethanol program and production are not the only reasons for the success of ethanol. Investments in research and development have made significant impact on the development of new technologies applied in sugarcane ethanol production and efficiencies. However, none of these steps would have been taken by the Government of Brazil in

conjuction with private sectors if sugarcane did not demonstrate a better advantage over other feedstocks in biofuel production.

A study presented by Banco Nacional de Desenvolvimento Economico e Social (BNDES) shows the general differences among biofuels existent in the market today. It can be noted that sugarcane ethanol demonstrates more advantages due to higher reduction in GHG emissions, low production cost, and higher ethanol production per hectare compared to other crops as shown on Table 5-2.

Table 5-2 General Biofuels Outlook

Feedstock	Production Cost	Biofuels production per ha.	Reduction of GHG emissions	Soil Conditions
Corn	Moderate	Moderate	Moderate to low	Fertile soils
Sugarcane	Low	High	High	Fertile soils
Soybean	Moderate	Low	Moderate	Fertile soils
Palm oil	Moderate	Moderate	Moderate	Wet and coastal soils
Source: (BNDES and CGEE, 2008)				

Among the biofuel existent today, one of the most prominent success of sugarcane ethanol is the energy it contains and the CO_2 emissions it avoids when compared to other biofuels or gasoline. Table 5-3 compares the GHG emissions avoided by different type of biofuels. Sugarcane ethanol surpass all raw material used for biofuel production with energy ratio of 9.3 with 89 percent of emissions avoided (BNDES and CGEE, 2008). Based on the study, by replacing gasoline to ethanol emissions of 12.6 M tonnes of CO_2 can be avoided for every 100 M tonnes of sugarcane used for ethanol production. Consequently, the use of other biofuels feedstock is not encouraging in regards to GHG emission, except for sugarcane.

Lignocelluloses residues, however, show encouraging potential as biofuel but further research will be required for viability of its mass production.

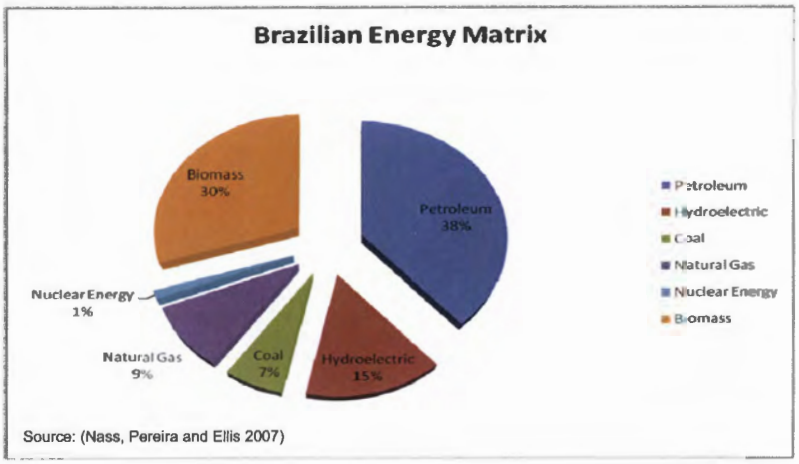
Another positive aspect of sugarcane ethanol in Brazil is the use of sugarcane pulp after the extraction of sugarcane juice (Bagasse) as biomass for enegry production. All Brazilian sugar and ethanol plants are auto-energy suficient and has been using bagasse to generate power in their mills to produce ethanol and sugar. Very often, these mills are able to produce energy surplusses and manage to export electricity to the public.

Table 5-3 Feedstock Fuel Energy Ratio and Emission Avoided

Feedstock Fuel	Energy Ratio	Reduction in Emissions
Sugarcane	9.3	89%
Corn	0.6 - 2.0	30% - 38%
Wheat	0.97 - 1.11	19% - 47%
Beet	1.2 - 1.8	35% - 56%
Cassava	1.6 - 1.7	63%
Lignocelluloses residues	8.3 - 8.4	66% - 73%
Source: (Adapted from BNDES and CGEE 2008 study)		

Globally, the use of biomass has been gaining popularity among developing countries. Biomass is widely used in developing countries especially Brazil, China, Colombia, Australia, Cuba, India, Philippines and Thailand (REN21, 2008) with a mature and larger sugar industry for power and heat production. In Brazil for example, the use of biomass corresponds to 30 percent of the primary energy used within the energy matrix. Figure 5-6 shows the energy matrix breakdown in Brazil.

