Biomass Residues for Second Generation Biofuel in the Brazilian Context

Silvia Palma Rojas
Armando Caldeira-Pires
Jorge Nogueira Madeira
Luiz Claudio Costa Ferreira
University of Brasilia, Brasilia, Campus Universitário Darcy Ribeiro 70910-9000, Brazil

Abstract. *In the last decade was worldwide observed an important growth of first generation biofuel consumption in the transport sector, and currently the attention are focued on the development and implementation of second generation biofuels production. From this context, Brazil plays a relevant role in the second generation biofuel scenario, due to its successfull experience with first generation ethanol and for being an important generator of biomass residues due to its agricultural capacity and structure. Among the main agricultural productiosn in Brazil are sugarcane, corn, and soybean; where only in 2008 the sugacane production was 648,973,000 tons, the corn production was 59,012,000 tons, and the soybean production was 57,857,000 tons. For the current existing panorama, the sugarcane bagasse is currently, the most attractive feedstock to use in the production of second generation ethanol and the soybean biomassa residue is considered one of the less attractive due to its little amount of residues generated in the production. The total potential of second generation ethanol production was estimated at 28.98 billion liters of ethanol and this amount potentiates an increasing rate of 53% of ethanol production in Brazil, without additional farming land.*

This paper aims to depicte the potential sustainable capacity of producing second generation ethanol from the major agricultural and silvicultural productions in Brazil, such as sugarcane, corn and eucalyptus, as well as to understand the estimated number provided by Petrobras of 40% of increase the Brazilian ethanol production by introducing second generation ethanol from bagasse. The results are based on three basic scenarios. One assesses 72% of sugarcane bagasse produced as feedstock; other assesses 50% of corn stover produced; and the last scenario assesses the eucalyptus roundwood residues produced from the cellulose and paper sector.

The results of this study are based on secondary data, theoritical characterizations of different biomass found in the literature, and production data from the recent years. In section one is a state of the art of the biofuel sector, and section two is described the general productive capacity in Brazil, where the potential ethanol production from sugarcane bagasse, corn stover and eucalyptus roundwood residues is estimated. In the section three, this potential capacity is assessed according to the regional production for 2009, thinking in future strategies of agroindustrial symbiosis to optimize the real productive capacity of second generation ethanol. And, in section four is found a conclusion and main results.

Keywords: *second generation Biofuels, bioethanol, agricultural residues, energy content, agroindustrial symbiosis*

1. Introduction

In the search for alternative fuels to replace or complement the petroleum-derivated fuels, have emerged the potential of biomass-derivated energy sources, such as biofuel that year to year increases its participation in the global fuel market. Despite the exact consumption of biomass is difficult to calculate, IAE (2010) points out that biomass represented about 10% of primary energy at global level in 2007, being the largest primary source of renewable energy sources. The usefulness of the bioenergy potential depend mostly on the main needs or available technology of the analyzed economy; for exemple, in countries with low level of development the main use for biomass is for cooking or direct heating, on the another hand, in richer countries there are more sofisticated uses, such as biofuels and electricity generation.

IEA (2010) states that nowadays the transportation sector is responsible for about 25% of greenhouse gases emissions and the sector consumes about 50% of the global fuel consumption. In Brazil, the transport sector consumed 28.3% of the final energy consumption in 2009, and according to World Resources Institute (WRI) and its Climate Analysis Indicators Tool (CAIT), the sector contributed with 39.2% of total greenhouse gas emissions emited in 2007 in the country. Thus, biofuels reaffirm its relevant role in the global fuel market as alternative source to decrease greenhouse gas emissions in the transportation sector, as well as important alternative to attain energy security especially, for petroleum importing countries and particularly, for economies with high agricultural capacity in the worldwide scenario.

Nowadays are studied and produced mainly three types of biofuels. The first Generation Biofuels (FGBF) are made from agricultural crops like corn, sugar-cane, soybean, and other grains and vegetables. It is important to stress that they are the only biofuel competing today in the fuel market; the Second Generation Biofuels (SGBF) are made from organic residues and; the third generation (TGBF) made form algae. The last two types are in the research stage with pilot production plants.

