Building Supply-Systems from Scratch: The Case of Biodiesel Chain in Brazil

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Abstract

The purpose of this article is to study the transplantation of complex agro-industrial systems. The main focus is the analysis of the biodiesel system in Brazil using the Agro-Chain System approach (AGS). The AGS analysis considers the institutional and organizational environments and verifies how a governance structure evolves as the institutional environment changes. The methodology used is a case study of the biodiesel chain system in the State of Minas Gerais – Brazil. This local system developed as a result of governmental incentives. The present study's contribution is that it identifies the main obstacles to implementing agro chains and networks involving regions and actors that do not have previous history of productive organizations.

Keywords: *Transplant of agro-industrial systems, bio-energy production*

1 Introduction

The Brazilian Biodiesel Program was established in December of 2004 in order to originate a sustainable chain of biodiesel production and use. It has since incorporated a number of new features so as to reach sustainability. Just as relevant as the environmental aspect, social inclusion and local development mechanisms are also an integral part of the program's agenda. This it aims to do by promoting the production of non-traditional crops in regions with chronic development problems. At the same time, it sets demand goals through the mandatory inclusion of biodiesel into the energy matrix.

This study addresses the biodiesel agro-system through a learning process based on both technological and organizational elements. Its main purpose is to adopt the Agro-Chain System approach (AGS) as an analysis tool to be applied in the bio-diesel system, taking into account sustainability on one hand, and the dynamic aspects of diffuse organizations on the other. The main contribution of the study is the identification of the main obstacles to implementing agro chains and networks that involve regions and actors that do not have a previous history of productive organizations. The results are useful in shedding light on the many initiatives focused on transplanting agro systems within different regions and countries.

The institutional agro chain analysis is relevant because it can suggest the typical hindrances to introducing new institutional arrangements. This first step of the analysis applies the concept of strictly coordinated supply system (Zylbersztajn and Farina 1999). According to Zylbersztajn (2000), among the elements required to develop the study of complex agro-industrial systems are: key features of the agents involved in the production, the industrial organization of the chain's sectors and the organizational and institutional frameworks. In order to become operational, the introduction of new institutional arrangements can result in unexpected costs when transplanted to new regions. To understand how the biodiesel

chain's agents organize their production system, one has to consider local formal and informal institutions.

Therefore, the AGS analysis considers the importance of the institutional and organizational environments that are built to provide support to production activities. Furthermore, the AGS dynamic is affected by changes in the institutional environment, seen as formal and informal rules that restrict the agents' action. According to North (1990, 1991), these include formal rules (constitutions, laws, and property rights) and informal constraints (sanctions, taboos, customs, traditions, and codes of conduct). The role of institutions is to control uncertainty and to create a favorable environment for decision-making. The purpose of North's (1990) analysis was to explore some characteristics of institutions for a better understanding of their involvement in economic growth. This macro-analytical process concerns the interaction between institutions and agents in the process of choosing organizational structures. The institutional environment has an impact on agribusiness chains and networks in general and on their strategies and structure in particular (Zuurbier and Hagelaar 2000).

The present paper is organized in five parts. Following the introduction, Part 2 presents the theory of institutions and the transplantation of institutions and organizations, pointing out the key elements related to the development of new agro supply chains. Part 3 describes the case of the development of the bio-diesel chain in the state of Minas Gerais, Brazil. Part 4 outlines the key obstacles that characterized the start-up operation of the biodiesel chain. Finally, Part 5 concludes, pointing to key elements to be controlled while transplanting models within different regions or countries.

2 Theory of institutions and transplanting organizations to develop new agro supply chain

Institutions are instrumental in the analysis of how organizations are set up, but the traditional price theory and production functions are not capable of explaining institutional arrangements. Institutions influence the choice of organizations or "institutional arrangements". On the one hand, the macro-analytical dimension is represented by the formal and informal institutions named "rules of game" as part of institutional environment. However, micro-analytic level, mechanisms of governance (markets, hybrids, hierarchies) are considered (Williamson 1996).

The analysis of arrangements within and among different organizations is important, in addition to what can be explained by pure market transactions as seen in the purchase of factors of production and the sale of goods. Therefore, the efficiency of the economic system depends on how organizations conduct their affairs, based on the institutional arrangements that govern the process of exchange.

The seminal article of Ronald Coase (1937), *The Nature of the Firm*, amplifies the traditional theory of the firm to consider contract-based organizations instead of a firm as a production function. The Neoclassical theory considers what occurs in the markets and focuses on price, supply, and demand without analyzing the internal arrangements and their contracts. The New Institutionalism's direction is a reaction to Neoclassical assumptions (Zylbersztajn 1995). According to North (1986), the choice set specified by the New Institutional economics is both broader and narrower than that conceived by traditional Neoclassical theory.

Besides the pricing mechanism, transaction costs must be considered. These are the costs for negotiation efforts, contract design, coordination, and so on. According to Arrow (1969, p. 59), transaction costs are the "costs of running the economic system". For Williamson (1985, p.2), "a transaction occurs when a good or service is transferred across a technologically separable interface". The friction of the transfer is the transaction cost.