Figure 5-6 Brazilian Energy Matrix Breakdown



Petroleum still remains as the main source of energy and corresponds to 38 percent (Nass, Pereira and Ellis, 2007) with 12.6 B barrels of oil reserves reported in 2009 locating Brazil as the second largest oil producer in South America after Venezuela. The country's oil consumption averaged at 2.52 M bbl/d and is forecasted to reach oil production to 2.81 M bbl/d in 2010 (EIA, 2009).

The tendency of using biomass for energy production will likely increase in the future due to a national target for renewable energy supply that has been carried by at least 64 countries worldwide. Policy target for biomass have been created as form of renewable energy source where China's national target by 2020 is 15 percent of primary energy which includes 30 GW from biomass (UNEP, 2009).

On the contrary, corn bioethanol has demonstrated some concerns regarding its environmental benefits. The study of BNDES and CGEE (2008) concludes that processing corn into ethanol takes less energy than sugarcane to be converted into ethanol; however all the energy used to process corn ethanol comes

from fossil sources. The process involves the use of natural gas boilers to steam, eletricity provided by the public grid which is dependent in fossil-fuel sources to a large extent. In the GHG emissions point of view, sugarcane is more beneficial to the environment than corn based ethanol.

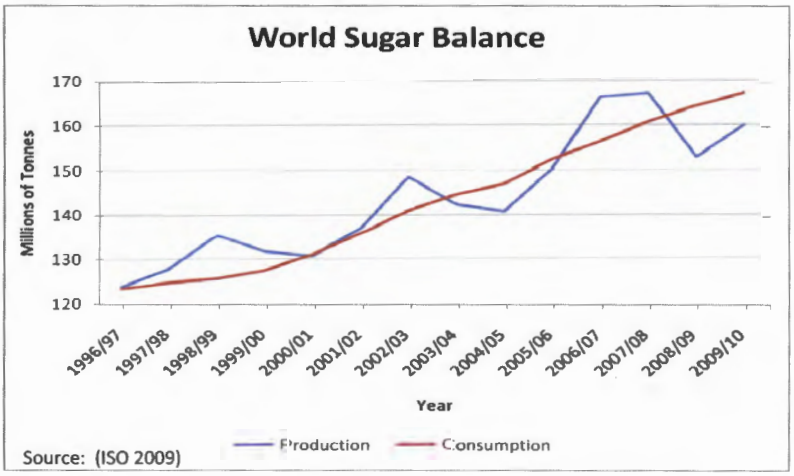
SECTION 7.0 PRESENT AND POTENTIAL FUTURE CHALLENGES

Many analysts are concerned about the biofuel market and food security. While ethanol from corn, mainly produced in US, has been blamed to be responsible for the increase in food prices, especially grains and corn, Brazilian government and local analysts have been claiming that ethanol from sugarcane have not been responsible for the increase in food prices (FAO, 2009). However, after analyzing the trends in the sugar and ethanol market, the future of sugar and ethanol prices remain uncertain not only for Brazil, but the rest of the world.

There are special concerns for developing countries in regards to high sugar prices. Food security has been theme of many conferences and seminars around the world. The Food and Agriculture Organization (FAO) had published many studies where it analyses the countries that are most affected when food prices rise and the concern is not only regarding Brazililian farmers taking land from food to produce more sugarcane for ethanol purposes, but whether it will be able to sustain its own internal consumption in terms of ethanol or sugar and secure consumers a fair price for food (sugar) and accessible to the product. Brazil is still a developing country where half of its population is considered poor with insufficient purchasing power. If sugar prices continue to rise, the population will be highly affected and smaller businesses will suffer.

While analyzing the sugar situation in the world, it was found that in the crop year of 2009/10, the world sugar balance deficit is high. In the commodity world, stocks play an important role to equilibrate the market and keep prices fair for consumers and producers. If stocks are low, commodity prices tend to be higher due to low supply and higher demand causing production shortage. The level of sugar stocks have been volatile since 2003 and felt sharply in 2008 by 11.34 M tonnes. When shortages occur, international sugar market will usually become tighter causing price volatility. World sugar consumption has increased 135 percent since 1997 to September 2009. The figure below clearly demonstrates world consumption is experiencing linear growth while total sugar production is cyclic causing prices fluctuation and volatility governed by supply and demand (ISO2, 2009).

Figure 5-7 World Sugar Balance



Based on the research, data review and analysis performed, the major challenge of ethanol production is for the Brazilian government and private agency to fully understand and predict factors that have internal and external effects on the

relation to sugar-ethanol demand and supply to avoid over production and flooding of the market. The governmet will have to establish production criteria and policies to safe guard farmers and producers to avoid overproduction, especially sugar-ethanol mills that have the capability to switch production to take advantage of the product yeilding the highest price. A constant production switch without a good understanding of short and long term forecast of sugar, ethanol, and oil supplies and demand will cause a fluctuating in price to market overflooding.

