THE BRAZILIAN BIODIESEL PROGRAM

Munir Y. Soares[1]
Margareth O. Pavan
Clara Barufi
Célio Bermann
Virgínia Parente
Postgraduate Program in Energy of the University of São Paulo
Instituto de Eletrotécnica e Energia
Av. Luciano Gualberto, 1289. Sao Paulo, Sao Paulo, Brazil, CEP: 05508-010

ABSTRACT

In 2003, the Brazilian government created the Biodiesel Program. This Program was designed to provide incentives for the production of biofuels from vegetal oil, such as palm oil, soy oil, and castor oil amongst other oil seeds available in Brazil. Through mandatory targets, the objective of the Program was to achieve the substitution of conventional diesel by 2% by the end of 2007, and by 2013 it should be expected that all diesel consumed in the country will hold a content of 5% biodiesel.

The Biodiesel Program addresses its actions in four main targets: (1) reduce the diesel imports of from other countries; (2) promote the production of biodiesel in different regions of the country by using a diverse range of raw materials, (3) feed the market with competitive prices and (4) promote social inclusion of agriculture labor force and enhance environmental sustainability. These aspects were considered an innovation in public policy. Through this Program there are special arrangements in which the government can subsidize the household units prepared to engage in these activities. This is a way to support the rural development of the less developed regions in Brazil, such as the northeast and north area of the country, yet encouraging the use of a renewable fuel that can account for reductions of CO2 and other air pollutants, such as SO2.

The production of biofuels in Brazil has achieved some important targets. Many companies which are currently supplying and distributing biodiesel, acquire important percentage of the commodity from household units engaged in the family agriculture. The first four auctions that the government promoted for demanders and suppliers of biodiesel were considered by some criteria a success, however other aspects need to be improved. There are still many questions that must be answered to prove that the Brazilian Biodiesel Program is really going to work.

It endeavors to describe and analyze the Brazilian Biodiesel Program as a public policy based on social and environmental sustainability. By examining the regional distribution of the production and the family production framework of the Program, it also presents the future perspectives of the Program and some suggestions to improve its basic design.

1. INTRODUCTION

The use of vegetal oil dates back to the end of ninetieth century, when Rudolph Diesel used in motors alcohol and peanut oil to run his motors (Shay, 1993). During the years of 1930 and 1940, different kids of vegetal oils were used in emergencies in diesel motors, mainly during the two world wars (Ma; Hanna, 1999). When the oil shock of the seventies occurred in the seventies, this opened a new perspective for the uses of non conventional fuels. For this reason, in 1975 the Brazilian government created the "Vegetal Oil Production Plan to Energy Uses" (PRÓ-ÓLEO). The PRÓ-ÓLEO was not successful, due to a lack of technology.

In 2003, the Brazilian government, by decree, created the National Program of Production and Use of Biodiesel (PNPB). This program was aimed to add biodiesel in the Brazilian Energy Matrix by blending 2% of biodiesel until 2008, and 5% until 2013. These targets should be enforced to all diesel commercialized in the country (Biodiesel, 2006).

This Program endeavors to have three important highlights: (1) the production of biodiesel from different oil seeds from the diverse regions of the country; (2) the promotion social inclusion through job creation; and (3) the support of a new source of oil supply with competitive prices and appropriate quality.

In economic terms, the production of biodiesel is an important way to balance the external commerce indicators and it's also a very important market for the country, because Brazil has the most important experience in biofuel production in the world - The National Program of Alcohol (Moreira; Goldemberg, 1999). From a social perspective the biodiesel represents a very important opportunity for social inclusion in the poorest regions of the country. Beyond that, the blend of biodiesel and diesel has important environmental advantages, reducing the dioxide carbon emissions and other toxic elements.

In this paper, we make the effort to evaluate the main results of the Brazilian Biodiesel Program giving priority to the environmental and social aspects. The analysis is going to be concentrated in the first four auctions and in the trends that we observe in the Brazilian biofuel market. To accomplish that, we present the main technological, institutional, legal, operational marks of the Brazilian Biodiesel Program.

2. THE BRAZILIAN BIODIESEL PROGRAM

In this section we are going to present the characteristic of the Brazilian Biodiesel Program, the institutional framework created by the Brazilian authority to the program and the special benefits to families engaged in agricultural activities.

