
Sustainability evaluation of the national programme of biodiesel use and production: comparative analysis: Quixadá Hub (Ceará) and Central Hub (Rio Grande do Sul)

Flavia Trentini*

School of Law of Ribeirão Preto,
University of São Paulo,
Rua Aymar Baptista Prado, 835,
14040-906 – Ribeirão Preto, SP, Brazil
E-mail: trentini@usp.br
*Corresponding author

Maria Sylvia Macchione Saes

School of Business Administration,
University of São Paulo,
Avenida Professor Luciano Gualberto, 908 sala C16,
05508-010 – São Paulo, SP, Brazil
E-mail: ssaes@usp.br

Abstract: This article analysed the conditioners of sustainability that can be related to family farmers involved in the production of raw material for the Brazil's National Programme for Biodiesel Use and Production (PNBP) in the Quixadá Hub (Ceará) and in the Central Hub (Rio Grande do Sul). The PNPB, officially launched in Brazil in 2004 with the goals of building a sustainable programme, fostering social inclusion, and providing added income to farmers, was innovative in instituting the social fuel label as a tool for sustainable family farming. The reference used to define the conditioners was the systemic analysis of Brazil's formal institutional framework. Surveys were conducted at a castor bean hub located in Ceará State's Central hinterlands and at soybean hub in the central area of the state of Rio Grande do Sul. Results allowed the conclusion that the PNPB provided new opportunities for the family farmers of the regions studied, evidenced through the presentation of sustainability conditioners.

Keywords: biodiesel; castor bean; soy bean; National Programme for Biodiesel Use and Production; sustainability; institutional framework; family farmers; Brazil.

Reference to this paper should be made as follows: Trentini, F. and Saes, M.S.M. (2011) 'Sustainability evaluation of the national programme of biodiesel use and production: comparative analysis: Quixadá Hub (Ceará) and Central Hub (Rio Grande do Sul)', *Int. J. Environment and Sustainable Development*, Vol. 10, No. 4, pp.345–363.

Biographical notes: Flavia Trentini holds a Doctorate in Law and Post PhD in Administration/Economics of Organisation at University of Sao Paulo. He has experience in the field of private law, with focus on agroenvironmental and consumer law. Also, he is active in the areas of sustainable rural development and industrial property.

Maria Sylvia Macchione Saes holds a Doctorate in Economic Sciences and Habilitation in Business Administration from the School of Business Administration at the University of Sao Paulo (FEA-USP). He is currently a Professor of Business Administration at FEA-USP, Coordinator of the Center for Organizational Studies (CORS) at USP, and the President of FEA-USP's research committee.

1 Introduction

Society's growing concern over environmental issues, combined with fears about the future of the world's oil supply and fluctuations in energy prices, has encouraged the development of renewable energy sources, and as a result this sector has seen an influx of significant investment. These concerns are justifiable in light of the global economy's dependence on fossil fuels, whose emissions of carbon dioxide into the atmosphere has been blamed for an overall rise in temperatures around the planet. For this reason, biodiesel has (along with ethanol) become an integral part of the energy matrix in much of the world.

Biodiesel was introduced into the global energy matrix in 2000. A biodegradable, non-toxic fuel that can be used in diesel engines, it is mainly derived from soybean and canola, although there are a variety of other adequate feedstocks.

In Brazil, the National Programme for Biodiesel Production and Use (PNBP), officially instituted in 2004, introduced the social fuel seal, an innovative instrument to promote sustainability on the part of farmers. The seal is granted to businesses that purchase raw material from farmers through a production buy and sell contract. The programme provides incentives for typically poorer family farmers in disadvantaged areas by stipulating that a minimum percentage of raw materials purchased by biodiesel producers must come from family farmers. In addition, producers must provide technical assistance to farmers.

The purpose of the present study is to analyse the conditioners of sustainability that affect those farmers in the states of Ceará and Rio Grande do Sul who produce raw material within Brazil's PNBP. To this end, we examine the biodiesel market through an interdisciplinary study that incorporates both economics of organizations and law (particularly environmental law), subjects which are essential to the purpose of this work. The analysis of the economic transactions and normative instruments that regulate the different segments of the supply chain is critical to enabling sustainable market strategies.

The growth of biodiesel production worldwide has mainly been driven by the valorisation of aspects connected with sustainability. The economic question can therefore only be analysed in the light of the institutional environment of the markets, i.e., incentives given by government authorities in countries that produce and consume the product.

Because policies often have competing priorities, one can observe that each market eventually focuses on one of the three aspects underlying the classical definition of sustainability – social, environmental, and economic. The PNBP aims mainly at social inclusion, but without neglecting the other pillars of sustainability.

We will examine the sustainability criteria applied to the institutional environment governing the agribusiness system (AGS) of biodiesel, particularly with respect to the role played by family agriculture within it.

2 National policy of PNBP

Law 11.097 of January 13, 2005 officially introduced biodiesel into the Brazilian energy matrix, taking into consideration the diversity of oleaginous plants available in the country, the guarantee of supply and quality, competitiveness vis-à-vis other types of fuel, and a policy of social inclusion. The rules allow production based on different oleaginous plants and technological paths, a fact that inserts family agriculture into the biodiesel productive process (Brasil, 2005a).

The above-mentioned law introduced the concept of biodiesel as follows: “fuels for internal combustion engines with ignition through pressure, obtained from a renewable and biodegradable source that can partially or entirely replace diesel oil from a fossil source, and that meets the technical specifications defined by the National Oil Agency”. The same law establishes as mandatory the addition of a minimum percentage of biodiesel to the diesel oil traded (Brasil, 2005a).

The institution of the social fuel label as an instrument to promote sustainability in family agriculture is an innovation of the PNPB. This seal is awarded to processing companies that acquire raw material from family growers through a contract of purchase and sale of production, with guarantees of technical assistance to farmers.

The mandatory percentage of raw material acquired from family agriculture needed for the issuance of the social fuel label to the company producing biodiesel will be altered over coming years, according to Table 1.

