

Building Supply Systems from Scratch: The Case of the Castor Bean for Biodiesel Chain in Minas Gerais, Brazil

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ABSTRACT

The present study contributes to identifying obstacles to the development of a local biodiesel agro-industrial system (AGS) in the state of Minas Gerais, Brazil. The research questions are: “How do local social characteristics influence the organizational effectiveness of agents involved in the joint production effort?”; and “How can the institutional arrangement of biodiesel production be described?” The method adopted is the case study, focused on family farmers served by the Family Farmers Rural Extension and Technical Assistance Company (EMATER). This state organization introduced castor beans (*Ricinus communis* L.) to family farmers as an alternative crop to supply a processing plant (Darcy Ribeiro Biodiesel Plant—DRBP) in northern Minas Gerais state, Brazil. These family farmers are not horizontally organized, and sign individual contracts with DRBP. The paper concludes that the primary obstacle to developing the biodiesel AGS with castor beans in Minas Gerais is the lack of horizontal organization among family farmers.

Keywords: Biodiesel production system; Agro-industrial System (AGS); Institutional Arrangement; Castor bean; Minas Gerais, Brazil; Family Farmers

JEL: D23; O13; Q163

1 Introduction: A model induced by regulation

Governmental policies aimed at promoting development in rural areas are usually directed at introducing new agro-based production systems. This is the case with biodiesel production in Brazil, which tries to engage family farmers through a governmental regional development program. Since this intervention is not an exception, and both successes and failures have been observed, the present study aims to identify the obstacles to the development of biodiesel AGS in traditional rural communities.

The regulation of biodiesel in Brazil is based on a Federal Law^{*} that introduced biodiesel into the Brazilian energy matrix and authorized its voluntary addition to diesel petrol starting in 2005. In 2008 the biodiesel mix became mandatory, and its proportion in the blend offered on the market is 5% as of 2010. The National Program for the Production and Use of Biodiesel (PNPB)[†] was established in order to originate a sustainable chain of biodiesel production and use. It has since incorporated a number of new features so as to become sustainable and enhance family farmers' income. Just as important to the program's agenda as the environmental aspect are family farmers' inclusion and local development mechanisms. The program aims to promote the production of non-traditional oil crops in regions with chronic development

^{*} Federal Law nº 11,097/05, approved by the National Congress on January 13th, 2005.

[†] PNPB is the acronym of Programa Nacional de Produção e Uso do Biodiesel. The PNPB was created in December 2004 in order to implement a sustainable form—in techniques and economics—of production and use of biodiesel.

problems. At the same time, it sets goals through the mandatory inclusion of biodiesel into the energy matrix.

The inclusion of family farmers in the biodiesel production system is not a spontaneous event. The main incentive to facilitate family farmers' inclusion in this system is the "Social Fuel Seal" promoted by the Ministry of Agrarian Development (MDA).[‡] This certification enables the biodiesel industry to obtain tax benefits and participate in the auctions organized by Brazil's National Petrol Agency (ANP);[§] however, they must agree to purchase a minimum percentage of feedstock from family farmers in order to participate in the program. On the other hand, family farmers receive incentives from the biodiesel industry—such as technical assistance, supply of seeds, and crop transportation—to participate in the biodiesel production system. Although there are regulatory incentives, local social characteristics play an important role in the institutional arrangement of biodiesel production. This study addresses the following questions: (i) How do local social characteristics influence the organizational effectiveness of agents involved in the joint production effort? (ii) How can the institutional arrangement of biodiesel production be described?

This study analyses the introduction of the biodiesel agro-system as an alternative for farmers based on organizational elements, by examining the institutional arrangement of biodiesel production involving family farmers, considering the initial operation in a region with no previous history of biodiesel production. In this study we adopt the concept of an institutional structure of production that explains the manner of organizing the transactions. The concept is based on Coase (1992) and Williamson (1996). The local social characteristics, such as culture and tradition, are taken into account in order to explain how they influence the start-up phase of local biodiesel production.

The Agro-industrial System (AGS) approach is adopted as an analysis tool to be applied to the biodiesel system. The AGS is analyzed under a systemic view and evaluates the relationships among the agents, also considering the importance of the institutional and organizational environments 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. To understand how the biodiesel chain's agents organize their production system, one has to consider the influence of local institutions, besides the formal ones. A Transaction Cost Economics (TCE) approach is applied, since the transaction is the basic unit of analysis (Williamson 1985).

The present paper is organized in six parts. Following the introduction, Part 2 presents an overview of the biodiesel AGS in the state of Minas Gerais and the castor bean family farmers' transactions. Part 3 describes the theoretical framework. Part 4 presents the methodology applied in this study. Part 5 points out the key elements related to the development of new agro supply chains in the case of the biodiesel AGS in the state of Minas Gerais. Part 6 concludes and outlines the key obstacles that characterized the start-up operation of the biodiesel chain.

2 The castor bean based on biodiesel AGS

The National Program for the Production and Use of Biodiesel (PNPB) was established at the national level in 2005, but local institutions should be considered, as the effectiveness of the program might differ from region to region. According to Ostrom (2008a), for large countries, rules that are appropriate in one region are rarely effective in another.

