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The quest for eco-social efficiency in biofuels production in Brazil

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ABSTRACT

Equating eco-efficiency with the business link to sustainable development is clearly limited, especially with the new paradigms brought up by Corporate Social Responsibility, which has shown that the private sector's contribution to sustainable development can go far beyond the sphere of pollution control. It is necessary to give eco-efficiency a broader meaning so that it can support the quest for sustainable development. This requires the inclusion of social aspects, leading to a kind of eco-social efficiency. The present paper illustrates this idea by comparing Brazilian production and use of ethanol from sugarcane, in the context of the National Alcohol Program (Proalcool), with biodiesel production and use, in the context of the Biodiesel National Program (PNPB). Despite the problems presented, PNPB was designed to encourage companies to align productivity concerns with social ones, what could be the beginning of the here called eco-social efficiency.

1. Introduction

The eco-efficiency concept arose from a request that the business sector present a proposal for actions in the environmental area for the United Nations Conference on Development and the Environment that took place in Rio de Janeiro in June 1992 (WBCSD, 2000a). It was presented by the WBCSD as the *business link to sustainable development*, putting forward the idea of the creation of more goods and services with ever less use of natural resources and generation of wastes and pollution: "*Eco-efficiency is achieved by the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth estimated carrying capacity*" (WBCSD, 2000b).

Eco-efficiency is not sufficient to attain sustainable development (Day, 1998; Hukkinen, 2001; Dyllick and Hockerts, 2002; Vinha, 2003; Mickwitz et al., 2006; Hart, 2007). It can contribute to greater process efficiency (cost reduction through a lower consumption of raw materials and energy and waste generation) and product improvement (adding value for companies and their customers). But the efficiency should not be assessed without referring to its ultimate purpose (Nunes, 2000). Ecological and economic efficiency, or the eco-efficiency, should involve a relation between means and ends, that should converge towards sustainable development, a comprehensive approach comprising economic, environmental and social dimensions. Companies' application of the eco-efficiency concept appears to have remained limited to the sphere of pollution control, in an intramural approach emphasizing cost reduction, resource savings, productivity improvements and the generation of competitive advantage (Vinha, 2003).

Hukkinen (2001) criticizes the narrow interpretation of the concept of eco-efficiency that focuses on measuring dematerialization using universal indicators, limiting the concept to the management of raw material and energy flows, disconnected from the local socio-economic and cultural context. Eco-efficiency parameters should be contextualized, varying according to different ecosystems' sensitivity and support capacity and stakeholders affected.

Equating eco-efficiency with the *business link to sustainable development* is clearly limited, especially with the new paradigms brought up by Corporate Social Responsibility – CSR, which has shown that the private sector's contribution to sustainable development can go far beyond the sphere of eco-efficiency. The concept of CSR is not new. The role of business corporations in society has

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been questioned since long time ago (Dodd, 1932). In the last decades there have been changes in society's expectations about the role of business, charging them with more responsibility in building a new development model (Frankental, 2001; Nelson, 2004). They are expected to control their risks, but without limiting their actions to the minimization of the negative impacts and negative externalities on the environment, society and stakeholders caused by their operations, but they can also create and add value, leveraging their positive impacts on the communities in which they operate (Nelson, 2004). Dyllick and Hockerts (2002) provided an important discussion on the concepts of eco-effectiveness, socio-efficiency and socio-effectiveness. Socio-efficiency supports the inclusion of the relation between a firm's value added and its social impacts, implying in minimizing negative social impacts and in maximizing positive social impacts in relation to the value added for the companies. However, eco-efficiency and socio-efficiency are relative measures, leading to relative improvements and sustainability is not only an issue of efficiency but also of eco and socio-effectiveness (Dyllick and Hockerts, 2002).

The alignment of the eco-efficiency with more responsible business practices should lead to the emergence of a kind of eco-social efficiency. Thus, the idea of creating more value with a lower environmental impact, or "doing more with less", should explicitly include the creation of value for the companies' stakeholders. Stakeholder engagement can support companies in the maximization of their contribution to local development, reduction of risks, rising opportunities and conquest of their license to operate, without focusing on the tensions between companies and society, but on their interdependence (Porter and Kramer, 2006). In order to translate the concept of sustainable development to the business level, more emphasis should be put on the social dimension, through the concept of eco-social efficiency (the third sustainability dimension, economic viability, is assumed as the main concern of business activities).