Therefore, in the last decade has been worldwide observed a rapid growth of FGBF consumption, this global tendency made that biofuels gave a participation of 1.5% in the global transportation sector. In Brazil, this tendency was even more observable due to biofuels consumption represented 20.25% of the fuels consumed in the sector in 2009; in that year the biofuels consumption was composed of 18.8% ethanol and 1.45% biodiesel (BEN, 2010) and these numbers demonstrate that sugarcane ethanol represents 93% of the biofuels in the transportation sector. In the European context, the biofuels consumption was about 4% in 2009 and 3.3% in 2008, having a growth rate of 0.7% in the road transport fuel participation. Contrary to the Brazilian market in 2009, the biofuel share in the European market was composed mainly of biodiesel with over 79.5%, and ethanol with 19%, and other types of biofuels had a participation of 1.1%. IEA (2010) projects that for 2030 biofuels will provide 9% of the total global demand of transportation fuel.

It is important to highlight that today European Union appears as the world's largest productor of biodiesel. In 2009, EU production was over 9 millions metric tons, representing a growth of 16.6% when comparing to previous year production. Germany was the leading biodiesel producer with over 2.5 millons tons in 2009, *i.e.* 28% of the European total production; in the last years others European countries have augmented their production share, such as France, Spain and Italy, and in 2009 their participation in the biodiesel production were 21.66%, 9.5% and 8.15% respectly. The Brazilian biodiesel production is relatively small if compared to European market, it reached 1.4 millions tons in 2009, this mean an increased of 38.7% compared to the previous year production. The increasing scenario is supported by the National Program of Production and Use of Biodiesel (acronym in portugues PNPB) that obligates to blend a specific percentage of biodiesel into the oil diesel, going from 2% in 2006 to 5% today. The biodiesel industry is based mainly on soybean oil, representing approximaly 80% of the feedstock uses in the sector.

On the other hand, United States is the largest producer of ethanol (corn-derived ethanol), followed by Brazil (sugar-cane-derived ethanol). According to RFA (2010) the USA fuel ethanol production in 2009 was about 32.2 millions metric tons (considering an ethanol density of 810 kg/ m^3). With a total of approximaly 200 biorefinaries, the United States blends 10% ethanol into 80% of the National gasoline. In the Brazilian panorama, BEN (2010) states that the ethanol production decreased 3.8% in 2009 resulting in 21 millions metric tons, where 73% of ethanol production refers to hydrated ethanol with aproximaly 15.5 millions metric tons, and anhydrous ethanol reached 5.7 million metric tons.

The energetic balance in the ethanol production or any other biofuel depends on the type of biomass used. It is found in the literature that sugar is the simpliest biomass to turn into fuel, due to sugar can be converted to ethanol directly, sugarcane is an example of it, where is got 8 BTUs out for every 1 BUT put in. The second easiest biomass to convert to fuel is starch because it needs more stages to get into ethanol, kernel of corn is an example of it and has an energetic balance of 1.3 BTU for every 1 BTU put in. The third group to made ethanol is cellulosic that is considered the most difficult to use because the natural structure of biomass is resistant to its easy separation in to primary streams cellulose, hemi-cellulose and lignin, also it difficult due to them must be converted in sugar by acid hydrolisis or enzimatic hydrolysis. Despite this, SGBF is considered the most potential feedstock source for ethanol production because its energy balance is up to 36 BTUs for each 1 BTU put in (Krupp & Horn, 2008). Shahbazi and Li (2006) explain that the conversion of biomass to ethanol includes the following processes: pretreatment that breaks the long-chain hemicellulosic down into five- and six-carbon sugars and makes the cellulosic component more accesible to enzimatic attack; Acid or enzimatic hydrolysis that break down the long-chain cellulose into six-carbon sugars; fermentation by microbes, converting the five- and six-carbon sugar to ethanol and other oxygenated chemicals and; distillation and dehydration of the fermentation broth to produce fuel ethanol. The lignin is an important co-product that can be obtained from the hydrolysis plant and can be burned to power biofuels refinaries.

The increase in global biofuel production is supported mainly by the energetic policies adopted by European Union and the United States that aim to expand the demand of biofuels, considering an increasing demand of SGBF. United States has adopted a mandatory blend of SGBF, this initiative is known as Renewable Fuel Standard (RFS) and it is part of the Energy Independence and Security Act of 2007. It is proposed that by 2022 approximaly half of renewable resources must be SGBF. On the other side, European Union adopted the Renewable Energy Directive (RED) in 2009, where is promoted the use of renewable resources energy. It is stipulated that in 2020 the SGBF should be commercially avaliable and that 10% of energy from the transport sector come from renewable energy.