Table 1 Minimum mandatory percentage of acquisition of raw material from family agriculture per region

<i>Region</i>	<i>Percentage in force until Feb/18/2009</i>	<i>Percentage of the 2009/2010 crop, in force as of Feb/19/2009</i>	<i>Percentage of the 2010/2011 crop, in force as of Feb/19/2009</i>
Centre-West and North	10%	10%	15%
Northeast and Semiarid	50%		30%
Southwest and South	30%		30%

Source: Ministry of Agrarian Development (MDA) (Brasil, 2005a, 2009)

The Ministry of Agrarian Development (MDA) is the body in charge of awarding the social fuel seal. Certified companies are afforded commercial and tax benefits. It should be emphasised that the innovation of the social fuel seal lies in fostering the production of raw material originating from family agriculture. Through its Normative Instruction No. 1 of July 5, 2005, the MDA defined the ‘family farmer’ as a beneficiary of the

National Programme for Strengthening Family Farming (Pronaf) and holder of a Declaration of Eligibility (DAP) (Brasil, 2005b).

To be designated as beneficiaries of the Pronaf, farmers must possess at most four fiscal modules¹; a gross income between R\$5 thousand and R\$110 thousand, with 70% of family income originating in agricultural and non-agricultural exploitation of the establishment; and finally, family labour must predominate, with salaried help being used only sporadically, according to the seasonal requirements of the agricultural activity, and with the possibility of a maximum of two permanent employees (Brasil, 2006; BNDES, 1999).

The social fuel seal confers to biodiesel-producing companies the right to the benefits arising from specific public policies aimed at fostering the production of renewable biodiesel along with social inclusion and regional development. It enables the commercial promotion of their production and free access to participation in biodiesel auctions.

3 The logic of the PNPB

The PNPB, as a programme aimed at creating a new bioenergy matrix, imposed, through the coercive means of the State, rules designed to create an incentive mechanism for private agents. In this sense, as observed by North (1991), institutions define political, economic, and social interaction structures, and therefore, compose the structure of incentives in society. Thus, institutions are basic determinants of economic performance.

The author establishes an analogy with a game: institutions would represent the 'rules of the game', whereas organisations would be the 'players'. Rules can be formal (such as laws) or informal. Main examples of formal rules include the Constitution of a country, complementary legislation, and the set of public policies. Informal rules, in turn, include codes of conduct, customs, and traditions.

Aoki (2005) calls attention to the importance of the relation between formal and informal rules. This interaction is important because it explains why certain social rules are followed and others are not. According to Aoki, if an institution acquires a symbolic or linguistic representation that is recognised and accepted by most of the agents it affects, it starts to exist as an objective reality. In this case, the action plans devised by these agents take into consideration this reality, which will define their relationships. We thus have sustainable institutions, i.e., those that lead agents to have their determinations enforced (*self-enforcing, self-enforced*). Therefore, an institution is self-sustainable when the patterns of social interactions are represented by significant rules, in which all agents know and incorporate as shared beliefs the ways social interactions should occur (state-individual and individual-society).

The dynamics of institutions is defined by endogenous and exogenous movements. Endogenous movements take place when certain rules have a representation recognised by the agents, who start questioning and influencing other individuals so that changes can be made. Exogenous movements occur either through coercive power, generally the State's, or when an institutional or economic crisis questions consolidated rules (Aoki, 2005). An example of endogenous modification is the PNPB, which instituted regulations for the creation of a new market.

In this sense, Aoki (2005) makes two important contributions to the understanding of the forms of complex organisations. The first concerns the need to consider time: in other

words, the sequence of acts over time demonstrates that 'history matters' and that a multiple balance can exist because different systems follow different trajectories. This means that a specific institution will have different results depending on the history of the social relations between the agents it affects. The second regards the fact that the direction of a new balance can imply feedbacks between agents and their environment; the process is evolutionary and depends upon perceptions and preferences that are endogenously formed and change over time.

3.1 Sustainability in the PNPB

State intervention in the case of the PNPB occurs at various levels, from the imposition of principles guiding the economic order to programmes regulated by infraconstitutional norms. State performance, as well as its reflections concerning the implementation of sustainable development, is punctually verified through the PNPB.

Given the importance of environmental problems, the United Nations held the first 'Conference on the Human Environment' in 1972 in Stockholm. This conference introduced environmental concerns into the international arena of political and juridical discussions. The Brundtland report offered a new paradigm, proposing so-called 'sustainable development' to the nations, defined as "[...] development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (ONU, 1987).

The report aimed to associate the environment issue with the predominant model of development and industrialisation in developed countries with high levels of consumption. It also pointed out, as a cause of environmental degradation, the imbalance of international relations and the poverty and social inequality in developing countries, which imposes a great pressure on natural resources as they seek survival within this context of inequality. Sen (2000), winner of the Nobel Prize in economics, corroborates the bases of the Brundtland Report: according to him the environment does not exist as a system disconnected from human actions, ambitions, and needs.

Sustainable development was held up as a principle by Art. 225 (preamble) of the Brazilian Constitution, which imposes on the Public Power and the collectivity the duty to defend and preserve the environment for future generations. The consecration of the environment as a constitutional juridical good establishes the problem of its harmonisation with other values and rights also recognised by the maxim norm, such as economic development (Brasil, 1988).

It is worth emphasising that the Brazilian formal institutional environment is composed of a normative system in which the norms of the highest degree are found in the Constitution of the Federative Republic of Brazil. Juridical norms are divided into principles and rules. The general principles of a specific field of law are norms that regulate something to be realised. The content of principles and their real dimension and reach, with all hues of the idea they provide, are only fully determined when they are applied to a specific context. On the other hand, rules are norms that may or may not be fulfilled, hence, the idea of grading their fulfilment is discarded (Grau, 2002).

Constitutional principles play an important role insofar as the Constitution establishes values that must be observed. Concerning environmental principles, they seek to establish a common base in the normative instruments and in the instructions for the federal, state, and municipal environmental legislative construction.

Each of the three dimensions of sustainability is considered to be permeated by the institutional aspect. The environmental dimension presents four sub-divisions. The first refers to the natural environment, which includes natural resources (water, air, fauna, flora, and soil). The second, referred to as the work environment, includes healthy work relationships and the quality of the work environment. The third sub-division, relating to the artificial environment, addresses issues connected with the ordering of the land. The fourth relates to the cultural environment and encompasses the cultural memory of a people.

The economic dimension is focused on monetary income and individuals' standard of living. The financial return can be considered a performance factor of this when assessed in the short-term, and serves as a base for continuity in the long-term (OECD, 2001).