The government objective with the program, as said below, is the insertion of a new fuel in the Brazilian fuel market, which enables the decentralized production of

biodiesel (using the oil seeds available in the regions), and which promotes social inclusion.

In economic terms, the production of biodiesel will reduce the diesel imports In 2006, 10% of diesel traded in Brazil was imported from abroad. The Brazilian government estimates that the addition of 2% of biodiesel to conventional diesel is going to represent savings of up to US$ 160 millions and 800 millions liters of diesel (Biodiesel, 2006).

From a social perspective, the Brazilian government is willing to create jobs for the household engaged in agricultural activities model. The number of jobs that will be created is uncertain. The Brazilian Ministry of Mines and Energy ("Ministério de Minas e Energia" - MME) estimated that by the end of 2006, 210.000 jobs were created for families engaged in the biodiesel production (Agência Brasil, 2006).

Another important objective of the Biodiesel Progam is to reduce the quantity of carbon emissions and to improve the quality of the air in big cities of the country.

The institutional framework of the program was created in 2003 by president's decree and was regulated by the law 11.097/2004. As said above, the government wants to promote social inclusion through the program, and for this reason, the government created a social certificate, a tax reduction to induce companies to employ families in the production of the biodiesel raw materials. Additionally, the government has stipulated minimum quantities of raw materials that must be produced from family agriculture project and big properties or conventional agriculture model (Table 1).

Table 1. Participation of the family agriculture among the raw-material suppliers per region of the country.

Region	*Family Agriculture (%)*	*Conventional Agriculture (%)*
North	10	90
Northeast	50	50
Center West	10	90
Southeast	30	70
South	30	70

Source: Ministry of Agrarian Development, resolution n# 1 from the ministry of agrarian development, 2004..

The biofuel trading has been regulated by the National Oil Agency ("Agencia Nacional de Petróleo" - ANP) through auctions. However, once the market is consolidated, it is expected that the agency will no longer carry out a regulating role in settling the auctions. These auctions have been made in the reverse way, since the regulatory agency establishes a maximum price. The suppliers, for their turn, must offer prices that are lower that the initial value, so that the winner is the one who offers the product for lowest price.

An import basket of subsidies was provided given by the government to companies which have a social certificate – The social post. These subsidies take into

consideration the oil seed used and the region of production. In some regions and for some oil seeds the producers are free of federal taxes (Accarini, 2006).

According to Macedo and Nogueira (2005) the quality standards of the biodiesel is an important issue that must be defined by the ANP, because it can affect the efficiency of the motors from the transport vehicles. For the time being, the specification of the fuel in Brazil is similar to that of Europe and the United States, but the country is going to start some tests with the automobile companies to define national parameters more adequate to the local reality.

3. TECHNOLOGICAL ASPECTS OF BIODIESEL PRODUCTION

Biodiesel is the denomination for fuels produced from vegetal oil and animal fat to be used in diesel motors. In Brazil, only the biodiesel from transisterification process, wich is chemical reaction of triglycerides, is known as biodiesel (Parente, 2003).

The raw-materials for the biodiesel are diverse. In Germany the main product is canola oil, in Malaysia palm oil is largely used with productivity of 5.000Kg/ha/year (Plano Nacional de Agroenergia, 2005).

In Brazil, there are a wide variety of plants that can be used such as: peanuts, jatropha, soy, palm, castor and others. The most important alternatives in the country are the soy seeds, with 90% of the production for vegetable oil; the palm oil, because of the large productivity; and the castor, because of its resistance to dry soils that are an important characteristic for the northeast region of the country (Plano Nacional de Agroenergia, 2005). The most important aspect that must be taken account is the production of oil per hectare (table 2) .

Table 2. Potential for the biodiesel production of some selected sources.

Specie	Oil Content (%)	Harvesting Months	Oil Prductivity (t/ha)
Palm (Elaeis guineensis N.)	26	12	3.0-6.0
Sunflower(Heleianthus annus)	38-48	3	0.5-1.5
Canola (Brassica camprestris)	40-48	3	0.5-0.9
Castor (Ricinus Communis)	43-45	3	0.5-1.0
Peanuts (Arachis ipogaea)	40-50	3	0.6-0.8
Soy (Glycine max)	17	3	0.2-0.6

Source: Macedo; Nogueira, 2005.