Hence, the development of second generation biofuels is a tradeble opportunity for emerging countries with high agricultural production, and consequently high amount of residues available, feedstock for SGBF. From this context, Brazil is having the opportunity to take advantages of its structure and competitiveness in the agricultural and selvicultural sector, and make grown its bioethanol production without additional land use or competing with food for feedstock production, issues widely discussed and critized in the FGBF panorama. It is important to stress that for taking advantages of the capacity of having a SGBF production, it is necessary to regard that new biorefinaries should operate in simbiosis with the agricultural sector, consequently, the selection of suitable biomass residue is extremly critical for new biorefinaries to operate in simbiosis (Hatti-Kault, 2010).

Among the main agricultural production sectors in Brazil are sugarcane, corn, and soybean; where in harvest year 2009/2010 the sugacane production was 604,513,600 metric tons, the corn production was 52,723,600 metric tons, and the soybean production was 68,688,200 metric tons, and for the selvicultural sector, the eucalyptus production was 124,363,000 metric tons. For the existing infraestructure and production, the sugarcane bagasse is currently, the most attractive residue to use as feedstock of second generation biofuel and the soybean biomassa residue is considered one of the less attractive due to its little amount of residues generated in the production stage. Thus, according to Petrobras's

Research & Development Center (Cenpes), it is estimated that bagasse-to-ethanol technology can increase the by some 40%.

This paper aims to depicte the potential sustainable capacity of producing second generation ethanol from the major agricultural and silvicultural productions in Brazil, such as sugarcane, corn and eucalyptus, as well as to understand the estimated number provided by Petrobras of 40% of increase the Brazilian ethanol production. The results are based on three basic scenarios. One assesses 72% of sugarcane bagasse produced as feedstock; other assesses 50% of corn stover produced; and the last scenario assesses the eucalyptus roundwood residues produced from the cellulose and paper sector.

The results of this study are based on secondary data, theoritical characterizations of different biomass found in the literature, and production data from the recent years. In section one is a state of the art of the biofuel sector, and section two is described the general productive capacity in Brazil, where the potential ethanol production from sugarcane bagasse, corn stover and eucalyptus roundwood residues is estimated. In the section three, this potential capacity is assessed according to the regional production for 2009, thinking in future strategies of agroindustrial symbiosis to optimize the real productive capacity of second generation ethanol. And, in section four is found a conclusion and main results.

2. Avaliable Feedstock for Second Generation Biofuel in Brazil

Since 1990, the Brazilian agro-business has grown significatly in the international scenario and it is consolidated as one of the largest producers and exporters of food around the world. According to Ministry of Agriculture, Livestock and Food Supply (MAPA) of Brazil, at the beginning of 2010, one of each four products in the international agro-market was a Brazilian product, and it was forecasted that by 2020, Brazilian agro-products will be one-third of the global trade. Hence, the generation of residues in the agricultural sector will grow in the same scale, as well as the capacity of the country to produce second generation ethanol or another type of SGBF.

Nowadays, in Brazil there are some pilot projects researching on second generation biofuels particularly focused on bioethanol. One of them is carried out by Petrobras and the other is commanded by the Brazilian Sugarcane Technology Center (CTC), both are based mainly on the development of bagasse-to-ethanol tecnology. According to Jagger (2009), other organizations making significant contributions to next generation biofuels technology in Brazil include the Brazilian engineering company Dedini and US bioresearch company Amyris.

From a quantitive perspective, in the harving year 2009/2010 the major agricultural productions in Brazil were sugarcane, soybean and corn. Also productions like rice, wheat and beans were important in the agricultural sector. For the selvicultural sector, the eucalyptus roundwood had an important performance in 2009. All this information is depicted in fig 1 for different harvesting years, from 2005/2006 until 2009/2010, and 2010/2011 were estimated values. In fig. 2 is depicted a diagram of a second generation ethanol plant were the assumptions of this article are based.