The biodiesel project in Minas Gerais has been developed since 2003 as a local development program coordinated by the state's Secretariat of Science, Technology and Higher Education (SECTES).^{††} Although the local government had begun an initiative to develop biodiesel prior to 2005, significant production impacts were not observed until 2009, when a new Petrobras processing plant, the Darcy Ribeiro Biodiesel Plant (DRBP), commenced operation in Montes Claros municipality. Table 1 shows that the production of biodiesel differs among regions. The main Brazilian biodiesel production regions are Rio

[‡] MDA is the acronym of Ministério do Desenvolvimento Agrário. In 2004, the MDA started establishing the regulation of the "Social Fuel Seal".

[§] ANP is the acronym of Brazil's Agência Nacional do Petróleo, which regulates the biodiesel market and approves biodiesel companies' operation and biodiesel marketing.

^{**} The minimum percentage of feedstock purchased from recognized family farmers to be eligible for the Social Fuel Seal is as follows: North and Mid-west: 15%; South-east, North-east, and Semi-arid: 30%; South: 35% (harvest of 2012/2013) and 40% (harvest of 2013/2014). (MDA, 2012)

^{††} SECTES is the acronym for Secretaria de Estado de Ciência, Tecnologia e Ensino Superior.

Grande do Sul, Mato Grosso, and Goiás, due to the large regional specialization in soybean production, the main feedstock for biodiesel.

Around the world, biodiesel has been mainly produced from edible vegetable oils, such as soybean, coconut, and palm, and thus may compete with food supply in the long-term (Encinar et.al., 2012). However, the PNPB promoted the diversification of feedstock away from the soybean and the development of the Brazilian northeastern and semi-arid regions (Brazil, 2005). The semi-arid regions comprise 11 Brazilian states, nine in the Northeast and two in the Southeast (Espírito Santo and Minas Gerais). In particular, production in Minas Gerais was insignificant in 2005, and its increase by 2009 was due to the launch of DRBP (table 1).

Table 1.
Biodiesel Production – B100 – in cubic meters

State	2005	2006	2007	2008	2009
Bahia	-	4,238.135	70,941.993	65,982.132	79,940.850
Ceará	-	1,956.2	47,276.165	19,207.526	49,153.503
Goiás	-	10,107.972	110,638.065	241,364.097	268,701.549
Maranhão	-	-	23,508.648	36,172.289	31,194.889
Mato Grosso	-	13.4	15,170.057	284,922.771	367,008.539
Mato Grosso do Sul	-	-	-	-	4,367.208
Minas Gerais	43.82	310.5	138.164	-	40,271.182
Pará	510.4	2,420.9	3,716.76	2,625.248	3,494.354
Paraná	25.57	99,5	12.1	7,294.371	23,681.277
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	454,189.287
Rio de Janeiro	-	-	-	-	8,201.079
Rondônia	-	-	99.175	227.646	4,779.355
São Paulo	-	21,251.395	36,885.267	185,594.154	236,302.001
Tocantins	-	-	22,772.705	13,134.566	33,547.442
Brazil	736.159	69,001.981	404,329.14	1,167,128.415	1,610,457.417

Source: ANP 2012

The introduction of the DRBP biodiesel plant in Montes Claros, with a production of 108 million liters per year, is intended to function as an alternative source of income for farmers in the northern region of Minas Gerais. This state has the second-highest number of family farmers among Brazilian states, amounting to 437,415 individuals occupying a total area of 8,845,883 ha (IBGE, 2006). The concept of the family farmer is defined in Federal Law n° 11326, July 24th, 2006, article 3: a family farmer is a person engaged in farm activities in an area no larger than 4 modules;^{††} the farm activities are predominantly performed by family members; the family income predominantly results from activities linked to the farm; and the farm activities are managed by family. Because the National Program for the Production and Use of Biodiesel (PNPB) focuses on family farmers and the diversification of biodiesel feedstock, DRBP took into account a new attempt to motivate family farmers to cultivate castor bean in the north of Minas Gerais. Moreover, DRBP must purchase feedstock from family farmers in order to receive the Social Fuel Seal.

The role of the Social Fuel Seal is to promote the social inclusion and diversification of the regions producing biodiesel. This certification is awarded to biodiesel companies that meet the following

^{††} The tax module is measured in hectares and differs in each region as follows: North: 5 to 100 ha; Northeast: 5 to 90 ha; Southeast: 5 to 70 ha; South: 5 to 40 ha; and Mid-West: 5 to 110 ha. In the state of Minas Gerais, located in the Southeast region, the minimum size of one tax module is 5 ha and the maximum is 70 ha (IBGE, 2006). Hence, the size of a family farm in Minas Gerais ranges from 5 ha to 280 ha.

requirements: (a) acquire a minimum percentage of feedstock from family farmers; (b) enter into contracts with family farmers establishing deadlines and conditions of delivery of feedstock; and (c) provide technical assistance to the farmers. For the latter requirement, the biodiesel company must supply its own technicians or contract specialized services (MDA, 2012). In the case of Minas Gerais, DRBP signed contracts with different institutions for technical assistance, such as the Rural Extension and Technical Assistance Company (EMATER), Institute of Labour in Family Farm (ITAF), Pioneira Agricultural Cooperative (Cooapi), São Francisco Small Rural Producers Agricultural Cooperative (Coopaf), and Grande Sertão Cooperative. Prior to providing technical assistance, these institutions seek out the family farmers, organize meetings in which DRBP establishes its objectives, and invite the family farmers to be their partners.