Eco-efficiency is also related to the replacement of fossil fuels with renewable sources, as well as fostering the sustainable use of renewable resources (WBCSD, 2000a). This paper presents the case of biofuels which illustrate the pertinence of eco-social efficiency by demonstrating how eco-efficiency and efficiency are insufficient to attain sustainability, where the mere replacement of fossil with non-fossil fuels cannot be regarded as synonymous with sustainability.

2. Biofuels: from an oil-based to a new green civilization[3]

At the beginning of this millennium, biofuels were presented as a favorable economic, environmental and social option, whose drivers were the concern with the world energy matrix's dependence on non-renewable energy sources, the opportunities they presented for rural development and the growing concerns with global climate change. However, this was soon followed by several criticisms regarding the sustainability of biofuels, in contrast to their initial presentation as a clean alternative to the use of fossil fuels (La Rovere and Obermaier, 2009). In 2008, biofuels were blamed for the sharp increase in staple food prices in the international market and all biofuels were indistinctly criticized as unsustainable energy options (Ziegler, 2007; Mitchell, 2008). Eventually it became clear that ethanol production from sugarcane has very better performance compared to ethanol from corn in the US (La Rovere and Obermaier, 2009). Still remaining are some concerns involving (La Rovere and Obermaier, 2009):

- The contribution of the cultivation of feedstock to the deforestation of tropical forests;
- Competition between biofuels and food-crops for fertile land, leading to increases in the prices of basic foodstuffs and thus affecting the food security of poorer populations and
- The effectiveness of biofuels in the struggle against climate change, where the greenhouse gas emissions that result from the production and use of biofuels can vary a great deal due to the release of carbon stored in soils and vegetation and as well as the removal of the vegetation cover for their production.

Sachs (2009a,b) places the discussion regarding biofuels in a broader perspective, embracing rural development and changes in lifestyles and consumption habits, where biofuels are not a panacea, but one of the possible uses of biomass in a modern biomass-based, socially inclusive and environmentally sustainable civilization (Sachs, 2005).

2.1. International biofuel sustainability initiatives

In response to these criticisms, various international standards, initiatives and certifications have established criteria, indicators and requirements to support the sustainability of biofuels production with the *Roundtable on Sustainable Palm Oil* (RSPO) and the *Roundtable on Sustainable Biofuels* (RSB) possessing some of the most detailed criteria.

The RSB is an international initiative of the École Polytechnique Fédérale de Lausanne joining producers, companies, governments, agencies and NGOs concerned with assuring the sustainability of biofuel production and processing. The RSB has been promoting a series of meetings and teleconferences aimed at achieving a multi-stakeholder consensus regarding Principles and Criteria for Sustainable Biofuel Production (RSB, 2008). The RSPO is a not-for-profit association joining palm oil industry stakeholders, including producers, processors, buyers, consumers, banks and financial institutions, NGOs and universities, to develop and implement global standards for sustainable palm oil (RSPO, 2007).

Table 1
Main social and environmental issues present in biofuel related sustainability initiatives.

Nature	Main issues
Environmental	- Soil and Land Use: fertility, control of erosion and degradation, burning, monoculture; - Water Resources: availability and quality of surface and ground waters, water management; - Air: air quality, atmospheric pollution, atmospheric emissions; - Control of pests, diseases, invasive species, minimization of the use of chemical pesticides, use of fertilizers; - Biodiversity; - Pollution Control: waste management, use of co-products; - Energy Efficiency (Energy Balance); - Global Climate Change (GHG emissions).
Social	- Employment and income generation; - Keeping people on the rural areas; - Landowning structure; - Food security and competition for food; - Human Rights; - Labor Rights and working conditions; - Land Use Rights; - Child Labor; - Technical Assistance and Rural Extension, Training and Capacity Development; - Transparency; - Stakeholders Engagement.

Source – Based on (RSB, 2008; RSPO, 2007).

[3] Sachs (2005).

Some of the main themes addressed by RSB and RSPO are listed in Table 1, divided into environmental and social issues. In general, these initiatives recommend the identification, assessment and monitoring of environmental and social impacts associated with biofuel production. They also address transversal issues such as legal compliance which is a necessary but insufficient condition; the tools that can be employed, such as life-cycle analysis and the means that can be used, such as the implementation of new business models and new partnerships between the public and private sectors and society, the exercising of CSR and the quest for continuous improvement.