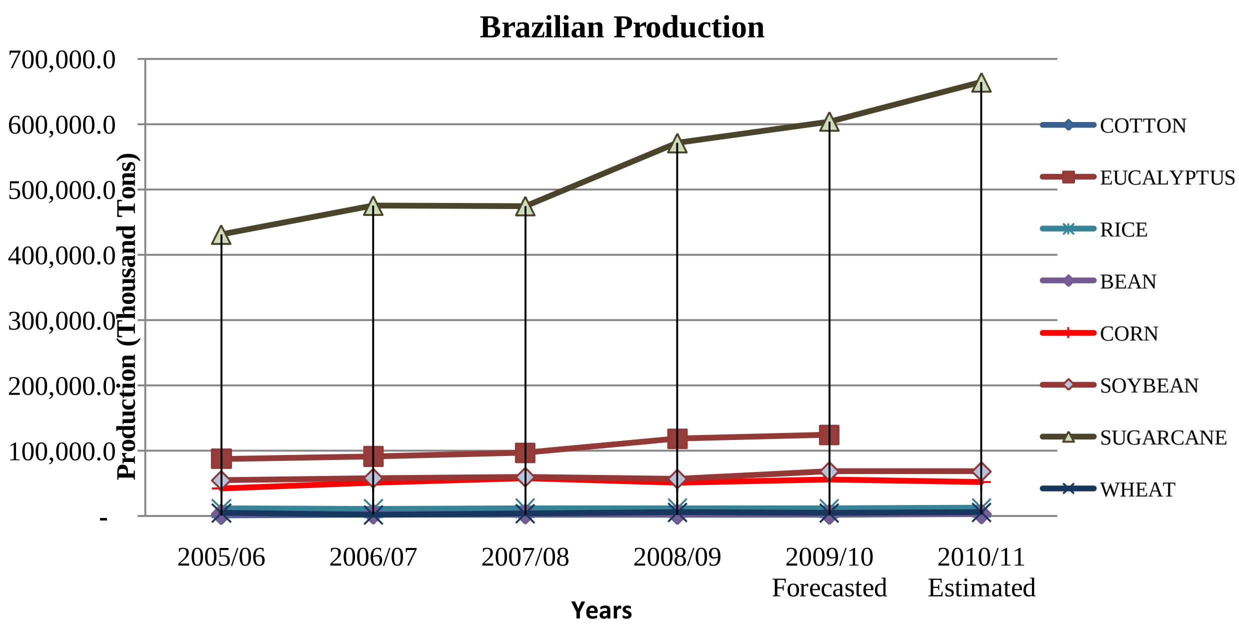

Figure 1. Total Production of the Main Brazilian Agricultural Products
Source: Own elaboration based on CONAB and ABRAF

In figure 1 is observed that the production of sugarcane has been relevant for the Brazilian agrobusiness, where for the harvest years 2008/2009 and 2009/2010 the total production were approximatly 571 million metric tons and 604 million metric tons in about 8.91 million hectars, respectively. According to MAPA, in the harvest year 2008/2009 the share of ethanol in the total production was 61%, this figure took place since the harvest year 1982/1983 when the percentage of ethanol (53%) overcame for first time the share of sugar production (47%) for the total sugarcane production.

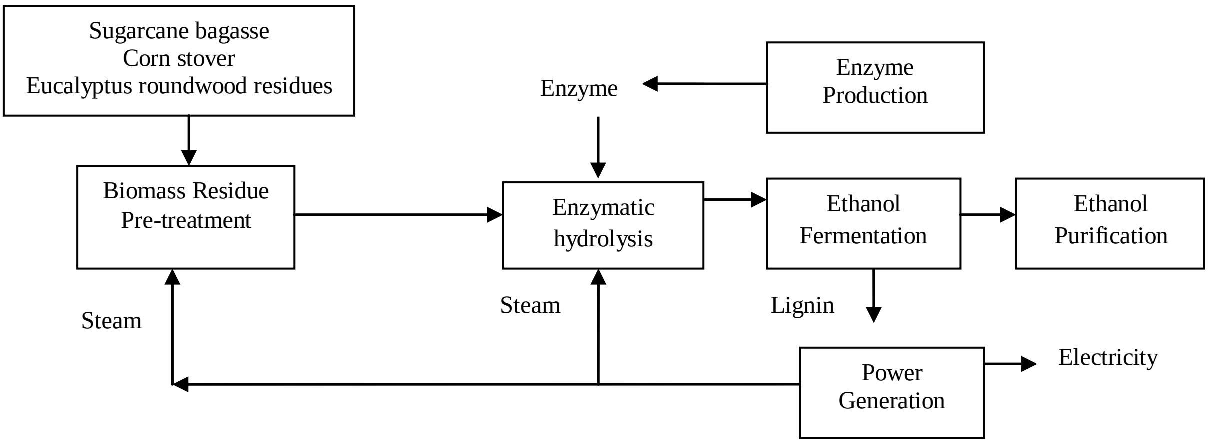

Figure 2. Flow Diagram of the Second Generation Ethanol by Enzymatic Hydrolysis
Source: own elaboration based on <http://www.tifac.org.in>

