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PRODUCTIVE INCLUSION OF SMALLHOLDER FARMERS IN BRAZIL'S BIODIESEL VALUE CHAIN: PROGRAMME DESIGN, INSTITUTIONAL INCENTIVES AND STAKEHOLDER CONSTRAINTS*

Clovis Zapata,** Diego Vazquez-Brust*** and José Plaza-Úbeda****

ABSTRACT

One of the principal challenges in sustainable development, especially in developing countries, is to build institutions that generate positive environmental and social externalities by helping individuals to perceive a positive relationship between self-interest and "the common good". Collective engagement can enable individuals to overcome self-interestedness and work toward shared goals, but "getting the institutions right" requires an understanding of how the particular set of market and non-market relationships really work for participants. In the context of the biodiesel value chain in Brazil, this paper explores how institutional arrangements need to evolve if they are to foster the productive and sustained inclusion of small farmers and promote sustainable innovation as a regional economic development strategy, one that helps reduce social vulnerability without increasing environmental risks. The paper uses the institutional analysis and design (IAD) framework, which looks at how actors are involved in repetitive situations affected by a biophysical world, a cultural world and a set of rules, in order to understand how different institutional structures can accommodate the power of both internal and exogenous forces that shape the trajectory of sustainable innovation. After a general overview of stakeholders and policy instruments in the biodiesel programme, the paper provides a brief institutional analysis of the interaction between actors and processes, with a view to offering insights into the current effectiveness of the programme as a sustainable rural development tool.

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* This working paper draws extensively on an earlier article by the authors, 'Institutional Incentives and Constraints to Reduce Social Vulnerability and Environmental Risk through Innovation: The Small-Scale Producers Bio-Fuels Programme in Brazil', in Robert G. Lee (ed), *Sustainable Resource Use and Technology Development*. Springer (2010). The aim of sharing this work through IPC-IG is to promote a broader dialogue on the design of programmes to promote the productive inclusion of small farmers and rural communities in the context of inclusive growth strategies in developing countries. This work has been partially funded by the Spanish Ministry of Science and Education and the European Fund for Regional Development (reference ECO2008-03445/ECO).

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1 INTRODUCTION

Innovative uses of land by small-scale farmers and their incorporation into sustainable value chains can be an important driver of sustainable development in transition economies. Small-scale entrepreneurs have the potential to complement technical innovation with artisan traditions in a context of harmony with nature (DFID, 2001 and 2009). The sustainable small-entrepreneur business model opts for sufficiency over business growth, encouraging environmental awareness and choices among clients while including the proactive protection of nature where financially feasible (Kearins et al., 2010). The model has the greatest chance of success when small farm businesses are integrated into global or national supply chains in ways that promote institutional clustering and greater value-added to the producers, as in the case of Fair Trade (DFID, 2009).

However, history and each region's institutional arrangements for natural-resource use and ownership may deprive small-scale farmers of incentives to move from the traditional use of their lands to more sustainable uses that are integrated into local, national or international commodity-driven markets (Barichello et al., 1995; Barbier, 2009). Public policy can create new institutional arrangements that shape incentives for individuals to see their own self-interest as being aligned with the common good (Steketee, 2010). Hence one of the most pressing issues for developing countries is how to design and implement such polices. To do so, innovative policy applications that take account of internationally driven markets with environmental and social benefits are of particular interest. But there are not enough case studies of environmentally and socially sustainable policy interventions that focus on heightening the wellbeing of small agricultural producers, especially in transition economies (Flora, 2010).

This paper seeks to make a contribution to this area by analysing a policy intervention aimed at reducing social vulnerability and environmental deterioration in the area of Guaribas in northeast Brazil, the country's poorest region. This policy, part of Brazil's biodiesel programme, promotes the implementation of innovative agricultural production models in socially and environmentally vulnerable drylands. Our analysis provides insights into the design and policy implications of the programme as a sustainable rural economic development tool for poor regions in Brazil, but it may also be of interest to other developing countries seeking to promote the integration of small farmers into productive value chains.