The social dimension tends to vary from society to society, but some factors are usually common to different groups. Reasonable working hours and the prohibition of child and slave labour are examples. According to OECD (2001), social sustainability is based on a process of improvement of quality of life in society through access to education, housing, and food, among other elements connected with biophysiological needs and intellectual formation.

It is worth highlighting that the three dimensions of sustainability are inter-related and as such must be integrated in this study. With the creation of conditioners for the Biodiesel AIS the discussion on sustainability moves from the abstract to the practical, thereby fostering an explicit discussion on the operational meaning of the term.

The formal Brazilian institutional environment extends beyond the establishment of sustainable development as a constitutional principle – this principle can also be found in infraconstitutional laws. Law no. 11.097 of January 13, 2005, which inserted biodiesel into the national energy matrix, prescribed in its Article 1 the following objective: “Art. 1. National policies for the rational use of energy sources shall aim at the following objectives: [...] XII – increase, on economic, social and environmental bases, the participation of biofuels in the national energy matrix” [Our bold] (Brasil, 2005a).

The unfolding of the principle of sustainable development can be seen at the infraconstitutional level, where it is set out that biofuels should increase social, economic, and environmental bases. It is a condensing of the constitutional principles of free initiative, social justice, and environmental preservation, thereby harmonising the precepts of the three pillars of sustainability (social, environmental, and economic).

In the case of the present study, the public power created an instrument to implement sustainability in the Biodiesel AIS by instituting a brand of certification, the social fuel seal, whose aim is to allow a sustainable biodiesel production process for family agriculture.

The normative instructions created by the MDA were drawn up to interpret the law in force; they are considered a regulation dispatched within the scope of secretariat of the ministry and thus hierarchically inferior to the Federal Constitution, complementary laws, presidential decrees, and interministry and ministry edicts (Ferreira Filho, 2009).

It is worth emphasising that the concept of sustainability is open, and therefore, depends on the establishment of parameters, which is done by infraconstitutional legislation. Thus, Normative Instruction No. 1, of February 19, 2009, explained which factors will serve as a basis for the construction of sustainability (Brasil, 2009).

It is worth noting that technical assistance is a mandatory clause in contracts between biodiesel-producing firms and farmers. Among the prerogatives of technical assistance are food security, which denotes criteria of social improvement; income generation, as an

economic conditioner; and finally, the reach of the sustainability of the property, which presupposes environmental preservation. Article No. 11 of the same normative instruction recommends that some principles must guide the conduct of technical assistance so as to provide sustainability to the biodiesel production process (Brasil, 2009).

Based on a systemic interpretation of the formal institutional environment that regulates biodiesel production, the conditioners of sustainability are taken. The main function of the conditioners is to assess conditions and trends in relation to targets and objectives; compare differences arising from location; and supply useful and timely warning information. Conditioners shall therefore deal integrally with the dimensions of sustainability because they are inter-related, and alterations in one aspect can imply alterations in the other dimensions of sustainability.

For the objective of this research the following aspects are assumed as conditioners of sustainability: economic (income generation, complementary income generation, and satisfactory financial returns); social (family's food self-sufficiency through crop diversification, incentive to collective decision processes, and protection of the cultural diversity); and environmental (protection of natural resources – soil and water – and crop rotation and consortia).

4 comparative analyses: Quixadá (Ceará) and Central Hub (Rio Grande Do Sul)

4.1 Method: treatment of sustainability conditioners

This study seeks to analyse the three dimensions of sustainability – environmental, social, and economic. To that end, the field survey was chosen for several reasons, among which were the complexity of the agents involved in the biodiesel supply chain and the emergence of this agro-industrial system.

Table 2 Sustainability conditioners of the biodiesel AIS

<i>Category</i>	<i>Subcategory</i>	<i>Indicators</i>
Economic	Income	Income generation
		Complementary income
		Satisfactory economic return
		Production diversification
Environmental	Natural environment	Protected areas (biodiversity)
		Water resources
		Crop rotation
		Soil conservation
Social	Income destination	Food sufficiency
	Participation	Collective decision process

Source: Created based on Normative Instruction 2009 MDA

A case study was conducted within a description, explanation, and judgement of family producers growing vegetable crops destined for biodiesel production. The process of sampling family farmers who supply raw material was intentional and non-probabilistic (see Table 2). It is noteworthy that the term majority refers to the sample and not to the population.

The geographic scope of the sample was limited to two regions producing biodiesel raw material, Rio Grande do Sul (RS) and Ceará (CE). Area selection resulted from an initial approach to the MDA, which supplied the hubs organised for producing raw materials, and the samples were taken based on these hubs. Among the various hubs indicated by the MDA, two AIS were chosen: the Quixadá Hub (castor oil) and the Central Hub of Rio Grande do Sul (soybean), both of which presented well-structured productive hubs.

The choice of the Northeast Region for the study of one of the cases resulted from the fact that government incentives were focused on developing alternative crops – mainly castor – and income generation for family farmers from this region, one of the poorest in the country. The study was conducted at Petrobras Biofuel (PBio), located in the municipality of Quixadá (CE). Interviews were carried out with representatives of the company; family farmers producing castor who supply their production to PBio; with regional class associations involved in the productive arrangement; and local government bodies that foster the participation of family agriculture in the sales of raw material to PBio.

The second case study was conducted in Brazil's Southern Region. This is the most important region for biodiesel production, with a contribution of 75.4% of the country's total as of November 2009 (ANP, 2009). The study focussed on the regional company Granol, whose biodiesel producing unit is located in the municipality of Cachoeira do Sul (RS), denominated by the MDA as the Central Hub of Rio Grande do Sul (RS). Granol uses soybean oil in biodiesel production. Interviews were conducted with this firm and its suppliers (exclusively in family agriculture). The Southern Region has the highest number of soybean producers in Brazil classified as family farmers (IBGE, 2010).

We conducted 60 interviews with family farmers who grow raw material (castor and soybeans) for biodiesel production. The conditioners are based on the answers, because they reflect the individuals' actions in response to the modifications of the institutional environment in establishing a new economic rationale of sustainable development, mainly through political options and the adoption of programmes.

4.2 Analysis of biodiesel hubs

This item presents the biodiesel agroindustrial system in the Quixadá Hub and in the Rio Grande do Sul Central Hub, with the purpose of discussing, from the perspective of sustainability, the impact of the PNPB on family farmers that participate in the described agroindustrial systems.