There are two types of residues in the sugarcane production: the bagasse, the fibrous waste that remains after the recovery of sugar juice via crushing and extraction, and the straw and leaves (Pippo *et al*, 2011). Each type of residue containes one-third of the sugarcane plant total energy and the remained one-third is hold by the sugarcane juice. Today part of this useful energy content from residues is used for energy cogeneration in the sugarcane agroindustry during the milling season, especially the sugarcane bagasse. And the rest of the plant, straw and leaves, that have the same energy content than bagasse, are left on the field to avoid erosion and protect the proprieties of the soil, or it is burned in the harvesting phase. In the state of Sao Paulo, the phase of introducing the mechanised harvest system should be completed by 2017.

Walter and Ensinas (2010) states that sugarcane bagasse is a strong candidate to ethanol production via hydrolysis because its cost is its opportunity cost as fuel. Another advantage of using bagasse as feedstock is the existing infrastructure in the sugarcane sector; thus, it would reduce the initial investiment and the operational costs.

In the sugacane residue scenario is presented four assumptions. First of all, it is assumed that potential production of feedstock is 76% of all bagasse available from sugarcane production (Walter and Ensinas, 2010), leaving 24% for cogeneration and 100% of straw and leaves is addressed to soil protection, cogeneration, and/or cattle feed, since the perspective of a complete mechanised harvest system. The second assumption sets that one ton of sugarcane produces 30% of bagasse and 34% of straw and leaves (Ferreira-Leitao *et al*, 2010). The third assumption is based on the plant projected by Walter and Ensinas (2010) for ethanol production from hydrolysis where one ton of bagasse produces 149.3 liters of ethanol. And the fourth assumption assumes that lignin is used as fuel in the cogeneration system.

Therefore, for a sugarcane production of 604 millions metric tons, the total sugarcane bagasse available for ethanol production would be 137.8 million metric tons. Thus, considering the described panorama, it would be possible to have a surplus potential of 20.58 billion liters of ethanol from sugarcane bagasse, without increasing the current land used for sugarcane plantation. This potential value represents 79% of the current ethanol production.

As shown in fig. 1, another major agricultural production for the Brazilian agrobusiness is corn production. In the harvest years 2008/2009 and 2009/2010 the total production were approximatly 51 million metric tons and 56 million metric tons in about 14.17 and 12.97 million hectars, respectively.

The internal demand of Brazilian corn is mainly used as food and feed for animals. In countries as United States, this grain is widely used as food, feed and raw material for ethanol production, and its residues has been intensive studied for second generation ethanol production. Hence, the experience and research of USA with corn can help to Brazil to use this residue for ethanol production.

The corn residue scenario presents also three assumptions to estimate the potential ethanol production. First of all, it is considered that corn stover has a relation 1:1 with the harvested corn. Second, it is considered that only 50% of stover should be used for ethanol production and the remained 50% is left on field to avoid damaging the soil quality. In the literature is found that one dry ton of stover produces 500 liters of ethanol as a theoritical yield, where it is stipulated that a mature plant yields 83% of the theoritical value and the initial plant performance is 60%. If a wet ton is the reference unit, that theoritical value goes to 420 liters for one ton of wet ton for 16% moisture content in the stover available. In this scenario is assumed an initial plant, where one wet ton of stover produces 252 liters of ethanol. Hence, for the current corn production, the potential of ethanol production from corn stover would be 7.05 billion liters of ethanol.

Currently, Brazil is one of the largest soybean producers, and its total production is projected to grow in the next years due to the new mandatory blend of 5% biodiesel, where 80% of its feedstock comes from the soybean sector. Despite this panorama, in the literature is found that soybean residue is considered limited for ethanol production. Shahbazi and Li (2006) states that the generation of residues in the soybean production is relatively small and necessary to prevent soil erosion, and it is degraded rapidly in the field, hence its use as feedstock in ethanol production is limited.

On the other hand, the largest production in the selvicultural sector is eucaliptus; it represents about 73% of the sustained forestry production composed by pinus and eucalyptus. As shown in fig. 1 the total eucalyptus roundwood production in 2008 was 118.7 million tons and 124.4 million tons in 2009, according to Cenbio one m^3 is equivalent to 0.68 tons of eucalyptus. The areas of eucalyptus planted forest for roundwood production were 4.3 million hectare and 4.52 million hectare in 2008 and 2009, respectively.