According to Macedo and Nogueira (2005), there are 100 million hectares available for the expansion of the soy culture. The Brazilian Biodiesel program intends to produce biodiesel from different oil materials, mainly the soy oil, the castor oil, and the palm oil. Allocating the sites of biodiesel production in the regions where these cultures are produced. This distribution is important because it ensures that each region will use their local resources in the biodiesel production.

The National Plan of Agroenergy, of 2005, signalizes that the north region of Brazil would be responsible for 10% of the total production of biodiesel having as its main raw-material the palm oil. The northeast region would be responsible for 15% of the production using the castor oil a plant that can promote social inclusion. In the center-south regions the main raw material would be soy oil associated with other different raw-material as animal grass, sunflower, and canola.

There are two industrial processes used to obtain biodiesel - transisterification and cracking. However, according to Lima (2005), the literature has defined the biodiesel as biofuel from the first process.

In Brazil, the transisterification is important, because it enables the use of ethanol from sugar cane. Brazil is the most important ethanol producer in the world with almost 16 billions liters in 2005/2006 (Unica, 2006). The use of ethanol is less efficient than the use of methanol for many reasons. For example, the methanol time reaction is 25% faster than de same reaction with the other catalyst (Parente, 2003).Even though, the use of ethanol is another opportunity to use local resources and decrease de external dependence of the country.

The environmental advantages of biodiesel represent an important strategy for the mitigation of CO_2 emissions, because as plants grow the CO_2 is absorbed. In Europe, the emissions from biodiesel have been evaluated over the last ten years, considering the use of soy, canola and methanol as catalyst. The results related to the pure biodiesel (B100) indicate a reduction from 40% to 60% of emissions related to the conventional diesel (Analysis of Energy Use and Greenhouse Gas, 2002).

The biodiesel promotes an important reduction of other gases and materials, such as sulphur oxides (SO_x). The reduction is proportional to the quantity of biodiesel present in the blend with diesel (table 3). In spite of these aspects, some studies point out that biodiesel may not be a good strategy to guarantee environmental improvements and economic efficiency (Wassel;Dittmer, 2006; Frondel; Peters, 2006) for the case of Europe and United States of America. In the Brazilian case, the biodiesel blend can bring important improvements for the mitigation of greenhouse gas emissions and for the air quality of the big cities, as São Paulo and Rio de Janeiro.

As it can be seen, there is an important reduction of particulate material (10%), when we use the B20 blend (Table,3). According to Knorus et al. (2003) the use of biodiesel reduces the emissions of aromatic polycarbonate which are responsible for various kinds of cancer. The oxides of nitrogen are the unique substances that have an increase by the addition of biodiesel, even with this fact the analysis favorable for this biofuel

Additionally, The Brazilian Biodiesel Program is an important sign to the world that there are Brazilians efforts to prevent the climate change effects. In spite of that, we believe that further economic study must be launch by the authorities in order to analyze the economic benefits of the biodiesel introduction in the Brazilian energy

matrix. This study must be conducted taking into consideration all the externalities of the program, such as job creation and other environmental externatilies. The state owned Brazilian Agricultural Research Corporation (Embrapa) estimates that only for soil recuperation inversions of almost US$ 20 billion will be necessary (Embrapa, 2006).

Table 3 – Toxic material emissions.

Poluente	Increse / Decrease	B100 (100%)	B20 (20%)	B10 (10%)	B5 (5%)
		Decrease or Increase (em %)			
Greenhouse gases	D	78	15	7.5	3.75
Sulphur	D	98	19	9.5	4.95
Particulate Material	D	50	10	5	2.5
NOx	I	13	2.5	1.3	0.65

Source: Barufi et al, 2007.

4. THE RESULTS OF THE PROGRAM

As mentioned above, biodiesel in Brazil is negotiated in a system of auctions controlled by the regulatory agency, ANP. This agency has already carried out four auctions with a negotiation volume of 840 liters of biofuel. The major part of this fuel was bought by the oil state owner – Petrobrás - 93% and the rest was sold to the "Refinery Alberto Pasqualini" that is controlled by Petrobrás and Repsol/YPF. These companies sell the biodiesel to distributors, like they sell the fossil diesel, where the blend is prepared. The distributors must have adequate installations in their operational sites.