Initiatives such as the RSB and RSPO provide important inputs for the discussion of biofuels sustainability. It is necessary to examine issues regarding the implementation, effectiveness and operationality of these initiatives more deeply, seeking to ascertain to what extent they will benefit the stakeholders involved. The quest for the de facto engagement of these stakeholders constitutes a permanent challenge. It should also be pointed out that a consensus has not yet been reached as to ways of assessing and measuring the sustainability of established sectors, yet alone the complex and new biofuels sector.

3. The case of the Brazilian alcohol program (Proalcool)

Brazil occupies a prominent position in the biofuel scenario, is the world's largest sugarcane and second largest ethanol producer and has accumulated 35 years of experience since the establishment of the Proalcool. The Proalcool was a federal program launched in 1975 during the first oil shock, driven by the need for energy security, and its main aim was to reduce foreign oil imports after the world energy crisis by including ethanol in the Brazilian energy matrix. Initially the program also had social objectives, such as reducing regional and individual income disparities by encouraging family farmer production of manioc alcohol, but which proved economically unfeasible with the sugarcane monoculture prevailing as the raw material for alcohol production (La Rovere, 1981). Ethanol consumption currently exceeds that of gasoline in light vehicles in Brazil, which possesses a flex-fuel fleet of around 5 million vehicles, where gasoline can contain up to 25% alcohol. Brazilian sugarcane ethanol is special due to its lower production cost and greater productivity – reaching 8000 liters per hectare – which is well above the global average (BNDES, 2008).

Despite its technological success, the Proalcool left a legacy of significant social and environmental costs. In the past, especially at the beginning of the Proalcool, one of the main environmental problems caused by ethanol production were the ecological accidents when wastewater and vinasse (waste by-product from alcohol distilling), a highly polluting liquid produced by ethanol distilleries in large amounts (10–17 L of vinhoto, 13 on average, are generated per liter of ethanol produced), reached fresh water streams due to the disruption of decantation dams during the rainy seasons (La Rovere, 1981). With the advance of technology, fertiirrigation began to be used as technique for the re-use of vinasse, besides the production of biogas (La Rovere and Audinet, 1993). In the social sphere, working conditions, remuneration and job seasonality limited the quality of the Proalcool's social benefits. The reduction of regional inequalities also fell short of expectations, the alcohol production is largely concentrated in the state of São Paulo.

3.1. From legislation to voluntary commitments

Some initiatives have been taken as a response to the problems relating to the sustainability of ethanol production in Brazil. In 2002, São Paulo promulgated State Law No. 11.241, which deals with the gradual elimination of cane burning, establishing deadlines and area restrictions to reduce the practice of burning, until its complete elimination in 2021 in mechanized areas and in 2031 in non-mechanized areas. The law addressed a crucial issue: the release into the atmosphere of particulates and ashes during the cane burning, that has also a negative impact on the health of neighboring urban center populations, such as the incidence of respiratory diseases and irritation of mucosae, which is worse in areas where there is a large concentration of distilleries (La Rovere, 1981). The law constituted recognition that the cane burning should be abolished, as it recommends not merely its reduction but its elimination. It also recognized the need to present alternatives to compensate for the social cost represented by the elimination of cane burning, such as the professional requalification of workers. Anyway, there are prospects of a technological breakthrough in the near future allowing for the production of second generation biofuels such as ethanol from cellulosic feedstocks. These will lead towards the use of bagasse for producing additional ethanol, while sugarcane tops and leaves (available from mechanical harvesting) will meet power generation needs.