The Brazilian government has chosen castor bean to promote social development in the Brazilian northeastern region (Campos and Cornélio, 2009; César and Batalha, 2010). Castor bean cultivation, unlike soybean, is mainly based on labor-intensive technologies in plots averaging two hectares. Castor bean is used as an alternative feedstock for the biodiesel industry, one that cannot be used for animal or human food since it contains the toxic protein ricin (Berman et.al., 2011). Worldwide, castor bean is available at low cost and is grown on marginal lands which are typically unsuitable for food crops (Berman et.al, 2011). Castor bean was identified as the ideal oilseed to be developed under adverse climate and soil conditions, such as those found in northern Minas Gerais (IICA, 2007). Moreover, the agricultural zoning⁵⁵ for this region has been designated for castor bean by the Ministry of Agriculture, Livestock, and Supply (MAPA). All these features make castor bean an attractive alternative biodiesel feedstock.

DRBP has motivated local family farmers to grow castor bean in order to participate in the biodiesel production system. Nevertheless, castor bean production by family farmers in northern Minas Gerais is hindered by prior negative experiences. In the 1990s, a processing plant for castor bean was installed in Minas Gerais, motivating local family farmers to engage in the activity. Family farmers planted about 20,000 ha of castor bean, but the processing plant did not fulfill its commitments with the families, resulting in substantial economic losses for them (Silva and Perez, 2011).

According to César and Batalha (2010), in northern Minas Gerais there is a weak culture of collective action. In general, there are several problems facing these family farmers, such as geographical dispersion; limited access to financial loans; and low adoption of chemical inputs as fertilizers. This condition is the result of low education and economic levels, as observed by Silva and Perez (2011). Besides the problems facing family farmers, oilseeds that do not have extant structured supply chains, such as castor bean, face coordination failures in their different stages of production—agriculture, industrialization, and distribution—as noted by Padula et al. (2012).

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. There are two levels of mechanisms to involve family farmers in biodiesel production: 1) informal mechanisms that engage local institutions in establishing long-term relationships between the social agents in order to organize local coordination; 2) formal mechanisms, which are contracts between family farmers and biodiesel companies, in accordance with PNPB. The former is the first approach to involve family farmers, and it is founded on agreements to produce castor bean that are based on trust between family farmers and technicians. The latter mechanism comes after the agreement, and is based on contracts signed between family farmers and the biodiesel company.

In this study we focused on family farmers organized by EMATER. The role of EMATER is to foster the organization of family farmers and provide them with technical assistance for planting and handling crops. Before EMATER starts providing technical assistance to family farmers, a process is followed to approach and involve them in the biodiesel program. First, EMATER contacts the association to introduce the biodiesel program. Next, EMATER's technicians visit the family farmers to motivate them to grow castor bean. Those family farmers interested in growing this new crop sign a letter of adhesion. Nonetheless, the letter of adhesion does not guarantee the participation of family farmers in the biodiesel program. Only when the family farmer signs a contract with the biodiesel industry is the participation formalized. The contract to supply castor bean to the biodiesel industry is performed with each family farmer individually.

Every transaction between a family farmer and DRBP is mediated by EMATER. Moreover, family farmers' representatives participate in the agreements between family farmers and biodiesel industry (MDA,

⁵⁵ Agricultural zoning is based on agronomic research from the Brazilian Research Corporation (EMBRAPA) that identifies climate risks, especially the lack of water during the critical stages of crops, and the best planting dates. Northern Minas Gerais has been identified as an agro-climatic zone for castor bean production and technical assistance has been developed for growing this crop. Hence, farmers from northern Minas Gerais that cultivate castor bean and follow technical guidance can apply for subsidized credit and participate in the PNPB.

*** MAPA is the acronym of Ministério da Agricultura, Pecuária e Abastecimento.

2012). In this sense, EMATER has the role participating in the agreements. DRBP offers incentives to family farmers based on a contract. The company offers technical assistance (EMATER), defines the price, and provides the bags for castor bean storage and transport to the plant.

The contract signed between DRBP and EMATER stipulates that EMATER technicians will visit each farmer four times. The first visit is to encourage the family farmer to join the biodiesel program; the second is to supply castor bean seeds to the family farmers; the third is to monitor and evaluate castor bean production; and the fourth is to coordinate, harvest, and transport the castor bean production. In practice, EMATER's technicians visit family farmers more than four times, since information exchange and crop improvement are constant. Consequently, the trust relationship between family farmers and EMATER technicians has been established. The castor bean family farmers transact with DRBP individually (figure 1).