The ANP forecasts that all biodiesel negotiated will be consumed until the end of 2007. Up to now, the sites that are offering the blend to their clients are very expressive, but by the end of 2007 the Petrobrás distributor wants to offer the blend in almost 95% of the sites (BR, 20006).

The auction format permits lower prices paid for the product. The undercharges in the auctions were 2.53 % and 8.29% for the second and fourth auctions respectively. In order to stimulate the companies which adopted the family model of production the first four auctions were opened only for the companies that had a social certificate or had initiated the certification in Ministry of the Agrarian Development (MDA).

In these auction a total of 23 companies were chosen as biodiesel suppliers. Analyzing the raw materials used by the companies, we note that castor oil is used by 8 companies located in the northeast region. This is a good sign because this vegetal is the option for the northeast; and in this region, as presented in table 1, the targets of social inclusion are more ambitious than in other parts of Brazil (ANP, 2006).

Table 4: Companies Suppliers in the first four auctions.

Company	Region	Volume (m^3)	Oilseeds used
Renobrás	Center-west	900	Soy, Sunflower
Binatural	Center-west	1,320	Sunflower, Jatropha
Biominas *	Southeast	2,651	-
Agrosoja	Center-west	5,000	Soy
Fertibom	Southeast	6,000	Jatropha, Sunflower, Castor oil
Agropalma	North	7,200	Palm oil
Soyminas	Southeast	8,700	Soy
Oleoplan	South	10,000	Soy
Barrálcool	Center-west	16,629	Sunflower and Jatropha
Ponte di Ferro	Southeast	19,000	Soy
Granol	Southeast	20,100	Soy
Fiagril	Center-wes	27,500	Soy (70%) e animal fat (30%)
Caramuru	Center-west	30,000	Soy, Corn, sunflower and canola
Ponte di Ferro	Southeast	31,000	Animal grass
Granol	Center-west	36,000	Soy
Biocapital	Southeast	60,000	Soy, Sunflower, Peanuts, Castor oil.
Bsbios	South	70,000	Soy, Sunflower e Canola
Brasil Biodiesel	South	80,000	Castor oil and Sunflower
Brasil Biodiesel	North	90,000	Castor oil
Brasil Biodiesel	Northeast	316,000	Castor oil

Eleven companies of the 23 use soy oil (ANP, 2006), this fact leaves society skeptical about the capacity that these companies have to employ the family agriculture in the raw-material production, because in the countryside the soy culture is characterized by plantations (Schlesinger, 2006).

The analysis of the volume offered for each region of the country is important to give evidence to problems related to the demand and the offer of the biodiesel. Even if ANP, for the firsts four auctions had closed the market to privilege companies with the “social post”, the data presented (figure 1) detached some important trends.
The most important quantity comes from the northeast region, 316,000 m^3, while 97,200m^3 are from the north. These two regions are where the program wants to promote a consistent focus on social inclusion. Even though, thirty eight percent of the total volume comes from the northeast region, it comes from a unique company. This fact is not desirable, because it demonstrates a market concentration. This characteristic may not be good for local raw-materials producers, because they will not have an option to offer their production to other companies.

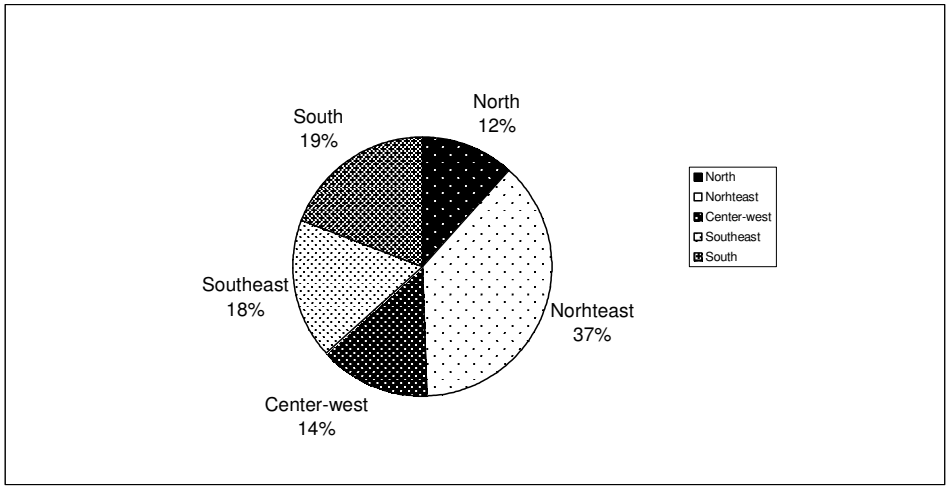

Fig.1. Regional distribution per volume (%) (ANP,2006).