In 2007, the São Paulo Sugarcane Sector's Agro-Environmental Protocol was signed by the Governor of the State of São Paulo, the State Secretaries of the Environment and Agriculture and Supply and by the President of the Brazilian Sugarcane Industry Association (UNICA), representing the state of São Paulo's producers. Adherence to the Protocol is voluntary and goes beyond the previous concern with sugarcane burning to include other requirements, presented in Box 1. The state public administration grants an Agro-Environmental Certificate of Conformity to agricultural and industrial sugarcane producers who adhere to and fulfill the Protocol's Technical Guidelines that serve as an incentive device for producers. The Protocol is part of the Green Ethanol Program, one of the São Paulo Environment Secretariat's strategic projects whose aim is to reward good practices in the sugar and alcohol sector. The Protocol addresses important issues such as the protection of Riparian Forest areas, measures to preventing soil erosion and the water resources conservation. It also mentions "good practices" – a vague expression, that can hinder the verification of compliance, posing a risk of loss of credibility, regarding the disposal of empty pesticide packaging, the minimization of atmospheric pollution caused by industrial processes, recycling and re-use of the wastes generated. Although mentioning sustainable development, the Protocol addresses mainly environmental issues, highlighting the partnership between public and private institutions. There are many challenges for all those involved, such as the monitoring and verification of compliance with the requirements of this voluntary protocol and ascertaining its effectiveness. According to the State Environment Secretary, 145 out of 177 plants in Sao Paulo have adhered to the Protocol (Green Ethanol Program, 2010).

Another important initiative related to ethanol production's sustainability was the publication in 2008 of the UNICA Sustainability Report, based on Global Reporting Initiative (GRI) guidelines. UNICA is the first agribusiness association in the world, and a Brazilian trade association, to produce a sustainability report based on the GRI guidelines (UNICA, 2008). UNICA refers to itself as the "largest organization in Brazil representing sugar, ethanol and bioelectricity producers", its members answer for more than 50% of all ethanol produced in Brazil and 60% of overall sugar production (UNICA, 2010). UNICA's initiative is a positive one and reflects the issue's importance for the sector in Brazil. However, one may question its claim to be a "Brazilian Sugarcane Sector's Sustainability Report" (UNICA, 2008), as it does not include all the sector's companies in all Brazil's ethanol-producing states. UNICA members are from the states of São Paulo, Minas Gerais (in the Southeast region of the country), Mato Grosso do Sul and Goiás (in the Central-West region of the country).

Box 1. São Paulo Sugarcane Sector's Agro-Environmental Protocol Technical Guidelines

- Moving up deadlines for the elimination of sugarcane burning to 2014 (mechanizable areas) and 2017 (non-mechanizable areas),
- Do not burn any sugarcane harvest in expansion areas,
- Do not burn bagasse or any other sugarcane by-product without a control system,
- Protection of the riparian forest of the sugarcane farms due to its relevance for the environment and biodiversity,
- Protection of the watersprings in the rural areas of sugarcane farms, recovering its vegetation,
- Implementation of a Soil Conservation Technical Plan, including the erosion control and rainwater contention,
- Implementation of a Water Resources Conservation Technical Plan, including programs to control water quality and the re-use of water used in the industrial process,
- Adoption of good practices for the disposal of empty pesticide packaging,
- Adoption of good practices for the minimization of the atmospheric pollution caused by industrial processes, recycling and re-use of wastes generated during sugarcane production.

Source: (Green Ethanol Program, 2010)

June 2009 saw the signing of the National Commitment to Improve Labor Conditions in the Sugarcane Activity. The document was signed by five ministries (Labor and Employment; Agrarian Development; Agriculture, Livestock and Supply; Education and Social Development and the Fight against Hunger), the General Secretariat of the Presidency of the Republic and the President's Office, the Federation of Registered Rural Workers in the State of São Paulo (FERAESP), the National Confederation of Workers in Agriculture (CONTAG), UNICA and the National Sugar-Energy Forum. The aim of this National Commitment is to foster cooperation between the public and private sectors to improve labor conditions in the manual cultivation of sugarcane, encouraging exemplary business practices (UNICA, 2009). Through voluntary adherence to the National Commitment, the companies should respect the business practices listed in Box 2. The signatories to this Commitment will constitute the National Dialogue and Assessment Commission of the National Commitment which, amongst other attributions will establish criteria to monitor and assess the results of the Commitment, and includes the possibility of an independent audit. The Commitment encourages business practices that go beyond the mere fulfillment of legal obligations, such as the direct hiring of workers for manual sugarcane planting and cutting activities, thus eliminating the intermediaries who has been a source of precariousness in work, and transparency in the measurement and payment of workers. 75% of the sector's companies adhered to the Commitment by the day of its implementation (UNICA, 2009).