Transaction costs are ex-ante for the costs of drafting, negotiating, safeguarding, and agreeing. There are ex-post transaction costs, such as those for aligning and adapting the

contract for unexpected situations. These ex-post costs include: "(1) the maladaption costs incurred when transactions drift out of alignment in relation […]; (2) the haggling costs incurred if bilateral efforts are made to correct ex post misalignments, (3) the setup and running costs associated with the governance structures (often not the courts) to which disputes are referred, and (4) the bonding costs of effecting secure commitments" (Williamson 1985, p.21). Economic agents align transactions with governance structures to effect economizing outcomes, and therefore the transaction costs of one governance mode are evaluated in relation to alternative feasible modes (Williamson 1996).

In addition to Transaction Cost Economics there are measurement costs (Barzel 2002b) that affect the allocation of property rights. According to Barzel, a transaction can be deconstructed into different dimensions, each one representing an exchange of property rights and affected by a measurement cost. This cost brings a specific value to agents involved in the transaction. Such value can be dispersed if the property rights are not well-defined, which can be difficult to measure, and so it can become difficult to contract specific attributes of a transaction (Zylbersztajn 2005). Therefore two different elements affect how transactions are organized. One is the rationale of transaction cost minimizations as it relates to the capture of quasi-rents associated with specific investments. The other vein in the literature addresses measurement costs and the protection of property rights associated with the different transaction dimensions, where specific assets do not play a relevant role.

Barzel (1997, p.2) defines transaction costs as "the costs associated with the transfer, capture, and protection of rights". Considering this assumption, according to the Coase Theorem, if the transaction costs were zero, the property rights would be perfectly established and protected. Barzel (2002b) considers that the easier the measurement and verification of contract stipulations, the more readily the contract can be enforced. This means that insofar as the measurement costs decrease, the agents will use contracts more often instead of performing vertical integration.

According to Zylbersztajn (2005), although both theories share similar grounds, they differ in internal logic, explicit assumptions, and key measurable variables, leading to methodological implications. Therefore, the difference between the transaction cost and the measurement cost theories lies in the empirical evidence of each theory to offer explanatory motives and testable hypotheses to determine alternative institutional arrangements, based on efficiency principles.

From the perspective of transaction cost economics, a firm's governance decision is based on a choice between competing alternatives, such as market, hierarchy, and hybrid form (Williamson 1991). Alternative ways of organizing the relationship among economic units are created in order to take advantage of labor division and economize on bounded rationality, as well as to safeguard parties against contractual hazards (Ménard 2005, p.282). A way of organizing is through an institutional arrangement called institutional structure of production (Coase 1992) or governance mechanism (Williamson, 1996).

An institutional arrangement that performs well in a specific region might not perform accordingly when transplanted to other places. If it is difficult to transfer an organization from one environment to another, transferring a model process of institutional arrangement would be even more complex. According to Zylbersztajn (2009), organizations are groups of individuals that operate within a framework of institutions and implement the norms and rules of this framework. An institutional arrangement might involve several agents when the transactions are performed based on complex, multidimensional hybrid network mechanisms instead of pure vertical integration.

Complex institutional arrangements will gradually adapt to the characteristics of the new environment. Organization theory and industrial sociology suggest that organizations are closely tied to their environment (Florida and Kenney 1991). As well, the adaptation of

organizations and institutional arrangements might be a slow process and the existing institutional environment is expected to play a role. It means that both formal and informal institutions should be taken into account.

2.1. Institutions: "rules of game". Institutions transplantation, institutions' dynamics and connection to institutional arrangement

The institutional arrangements and "rules of game" can also be transferred to different environments. An institutional arrangement transfer suggests that agents involved will gradually adapt to the incentives placed by the new institutional environment. Furthermore, the analysis of institutional arrangements might be applied in different places, since it considers local institutions. Institutions are formal and informal rules that provide a set of incentives and disincentives for the individual. They arise and evolve because of the interaction of individuals (Williamson, 1996, p.378).

In addition to developing local institutions, countries often adopt policy institutions from other countries in order to improve the performance or legitimacy of their own institutional structures. Institutional transplantation is no new phenomenon and it was often imposed on conquered territories and populations (Mamadouh, Jong, and Lalenis 2003). Institutional transplantation can be analyzed on two levels: 1) the institution of one country that can be transferred to another (international transplant); 2) the institution from one region to be applied to another region of the same country (local transplant). Although the analysis can be done on two levels, this study will focus on local transplant, specifically in the state of Minas Gerais.

For international transplant, the adaptation and copying of new institutions would be more difficult, due to the heterogeneity of different regions from country to country. For instance, if the Brazilian Biodiesel Program were transplanted to another country, local institutions would have to be taken into account; therefore, adaptation is expected. This transplantation takes a long period and the results might not be the same as those of the original country. At the limit, property rights protection might limit the successful insertion of the exogenous institutional arrangement.

Local transplantations are expected to be easier in comparison with international transplantations given the level of homogeneity. Existing social norms observed in small and stable communities might allow for easier adaptation. An example of local transplantation is the implantation of the Brazilian Biodiesel Program in Minas Gerais. Even though this local transplantation might be easier than an international transplant, an adaptation process is nevertheless underway. The effectiveness of the National Biodiesel Program in Minas Gerais might be different in comparison with other Brazilian regions. For large countries, such as Brazil, rules that are appropriate in one region are rarely effective in another (Ostrom 2008b). Considering the context of institution transplantation, Ostrom's research (2008a) examines whether farmers who are managing irrigation systems based on the collective use of water might succeed considering the presence or absence of shared norms that facilitate coping with such a difficult process.