According to CENBIO (National Refenrence Center on Biomass), the residue generation in the selvicultural sector could be divided in: after logging (15%), after processing (50%) and in the furniture industry (20%). The provided data for this study are from total roundwood production; hence the generation for residues from logging can not be estimated. Also, the residues in the stage of furniture sector are not regarded here because the location of its production is spreaded and unprecisely defined.

Brazil consumed domestically almost all its roundwood production coming from planted forest, and the major consumer for industrial use is the Cellulose and Paper sector. In tab. 1 is presented the consumption of eucalyptus roundwood by segments for industrial use.

Table 1. Consumption of eucalyptus roundwood by sectors for industrial use (2008 and 2009)

Sector	2008		Percentage (%)	2009		Percentage (%)
	1000 m^3	1000 tons		1000 m^3	1000 tons	
Cellulose and paper	48,395	32,908.6	43.70	52,545	35,730.6	47.27
Industrial wood panel	3,278	2,229.0	2.96	2,872	1,952.96	2.58
Wood industry	3,282	2,231.7	2.96	3,093	2,103.24	2.78
Coal	21,385	14,541.8	19.31	19,388	13,183.84	17.44
Industrial wood	33,537	22,805.16	30.28	32,363	22,006.84	29.11
Others	876	595.68	0.79	895	608.6	0.81
Total	**110,753**	**75,312**	**100%**	**111,156**	**75,586.08**	**100%**

Source: own elaboration based on ABRAF (2010)

In this eucalyptus residue scenario, it is estimated the roundwood residues from the stage of processing for the Cellulose and Paper sector, assuming as the only roundwood residue feasible for ethanol production. Thus, it is assumed a rate of residues generation of 50% of the total roundwood consumed in the sector and it is presupposed that the sector not used wood residues for stream and power generation. It is important to stress that this assumption is very strong since the sector normally uses all its roundwood residues for stream and power generation, but for effects of estimating the potential of eucalyptus residues for ethanol production, this consideration is valid.

The eucalyptus plantation for the cellulose and paper sector is over 2 million hectares. Considering this scenario, the roundwood residue available in 2009 was 17.86 million metric tons in the analysed sector. The second assumption sets one dry ton of eucalyptus roundwood produces 214 liters ethanol, as conversion factor. If it is considered 50% moisture content in the roundwood residue, the potential ethanol produced from eucalyptus residues is 1.9 billion liters of ethanol. All three scenarios analysed in this section estimate a total ethanol surplus of 29.5 billion liters without additional land use for plantation. The total plantation area for sugarcane, corn and eucalyptus production in 2009 was 26.4 hectares. In tab. 2 is presented the characteristics of the potential second generation ethanol production for the major crops in Brazil.

Table 2. Potential Second Generation Ethanol Production for the Major Crops in Brazil

Scenarios (2009)	Total production 10^3 tons	Type residue	Share Residue (%)	Total Residues production (10^3 tons)	Available Residues (%)		Residues Avaliable (10^3 tons)	Conversion factor (lts/wetton)	Ethanol Production (10^9 lts)	Energy Balance 1Joules$_{in}$ (J$_{out}$)
Sugarcane	604,513.70	bagasse	30	181,354.11	76		137,829.12	149.30	20.58	36
Corn	55,968.00	stover	100	55,968.00	50		22,984.00	252.00	7.05	36
Eucalyptus	35,730.60	residue	50	17,865.30	100		17,865.30	107	1.91	36
Total							**178,678.42**		**29.54**	**36**

3. Avaliable Feedstock for Second Generation Biofuel according to regional production.

When is estimated the potential amount of biomass residues available for producing second generation ethanol, it is important to consider some aspects, such as, small distances betweeen biorefinary and the agricultural crops; problems of emissions of foul odors and growth of fungus and plagues, if the feed site and storage place is not apropriated and; agricultural products have specific production seasons, thus when their residues is feedstock for the sector, seasonality should be part of the planning. From this context, it is estimated the potential amount of available biomass residues based on regional production and infrastructure availability for the biofuel sector, in order to attain a competitive strategy for the new sector. According to EIA (2010), once SGBF become comercially viable, a domestic industry can be built upon exiting infrastructure and feedstock sources for reducing overall investment cost.

It is assumed that consumption per capita of ethanol in Brazil in 2009 was 119.6 liters of ethanol, considering the total populational and the total consumption of ethanol, approximatly 22.8 billion liters. Also, it is considered that the production capacity of the new biorefinaries is over 100 liters/wt ton, currently an average first generation biorefinary produces 85 liters/ton of sugarcane.