Through this report and the literature study, it is well understood that the demand and supply of sugar and ethanol has direct correlations. Factor governing internal consumptions of ethanol, production capacity and rate are much more easier to regulate. The major challenge is to predict the yeild of each crop season with the future changes in weather conditions.

CHAPTER 6.0 CONCLUSION

The present study has been cast in the background of uncertainities in ethanol industry worldwide and particularly in Brazil – the leading producer of ethanol based on sugarcane. Researchers had predicted high sugar and ethanol prices in 2010 based on the supply-demand dynamics and Brazil is the country to benefit from this prospective event (Koizumi, 2003; UNICA, 2009). Brazil is one of the few countries which has demonstrated technical capabilities of a sustainable biofuel industry without sacrificing the interests of consumers, the sugar industry and food suppliers. The present study contributes to the literature by examing the underlying reasons for the present success of biofuel industry in Brazil.

Ever since the spike in oil prices globally and the increasing concern about carbon emissions and global climate change, Brazil has pursued a policy of promoting biofuel industry based on sugarcane as a solution to energy independence and its international climate change commitments. The blossoming of ethanol industry can be traced to a number of public policy initiatives. The initiatives taken by Brazilian government to enhance the productivity of sugarcane cultivation through large investment in R&D is one crucial factor. The enhanced production of ethanol was accompanied by the development of FFVs which are capable of running on gasoline and ethanol has contributed to a large extent the development and promotion of biofuel industry in Brazil. During the 2009, Copenhagen Summit, Brazil has further committed to reduce its carbon emission by 36% by 2020. Even though this is not a binding target, Brazil's intention was to

put pressure on developed countries to move forward with a world binding target on the next Summit. A solution forward in these fronts is to vary the ethanol blending rate according to supply-demand dynamics.

However, many Brazilian analysts have cast doubts about the sustainability of the Brazilian ethanol program as the government had recently suggested lowering the current ethanol to gasoline blending rate for fuel in Brazil from 25 to 20 percent. The system seems to be facing needs for change through better planning and consideration for internal consumers. If ethanol prices continue to increase due to demand-supply unbalances, carbon emission targets could be impacted due to potential switching back to gasoline. Studies have indicated that when ethanol prices are above the 70 percent ceiling price of gasoline, consumers will switch to gasoline.

Brazil is on its way to become one of the major petroleum producer and perhaps exporter. The future of sugarcane ethanol can be jeopardized if Brazil manages to tap into the potential oil reserves along the eastern coastline, which may cause an oversupply of cheaper petroleum based fuel causing lesser demand for ethanol, which could lead to producers switching back sugar production.

Sugarcane ethanol in many ways has been proving to be one of the most cleaner, and advantageous biofuel among all the existent biofuels. Today, when compared to other greener investments available around the world, Brazil is still a laggard in terms of new energy source investment when it comes to utilizing natural sources. As long as Brazil is using natural resources to produce ethanol, the market is susceptible to a volatile market since weather and political conditions, oil prices and other factors contribute to enhanced uncertainties.

From a public policy perspective, Brazil needs to protect the sugar and ethanol market, and also protect consumers and small business. Since Brazil is on its way to become an important biodiesel producer and exporter, it is necessary for the government to establish targets for renewable energy and biofuel to avoid the creation of internal competition for biomass and most importantly to protect food security. A study performed by UNEP (2009), suggested a creation of a biomass strategy that would bring into consideration the use of all types of biofuels in the future.

Even with extensive experience in ethanol production and technology, there are a few outstanding steps requiring attention in order for Brazil to achieve its fuel mandate, agricultural effectiveness, environmental and ethanol production targets. These steps include sustainably expanding the sugarcane plantation to increase yield and into new areas while protecting the "Cerrado"; investing in infrastructures such as roads for accessibility to plantation areas, mills and safe transportation of goods; developing new technologies and businesses with international markets while working on improving the efficiencies of the ethanol mills and improve production of existent sugarcane plantation areas. Brazil has over 300 ethanol mills operating in both sugar and ethanol production, but technological gaps can still be found between best practices and actual performance of the mills. Due to the dissemination of technology in the biofuels industry, R & D and investment, there are significant opportunities for Brazil to expand its green industry (ethanol) program in internal and international market. However, to better understand these opportunities and how this positively impact the internal and external market, further research in the are are required.

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