Although rules are potentially transferred, they also evolve internally and are acquired in the context of the local environment with which the individual frequently interacts, and change in this context (Ostrom 2008a). According to Ostrom (2008a), formal rules may exist but not be followed or even be known by the participants. These rules are established by the State; there is no possibility to reach all personal expectations and informal rules might arise. Moreover, local rules tend to achieve a higher performance rate than systems where the rules are entirely determined by external authorities.

According to Eggertsson (1990), government regulation would induce specialized investments and motivate long-term contracts, because it is State-guaranteed. However, in the absence of government regulation, private rules would arise in order to guarantee property rights. From another perspective, economic rights and legal rights could be considered. According to Barzel (2002a, p.6), "[…] economic rights reflect individuals' ability to consume or exchange commodities. These rights may exist in the absence of legal rights, though the latter tend to enhance the former. Legal rights are rights delineated by the State. The State, as a rule, chooses to enforce the rights it delineates."
The complement of rules is another aspect to be considered. Private and public institutions can coexist and they can be considered complementary instruments (Fig. 1). According to Klein (1992) and Mazé (2005), the complementary view suggests that the use of public and private institutions provide more efficient outcomes than the use of either individually.

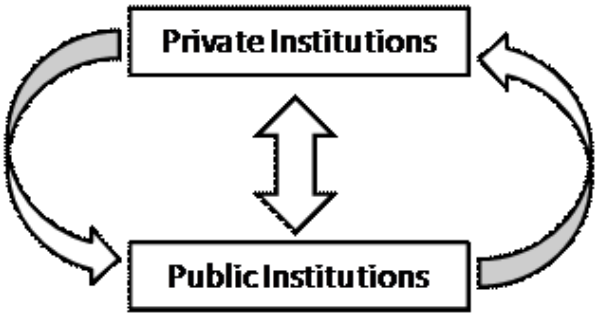

Figure 1. Institutions dynamic: public and private institutions
Source: the author

On the one hand, institutional arrangements might be adapted according to a new environment. On the other hand, an institutional arrangement might alter the new environment in order to reach its functional requirements. Institutional environments are influenced by agents involved in the AGS. Therefore, institutional arrangements and institutional environments are interdependent and dynamic (Fig.2).

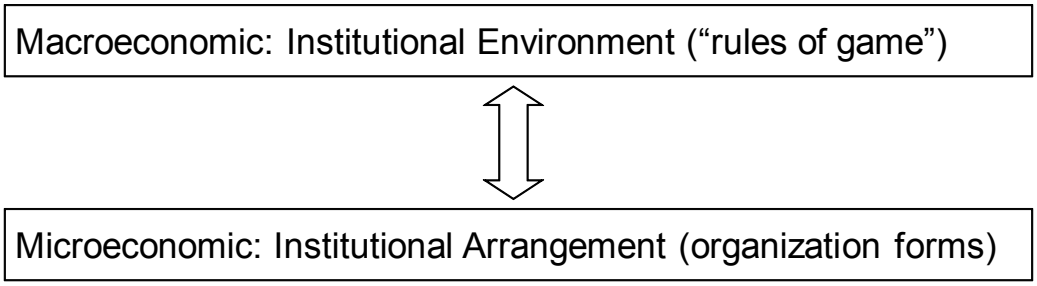

Figure 2. Macroeconomic and microeconomic analysis
Source: the author

Considering the AGS approach as an analysis tool, the systemic view is taken into account and evaluates the relation among the agents. Moreover, the AGS is considered as a governance structure that has a dynamic view of performance, since it can change insofar as the relations among the agents change according to each environment. The action of agents depends on external incentives and it concerns the global system for local strategies (Bortot 2001). In addition to external incentives, at each environment internal incentives are observed, such as policy, economic, financial, technology development, culture, and legal rules.

The AGS analysis considers institutional and organizational environments that are built to give support to production activities. This analysis tries to verify how a structure of governance might be implanted in a new environment. The other issue to be taken into account is the impact of environment on the formation of a structure of governance. Considering the study of biodiesel in the state of Minas Gerais (Brazil), it is a new process and the institutional arrangement is in formation. Moreover, sustainability issues should be taken into account in the conceptual model of analysis. Social and environmental aspects are part of institutional arrangements and institutional environments as well (Fig. 3).