In the scenario of regional sugarcane residue are considered the same values regarded in tab. 2 because the bagasse is the fibrous waste remains after the recovery of sugar juice via crushing and extraction at the refinary. Thus, it is assumed that the sugarcane bagasse is already in the production site for energy generation and biofuel production. In Figure 3 is observed the growth in sugarcane production, especially in the southeast of Brazil that produces over 69% of the total production.

The corn stover availability in South and Midwest of Brazil is abundant due to the regions have the largest productions of corn in the country with 40% and 30%, respectively. The production is about 11.4 million tons in the southern region and 8.4 million of tons in the Midwest. Only Federal District is not a large producer in the midwesten region, and all states in the southern region are large producers of corn. In this corn residue scenario, Federal District is considered for the total of potential residue production due to be located near to Goias, states ranking in the fouth position of corn production in the country. On the other hand, Southeast of Brazil produces 19% of the total corn production, with two important producing States, Minas Gerais and Sao Paulo. Minas Gerais produces about 57% and Sao Paulo 42% of total southeastern production. Due to those states have an important role in the first generation ethanol production and their FGBF infrastructure is well developed, their stover production is also considered in this scenario.

As depicted in fig. 2, the northeastern region and northern region represent roughly 8.4% and 2.5% of the Brazilian total corn product, respectively. In this scenario is considered only the potential production of stover from the counties of Extremo Oeste Baiano from the State of Bahia, northeastern region. Those counties produce together 2.1% of the national corn production and their total potential ethanol production is approximatly 147.5 millions liters. Also, it is considered this potential production in this scenario because if this value is considered for internal consumption, the consumption per capita would be 281.4 liters per capita, number over the estimated average consumption. Thus the production could be consumed internally and sell to other counties near to the region.

Hence, the total potential of corn stover production and sustainable ethanol production would be 25.8 million tons of sustainable corn stover, and 6.5 billion liters of ethanol respectively.

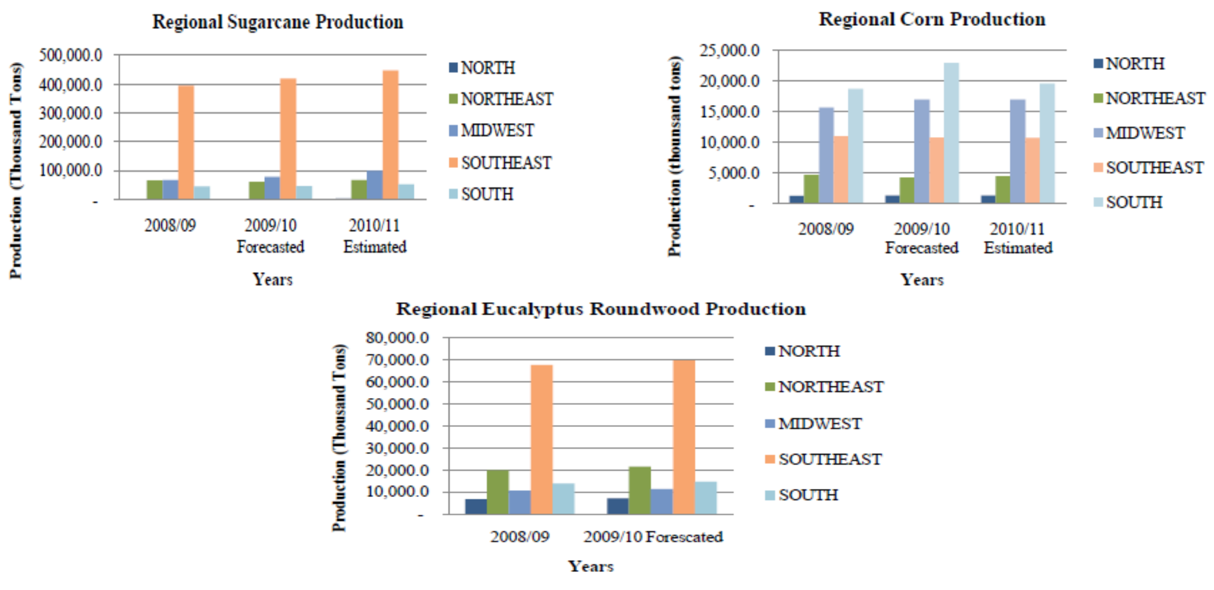

Figure 3. Brazilian Sugarcane, Corn and Eucalyptus Roundwood Production by Regional Distribution
Source: Own elaboration based on CONAB and ABRAF