Each region that produces raw material for biodiesel has a prevailing system for organising production, a consequence of its socioeconomic, historical, and cultural specificities: hence, the need to use a production poll in each region and not the regions as a whole.

4.2.1 History of the Quixadá Hub (CE)

The Central hinterlands of the State of Ceará comprise 12 municipalities. The total population is 352,397 inhabitants, of which 165,184 live in rural areas, corresponding to 46.87% of the total. This region has 23,045 family farmers and 2,033 settled families (Brasil, 2006). The rural economic basis of Ceará's hinterlands is based on corn and bean crops, followed by sugar cane and manioc. Castor bean does not yet represent a significant portion of the agricultural production of these hinterlands.

According to the survey sample, Ceará's family farmers present the following profile: male, over 40 years of age, illiterate, settled through the national Agrarian Reform Programme, and with an experience of over ten years in agriculture. The average size of the properties is 23.69 hectares; nevertheless, the area given over to castor bean crops does not average more than 2.18 hectares.

4.2.2 History of the Central Hub (RS)

The Central Region of Rio Grande do Sul, an area of 32,457.00 km², comprises 34 municipalities. Its population is 650,500 inhabitants, of which 119,811 live in rural areas, accounting for 18.42% of the total. It has 29,808 family farmers, 1,248 settled families, and eight quilombola (maroon) communities. Its HDI is 0.81 (Território e Cidadania, 2010).

The rural economy in Rio Grande do Sul's central region is based on soybean and rice production in quite similar percentages, which together represent 70% of the total agricultural production. Soybean has been the main crop in the Southern Region since the mid-1960s: various government incentives contributed to the leading position of soybean in that region. Among them are the programme 'Operation Armadillo', which promoted soil fertility correction; installation of an industrial park for soybean processing; machinery and agricultural inputs through fiscal incentives from the government; the facility for full mechanisation of agriculture; emergence of a dynamic and efficient cooperative system, which strongly supported production, industrialisation and marketing of crops; and improvements in the road, port, and communication systems (EMBRAPA, 2010).

The characterisation of family farmers in Rio Grande do Sul's Central Hub is based on the interviews conducted. All of the respondents are male, over 30 years of age, and literate; however, most (68%) have not completed primary school. 83% of them are owners and leasers of the properties, with over ten years of experience in agriculture. The average size of the properties is 61.10 hectares, but the land destined for vegetable crops is no larger than 44.33 hectares on average.

4.3 Economic sustainability

Agriculture appears in both regions as the respondents' main source of income. However, we observed two distinct situations concerning the incorporation of the production of vegetable crops into the families' incomes.

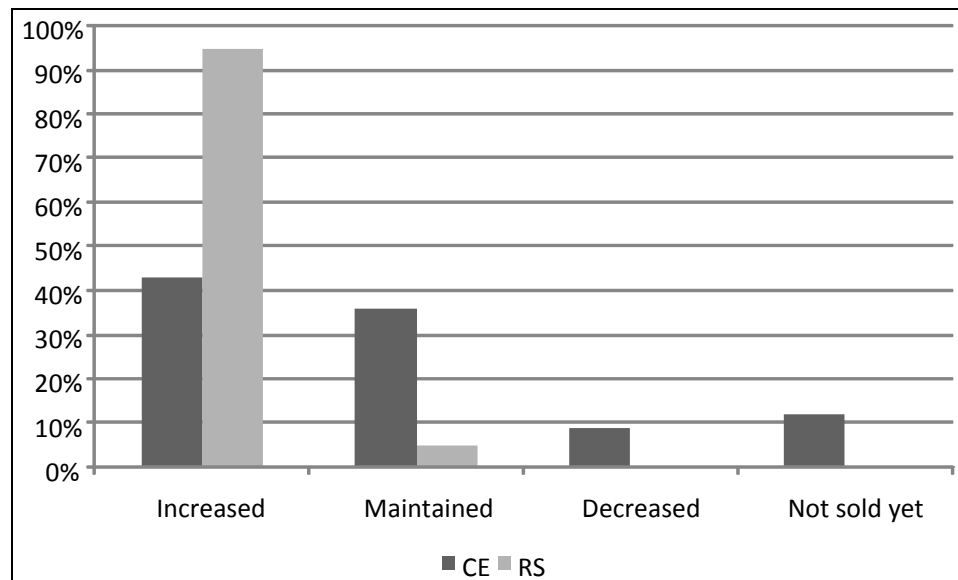
The first difficulty encountered involved the meaning of the word income, which presents diverse connotations in both juridical and economic science. For the purpose of this research, 'income' is understood as the sum received by an individual in the form of

a salary, profit, interest, rent, lease, or remuneration for services rendered (Sardoni, 2009).

We set this limitation to avoid considering as income the financial assistance provided to needy families through the Family Assistance programme Bolsa Família (PBF) and State support such as the Ceará government's no-repayment credits. Beneficiaries of the PBF programme include families with a per capita income per month from \$39.52 USD to \$79.04 USD), and extremely poor families with a per capita income up to R\$70.00. In turn, families benefiting from the programme are committed to keep their children and/or dependents attending school and vaccinated (Bolsa Família, 2010).

Figure 1 shows that, in the Northeast hub, the agriculture extant before the introduction of the PNPB was of a subsistence nature, mainly structured around corn and bean crops. This was modified with the insertion of castor bean in the region, which began to be an important source of income for farmers. Therefore, a new source of income for family farmers was created in the Quixadá hub.

Figure 1 Income behaviour after the production of vegetable crops for biodiesel production



Source: Field survey

It is worth noticing that in the Rio Grande do Sul hub the income of family agriculture also comes exclusively from the cultivation of two species, soybean and rice. However, two significant differences must be analysed.

The first observation is that both crops are destined for the market, and planted in different periods and on a greater scale than the crops in the Northeast, mainly because of the area of the properties and the level of technological development of production.

The second characteristic that differentiates the hubs, observed through the data collected, lies in the fact that the creation of the Rio Grande do Sul Central Hub has brought only *one more* income alternative with the installation of a biodiesel producing company in the region. Over 90% of the farmers from Rio Grande do Sul stated that if they did not sell to Granol they would be able to negotiate with other buyers. However,

they prefer to sell to the biodiesel producing company because the price paid is better. Thus, the financial return is observed to be considered as significant by farmers.