The analysis of the number of companies per region (Figure 2) enables us to understand that the north region and the northeast have their markets controlled by only two companies – "Agropalma and Brasil Biodiesel". The southeast region and the center-west region have more companies, 60% of the total, and these companies produce small quantities of biodiesel (table 4), which is interesting to the local family agriculture. The south region has two companies that were present in these auctions, Brasil Biodiesel and Bsbios. As we notice, there is one company (Brasil Biodiesel) producing almost 60% of the biodiesel production negotiated in the firsts auctions.

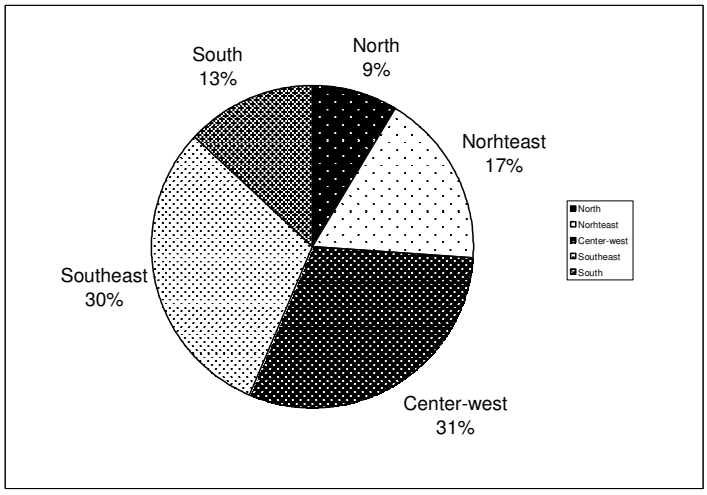

Fig. 2. Regional distribution per units of production (%) (ANP,2006).

The comparison between the demand of fossil diesel and the regional supply of biodiesel permits us to analyze the equilibrium between these factors, furthermore, it also permits us to evaluate if the supply of biodiesel is in equilibrium with the demand of diesel.

The comparison between the diesel consumed in 2005 and the volume of biodiesel contracted in the first auctions evidences that there is an important distortion between the supply and demand in the southeast region. This region concentrated 44% of the demand of diesel and only produced 18% the biodiesel. Inversely, the northeast region produced 40% of the biodiesel and they consume only 15% of diesel, so the supply Is much higher than it would be necessary. The biodiesel production must be localized next to the consumer centers; because it can reduce energy expenses and improves the energy balance of this biofuel.

Unless we notice this disequilibrium, this fact, up to the moment, is not so relevant, because the auctions were opened to companies which had the social certificate and for this region the model of social inclusion will not be very representative. But for future of the program is important that these to factors have a balance (Figure 3).

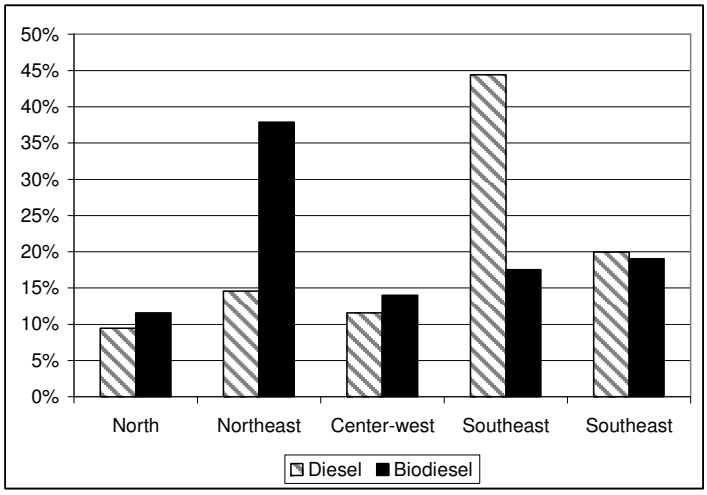

Fig. 3. Comparison between offer and demand of biodiesel (%) (ANP,2006).