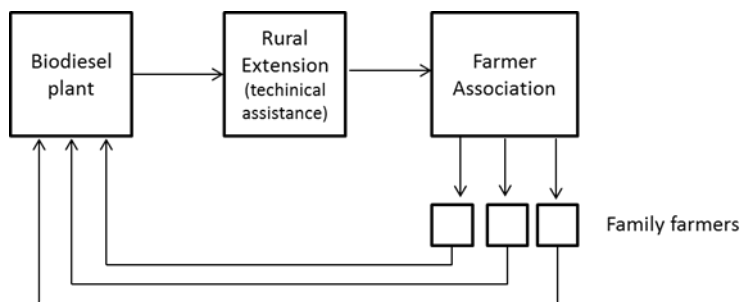


Figure 1. Process for contracting family farmers through rural extension (EMATER)

Source: Adapted from Watanabe, et. al., 2011

Initially, DRBP signed a contract with EMATER in 2007 in order to have feedstock from family farmers for the start of biodiesel production in 2009, and the goal was to involve 15,130 family farmers in castor bean production. However, in 2008–2009, only 8,675 family farmers were interested in participating in the biodiesel program and signed the letter of adhesion, and just 4,147 of these actually signed the contract. In 2009–2010, the number of family farmers interested in the biodiesel program decreased to 2,800, and the number of signed contracts was 2,462. The reason for this decrease was due to mistrust of DRBP. In the beginning of the contacts between EMATER's technicians and family farmers, the provision of fertilizer and other soil improvements were offered by DRBP. However, DRBP failed to fulfill these agreements, resulting in a decrease of family farmers involved in castor bean cultivation.

3 Organizing agro-based supply chains: a conceptual model

The Agro-industrial System (AGS) approach is applied as an analysis tool. Studies based on AGS have been done in different production systems, such as coffee (Zylbersztajn and Farina, 2001); wheat (Rossi et.al, 2005); sugar cane (Neves and Conejero, 2007); and beef (Mondelli and Zylbersztajn, 2008). The present study, focused on the production of biodiesel, also employs a systemic view for analysis. The production system is a strictly coordinated supply system (Zylbersztajn and Farina 1999) when the degree of asset specificity is high; the concept of strictly coordinated supply systems is dependent on cooperation and/or hierarchical power. Different agents in biodiesel production systems are connected, and a leading firm assumes the coordination role. In our study, we identified DRBP and EMATER as the agents that assume the coordination of the supply system, and DRBP monitors EMATER, since the contract is established by the former.

Considering the case of the biodiesel production system in Minas Gerais, DRBP enters into contracts with family farmers in order to maintain its "Social Fuel Seal". The contracts guarantee the purchase of feedstock from the family farmers. Despite the fact that the analysis is from a system perspective, the selection of agents is related to each transaction of the system. In this study, we focus on transactions that involve family farmers who produce castor beans to supply DRBP. The transactions in the complex agro-industry system are not necessarily static and linear: for instance, the biodiesel industry can supply family farmers with inputs and purchase their production.

Given that the biodiesel AGS in the state of Minas Gerais is a new process, a complex agro-industrial system might arise. Complex forms of governance in the agriculture field involve contracts for vertical and horizontal coordination. Lazzarini et al. (2001) introduced the concept of netchain analysis, which studies interdependence in networks. "Network" is a general term that encompasses all arrangements involving a

set of recurrent contractual ties among autonomous entities (Ménard, 2004). According to Zylbersztajn (2000), among the elements required to develop the study of complex agro-industrial systems are: key features of agents involved in the production, the industrial organization of the chain's sectors, the organizational and institutional environments, and the characteristics of the transaction involved in the cooperative production efforts. We consider the transaction to be the principal unit for analysis within a production system.

Figure 2 summarizes our theoretical framework, which presents the transactions with castor bean family farmers in the biodiesel production system and the institutional and organizational environment.

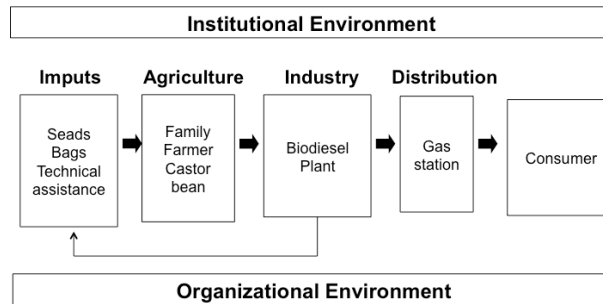


Figure 2. Biodiesel production system
Source: Adapted from Zylbersztajn (1995)

The efficiency of an economic system depends on how agents conduct their affairs. The agents are organized based on the institutional arrangements that govern the process of exchange. The seminal article by Ronald Coase (1937), *The Nature of the Firm*, amplifies the traditional theory of the firm to consider contract-based organizations instead of the firm as a production function. Besides the pricing mechanism, transaction costs are considered in evaluating different alternative governance modes (Williamson, 1996), since economic agents align transactions with governance structures to effect economizing outcomes. Transaction Cost Economics (TCE) considers the ex-ante costs of negotiation efforts, contract design, and safeguarding of agreements, and the ex-post costs of adapting the contract to unexpected situations (Williamson 1985).

The choice of institutional arrangements—market, hierarchy, or hybrid form—depends on economizing the transaction costs (Williamson 1991, Williamson 1996). The market form is the arrangement wherein autonomous parties exchange products or services without previous planning. The hierarchy form exists when transactions are placed under unified ownership and all activities are internalized. The hybrid form is a long-term contractual relationship that preserves autonomy but provides added transaction-specific safeguards. According to Williamson (1979, 2005), there are three characteristics of transactions that affect the choice of institutional arrangement: asset specificity, uncertainty, and frequency.