Another important instrument for encouraging the sustainable production of sugarcane in Brazil is the National Agro-Ecological Zoning of Sugarcane, approved by Decree N°. 6.961, published in September 2009. It forbids the expansion of sugarcane in any area of native vegetation, in the Amazon, Pantanal Wetlands and the Upper Paraguay River Basin. These areas, together with the conservation units, Indian land reserves and land that is unfit for the plantation of sugarcane leaves 7.5% of the Brazilian territory available for the planting of sugarcane, where the area occupied by

Box 2. National Commitment to Improve Labor Conditions in the Sugarcane Activity Business Practices

- Work Contract,
- Hiring of Migrant Worker,
- Transparency in Production Measurement,
- Labor Health and Safety,
- Transportation of workers to rural work areas,
- Meals,
- Trade Union Organization and Collective Negotiations,
- Responsibility in Community Development,
- Disclosure of Good Practices.

Source: (UNICA, 2009)

the production of ethanol accounts for around 1% of Brazil's cultivatable land (Secretaria de Comunicação Social da Presidência da República, 2009). The federal government has sent a bill of Law to Congress that orients the National Monetary Council to establish new conditions, criteria and restrictions for the granting of rural and agro-industrial credit for the production and industrialization of sugarcane, sugar and biofuels. Table 2 shows the recent initiatives taken in the quest for sustainable ethanol production in Brazil.

3.2. Lessons learned

The Proalcool's first victory was to demonstrate the technical feasibility of large scale ethanol production from sugarcane and its use to fuel car engines (La Rovere and Audinet, 1993). Brazilian ethanol's efficiency and productivity are recognized internationally, with sugarcane ethanol providing the best biomass energy option in terms of productivity per area unit and the energy balance. Brazilian sugarcane can reach 9.3, considering ethanol and surpluses of electric power and bagasse (Macedo et al., 2008). The main co-products of ethanol production are sugar and electricity, using the bagasse as fuel in cogeneration systems (bioelectricity). Besides the possibilities provided by co-products, the production of electricity using bagasse is eligible for carbon credits through the Clean Development Mechanism. Sugarcane biomass currently accounts for 2.5% of electricity production in Brazil's energy matrix (Balanço Energético Nacional, 2008). During the 1980s, the productivity of Brazilian sugarcane ethanol was around 2000 liters per hectare, compared to today's figure of 6000 to up to 8000 liters per hectare (BNDES, 2008).

Despite the Proalcool's technical success, its significant social and environmental costs have tarnished the sugarcane sector's image in this period. The legal framework at that time was fragile

Table 2
Brazilian ethanol production sustainability initiatives.

Year	Initiative	Nature	Focus
2002	State Law No. 11.241, São Paulo, which deals with the gradual elimination of cane burning	Compulsory	Environmental
2007	São Paulo Sugarcane Sector's Agro-Environmental Protocol	Voluntary	Environmental
2008	Publication of the Unica Sustainability Report based on the GRI Guidelines	Voluntary	Socio-Environmental
2009	National Commitment to Improve Labor Conditions in the Sugarcane Activity	Voluntary	Social
2009	Agro-Ecological Zoning of Sugarcane	Compulsory[a]	Environmental
2009	Bill of Law Regarding Restrictions on the Granting of Rural and Agro-Industrial Credit	Compulsory	Environmental

[a] For obtaining credit.

regarding environmental and social issues, and public opinion, government and society were mobilized, controls were imposed and environmental legislation evolved. Today, the increase in the domestic and external demand for ethanol and pressures in favor of sustainability has been encouraging commitments to the voluntary initiatives presented here.

Brazilian ethanol's technical, economic and energy efficiency contrasts with the socio-environmental problems that persist such as social exclusion, the concentration of land and power and rural conflicts (Abramovay, 2008; Hall et al., 2009). Abramovay (2008) has referred to this situation as "the contradiction of Brazilian ethanol". It is not enough to produce efficiently, which should not be reduced to the liters of ethanol per hectare of land used, or eco-efficiency, which should also not be reduced to the liters of water used during ethanol's industrial production process. Obviously, it is important to increase levels of productivity, thus avoiding the expansion of cultivated areas and reducing costs of production, but this efficiency should be defined in terms of the relation between means and ends, and cannot be assessed without referring to its ultimate purpose. If the end is to produce ethanol with sustainability, an eco-social efficiency approach should be adopted.