Brazil's federal government has focused the programme on the production of castor beans, an environmentally friendly crop that can be grown on small farms in conjunction with subsistence agriculture. The programme can therefore have positive effects on biodiversity protection and soil fertility. Additionally, by including small-scale family farmers in the global supply chain of biodiesel, the programme aims to consolidate a financially viable and socially just agrarian production model to challenge the growth of large industrial farms that help perpetuate rural inequality.

The IAD framework (Ostrom et al., 1994; Ostrom, 2005) shapes our investigation of the institutional arrangements and stakeholder interactions supporting the programme. The use of IAD is informed by the importance of collective action—a "classical" area of IAD application—in the Brazilian biodiesel programme. It builds on Steketee's (2010) use of IAD to analyse incentives for sustainable innovation, as well as its use by Di Gregorio et al. (2008) to study poverty.

The paper is organised as follows. First it provides a brief summary of the biofuels controversy and how the Brazilian biofuels programme fits into the debate. It then discusses the IAD framework and presents the methodology. That discussion is followed by an analysis of findings in the case of the biodiesel programme, using the IAD approach, and by some policy implications and conclusions.

2 SUSTAINABILITY AND BIOFUELS

Biofuels can reduce dependence on fossil fuels and help lessen greenhouse gas emissions from the transport sector. Feedstock farming can generate labour and wealth for deprived areas. Biofuels producers can also provide an alternative outlet for some currently low-price farm products. The conversion processes (fermentation or esterification) are well developed and operational at commercial scale, thus making diversification of farming economies financially viable (Keyzer et al., 2008).

However, there is an ongoing controversy about biofuels. The most debated topic has been the impact of biofuel investments on poverty and food scarcity as a result of competition over the use of land for food crops in a number of instances. Growth in the contribution of biofuels to overall energy needs in transport can push food production beyond its limits (OECD, 2008). Environmental externalities related to feedstock farming include biodiversity loss and a decline in soil fertility stemming from extensive farming and land erosion (Gomiero et al., 2009). Other negative impacts are nutrient and pesticide run-off and land conversion (Delucci, 2007). The net savings on fossil fuels have been less than expected because of the high fossil-fuel intensity of large-scale farming practices (Keyzer et al., 2008; OECD, 2008), land-clearing fires and the use of emission-intensive nitrogen-based fertilisers (Crutzen et al., 2007) . Processing and transport further reduce net emissions savings.

Empirical research on the link between biofuel investment and poverty reduction has yielded conflicting evidence. This suggests that additional efforts are required to understand when and why this positive or negative relationship occurs, as well as to identify technological/ecosocial approaches that can help reduce competition with food production and limit emissions caused by production processes. Some studies suggest that biofuels investment increases growth and reduces poverty, despite some displacement of food crops by biofuels (Arndt et al., 2008; OECD, 2008). Other findings, however, point to a negative relationship (Gomiero et al., 2009; Oxfam, 2008).[1] Brazil is the only country where biofuels production is profitable without reliance on subsidies (Keyzer et al., 2008). With current technology, biofuels can only marginally enhance energy security in individual countries because domestic harvests of feedstock crops meet only a small part of the demand for transport fuels. Additionally, industrial biofuel farming has been linked to human rights abuses and exacerbates agrarian inequalities (Gomiero et al., 2009). Although there has been much less research on the sustainability outcomes of investment in small-scale biofuels farming, the results are equally inconclusive (Msangi et al., 2010). Biofuels can benefit smallholder farmers by generating employment and increasing rural incomes, but the scope of those benefits is likely to remain limited with current technologies.