The situation in the north-eastern hub is the contrary, insofar as some 70% of the family farmers responded that they do not have another buyer for their castor bean production. Less than 20% reported the presence of a third party that could eventually buy the castor beans – but they prefer to sell them to the biodiesel company because it enables the crop through the distribution of seeds. Some farmers reported the importance of the commitment – not always necessarily associated with the existence of a contract – to the donation of seeds and the technical assistance rendered by agencies connected with the municipality and the state.

When questioned about an increase in their income, farmers from the Rio Grande do Sul Central Hub answered that it has grown. On the other hand, two different situations emerged in the Northeast:

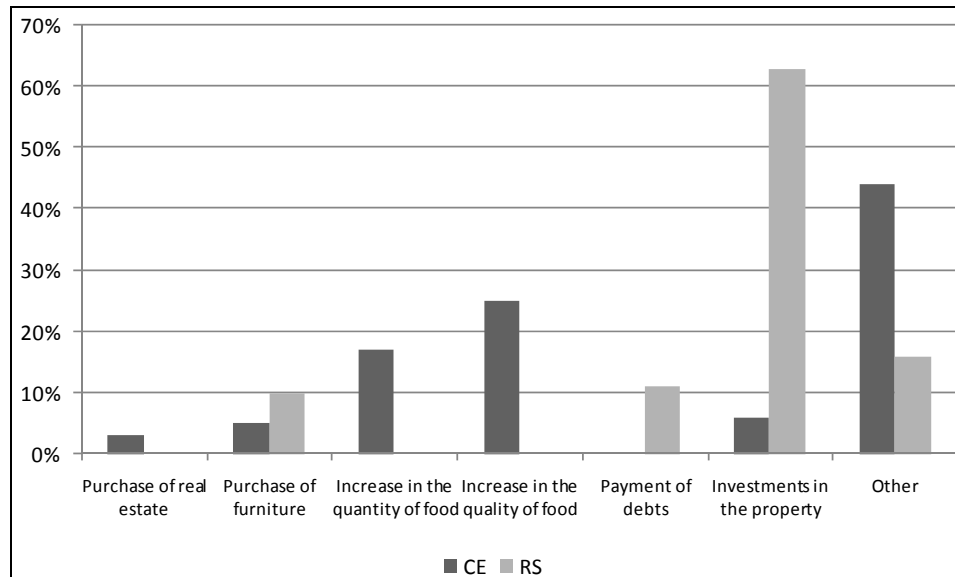
- a Most, some 40%, consider that their income has increased.
- b 35% responded that their income remained the same, and explained that, due to 2009's atypical winter weather conditions, with an excess of rain, they lost part or all of their production.
- c Also due to weather conditions, 10% of the respondents reported that their income decreased because the planted area could have been destined for other crops (beans and corn). As a result, they were obliged to buy products that they could have produced themselves.
- d Some farmers were also observed not to have sold their production (see Figure 1).

The questioning about the investment of income from the sale of vegetable crops for biodiesel presented significant differences in the hubs studied. In Rio Grande do Sul, family farmers had difficulty in differentiating the income from soybean destined for biodiesel from the income derived from the sale of soybean for other uses. In sum, 62% indicated that they had made investments in the property, mainly the purchase of machinery, to which can be added the 11% who purchased real estate. Debt payment also accounted for a significant amount. The increase in income has been used, by and large, for investments in the property.

In the Northeast, the economic sustainability indicator – i.e., income generation – is strongly aggregated to improvements in food security, insofar as 43% of the respondents answered that the income generated by castor beans was invested in improving the quality and increasing the quantity of food.

An interesting case in point is that income investments in the purchase of small animals are not necessarily a way of investing in the property, but in food. An example is the purchase of goats, sheep, and poultry. These answers were grouped under the item 'other' on the form used in the interviews (see Figure 2).

Finally, the answers of the family farmers demonstrate that the economic indicator – i.e., income increase – influences both hubs studied. However, castor bean production in the Northeast is the only existing source of income due to the conditions of family agriculture in that region. The investments made with the income from the sales of castor bean meet farmers' need for improving their food security. A clear correlation is seen between the economic indicator and the social indicator of enhanced quality of life.

Figure 2 Destination of income arising from sales of vegetable crops to the biodiesel industry

Source: Field survey

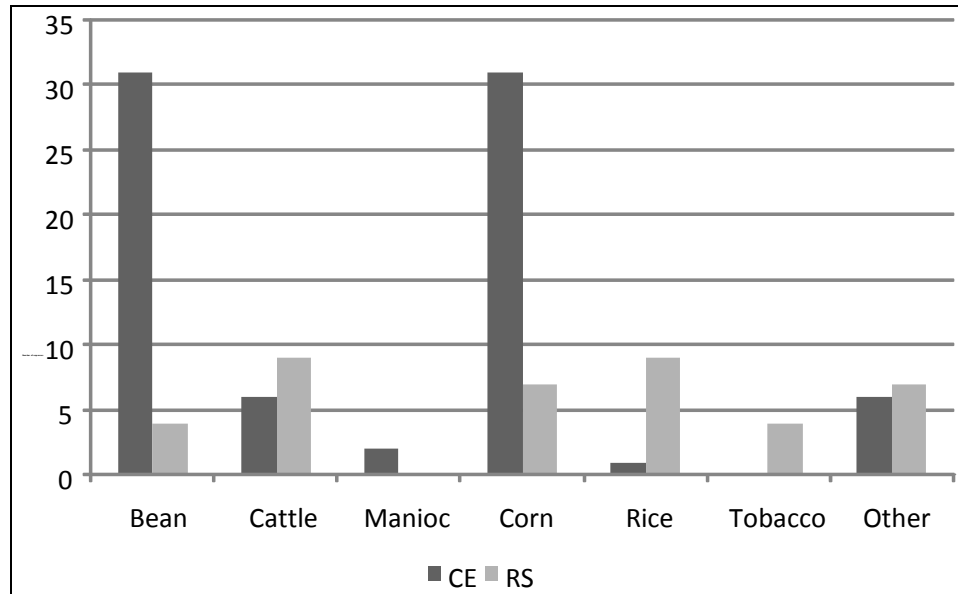
It is important to draw attention to the fact that farmers in Ceará's hinterlands obtain incentives from the state government for planting. This item was expressly taken out of the form so that the question would refer only to investments with the income arising from the sale of raw material for biodiesel production. It did not include government incentives, to avoid possible biases.