More recently, the drive towards ethanol exports promoted by external investments is leading to the development of new production regions. It will be interesting to monitor the eco-social efficiency of these new players.

A great deal still can and needs to be done and sustainability involves a much broader agenda that includes the reduction of poverty, conflicts and social inequality in the vicinity of the ethanol distilleries and the reduction of regional inequalities in a country where 60% of ethanol production is concentrated in a single state – São Paulo.

Anyway, it looks a little odd that "dirty" oil products (e.g. Brazilian gasoline to the US) are not questioned in its sustainability, indicating that other reasons may exist to imposing such trade barriers.

4. The case of biodiesel in Brazil – learning from the Proalcool experience?

4.1. Legal framework

In 2003 Brazil took the first steps towards establishing the legal and regulatory framework and taxation model for biodiesel, which was introduced into the Brazilian energy matrix in a very innovative way. Against the backdrop of the Proalcool's legacy, the Inter-Ministerial Executive Commission and the Biodiesel National Program's Management Group (PNPB), instituted in 2003, concluded that biodiesel could, besides reducing the country's dependence on oil imports, contribute favorably to addressing the following fundamental issues: job and income generation, reduction of emissions and healthcare costs, mitigation of regional disparities and finally the enhancement of the renewable character of the Brazilian energy matrix in order to strengthen the country's energy security (Accarini, 2006). The PNPB was launched in December 2004 based on the principle of social inclusion promoting, job and income generation and the mitigation of regional disparities, producing oilseeds suitable to each of the country's regions, focusing on the North, Northeast and Semi-Arid regions.

Law No. 11.097 (Law B2/B5), was sanctioned on January 13, 2005 and established a minimum compulsory percentage addition of biodiesel to the diesel oil sold to the final consumer in any part of the country. The Law clearly establishes the participation of family farmers in the supply of feedstock. It was determined that between 2005 and 2007 the use of B2 (2% biodiesel and 98% diesel) would be optional, increasing gradually up to 2013, when the use of B5 would become compulsory. The Brazil's National Petroleum, Natural Gas and Biofuels Agency have been organizing biodiesel auctions to increase the supply of biodiesel and foster the development of a domestic biodiesel market.

The taxation model was inspired by the PNPB's principles, encouraging family farmer's participation through the creation of the "Social Fuel Certificate" – SFC, and also defined lines of credit. The Certificate is granted by the Ministry of Agrarian Development – MDA to those biodiesel producers that "*foster social inclusion and regional development through the generation of employment and income for family farmers who fulfill the criteria of the National Program to Strengthen Family Agriculture – PRONAF*" (Brazil, 2005), through contracts specifying commercial conditions that guarantee income and deadlines adequate, besides assuring technical assistance and training for family farmers. It is important to mention that small scale farming represents about 90% of the farms in Brazil, but occupies only 33% of the total agricultural area and produces only 40% of the gross agricultural production value (Hall et al., 2009). It was established that the SFC would be granted to biodiesel producers that purchase feedstock from family farmers in minimum percentages calculated on the feedstock purchasing costs (50% for the Northeast and Semi-Arid regions, 30% for the Southeast and Southern regions and 10% for the North and Midwest regions), assuring that the farmers would receive technical assistance and training and establish contracts with them through a representative of the family farmers' association, stipulating the duration, total value of feedstock purchases, price agreements and delivery conditions, besides the guarantee of both parties and the name of the organization that represents the family famers and the agreement.

4.2. The Social Fuel Certificate predicament

The diversity of the stakeholders involved in the Brazilian biodiesel program and the complexity of its legal framework has created an environment for the development of a new business model, where the link established between the production of biodiesel and the strengthening of family farmers seems to be unique in the world, especially as regards its system of governance and the diversity of the actors involved: the private sector, government, rural worker trade unions, social movements and NGOs (Abramovay and Magalhães, 2007). However, the PNPB's ambitious objectives, conceived with the aim of encouraging family farmer's participation in the biodiesel production chain, have not been achieved as planned (Abramovay and Magalhães, 2007; Carvalho et al., 2007; Garcez and Vianna, 2009; Wilkinson and Herrera, 2010; Ottinger and Tafur, 2010).