This mixed evidence suggests a need to follow a contingent approach to the relationship between biofuel investment and sustainability indicators. Whether sustainable growth results from a move from traditional land use to biofuel crops will depend on a range of

contingencies, both internal (type of crops, type of technology, opportunities for crop spillover, community attributes, development of certain capabilities such as innovation, total quality management, cross-stakeholder management or shared vision) and external (such as the structure of the biofuel supply chain, characteristics of the product market, and the complexity, uncertainty and dynamism of the environment).

This paper analyses the design and impact of the component of the Brazilian biodiesel programme that focuses on small-scale family farmers. The programme design sought to overcome most of the criticism of biofuels production outlined above. First, a range of environmental challenges are addressed. Castor farming is compatible with agricultural practices that help safeguard diversity and soil fertility, since castor crops grow well in conjunction with other native species or subsistence farming. Since castor thrives on the coexistence with other plants, clearing fires are not needed. Production is not intensive in the use of fossil fuels, nitrogen fertilisers or pesticides. Second, as regards impacts on poverty and growth, production of the crop in small land areas appears to be economically and technically feasible given current and expected production quotas, thus providing a niche market for small farmers and local entrepreneurs. Finally, linking small farmers to the biodiesel supply chain may empower them and increase their social capital.[2]

3 THE BRAZILIAN BIODIESEL PROGRAMME

Brazil's biodiesel programme was launched in 2004 and follows the country's longstanding tradition of fostering the use of biofuels. In the 1970s, Brazil implemented the world's most successful large-scale policy to promote the use of bioethanol. At the time, the government's concern was to use the locally produced fuel to combat economic problems that had arisen during the international petrol crises. The pioneering ethanol programme was an important policy experience, and in principle the country was virtually able to convert the entire automobile fleet to ethanol-only vehicles. The National Alcohol Programme (Pró-Alcool) provided energy security, environmental gains by reducing polluting emissions in the centres of Rio De Janeiro and São Paulo, and large macroeconomic gains (Zapata and Nieuwenhuis, 2009).

The biodiesel programme has followed the same pattern and responds to similar energy security concerns. But one of the most important matters to be noted with regard to the design of the biodiesel policy is the explicit preoccupation with incorporating small-scale family farmers into the supply chain. This posed a challenge for the government because similar policies had never been successfully implemented on such a large scale in a country as vast and diverse as Brazil.

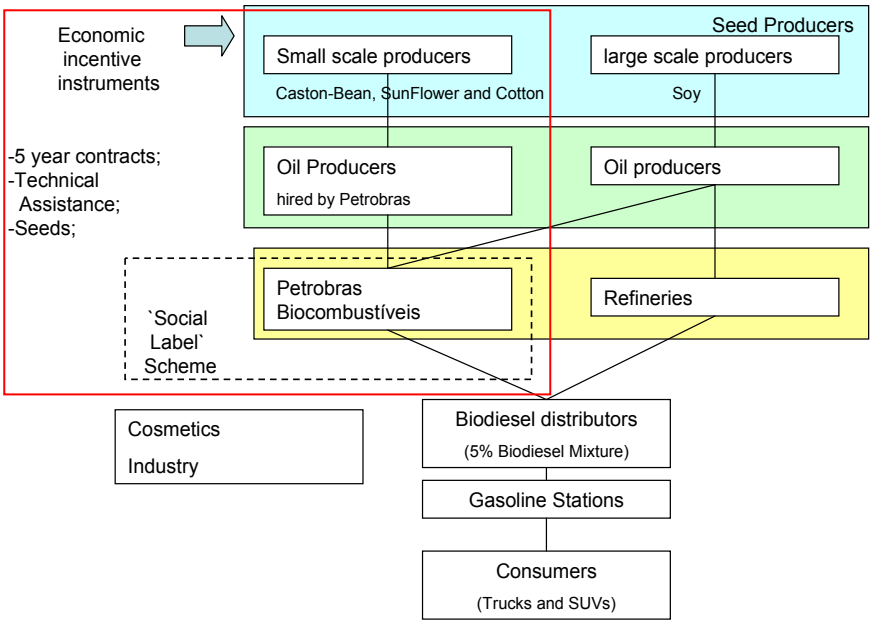
One of greatest difficulties in designing the programme was to combine the production of large-scale and small-scale farmers. The former use soy, while small-scale farmers have a wider range of feedstock crop options but tend to rely on castor. The two kinds of farmers have significantly different production models. Large-scale farmers have a highly sophisticated production model with mechanised production and significant economies of scale. They are also very organised and received a significant amount of credit. Small-scale farmers use traditional labour-intensive techniques, are disorganised, and have limited access to credit.