In the Rio Grande do Sul hub, production is also having positive results, but the income is used for purposes other than food. Farmers showed other needs, insofar as food security seems to be an indicator already dealt with by the family producers studied.

Crop diversification is visible both in the Rio Grande do Sul Central Hub and in Ceará's Central hinterlands. The difference lies only in the focus of diversification – while southern farmers aim at the market, the goal of north-eastern farmers is alimentary subsistence.

The presence of various crops in the property is well-correlated with the economic indicator of diversified production, i.e., the entry of income from other activities. In the north-eastern hub, diversity does not represent income generation, but a means of food security and subsistence for farmers, because both bean and corn are part of their staple diet. It is important to bear in mind that the existence of various crops does not necessarily imply crop rotation, because these plants can be planted in consortia, which leads to soil impoverishment (see Figure 3).

Through the economic conditioner analysed, we observed that the PNPB is achieving a satisfactory result in terms of economic sustainability. It is worth noticing that even in distinct categories, both hubs present positive results. PNPB's institutional framework is changing the economic performance of farmers involved in the biodiesel AIS.

Figure 3 Other agricultural activities in the rural properties studied

Source: Field survey

4.4 Environmental sustainability

The concept of environment entails four aspects: natural, artificial, cultural, and work environment. However, this research is based on the analysis of the natural environment.

The natural environment is the one existing by itself. In other words, it does not depend on human influence. A few such examples are the atmosphere, water (rivers, seas, lakes, etc.), flora, forests, fauna, and soil. The natural environment is directly addressed by the preamble of Article 225 of Brazil's Federal Constitution of 1988 (Brasil, 1988).

With regard to the environmental aspect of the concept of sustainability, this study presents the conditioners referring to spaces protected within the rural family property. These spaces are divided into Legal Reservations and Permanent Protection Areas (APPs), both aimed at the maintenance of biodiversity.

APPs and Legal Reservations are variants of the classification 'protected territorial spaces', which are established in Section 3, Paragraph 1 of Article 225 of Brazil's Federal Constitution (Brasil, 1988). The space destined for Legal Reservations must be determined by the owner and approved by the appropriate state body, whereas the limits of the APPs are established by law.

Nevertheless, the APP is primarily destined to preserve and protect sources of water, rivers, and dams. On the other hand, the Legal Reservation is destined to maintain, within each property, a minimum percentage of native vegetation, which fulfils an important ecological function as habitat for biodiversity (Brasil, 1965).

Farmers from the regions interviewed were questioned about the existence of uncultivated areas aimed at the preservation of vegetation. The results that emerged were

similar: in the central hinterlands of Ceará, 64% of the farmers reported having an area not destined for cultivation, whereas in Rio Grande do Sul 80% of the respondents do not grow crops in a specific area.

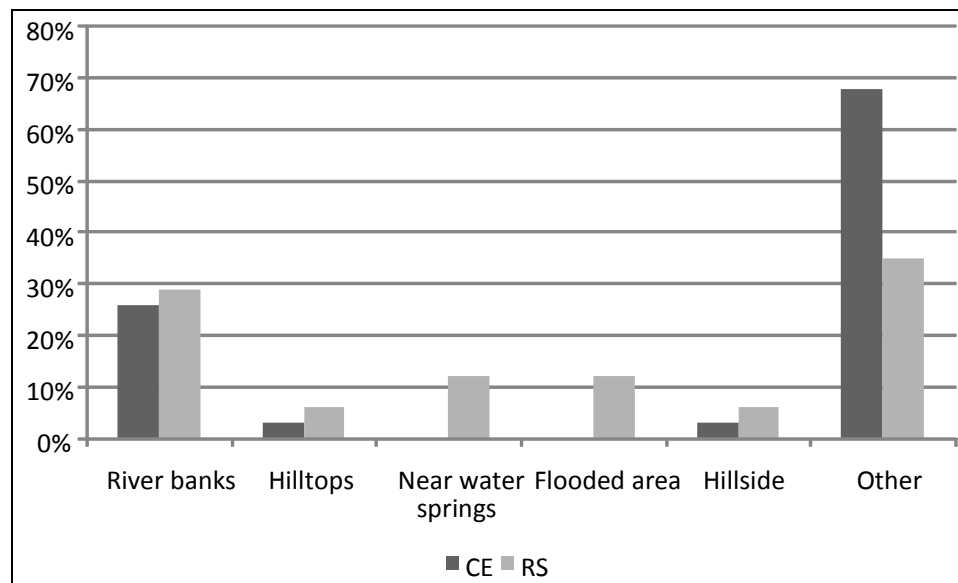
Those who answered affirmatively to the question that verified the existence of a space set aside for preservation were asked about the location of this area so as to verify whether it could be considered a Permanent Protection Area or Legal Reservation.

Respondents could opt for the alternative of Permanent Protection Area or the possibility of 'other areas' not described. The choice for 'other area' would fit the concept of 'legal reservation' because the areas of the Legal Reservation are not previously delimited.

According to the data amassed, Ceará's Hub presents a significant area, of approximately 68% of the total, destined to the Legal Reservation, which derives from the way properties are acquired – all of the respondents are settled through the national Agrarian Reform Programme, which requires the registration of the Legal Reservation area. Another factor accounting for the significant presence of the Legal Reservation is the lack of machinery to work the land.

In the Rio Grande do Sul Central Hub, non-cultivated areas are disseminated among the options suggested. The Permanent Protection Area, known as ciliary forest, represents 26% of the total, whereas Legal Reservation areas are close to 35% (see Figure 4).