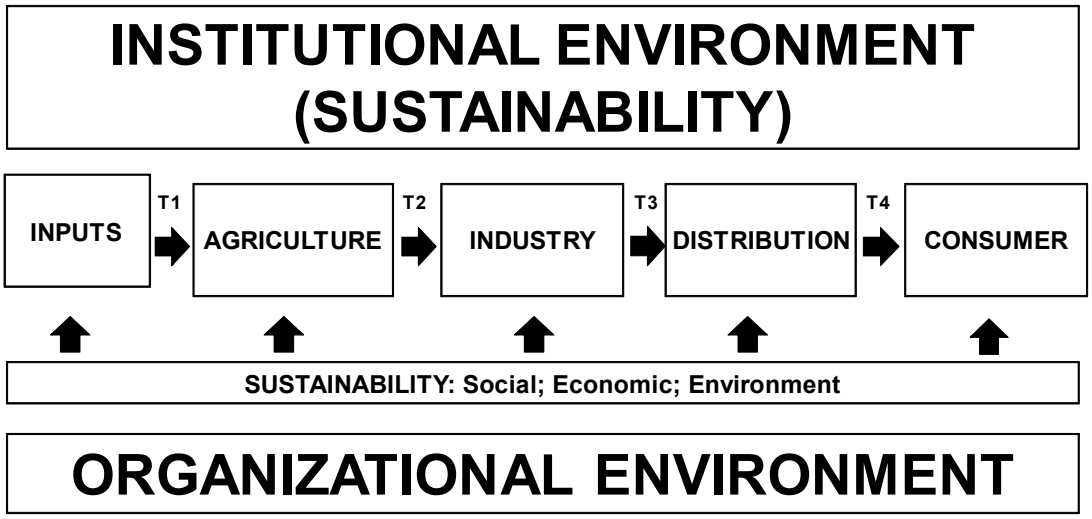

Figure 3. Sustainable Agribusiness System and Typical Transaction.
Adapted from Zylbersztajn (1995)

For the development of a new agro supply chain, such as a biodiesel system, the environment must be taken into account. Each environment has its particularity due to the social structure. The role of the social structure influences individual or collective behavior and performance. Granovetter (1985) uses the term embeddedness to explain that social relations affect the behavior of economic agents and institutions. That means that individuals are embedded by ties and a network of interpersonal relationships is built. The embeddedness argument considers the role of personal identities and the structures of such relations that create trust and control opportunism. Therefore, the concept of environmental "embeddedness" is relevant to studies of the development of new agro-industrial systems, such as the biodiesel system analysis.

Embeddedness can be stronger when the relationships are long-term, and it considers effort incentives, trust, and reciprocity. Although the social structure should be considered when analyzing the biodiesel system in Minas Gerais, the observed social ties are weak since it is a new system and still being formed; the agents do not always have previous social relations, hence their reputation and trust are in a process of construction. This weak relationship between small farmers and the biodiesel industry might affect the decision of small farmers about producing a new and unknown crop. On the side of the biodiesel industry, more efforts are necessary for convincing the small farmers to produce a new crop to be used on the biodiesel production system. These efforts mean costs in the form of incentives for small farmers such as technical assistance, donation of seeds, and a guarantee of acquiring the production.

3 Building a new supply chain system, considering the AGS analysis

The biodiesel AGS analysis considers institutional and organizational environments. This analysis verifies how a structure of governance might be implanted in a new environment, such as biodiesel AGS in the state of Minas Gerais (Brazil). The other issue to be taken into account is the impact of the institutional environment on the formation of a structure of governance.

The AGS analysis takes into account the relations among inputs industry, farmers, agro-industry, and consumers. The agents involved in the AGS are interdependent and organized in a chain or network system. The concept of AGS as a systemic view was presented in the research of Davis and Goldberg (1957) that first used the term "agribusiness". After one decade, Goldberg (1968) developed the analysis named commodity system approach (CSA). This analysis was more complete because the institutions, such as governmental institutions, markets, and commercial associations, were taken into account alongside the production system activities.

The French School of Industrial Organization also introduced systemic analysis and named it *filiére* analysis. The French and American concepts are very similar and both of them focus on productive process as a system. The institutional environment (culture, traditions, legal system, behavior) is another aspect considered by both concepts and it can interfere with the production system (Farina and Zylbersztajn 1994). The AGS analysis has been studied since the 1950's with the agribusiness concept, and new configurations[1] (Ménard 2004) of the system were elaborated in order to examine the complex forms of relations in these arrangements.

The micro-analytical analysis considers the AGS as a structure of governance that faces the changes in the institutional environment, and its agents must respond through continuous innovation. Moreover, environment and social issues are concerned as well as the economical performance of an organization. The challenge for building the biodiesel AGS in the state of Minas Gerais is to reach efficiency while considering the environmental and social issues as well. Complex forms of governance might be implemented in the biodiesel chain, involving contracts for vertical as well as horizontal coordination. Complex forms are discussed by Lazzarini et.al. (2001) with the concept of netchain analysis, which studies the simultaneous mechanisms of vertical and horizontal interdependence in networks. Netchain is defined as "(…) a set of networks comprised of horizontal ties between firms within a particular industry or group, such that these networks (or layers) are sequentially arranged based on the vertical ties between firms in different layers" (Lazzarini et al. 2001) p.7.

Complex forms of governance focus on different types of interdependencies that are arranged either vertically and/or horizontally. AGS considers vertical coordination to be the relationship among different agents, such as inputs industry, farmers, agro-industry, and consumers. With horizontal coordination, transactions among the same layers are considered, being motivated by scale economies, market power balance, and the search for new opportunities to augment value as brand or social stamps. Horizontal coordination can add value if agents combine competitive differentiation to reduce costs based on common use of resources; share benefits and costs; and share access to new markets and new technologies. Olson (1965) analyzed individual rationality and examined the extent to which individuals that share a common interest find it in their individual interest to support the cost of the organization effort.

1. Following Mènard, the term "configuration" is used rather than "theory" because not all these approaches develop a theoretical framework from which testable propositions can be derived.