Family farmer's participation has not been increasing along with biodiesel production, and nor has the use of the diversity of oilseeds available in the country. The main feedstocks currently used in biodiesel production in Brazil are soybean (82.9%), animal fat (12.1%), cotton (2.4%) and other greasy materials (2.6%) (Mines and Energy Ministry, 2010). The castor bean, chosen by the federal government as the PNPB's main oilseed for the Northeast is a typical family farmer crop in Northeast and adapted to semi-arid conditions, but has been displaying low productivity and has not been used to produce biodiesel in Brazil since January 2008 (Campos and Carmélio, 2009).

Brazil has 47 biodiesel plants authorized to operate (Mines and Energy Ministry, 2010), of which 30 possess the SFC (Ministry of Agrarian Development,). Most plants are located in the Center-West, a region characterized by the soybean monoculture, in contrast with the PNPB's ideals of producing biodiesel in various regions using several different oilseeds such as the castor bean,

palm, jatropha, peanuts, sunflower and sesame. In 2007, around 37,000 family farmers sold oilseeds to biodiesel industries, accounting for 18% of the biodiesel produced in the country (Campos and Carmélio, 2009), a small participation compared to the 200,000 family farmers expected by the MDA (Campos and Carmélio, 2009).

4.3. Changes in the social fuel certificate's rules

In 2009 the MDA published a new Normative Instruction modifying the SFC rules (Ministry of Agrarian Development, 2009), changing the minimum compulsory percentages for feedstock purchases from family farmers. These were reduced to 30% for oilseeds from the Northeast and Semi-Arid regions and increased to 15% in the North and Center-West regions (as from the 2010/2011 crop year). The percentages for the South and Southeast regions were not changed. There was also a change in the calculation of the cost of feedstock purchases from family farmers to enable the biodiesel producer to include, besides the value of the feedstock purchase itself, the value of expenditures on soil analysis, production inputs and technical assistance.

It also became mandatory for contractual negotiations to include at least one body representing family farmers and to prepare a Technical Assistance Plan showing the participation of technicians and contracts with institutions, in which each technician would be responsible for catering to a maximum of 150 families. The new rules also sought to characterize the technical assistance provided and recommended the observance of the following guiding principles (Ministry of Agrarian Development, 2009): i) food security, stimulating diversified production and sustainable environmental, cultural, economic and social practices and that respect cultural diversity; ii) sustainability of production systems, emphasizing the respect for the culture and knowledge of family farmers, appropriate use and management of soil and water; iii) income generation, focusing on the inclusion of women and youth and iv) reduction of rural poverty, where the participation of family farmers in biodiesel's production chain should be envisioned as a complimentary income generation for the family.

Criteria were established to monitor the fulfillment of the SFC's criteria, such as the remittance to the MDA of information on a quarterly and annual basis regarding the purchase of feedstock and technical assistance respectively.

4.4. Critical analysis of the PNPB's sustainability

Nowadays, it seems not so urgent to produce biodiesel as it was in the case of ethanol at the time of the Proalcool, thus the PNPB's pace should be adapted to the social goals of the Program, centered on family farmers' inclusion in a new production chain. The demand for biodiesel has accelerated due to governmental decisions regarding faster adoption of higher levels of biodiesel in the blend with diesel oil (3% in 2008, 4% in 2009 and 5% in 2010) but family farmers has not had time to adapt to this faster pace.

The resulting trend is strengthening soybean hegemony among the feedstocks used in the production of biodiesel, transferring the subsidies aimed at family farmers to consolidated industrial groups, who are interested in rapidly increasing the biodiesel blend. The predominance of soybean is incompatible with the sustainable production of feedstock by family farmers for the production of biodiesel. Considering CSR, this is a contradiction, especially for the companies that received the SFC and its benefits.

The private sector could support actions to improve the SFC compliance and requirements, incorporating socio-environmental criteria, as a way of rewarding those that are looking not only for efficiency or eco-efficiency, but for the eco-social efficiency. In PNPB the relation between a company's value added and its social impacts (socio-efficiency) is fostered by the SFC, designed to bring opportunities for both: biodiesel producing companies and family farmers.