The main transaction characteristic developed by Williamson was asset specificity, which is related to the specific investments involved in a transaction. This transaction characteristic results in a bilaterally tied transaction, because specific investment in a transaction creates a dependency relationship. For instance, if a specific product requires special equipment for its production, which cannot be easily substituted (physical asset specificity), the institutional arrangement will be conducted according to a hybrid or hierarchy form. In other words, a specific investment cannot be replaced with another transaction without value loss.

In terms of transaction frequency analysis, there are different frequency levels that influence the trust among the transaction participants. If the transaction is more frequent, reputation among the participants will increase, in turn constraining opportunistic behavior such as contract breach. The role of transaction frequency is related to trust building and reduction of information asymmetry, which can affect the agents' efforts to transact, and enables the design of a less detailed contract; consequently, transaction costs decrease.

The transaction characteristic of uncertainty is related to information asymmetry, demanding greater effort from agents in the transaction. The role of uncertainty varies according to the choice of transaction. For instance, bilateral contracts fall within the hybrid form, and the adaptation of the transaction requires agreement from both parties. In both market and hierarchy organizations, decisions are taken unilaterally. Hence, uncertainty is determinant for institutional arrangement choice. Further, the transactions are part of an institutional environment, and institutions arise to reduce uncertainty and to facilitate the transactions (North 1990, 1991).

3.1 Organizational and institutional environments

Organizational environments involve agents who indirectly participate in the production system and play an important role in facilitating the transaction. The institutional environment represents both formal and informal institutions. North (1990, 1991) describes institutions as the rules of the game, encompassing 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 create a favorable environment for decision-making. The purpose of North's analysis (1990) concerns the interaction between institutions and agents in the process of choosing organizational structures. Institutions are instrumental in the analysis of how organizations are set up, but traditional price theory and production functions are not designed to explain institutional arrangements. In order to better understand both institutional and organizational environments, we describe them in the following two subsections.

3.1.1 *Institutions' dynamics and connection to institutional arrangement*

Formal and informal institutions form the institutional environment. These institutions provide a set of incentives and disincentives for the individual, and arise and evolve because of the interaction of individuals (Williamson 1996). For the purposes of this study, the institutions are focused on the biodiesel production system in Minas Gerais State. Formal institutions are those regulated by the State, such as the Brazilian Biodiesel Program (PNPB), the Social Fuel Seal, and so on. Informal institutions we considered include local traditions, family farmers' beliefs, local rules, and agreements.

Institutions evolve internally in the context of the local environment with which the individual frequently interacts (Ostrom 2008 b). Although the PNPB applies to all of Brazil, it is not followed or even known by many family farmers. According to Ostrom (2008b), the rules established by the State are not able to meet all personal expectations, so informal rules arise. Moreover, local rules might achieve a higher performance rate than systems where the rules are entirely determined by external authorities.

According to Eggertsson (1990), government regulation induces specialized investments and motivates long-term contracts, because they are guaranteed by the state. However, in the absence of government regulation, private rules arise in order to guarantee property rights. From another perspective, economic rights and legal rights are considered. According to Barzel (2002 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." Based on the evolution of institutions, initially, individuals have no legal rights over the assets they acquire because no legal institutions exist (Barzel 2002). Therefore, economic rights can exist in the absence of legal rights.

The challenge for building the biodiesel AGS in the state of Minas Gerais is to attain efficiency while also considering environmental and social issues. Social aspects are relevant for AGS analysis in cases when informal institutions explain the observed institutional arrangements. According to Zylbersztajn (2009), data collection of contracts only capture a part of the incentives present in most of the institutional arrangements, and informal incentives such as agreements should be considered.

It is important to consider the impact of environment on the formation of an institutional arrangement. Biodiesel in Minas Gerais is a new process, and the institutional arrangement is still evolving. The role of the social structure can influence either individual or collective behavior and performance. Granovetter (1985) uses the term "embeddedness" to explain how social relations affect the behavior of economic agents and institutions. In other words, social ties embed individuals, and a network of interpersonal relationships is built. The embeddedness argument considers the role of personal identities and the structures of the relations that create trust and control opportunism. The concept of environmental embeddedness is therefore relevant to the development of new agro-industrial systems, such as the biodiesel system. Embeddedness can form strong effects when the relationships last. In such cases, effort incentives, trust, and reciprocity play a role.

3.1.2 *The organizational environment*

The organizational environment is composed of agents that indirectly participate in the production system. These agents are important for the operation of production, since they facilitate the transactions. In this sense, educational and research institutions, financial institutions, and other agents are all part of the organizational environment. In terms of biodiesel production, local institutions exist to coordinate production, which involves several operations before signing of the contract, such as convincing the family farmers, organizing them, supplying technical assistance, providing loans for production, and so on. The coordination is structured with the creation of Management Working Groups, and it 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). Based on Poulton et al. (2010), the organizations are intermediary institutions that facilitate coordination between small farmers and service providers.