The size and heterogeneity of a group might impact the costs of organizing for collective action. Olson (1965) observed that individuals in large groups could gain less per capita from a successful collective than individuals in small groups: the incentive for group action diminishes as group size increases. The heterogeneous group might have higher transaction cost for collective action than the homogeneous group (Nassar and Zylbersztajn 2004).
Social aspects are relevant for AGS analysis in cases when informal institutions explain the observed institutional arrangements. Learning aspects and the dynamic of agents involved in the contractual relation should be taken into consideration. According to Zylbersztajn (2009), data collections of contracts only capture part of the incentives present in most of the institutional arrangements, and informal incentives such as agreements should be considered. Based on Barzel (1997, 2002a), contracts are legally enforced and agreements are economically enforced. Barzel's approach considers property rights transacted. When the property rights are well-defined and easy-to-measure attributes, the transaction will be performed by formal contracts. These contracts exchange "legal rights". Insofar as it is difficult to measure the attributes, the transactions will be performed by agreements and extrajudicial mechanisms to protect property rights will be used.
Zylbersztajn (2009), expanding on Barzel, suggested that when the attributes of a transaction are difficult to measure, contracts are not performed and the agents will develop alternative mechanism of protecting value. If both contract and agreement fail to protect rights associated with the transaction, then some value remains in the public domain.
All the aspects described above might be observed upon building a new supply chain system. The case study of biodiesel AGS in Minas Gerais tries to analyze the dynamic of agents involved in its production system. As biodiesel AGS is a process of learning, the institutional arrangement should be observed in a dynamic process. Some transactions in Minas Gerais might be performed by contracts taking into account the Brazilian Biodiesel Program. However, the social environment should be considered to help understand the difficulty in implementing this program in Minas Gerais.

3.1. Building a new supply chain system: the case of biodiesel AGS in the State of Minas Gerais

The National Program for the Production and Use of Biodiesel (PNPB) was implemented in December of 2004 in order to implement a sustainable arrangement of production and use of biodiesel. Moreover, this program intends to create incentives for social inclusion and regional development through the generation of jobs and income for low-income family farmers.[1] This program is designed to meet three aims: to introduce a sustainable program with social inclusion of family farmers; to guarantee competitive price, quality of products, and supply of biodiesel; and to produce biodiesel based on different types of oil crops in different regions in Brazil.
The regulation of biodiesel in Brazil is based on Federal Law nº 11.097/05, approved by the National Congress on January 13th, 2005. This Law introduced biodiesel in the Brazilian energy matrix and authorized a voluntary addition of biodiesel to petrol diesel from 2005. In 2008 the mix became mandatory, and its proportion in the blend offered in the market is 5% as of 2010.
At the beginning of the biodiesel program, mandatory public policies were adopted to enforce the demand and create incentives for production. The policy tools adopted are those of tax reductions to industry and price and credit incentives for farmers in order to introduce this renewable energy source into the energy matrix. Although biodiesel is not competitive in

1. http://www.biodiesel.gov.br/index.html

comparison with fossil fuel, it is necessary to take into account its positive externalities, since it brings both environmental and social benefits, and a learning process was set in motion both in terms of the adoption of the crop technologies and also in terms of the organizational design of the new network.

Biodiesel's cost of production from farming to processing varies depending on the choice of the crop to be used, production region, and industrial scales. The biodiesel industry (Fig.4) is concentrated in the Mid-West region due to the availability of feedstock, mainly soybean.

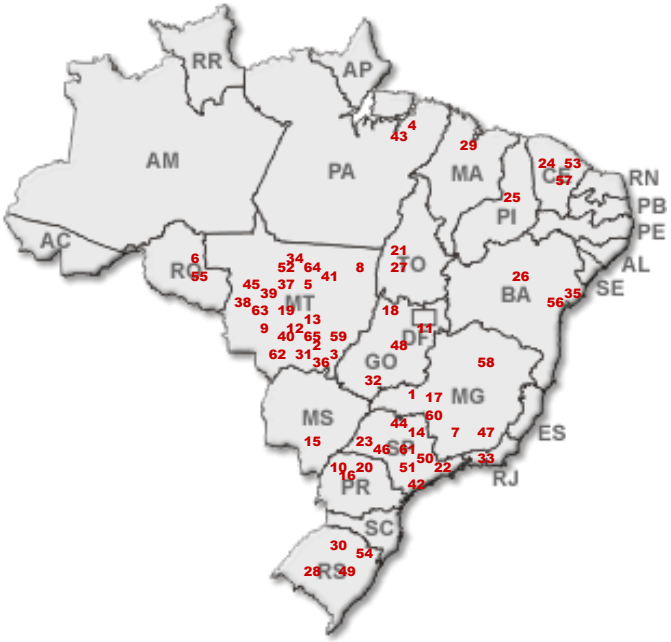

Figure 4. Map of Biodiesel Industries

Source: ANP 2009. Elaboration: Camila Mourad – PENSA – USP

The primary feedstock used for biodiesel production is soybean (table 1), based on the cost advantages and low transaction costs to access the product. The reason for using soybean is that the production system is already organized and alternative crops lag behind in terms of costs of production and organization of markets. Therefore the main goal of the program, to create a new network of production based on small family farmers, is only partially fulfilled.

Table 1. Feedstock to biodiesel (%)

Raw Material	2008		2009									
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Soy oil	82,17	78,44	71,16	73,68	85,37	76,37	81,33	81,10	78,70	83,29	74,88	77,35
Animal fat	10,70	16,44	24,54	19,25	10,94	19,36	16,11	14,03	14,62	10,33	16,27	15,48
Cotton oil	3,64	2,44	3,25	4,96	1,59	2,04	-	2,97	4,11	2,60	6,16	4,29
Other	3,49	2,68	1,05	2,11	2,10	2,23	2,03	1,90	2,57	3,78	2,69	2,88

Source: ANP 2009

The production of biodiesel in Minas Gerais is not relevant in comparison with other Brazilian States (table 2). In 2008, Minas Gerais did not have a significant production of biodiesel. It was only in 2009, that a new processing plant was in operation in the region Montes Claros (North of Minas Gerais). The initiative was made by the government controlled oil company, Petrobras, and resulted in a significant increase in biodiesel production in Minas Gerais. This does not mean that the crops being processed came fully from family farmers, in spite of the incentives promoted by the company, in terms of credit, and technical assistance.