5. THE SOCIAL INCLUSION FRAMEWORK

The results of the social certificate show that there are uncertain aspects that must be clarified by the authorities and by the companies to prove that the social points of the program are being respected.

The winners of the first four auctions totaled 28 projects among 17 participating companies. Before signing the contract with Petrobrás, 13 companies initiated the process to obtain the social certificate, and in 2006, 8 companies also solicited the "social post". The ministry of agrarian development indicates that 30,000 families were employed in raw-material production in biodiesel production (MDA, 2006).

The family agriculture projects has been criticized by some social movements and Non Governmental Organizations (NGO) because according to them the social approach adopted by the government is not adequate to promote rural development in some regions. According to Barufi et al (2007) the family production framework does not permit to the families engaged in raw-material production to negotiate good contracts to sell their products. Soares et al (2006) presents the job creation perspective for the biodiesel as much less optimistic as the government, while the official numbers demonstrated that the number of families employed were 200,000, this study estimates that in fact, the number was closer to 60,000 families for the B5 blend.

The family agriculture production framework consists in an association among a biodiesel producer company, a raw-material family producer(s) and the regional public power or the federal authorities. The company offers to the local families technical assistance for the tillage and a guarantee that the production will be bought by the company. The families use their properties to cultivate the oilseeds and borrow money for financial costs. The regional authorities provide financial assistances with low interest taxes (Soares et al, 2006). The families and the companies must negotiate a contract for this commercial agreement.

According to the Biomass Reference Center (CENBIO), located in Brazil, this model is adequate to promote social inclusion (Cenbio, 2006), because agricultures have technical assistance and they have a guarantee that their productions will be bought by the company. However, Barufi et al. (2007) argue that this way of production does not allow the appropriation of the production technology by the farmers and there is not a perspective of dynamic development.

Another point that we can add is the way the contracts are being negotiated. They are agreed upon between the families and companies and these terms oblige the raw-material producers to sell their production to only one company. Another point is the fact that the contract links the price of the production to international costs of the oilseeds. This fact leaves the families unprotected against international variations in the prices. So, the families are very dependent on the companies that buy their products, the power correlation is unequal.

Unless the government announces that the main targets of the program are social inclusion, they did not create a special financial assistance for the creation of rural cooperatives of biodiesel to promote a more dynamic social inclusion action with the creation of an important job chain, as idealized by Sachs (2005).

The environmental impacts that the biodiesel program may cause are not clear. The main problem that can occur is that the expansion of some oilseeds like soy, will extend to forested areas and to Amazonian region. According to Barufi et al (2007) the dynamic of this process is very uncertain, but the authorities must guarantee that the expansion of this oilseed happens in an available area, that had already been transformed by anthropologic action.

Other aspects are the lack of study of research about the expansion of some raw-materials that were not cultivated largely until the beginning of the program, like the castor oil and the Jatropha (Cenbio, 2006). This expansion can cause serious problem to soil and contaminate rivers (Barufi et al, 2007).

6. CONCLUSION

As discussed in this paper, the Brazilian Biodiesel Program is a considerable initiative from the national authorities due to the fact that: (a) it focuses on social inclusion; (b) It promotes local and global environmental sustainability; (c) it tries to succeed in the insertion of new fuel in the Brazilian energy matrix; (d) it aims to promote regional rural development from different oilseeds in different areas of the country.

The present results provide evidence that the Program has obtained some important achievements, such as an increasing undercharge in the auctions as well as, negotiating an important volume of biodiesel that will supply the demand until the end of 2007. However, the analysis of the market showed that there is a concentration of the market by one company, responsible for 60% of the contracts in the auctions from which the biodiesel family production was negotiated.

The analysis of the regional supply and demand of biodiesel points out that there is no balance between the diesel demand and the biodiesel supply, but this fact has not been relevant up to now, because these auctions included only the companies, which has the social certificate. It is necessary to wait the overture of the biodiesel market to have a complete overview of the situation.

The evaluation of family agriculture production indicates that the families involved will not be able to negotiate fair contracts and will be exposed to variation of the international oilseed prices. Additionally, the model adopted by the government does not empower local families to create cooperative industries, as presented in section 5, because of the way the Brazilian Biodiesel Program is designed.