The central policy instrument used to include small-scale farmers has been the "social label" scheme. This gives a tax break on two federal taxes (PIS/PASEP and COFINS) to biodiesel producers who buy minimum specified feedstocks from small-scale farmers.

FIGURE 1

The Biodiesel Supply Chain

The focus of this paper is interactions within the red rectangle.



Small-scale and large-scale farmers are the suppliers of vegetable feedstock (see Figure 1). The seeds are given to the crushers that make vegetable oil. In the northeast region, Petrobras Biocombustíveis has been responsible for contracting oil producers to make the oil and transport it to the Petrobras refineries in Candeias and Quixada. Large-scale producers can sell their output directly to oil producers. The seeds are transformed into vegetable oil, which is sent to biodiesel refineries. At the moment, in the northeast, Petrobras Biocombustíveis is the only biodiesel industry that has a legal mandate to work with small-scale farmers. The firm also provides technical assistance, distributes seeds and has established five-year contracts with small-scale farmers (Zapata et al. 2010). In this sense it is the only firm supported by the benefits arising from the "social label" scheme. Once biodiesel is produced, it is directed to the distributors that mix it with traditional diesel at a 5 per cent combination. The mixture is then sold to consumers at the gas station. Only trucks and a few utility vehicles may be diesel powered. Diesel powered passenger cars are neither produced not imported.

The programme was launched with a large degree of political fanfare by the central government, which officially presented the biodiesel initiative as a key policy measure to alleviate the lingering problems of the rural poor. It followed previous financing schemes that provided distinct economic support to small-scale farmers and entrepreneurs in deprived areas, such as the north and northeast regions. It was applied to all the states of Brazil. There was an understanding that the programme would be successful in terms of small farmers' participation and economic benefits. Most small-scale farmers, however, were not interested in taking part in the programme, and many of those who participated faced economic losses

because of price fluctuations in the fuel market. There is also a strong correlation between productivity levels and the participation of small-scale farmers, the latter having given rise to low productivity.

The results were particularly disappointing in the northeast, where the programme had been heralded as the start of an agricultural revolution to end chronic poverty. According to information from the Instituto de Assistência Técnica e Extensão Rural do Piauí (EMATER-PI), the productivity of castor in the region was estimated at about 0.5 kilograms per hectare in 2008/2009. Pilot projects indicate that under proper conditions, productivity of 1.5 tons per hectare of castor can be reached (Freire de Sousa and Figueira, 2009). Table 1 shows how far below that target is the average productivity of small-scale farmers in Serra da Capivara (2008/2009), the most deprived territory in the northeast and the focus of this paper.

TABLE 1

Productivity of Family Farmers in Serra da Capivara (2008/2009)

Municipality	Tons	Hectares	Productivity (ton/ha)
Anísio de Abreu	8.8	30.3	0.29
Bomfim do Piauí	1.1	3.0	0.36
Caracol	56.2	111.5	0.5
Coronel José Días	1.5	2.7	0.56
Fartura do Piauí	37.8	66.3	0.57
Guaribas	4.2	10.5	0.4
João Costa	2.5	12.5	0.2
Jurema	5.5	17.9	0.31
São Braz do Piauí	5.1	25.5	0.2
São Lourenço do Piauí	1.2	8.0	0.15
São Raimundo Nonato	49.7	63.4	0.78
Várzea Branca	2.6	9.6	0.27
Total	**176.3**	**361.1**	**0.49**

Source: Sisdagri (2010).