Table 2. Biodiesel Production – B100 – in cubic meters

State	2005	2006	2007	2008	2009 until October
Bahia	-	4.238,135	70.941,993	65.982,132	6.602,022
Ceará	-	1.956,2	47.276,165	19.207,526	39.685,103
Goiás	-	10.107,972	110.638,065	241.364,097	226.703,005
Maranhão	-	-	23.508,648	36.172,289	20.962,316
Mato Grosso	-	13,4	15.170,057	284.922,771	292.062,283
Mato Grosso do Sul	-	-	-	-	2.902,063
Minas Gerais	43,82	310,5	138,164	-	31.595,467
Pará	510,4	2.420,9	3.716,76	2.625,248	2.565,362
Paraná	25,57	99,95	12,1	7.294,371	20.522,665
Piauí	156,369	28.603,529	30.473,645	4.547,574	3.615,902
Rio Grande do Sul	-	-	42.696,398	306.056,041	365.864,081
Rio de Janeiro	-	-	-	-	5.301,079
Rondônia	-	-	99,175	227,646	2.885,796
São Paulo	-	21.251,395	36.885,267	185.594,154	189.862,188
Tocantins	-	-	22.772,705	13.134,566	25.670,695
Brazil	**736,159**	**69.001,981**	**404.329,14**	**1.167.128,415**	**1.291.800,027**

Source: ANP 2009

The main purpose of PNPB is to integrate family farmers into biodiesel production and, consequently, contribute to their income. The participation of family farmers in the biodiesel AGS is an alternative for social inclusion that is part of a public policy of social and environmental sustainability. According to Abramovay and Magalhães (2007, p.14), the

production costs of the family farmers are competitive in comparison with large farmers, since family farmers produce the raw material for biodiesel with subsidized credit.
The Ministry of Agrarian Development (MDA) has promoted the "Social Fuel" seal in order to certify that biodiesel refineries source from family farmers. This "Social Fuel" establishes the conditions for biodiesel industries to obtain tax benefits and enables them to participate in the auctions organized by the National Petrol Agency (ANP). The requirements for biodiesel industries to participate in the "Social Fuel" seal program are: a) to purchase a minimum percentage of raw material from family farmers, established by the Ministry of Agrarian Development (MDA); b) to sign contracts with family farmers under the supervision of certain labor unions, such as National Confederation of Workers in Agriculture (Contag), the Federation of the Workers of Familiar Agriculture (Fetraf), the National Association of Small Farmers (ANPA), and other institutions determined by MDA; and c) to provide technical assistance to the family farmers;
Petrobras motivates family farmers to produce biodiesel crops integrated with different crops, resulting in a diversification of production. The integrated system allows family farmers to have alternatives instead of being completely tied to the biodiesel industry. Moreover, this integration system motivates the farmers to keep producing food. The biodiesel production system of Petrobras is performed through different transactions (Fig. 5).

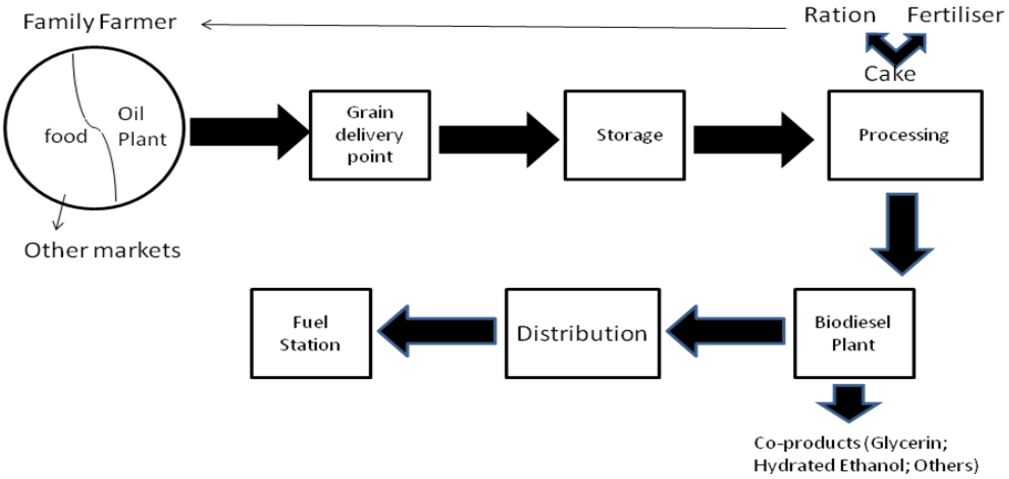

Figure 5. Petrobras Biodiesel Production Chain
Adapted from Petrobras

The participation of family farmers in Montes Claros in the biodiesel production of Petrobras is increasing (table 3). However, this participation is not spontaneous and further efforts from the biodiesel industry are needed.