From an environmental point of view, it was demonstrated from the primary results that the Brazilian Biodiesel Program can significantly improve the air quality especially in the big Brazilian cities. However, in order to prove this more studies must be conducted. In addition to this, a further study must be carried out to evaluate the externalities on the entire national biodiesel supply chain,

Another important externality is in reference to the expansion of some crops like soy, which encourages deforestation in the forested areas and the protected areas in the Amazon and the savannah areas. The Brazilian experience with biofuels shows that it can cause some major impacts on the maintenance of biodiversity, as such it is important that mistakes made, for example, with alcohol production in the past few years do not occur in the future in the biodiesel framework production.

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REFERENCES

ACCARINI, J. H., 2006, Biodiesel no Brasil: Tendências de desenvolvimento, Seminário Matriz Energética x Custos e Benefícios do Usuário,July 13-13,2006. São Paulo, Sã Paulo, Brazil.

Agência Brasil, 2006, http://www.agenciabrasil.gov.br/noticias/2006/08/20/materia.2006-08-20.0260519074/?searchterm=empregos%20and%20biodiesel, Accessed in Agust 20, 2006.

ANP, 2006, www.anp.gov.br, Accessed in July 16, 2006.

BR, 2006, www.br.com.br, Accessed in Jan. 31, 2007.

Biodiesel, 2006, www.biodiesel.gov.br, Accessed in Sept. 01, 2006.

BARUFI C. et al., 2007, Biodiesel e os Dilemas da Inclusão Social: uma análise do programa brasileiro, in As novas energia do Brasil: dilemas da inclusão social e programas do governo, Org. Bermann C.: FASE PRESS.

CENBIO, 2006, Reference Center in Biomass, personal communication in Aug. 15-18,2006.

EMBRAPA, 2006, www.embrapa.com.br, Accessed in July 13, 2006.

FRONDEL M.;PETERS, J., 2006, Biodiesel: A new oildorado?, Energy Policy, in press.

KNOTHE, G.; DUNN, R. O.; BAGBY, M.O., 2003, Biodiesel:the use of vegetable oils and their derivatives as alternative diesel fuel. National Center for Agricultural Utilization Reaserch, Peoria.

LIMA, P. C. P. Biodiesel, 2005, Um novo combustível para o Brasil. Câmara dos Deputados. Consultoria Legislativa, 31 p., Brasília.

Ma, F.; HANNA, M. A., 1999, Biodiesel production: a review. Bioresource Technology. 70:1-15.

MDA, 2006, Ministry of Agrarian Development. www.mda.gov.br Accessed in Sept 06, 2006.

MACEDO, I. C.; NOGUEIRA H. A. L., 2005, Avaliação do biodiesel no Brasil,In Biocombustíveis, edited by Núcleo de Assuntos Estratégicos da Presidência da República.

MOREIRA, J. R.; GOLDEMBERG, J., 1999, The Alcohol Program, Energy Policy, 27: 229-245.

PARENTE, E. J. S., 2003, Uma aventura tecnológica num país engraçado, Ceará, 2003. Available in www.tecbio.com.br, Accessed in july 15, 2006.

PLANO NACIONAL DE AGROENERGIA, 2005, Brasília: República Federativa do Brasil.

SACHS, I.,2005, Da Civilização do Petróleo a uma Nova Civilização Verde. Revista de Estudos Avançados 55:17-214.

Schlesinger, S., 2006, O Biodiesel da Soja: queimando óleo e florestas, chamuscando gente. Rio de Janeiro: FASE.

SOARES M. et al.,2006, Programa Nacional de produção e uso do Biodiesel e a geração de empregos - O modelo de Agricultura familiar, International Conference of Agroenergy I, Dec 11-16, 2006. Londrina, Paraná, Brazil

SHAY, E.G. Diesel fuel from vegetables oils: status and oportunities. Biomass and Energy; vol. 4, n. 4, p. 227-242, 1993.

WASSEL Jr, C.;DITTMER, T. P., 2006, Are subsidies for Biodiesel economically efficient?, Energy Policy 34:3993-4001.

Unica, 2006, www.unica.com.br Accessed in Nov 15, 2006.