Certification is a key point in the debate regarding PNPB's sustainability. The SFC's credibility has been affected by the gap between its objectives and reality. Distortions need to be corrected, such as the fact that biodiesel producing companies may buy feedstock from family farmers for uses other than the production of biodiesel, thus allowing family farmers to be used to obtain tax breaks provided by the SFC and access to the more advantageous financing conditions provided by the PNPB. This is another contradiction from the CSR point of view. The changes that occurred in the SFC's rules were important in order to characterize technical assistance and establish criteria for monitoring the fulfillment of the Certificate's requirements. The new rules were expected to fill the gap regarding environmental requirements, but these were addressed in general terms, expressed in the adoption of "environmentally sustainable" practices. There is no mention of burning, an agricultural practice used by both large and small producers, as in the case of ethanol, where it is being eliminated.

There is a need for creating awareness, controlling and gradually minimizing the burning in the planting of oilseeds by family farmers. In the spirit of the institutional innovation imparted by the SFC, alternative solutions may be sought, with biodiesel producing companies strengthening the work that is already being undertaken by social movements and NGOs in this sphere (GEI/IE/UFRJ and LIMA/COPPE/UFRJ, 2007). It is important to survey and monitor the socio-environmental impacts caused by the introduction or increase in the planting of oilseeds in the agricultural production systems of family farmers in local biomes, per oilseed and per region. Thus, the impacts can be managed with a minimization of the negative and leveraging of the positive effects on the environment and family farmers.

There is a need for investments in research, technology and rural technical assistance of satisfactory quality and in sufficient quantity, but always adapted to family farmers' reality and specificities. It is also important to prioritize the cultivation of more efficient oilseeds or those with a better energy balance, with a consequent optimization of greenhouse gas emission levels, and crops that minimize land and water requirements and the use of agrochemicals.

It is clear that biodiesel costs are higher than diesel oil costs under current prices in Brazil. However, its sustainability should be assessed as a social policy tool, and not purely as an energy program.

Anyway, there is also a great potential for future biodiesel production cost reductions, thanks to the optimization of the technologies that are most appropriate for the production of biodiesel from various Brazilian oilseeds, as illustrated by the research in progress at Petrobras's Leopoldo Américo Miguez de Mello Research and Development Center – CENPES. Additionally, synergies between the production of biofuels, sustainable development and climate change could also be exploited (La Rovere et al., 2009; Rocha, 2009).

The PNPB shows that the eco-efficiency concept cannot be implemented in a way that is disconnected from its socio-economic context, given the agricultural and family farmer's world's specificities, in the quest for eco-social efficiency.

5. Conclusion

Eco-efficiency should not be reduced to simply producing more with less or characterized as the "business link to sustainable development", given that that the private sector has the potential to

contribute much more than mere pollution control, by exercising its Corporate Social Responsibility. The alignment of the eco-efficiency and more responsible business practices leads to the emergence of a kind of eco-social efficiency.

This study illustrates this idea comparing Brazilian sugarcane ethanol, in the context of the Proalcool, with biodiesel in the context of the PNPB. Brazilian ethanol has been evolving in terms of efficiency and eco-efficiency requirements. But socio-environmental problems have persisted over the years, especially the practice of burning and working conditions on sugarcane plantations. The government and the private sector have been implementing compulsory and voluntary initiatives, presented in this paper. From eco-social efficiency perspective a great deal remains to be achieved.

The introduction of biodiesel into the Brazilian energy matrix began in an innovative way, by encouraging the participation of family farmers through the Social Fuel Certificate, granted to biodiesel producers that foster social inclusion and regional development by purchasing minimum quantities of oilseeds from the family farmers. The demand for biodiesel in the country has accelerated in a supply driven way, with 80% of domestic biodiesel produced with soybean from agribusiness. Considering Corporate Social Responsibility, biodiesel producing companies are involved in some contradictions, presented in the paper. One should not fail to recognize the PNPB' importance and the international example it provides of a policy designed to foster biofuel production's sustainability, but the Program does not appear to be applying the lessons provided by the Proalcool.

Eco-social efficiency is work in progress. It can be applied in other areas traditionally identified with eco-efficiency, like enhance recyclability or reducing energy and material intensity. In the case presented, the replacement of fossil fuels with renewable sources, despite the problems presented, PNPB enables that companies align productivity concerns with more responsible business practices, what could be the beginning of the here called eco-social efficiency. The biofuels case illustrates the eco-efficiency concept's shortcomings and the need to move beyond it towards eco-social efficiency. The evolution of efficiency requirements is made more pressure by the progress achieved by society in the operationalization of the sustainable development concept.

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