Table 3. Petrobras (Montes Claros unit) transaction with family farmers: oil acquisition and contracts signed from 2007 to 2010. * Perspective of oil quantity and number of contracts

Feedstock	2007/08 tons of oil	2008/09 tons of oil	2009/10* tons of oil
Castor	276	1514	8000
Soybean	0	5600	20000
Sunflower	32	1464	2000
Macaúba (palm oil)	0	200	3000
Peanut	92	0	0
Contracts (#)	600	4469	15000*

Source: Interview with Julio C Lopes, manager of Petrobras biodiesel in Montes Claros – 19/11/2009

The integration of family farmers has involved several agents that are part of the organizational environment, such as technical assistance, research institutions, financial institutions, cooperatives, the Ministry of Agrarian Development, and trade union development. These agents are important to support the AGS operation, but they are not agents of the production system despite being part of the AGS. For the organizational environment, they are considered bureaucracy, which means "the support staff that is responsible for developing plans, collecting and processing information, operationalizing and implementing executive decisions, auditing performance, and, more generally, providing direction to the operating parts of a hierarchical enterprise."(Williamson 1996, p.377).
The biodiesel industries select the family farmers through the trade union movement, which negotiates the contracts and organizes the supply. Therefore, the trade unions defend the interests of family farmers and participate actively in the formulation and performance of contracts. All the effort made by trade unions in searching family farmers and organizing them in order to supply biodiesel production allows the biodiesel industries to reduce their transaction costs. Moreover, the contracts are standardized, which reduces the ink cost: it is not necessary for each to be negotiated or explained individually, because they are accepted through the trade union diffusion work and are signed by each family farmer or cooperative organization.
Technical assistance is provided by the biodiesel industries and there is a price guarantee. Petrobras in Montes Claros (Minas Gerais) has contracts with different institutions for technical assistance, such as EMATER, ITAF, Grande Sertão Cooperative, Copersan, Copasf, and Coap. Prior to providing technical assistance, these institutions seek out the family farmers, organize meetings in which the biodiesel industries establish their objectives, and invite the family farmers to be their partners.
There are two mechanisms to attract family farmers to the biodiesel production system: 1) formal mechanisms, which are contracts between family farmers and biodiesel industries, in accordance with PNPB; 2) informal mechanisms that involve local institutions in establishing long-term relationships between the social agents in order to organize the local coordination.

The purpose of local coordination is to coordinate the contracts that involve several operations, such as convincing the family farmers, organizing them, and so on. The coordination is structured with the creation of Management Working Groups and involves different agents such as the biodiesel companies, representatives of the trade union organizations, technical assistance companies, financial organizations, research institutions, cooperatives, and other public or private organizations (Abramovay and Magalhães 2007).
The Management Working Groups analyze the potential of production of raw material for biodiesel production and establish the framework for credit policies, technical assistance, training and technological innovation. Particular to Minas Gerais state, in addition to Management Working groups, the State Secretariat of Science, Technology and Higher Education (SECTES) implemented a program named Local Production Arrangement (LPA). The concept of LPA is based on geographical clusters of companies that act in the same segment, cooperating with each other. Moreover, other institutions, such as government, associations, financial institutions, and research institutions are involved in LPA.
The biofuel LPA is coordinated by Bio-energy Innovation Center of Minas Gerais (SECTES-BIOERG). This center focuses on the production of ethanol, biodiesel, and vegetable coal. The biodiesel LPA is located in Montes Claros and tries to identify production arrangements and natural clusters that might stimulate and develop technical activities. The biodiesel LPA (Fig. 6) is able to organize the distribution of raw-material and involves different levels of production and several agents. The strategies of the biodiesel LPA are: a) formation of human resources through development of courses in three levels: reading and writing, technical, and

superior level (universities); b) development of the supply chain through research into the agro-chain and the complex system of the biodiesel chain to examine how they perform; c) products and co-products of the biodiesel chain. The basic objective is to aggregate value on products with the intent that farmers should not be hostages of biodiesel production. This is the reason for the diversification of products in order to aggregate value on production.