Figure 4 Non-used locations



Source: Field survey

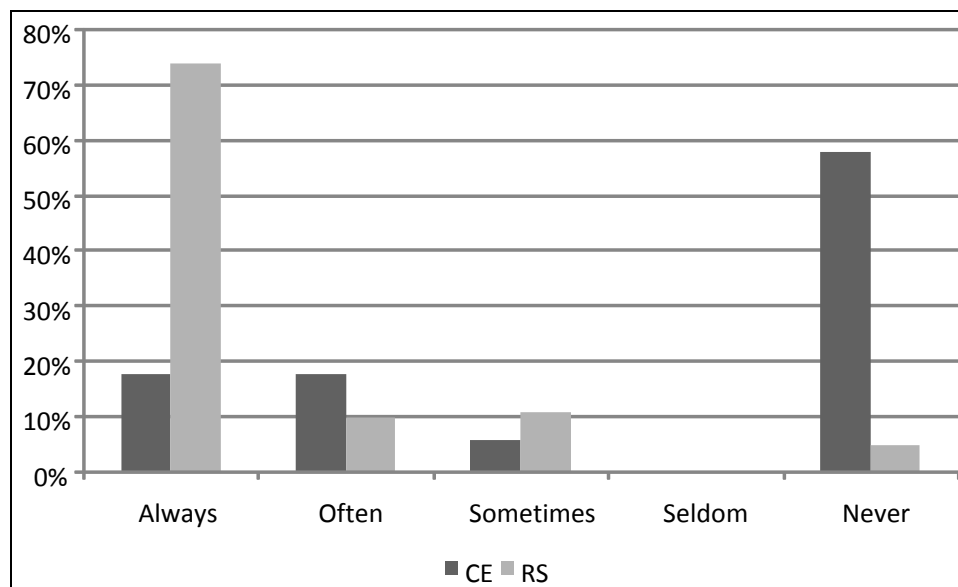
The conditions of water resources were addressed through the perspective of elimination of the farmer's contribution to their pollution through the discharge of residues. The majority of north-eastern farmers (91%) reported not discharging any type of residues

(into rivers, brooks, or water springs). An inferior percentage was collected in the centre of Rio Grande do Sul, where 75% reported eliminating the discharge of residues.

Soil protection was verified through a specific question on the theme. The use of soil correctives is higher in Rio Grande do Sul's Central hub, estimated at some 70%, whereas in Ceará's Central Hinterlands hub this index is lower, at 58%.

Crop rotation is another factor related to the use of soil correctives, which significantly contributes to soil protection. The concern lies in the possible types of crop consortia, as some of them are not recommended for soil protection and preservation (see Figure 5).

Figure 5 Frequency of the use of soil correction practices

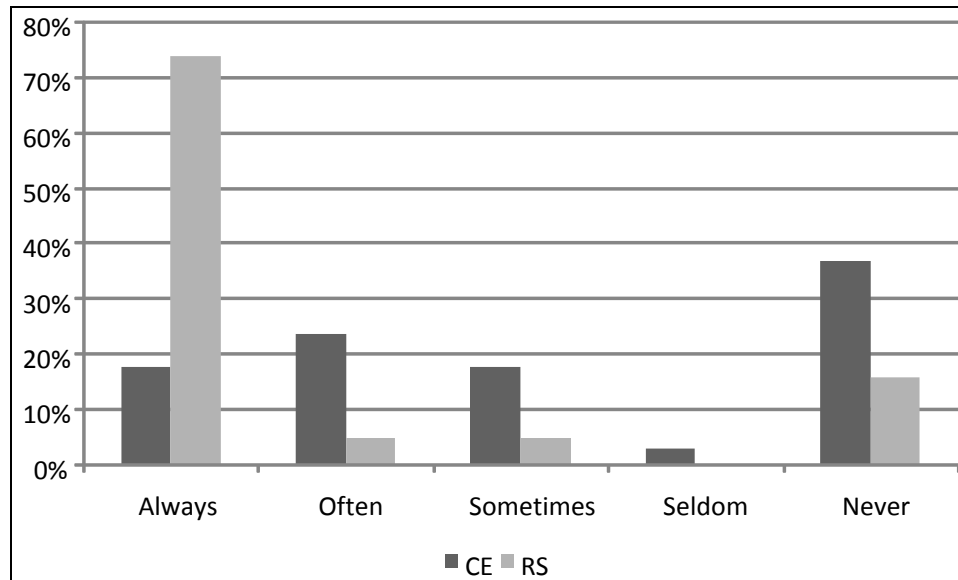


Source: Field survey

It is worth emphasising that the separation of residues can be an important factor in soil protection because organic residues are used in composting, as organic manure. The percentage of farmers that separate residues in Ceará is low, given the scarcity of food in the region, whereas inorganic resources are burned.

The unexpected datum was in Rio Grande do Sul's hub, where 73% of the answers were affirmative regarding the separation of organic and inorganic residues. The explanation is the existence of selective garbage collection in the rural area carried out by the municipalities, as well as the use of organic resources to compost the soil used for growing vegetables, and to feed small animals (see Figure 6).

The environmental conditioners found have little connection with the PNPB, and much more with the local culture, beliefs, and performance of state agencies (Aoki, 2005). The PNPB, through the social fuel seal, must seek alternatives for the implementation of the pillar of environmental sustainability that are not limited to occurring after the degradation of the environment has already taken place.

Figure 6 Residue separation

Source: Field survey

4.5 Social sustainability

The result of the analysis of the economic conditioners of sustainability – categorised as income increase arising from growing vegetable crops, income generation, and satisfactory economic return – showed that income increase is closely associated with improvements in the familial living conditions of family farmers. This fact is observed in the purchase of home furniture and in improved food quantity and quality, in the case of Ceará's hub. Reinvesting in the property also reflects an enhancement in the quality of life, in an indirect manner.

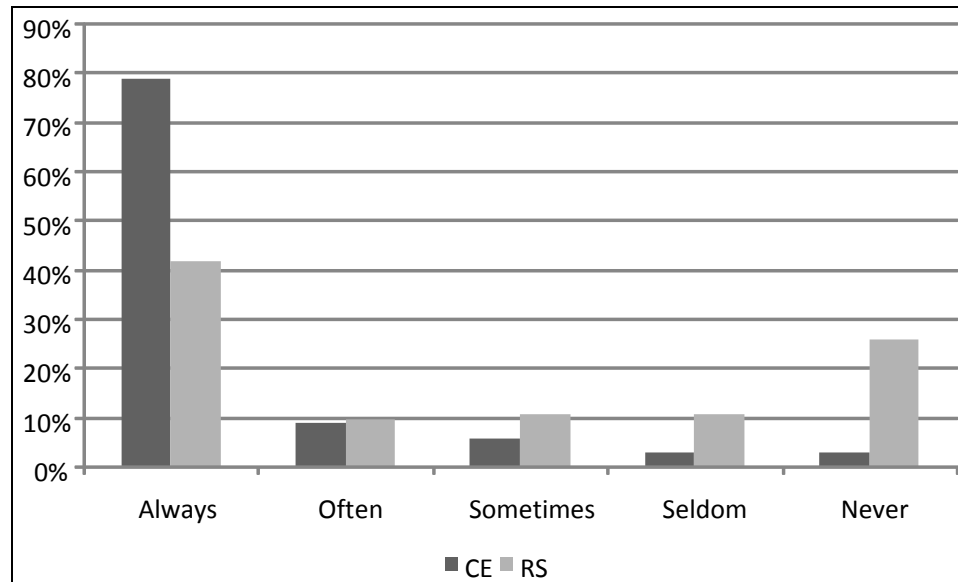
There are collective decisions about the planting of vegetable crops for biodiesel, and even about the problems encountered in production. There is news of seminars on the subject. At the Ceará hub, 79% of the respondents participate in community discussions. Two factors must be stressed in accounting for this high percentage: the fact that these farmers do not have experience in growing castor bean, and the way they acquired their property – through agrarian reform. The length of residence at the property becomes relevant because it was not considered as a factor of social aggregation (see Figure 7).