As indicated in section 2, in the scenario of eucalyptus roundwood residues is assumed that only the roundwood residues from the stage of processing for the Cellulose and Paper sector is feasible for ethanol production. Also it is assumed that the cellulose and paper sector can work in symbiosis with the new biorefinaries to feed them and that the sector considers more profitable to feed the biorefinaries that to generate power from the residues produced in site. Therefore, the values in this scenario are based on tab. 2. Table 3 depictes the results of sustainable ethanol production for the three main feedstocks available in Brazil. Also it is estimated the potential in lignin production in theses scenarios.

Table 3. Potential Second Generation Ethanol Production Based on Regional Production

Scenarios (2009)	Potential Sustainable Production 10^3 tons	Type Residue	States		Residues Avaliable (10^3 tons)	Potential Ethanol Production (10^9 lts)	Co-product	Potential Energy Content Lignin TJ
Sugarcane	604,513.70	bagasse	all		137,829.12	20.58	Lignin	446,910.92
Corn	51,536.90	stover	Southern states, Midwestern states, sao Paulo, Minas Gerais and part of Bahia		25,768.45	6. 49	Lignin	83,554.20
Eucalyptus	35,730.60	residue	all		17,865.30	1.91	Lignin	57,928.23
Total					**181,462.87**	**28.98**		**588,393.36**

4. Conclusions

In the search of renewable energy a number of renewable options have been available for generation of electricity and heat, such as solar, wind, hydroelectric and biomass. But for production of liquid and gasesous transport fuels, biomass is currently the only renewable source that can be used to produce them. But one of the critical points of development biofuels is the unsecurity in available feedstock, technology development needed to process different types of feedstock and the possibility of destroy the environment if resources are overused.

From this context, second generation biofuels apper as a good option to be developed as a liquid fuel due to use agricultural and silvicultural residues as feedstock. Hence, it is added value to the agricultural waste before leaving on the field or idled.

Brazil due to agricultural capacity and experience in the bioethanol sector can participate proactively in this new biofuel tendency. Nowadays there are some pilot projects researching on second generation biofuels in Brazil. One is carried out by Petrobras and the other one is commanded by the Brazilian Sugarcane Technology Center, both are based on the development of bagasse-to-ethanol tecnology. According to Petrobras's Research & Development Center (Cenpes), it is estimated that the first commercial production of second generation etanol will start by 2015. Also, it is estimated that bagasse-to-ethanol tecnology can increase the Brazilian ethanol production by some 40%.

According to the estimated value in this study, based on the harvesting year 2009/2010 values, the ethanol production from available sugarcane bagasse can contribute with an ethanol surplus of 20.58 billion liters. Since the production in the harvesting year 2009/2010 was 25.7 billion liters of ethanol, the ethanol production regarding second and first generation ethanol could have an increasing rate of about 44% without increasing the demand for arable land for sugarcane plantation. Thus, the ethanol production is almost duplicated in the same 8.91 million hectars of sugarcane plantation.

In addition to sugarcane bagasse as feedstock, corn stover and eucalyptus roundwood residues were used as available feedstock for estimaing the potential ethanol production. If it is considered the corn stover as only available feedstock, assuming all sugarcane bagasse and eucaluptus roundwood residues are more profitable used in cogeneration systems, the surplus ethanol would be 6.45 billion of liters, representing an increasing rate of approximaly 20% of the current ethanol production.

Therefore, the total potential of second generation ethanol production is estimated at 28.98 billion liters of ethanol and this value contributes to an increasing rate of 53% without additional farming land. The area to produce the total potential of ethanol was 21.04 million ha coming from sugarcane production, corn production and roundwood production for cellulose and paper sector.

National Agency of petroleum, Natural Gas and Biofuels (ANP) issued that at the beginning of 2011, the average parity price of ethanol and gasoline overpassed 0.7. It makes ethanol not longer competitive in relation to gasoline and unattrative alternative for the final consumer. According to ANP, the average parity price ethanol vrs gasoline was 0.53 in 2007, 0.535 in 2008, 0.561 in 2009, 0.643 in 2010 and in the first months of 2011, this value got to 0.718. Hence, increasing the supply of second generation ethanol in the Brazilian market would help to keep ethanol price competitive without depending mainly on other international commodities prices, such as sugar prices.

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