The reason for creating an organization is due to factors such as minimizing transaction costs, providing conflict solutions, reaching the scale of production, and altering the rules of the game in favor of the participants (Saes, 2000). Therefore, organizing family farmers means attaining economies of scale and reducing transaction costs, which is beneficial for both family farmers and biodiesel companies. By working through family farmer's organizations, biodiesel companies can reduce costs on seeking out the farmer's production and delivering services to them. On the family farmers' side, they can bargain and enforce the agreements with companies through their organization.

The organizational environment can influence the level of transaction costs (Zylbersztajn, 1995), and must be taken into account to understand the choice of different institutional arrangements. For instance, transactions between biodiesel companies and family farmers organized into cooperatives are performed directly through the cooperative, whereas in cases where the family farmers are instead organized in an association, they transact directly with biodiesel company.

The State Secretariat of Science, Technology and Higher Education (SECTES) is part of the organizational environment, since it coordinates the Mineiro Biodiesel Program. Research institutions, such as the Brazilian Agricultural Research Corporation (EMBRAPA) and the Agricultural Research Corporation of Minas Gerais (EPAMIG), are part of the organizational environment as well, because they develop research focused on oleaginous plants used for biodiesel production.

In our study, EMATER is part of the organizational environment because it facilitates the transaction between family farmers and DRBP. Prior to providing technical assistance, EMATER seeks out the family farmers, organizes meetings in which DRBP establishes their objectives, and invites the family farmers to be part of the biodiesel program. In the case of promoting castor bean in the biodiesel program, EMATER technicians approach family farmers through local associations. These associations are part of the organization environment as well, providing family farmers with opportunities to participate in different development programs, such as the biodiesel program (PNPB).

The organizational environment consists of several agents that support family farmers in their production and transaction activities. Besides the agents described above, others that are part of this environment include financial institutions, farmer unions, bargaining associations, and marketing cooperatives. The organizational environment affects both production and transaction conditions, and therefore affects the choice of institutional arrangements.

The organizational and institutional environments play an important role in the selection of institutional arrangements to minimize transaction costs. In this study we used TCE for a static model analysis through the data collection over a certain period. However, in order to explore the dynamic perspective to understand how the biodiesel production system in Minas Gerais might evolve, other perspectives of analysis could be applied, such as the evolutionary perspective that arose with the studies of Penrose (1959), and property rights (Demsetz, 1967; Barzel, 1994, 1997). The Resource-Based View (RBV) theory that is related to the analysis of potential value creation can be adopted as well. Foss and Foss (2005) examined the relationship between RBV and transaction costs. Fowler and Zylbersztajn (2012) explored the relationship between property rights and RBV.

4 Methodology

The case study method has been chosen for the analysis, adopting the agro-industrial system (AGS) approach. The purpose of the case study method is theoretical generalization rather than statistical generalization, and it is well accepted in social sciences (Yin, 1989; De Vaus, 2001). A qualitative and exploratory study was carried out to analyze the complex institutional arrangements within the formation of a biodiesel production system involving family farmers in Minas Gerais.

Direct observations were made during the years 2009 and 2010 in northern Minas Gerais (figure 3). The period of our visits was the start of biodiesel production in the municipality of Montes Claros, since PETROBRAS, an open capital company controlled by the Brazilian Government, opened a new processing facility, the Darcy Ribeiro Biodiesel Plant (DRBP), in 2009. PETROBRAS selected Montes Claros because it is the main urban center of northern Minas Gerais. Moreover, Minas Gerais is home to a large number of family farmers, particularly in the north of the state.

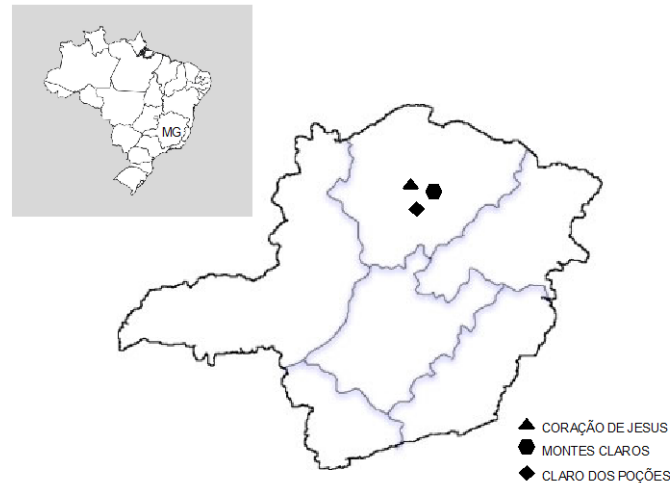


Figure 3. Map of Minas Gerais and research areas

The first visit to Minas Gerais was in July of 2009, to obtain an overview of the biodiesel production system and to contact the stakeholders involved. This visit focused on the identification of the main agents involved in biodiesel production in Minas Gerais and the understanding of how they had been organized to implement the biodiesel program. The second visit was in November of 2009, to Darcy Ribeiro Biodiesel Plant (DRBP) in Montes Claros, to obtain information about the castor bean-producing family farmers and learn about the transactions between them and the DRBP. The last visit took place in April of 2010 in three municipalities: Montes Claros, Coração de Jesus, and Claro dos Poções.