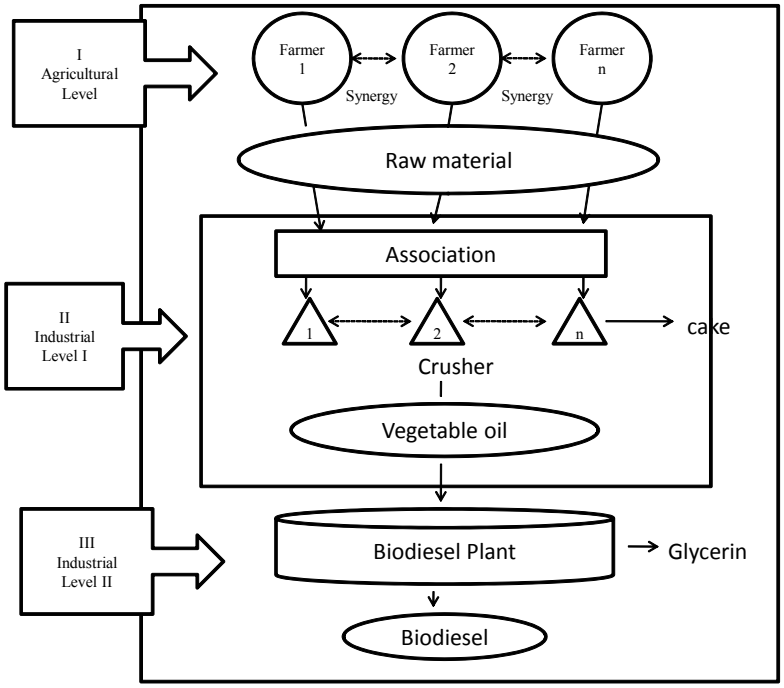

Figure 6. LPA to biodiesel plant
Adaptation from EMBRAPA/2009

4 The key obstacles that characterized the initial operation of the biodiesel chain

Building a new supply chain is a challenge and involves several agents as well as a complex mechanism of incentives and controls. The creation of Management Working Groups is relevant, since it is possible to bring together different agents to discuss and analyze local aspects of developing the biodiesel production system. The Management Working Group of Minas Gerais has evaluated some positive and negative aspects in implementing the biodiesel production system, considering as its main purpose the inclusion of family farmers into the biodiesel AGS.

The positive aspects of PNPB in Minas Gerais on behalf of family farmers are: a) a guarantee of markets for the local production of family farmers; b) the possibility of improving the income of low-income families; c) facilities for cultivating and trading oil plants; d) a minimum price guarantee; e) technical assistance; f) free transport of product to industry; g) free access to seeds for new crops; h) access to financial support; and i) regional development that changes the historical context of Minas Gerais.

Although positive aspects are observed, efforts from the biodiesel industry are necessary to convince and organize family farmers, since no spontaneous interest to engage in the network for biodiesel production is observed at the beginning. The key obstacle for implementation of PNPB in Minas Gerais is to organize the family farmers. Several family farmers are resistant to biodiesel program, and the reputation of the biodiesel industry is still nascent. On the other side, the biodiesel industry is in the process of learning how to work

with small farmers and it is necessary to understand local culture. In this sense, the informal mechanism to involve family farmers is involved while the formal mechanism might not have reached a level sufficient to support the production. Therefore, the institution transplant might not have been effective at the first stages of the governmental plan.

Some family farmers had negative experiences, such as difficulty in accessing seeds; delays in production collecting and payment; and difficulty in accessing subsidized loans. These negative aspects influenced the decision of some family farmers to discontinue the engagement in the program. The reason for the delays is the lack of family farmers' organization and consequently the presence of information asymmetry among the agents. No horizontal spontaneous forms of organizations such as cooperatives have been observed in the most-needed areas.

The difficulty in accessing funding loans from financial institutions is due to the large probability of contract breaches by family farmers that do not have social ties with banks or public agents of industries. In general, these family farmers have not fulfilled the promises and they cannot access funding loans from public programs such as the National Program for the Strengthening of Family Agriculture (PRONAF). Private mechanisms might arise for providing family farmers with opportunities to participate in biodiesel production. For instance, some biodiesel industries are motivated to supply the seeds, technical assistance, and coordinate all production. The reason biodiesel industries invest in family farmers is the acquisition of the "Social Fuel" seal, which brings tax reductions.

The lack of family farmers' organization results in difficulties for coordinating the biodiesel AGS. The family farmers are spread over a large region and consequently it is difficult to offer technical assistance and collect their production. Moreover, family farmers do not have power in negotiations with biodiesel industries. For this reason, a collective action would be important for future price negotiations and better conditions to participate in the biodiesel AGS.

The other aspect of concern for a sustainable program is the environment issue. The key obstacle observed in this aspect is related to property rights of land. According to BIOERG-SECTES, several family farmers do not have formal titles to their land. As a consequence, these farmers are not required to follow existing regulation related to environmental conservation, for instance legal reserve annotation of property. Legal reserve is a requirement for 80%, 50%, 35%, or 20% of land (depending on the region) to be set aside for conservation.

5 Key elements to be controlled in cases of transplant of models among different regions or countries

It is difficult to transplant a model among different regions or countries and it might gradually take on characteristics of the new environment. The transplant must take into account the characteristics of local institutions. Forms of organization and the institutional environment have a reciprocal relationship. The transplant of models provides evidence that organization forms and formal institutions can be effectively transferred from one environment to another; however, adaptation must be made to the new environment, so consequently informal institutions are considered.

The adoption of Agro-Chain System approach (AGS) for analyzing biodiesel production systems in different environment is possible, since the institutional environment is taken into account. Environment has a strong effect on organization forms and formal mechanisms might not be enough for implementing the PNPB in Minas Gerais. In addition to formal mechanisms, informal mechanisms might be a complement and the PNPB will adapt according to the local environment.

Considering the analysis of transplanting the PNPB to Minas Gerais, intensive work with family farmers is necessary to develop a network of suppliers to biodiesel industries. The technicians who will seek out and have contact with family farmers should know the local institutions. The organizational form of the biodiesel production system might change according to the characteristics of the new environment. Therefore, there is no static form of biodiesel AGS and the dynamic of agents must be taken into account for its analysis. For the involvement of family farmers in the biodiesel AGS their organization is necessary, and it might be possible through collective action.

The trade union movement is important for organizing family farmers and for increasing their power for price negotiation. Furthermore, this movement builds a network of suppliers, coordinates the production, and consequently transaction costs are reduced.

This introductory study also suggests that the Brazilian biodiesel program is yet to reach its maturity, being subject to several obstacles. Therefore, the idea of transplanting its design to other countries is a matter for definitive and deep prior analysis.

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