Although farmers in Rio Grande do Sul have lived in their property for a longer period of time, the data showed that this fact does not interfere with the social interaction about the destination of the soy bean crop. Farmers already have experience in its cultivation and have not acquired their properties through equal processes.

Family farmers were questioned about the possible changes in their lives after the planting of the respective vegetable crops destined for biodiesel production. 84% of farmers from Rio Grande do Sul stated that their life conditions improved. For their part, 39% of farmers from Ceará felt that there were improvements, but most – 61% – reported that everything remained the same. Taking into consideration that some 11% of the

farmers interviewed did not sell their production. The result is as expected, since there was no income increase.

Figure 7 Frequency of participation in community discussions



Source: Field survey

Social conditioners have shown themselves to be interconnected with the economic conditioners; improvements in the economic echo in the social. Therefore, to induce changes in the social base of the tripod of sustainability it is necessary that there be integration with other public policies.

5 Final considerations

Among the sustainability indicators arising from the analysis of the institutional framework of biodiesel, the economic and social conditioners pointed to positive results after the creation of the PNPB. It is worth emphasising, however, that in each hub studied, the internal elements of the conditioners were overcome according to the history of each region.

Another relevant point is the technological question. In the central region of Ceará's hinterlands the soil is inferior to that of Rio Grande do Sul's central region, thereby requiring appropriate technology. The adoption of the same institutional model for regions with different histories led to the use of different conditioners (Aoki, 2005).

With regard to the environmental pillar of sustainability, the conditioners were weak and rarely correlated with biodiesel production, but rather with cultural values and the overall state performance of environmental protection. The presence of an environmental responsibility clause occurs subsequent to environmental degradation. Within the scope of the PNPB, therefore, we suggest a revision to the programme by the body that awards the 'social fuel' label.

The use of a 'social fuel' certification is serving as a public policy instrument, acting to regulate the biodiesel industry primarily through the obligation of including family agriculture. The biodiesel certification is very much a new way of regulating the sector for a future international market, with the state already intervening in the production process.

References

- Aoki, M. (2005) 'Endogenizing institutions and institutional change', Stanford University, This paper is a revised version of a paper presented at an invited session of the 2005. World Congress of the International Economic Association held in Morocco.
- Banco Nacional do Desenvolvimento (BNDES) (1999) Available at http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Linhas_Programas_e_Fundos/pro naf.html (accessed on 4 August 2009).
- Bolsa Família (2010) Available at <http://www.mds.gov.br/bolsafamilia> (accessed on 9 February 2010).
- Brasil (1965) Código Florestal. Lei no. 4.771, de 15 de setembro de 1965, available at <http://www.planalto.gov.br> (accessed on 15 August 2009).
- Brasil (2005a) Lei no. 11.097, de 13 de janeiro de 2005, available at http://www.biodiesel.gov.br/docs/lei11097_13jan2005.pdf (accessed on 30 July 2009).
- Brasil (2005b) 'Ministério do Desenvolvimento Agrário', Instrução Normativa no. 02 de 30 de setembro de, available at http://www.biodiesel.gov.br/docs/IN%2002%20proj%20com_social.pdf (accessed on 12 August 2009).
- Brasil (2006) 'Ministério do Desenvolvimento Agrário', Instituto Nacional de Colonização e Reforma Agrária, (accessed on <http://www.incra.gov.br/> (accessed on 4 January 2009).
- Brasil (2009) 'Ministério do Desenvolvimento Agrário', Instrução Normativa no. 01 de 19 de fevereiro de 2009, available at <http://www.mda.gov.br/saf/arquivos/0761220182.pdf> (accessed on 4 August 2009).
- Brasil (1988) 'Constituição [da] República Federativa do Brasil', available at <http://www.planalto.gov.br> (accessed on 9 January 2010).
- EMBRAPA (2010) Available at <http://www.embrapa.br/> (accessed on 25 February 2010).
- Ferreira Filho, M.G. (2009) *Curso de Direito Constitucional*, 35 ed., Saraiva, São Paulo.
- Grau, E.R. (2002) *O direito posto e o direito pressuposto*, 4 ed., Malheiros, São Paulo.
- North, D.C. (1991) 'Institutions', *Journal of Economic Perspectives*, Winter, Vol. 5, No. 1, pp.97–112.
- ONU (1987) *Relatório da Comissão Mundial Sobre o Meio Ambiente e Desenvolvimento*, Fundação Getúlio Vargas, Rio de Janeiro.
- Organization for Economic Co-operation and Development (OECD) (2001) *Environmental Indicators for Agriculture: Methods and Results*, Vol. 3, OECD, Paris.
- Sardoni, P. (2009) *Dicionário de Economia no Século XXI*, Record, São Paulo.
- Sen, A.K. (1999) *Desenvolvimento como Liberdade*, Companhia das Letras, São Paulo.
- Território e Cidadania (2010) Available at http://www.territoriosdacidadania.gov.br/dotlrn/clubs/territoriosrurais/sertocentralce//project-manager/one?project_item_id=2750435 (accessed on 1 February 2010).

Notes

- 1 The rural module varies according to natural and socioeconomic factors. In other words, it concerns the quantity of land necessary for a worker and his family (of four people) to be able to maintain themselves. Wherever production conditions require less space, the rural module is smaller, whereas in regions requiring more space the module is larger (Brasil, 2009).