Direct personal interviews using three different semi-structured questionnaires were applied respectively to three groups: family farmers, biodiesel industry representative from DRBP, and transaction facilitators (EMATER technicians). In total, 38 stakeholders were interviewed: 29 family farmers, 1 DRBP representative, and 8 transaction facilitators. Due to the difficulties accessing the family farmers, the EMATER technicians facilitated the approach to every family farmer that answered the questionnaire. The visit to these three municipalities provided information about the castor bean family farmers assisted by EMATER. In addition to visiting family farmers, visits were made to both DRBP and the EMATER office located in Montes Claros.

The interviews were organized in order to identify the agents and the detail about the transactions each performs to implement the biodiesel program in Minas Gerais. Moreover, we focused on the information about family farmers supplying DRBP. For this paper, we considered those family farmers organized by EMATER. The main criterion for selecting a case study focused on castor bean farmers was because the Brazilian government has chosen this crop to promote social development in the northern and semi-arid regions of the country, such as northern Minas Gerais (Campos and Cornélio, 2009; César and Batalha, 2010).

The choice of EMATER is justified since this institution plays a key role in the governmental strategy and reaches a wide number of family farmers in northern Minas Gerais to organize them to produce castor bean. EMATER Minas Gerais was created in 1975 to work both actively and in operational planning, especially in developing outreach programs for family farmers. Its technicians are trained to exchange information for improving family farmers' conditions and production quality. Moreover, EMATER includes family farmers that are part of an association in programs that generate employment and income.

During the visits to Minas Gerais we used direct observations to understand the production and transaction system, and collected secondary data in interviews. Through the information obtained during these visits, we present a description of castor bean family farmers that supply DRBP, and analysis of the start-up phase of the complex agro-based systems based on our theoretical framework.

5 Transactions of biodiesel AGS using castor bean in Minas Gerais

Based on the interviews given to the agents involved in the biodiesel production system in Minas Gerais, the following statements were observed. The social ties in the biodiesel system in Minas Gerais are weak since it is a new system, still being formed. The agents do not always have previous social relations; hence, mutual reputation and trust are in a process of construction. Although there exists a national biodiesel program determined from top to bottom, local institutions must be taken into account in constructing it. Hence, family farmers do not immediately adopt written contracts to introduce a new oil crop. Rather, an agreement is first made between the family farmers and EMATER technicians, and then the contract between family farmer and DRBP is signed. The agreement is mainly based on trust that family farmers place in EMATER technicians.

Although the family farmers coordinated by EMATER are collectively organized in an association, they do not show a strong collective organization as we have observed in some Brazilian cooperatives, such as Coopi and Coopaf. This association has different purposes than cooperatives and its regulation is different. The former is an organization whose purpose is to promote social, educational, or cultural assistance, whereas the latter has economic purpose. These differences determine the way in which family farmers transact with DRBP. In terms of family farmers collectively organized into cooperatives, a single transaction would involve a large number of family farmers. Unlike family farmers affiliated with cooperative, the castor bean family farmers transact with DRBP individually.

We analyzed the transactions between castor bean family farmers and DRBP, according to the elements proposed in the theory. The following transaction characteristics (Williamson, 1979, 2005), such as asset specificity, were observed:

- 1) DRBP must transact with family farmers. Therefore, the industry provides some incentives, such as technical assistance, purchase guarantees, free bags for holding the crop, and transportation support (minimum of 2,000 kg).
- 2) For castor bean producing family farmers, DRBP represents an exclusive market. Furthermore, the castor bean is considered toxic and it cannot be used to feed animals or human beings. Therefore, family farmers are tied to DRBP and more exposed to opportunistic behavior on the part of the buyer.

Every transaction between a family farmer and DRBP is intermediated by EMATER and, in terms of transaction frequency, the following aspects were observed:

- 1) DRBP and EMATER entered into a formal contract, under which technicians must visit each family farmer four times. However, EMATER's technicians visit family farmers more than four times for information exchange and crop improvement. Because the trust relationship between family farmers and EMATER technicians is already established, a number of family farmers cultivate castor bean and continue doing so.
- 2) The frequency of transactions between family farmers and DRBP is not constant, since EMATER intermediates these transactions. The relationship and trust between family farmers and DRBP is still under construction. Family farmers do not trust DRBP because DRBP has breached some agreements, such as that for the provision of fertilizer and other soil improvements. There is no law that requires these incentives for family farmers and DRBP only made agreements with family farmers, without signing any contract. Even though there is no contract, there were verbal agreements that have not been fulfilled, what makes it difficult for EMATER to convince family farmers to cultivate castor bean.

In terms of uncertainty in the transactions between family farmers assisted by EMATER and DRBP, we observed the following:

- 1) As DRBP initially did not fulfill the agreements, EMATER has difficulty for convincing the family farmers to produce castor bean.
- 2) On the other hand, some family farmers also fail to fulfill the agreement for cultivating castor bean. Initially, a number of family farmers were motivated to cultivate castor bean and signed the letter of adhesion. However, because DRBP did not fulfill the agreement to supply fertilizer and provide other soil improvements, some family farmers breached the agreement and did not sign the contract. In these cases, the family farmers receive a private punishment, since they are excluded from supplying the DRBP the next time.

Firstly, the relationship between family farm and biodiesel industry resulted in agreements based on informal institutions. These agreements are related to letters of adhesion and verbal agreements for providing certain inputs, which are not required by law. As the relationship between family farmers and

DRBP is under construction, reputation is low and agreements can be breached. Insofar as social relations are established between family farmer and biodiesel industry, the former accepts to produce a new oil crop and the written contract is performed. The reason for this is the fact that the social relationship provides reputation and, consequently, the decrease in transaction costs to perform a written contract. Moreover, the agreements enforced by informal institutions (social norms) are replaced by the contract, which is enforced by law (Eggertsson, 1990; Barzel, 2002).

The process whereby EMATER approaches the family farmer is developed through four steps. We observed that the first and second steps are part of building the social relationship, related to the concept of embeddedness (Granovetter, 1985). The first step is when EMATER contacts the farmers' association to introduce the biodiesel program, and the second is when EMATER's technicians visit family farmers to convince them to grow a new crop. The third step describes the situation wherein property rights are not perfectly protected and the formal institutions are weak; consequently, informal institutions prevail. Informal rules play a relevant role in convincing family farmers to grow oleaginous plants, and agreements are undertaken. The fourth step is when the family farmer signs the written contract with the DRBP. At this stage, the transaction is based on formal institutions.

Because the Social Fuel Seal program stipulates that the biodiesel industry must purchase feedstock from family farmers and provide technical assistance, free storage bags for castor beans, and transportation support, the transaction is organized in hybrid form. Hence, the relationship between family farmers and DRBP is first based on informal institutions or economic rights (Barzel, 2002), and organized in hybrid form—agreements. As trust increases, a contract is signed by the family farmer to provide castor bean to DRBP, and the transaction is organized in hybrid form—contract (figure 4).

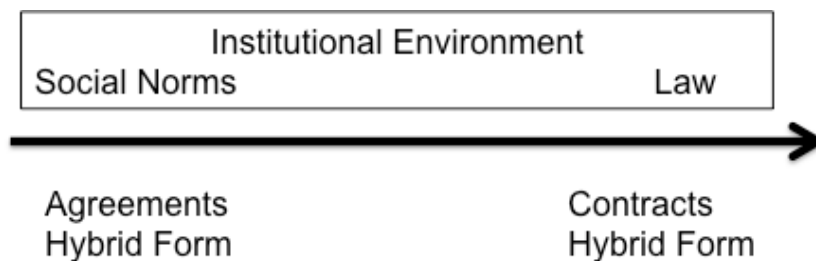


Figure 4. Institutional environment and hybrid forms.

6 Conclusion

Castor bean cultivation is mainly done by hand and in small areas of, on average, two hectares. Moreover, this crop is appropriate for adverse climate and soil conditions, such as found in northern Minas Gerais. However, the weak relationship between family farmers and the biodiesel industry might affect the decision to engage in the production of castor bean. A family farmer's decision to cultivate castor bean is not immediate. Negative experience with castor bean cultivation in the past was observed to have a negative influence on family farmers' decisions about cultivating the crop again. Other hindrances to the introduction of castor bean are related to soil conditions, weather conditions, and local culture. In terms of culture, most family farmers in northern Minas Gerais raise cattle and believe castor beans are poisonous for their livestock.

On the part of the biodiesel industry, more efforts are necessary to convince small farmers to produce a new crop for 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. Considerable effort from EMATER technicians is required to convince family farmers to grow this crop.

The key measure for implementation of PNPB in Minas Gerais is to organize the family farmers. The castor bean producers who supply DRBP do not have a tradition of collaborating in collective action. Several family farmers are resistant to the 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 for it to understand local culture. In this sense, the informal mechanism to involve family farmers is employed, while the formal mechanism might not have reached a level sufficient to support the production.

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 all influenced the decision of some family farmers to discontinue their 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 areas where they are most needed.

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 their promises and cannot access funding loans. The lack of organization of family farmers results in difficulties 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, collective action would be important for future price negotiations and better conditions to participate in the biodiesel AGS.

Based on the analysis of the introduction of the PNPB to Minas Gerais, intensive work with family farmers is necessary to develop a network of suppliers to the biodiesel industry. The technicians who are to seek out and have contact with family farmers should know the local institutions. For family farmers to be involved in the biodiesel AGS, it is necessary for them to be organized, which might be possible through collective action. This introductory study also suggests that the PNPB has yet to reach its maturity, being faced with several obstacles.

Considering that in order for the DRBP to participate in the Social Fuel Seal Program it must purchase feedstock from family farmers, the institutional arrangement cannot be a vertical integration. Because the DRBP must provide family farmers with technical assistance, free bags to store castor beans, and transportation support, the institutional arrangement is a hybrid form. Firstly, the relationship between family farmers and DRBP is based on informal institutions or economic rights through agreements. As trust increases, a contract is signed by family farmers to provide castor bean to DRBP. This is made possible by the act of building the castor bean supply chain, through which relationships have been established to seek a long-term partnership to meet biodiesel program expectations.

This study represents only a first attempt to explore a static perspective, using as a theoretical underpinning Transaction Cost Economics to analyze data collected in a set period. Future studies from a dynamic perspective might be interesting, employing different theoretical perspectives for analysis.

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