This paper investigates the causes of the failure in participation, focusing on an analysis of institutional arrangements that may deprive small-scale farmers of incentives to move from the traditional use of their lands to more sustainable uses. Using IAD, it is possible to understand how institutional structures can accommodate internal and external variables that directly shape sustainable innovation.[3]

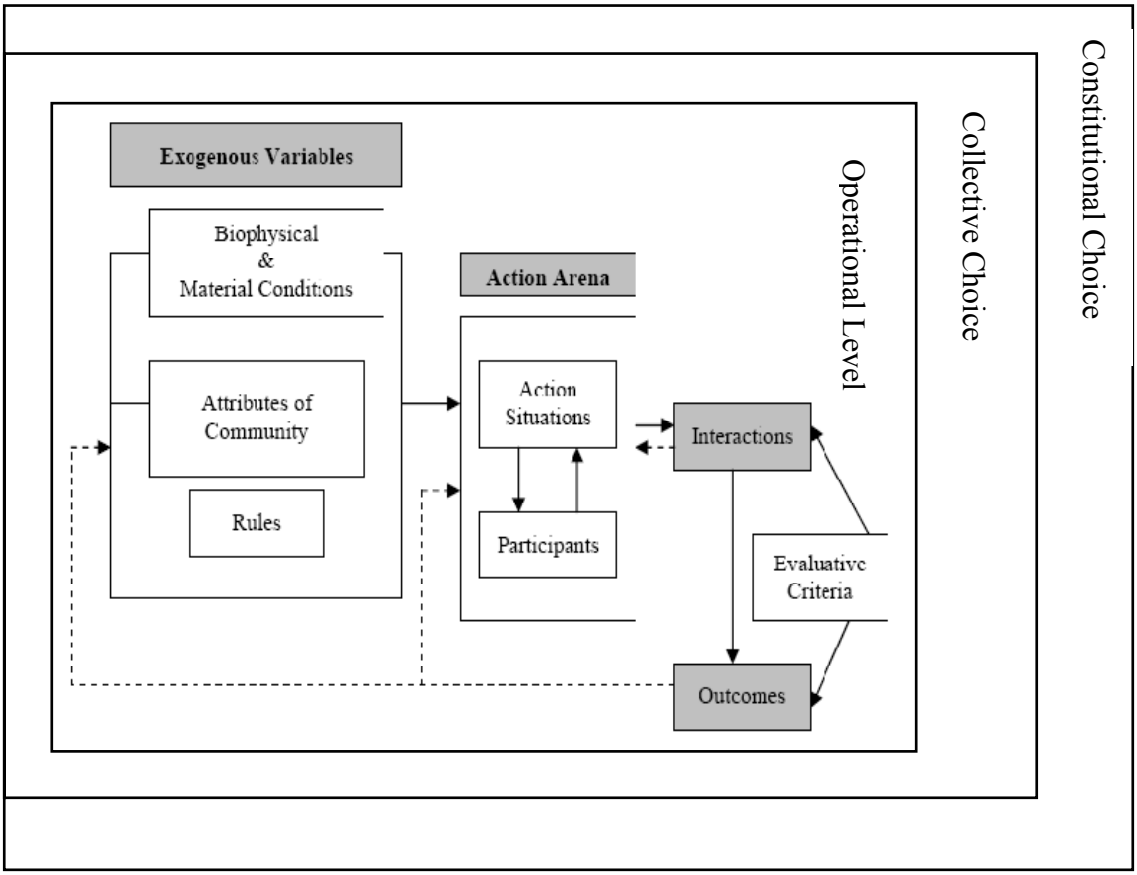
4 INSTITUTIONAL ANALYSIS AND DESIGN (IAD) FRAMEWORK

The literature on the determinants of sustainable innovation[4] (see for example, Steketee, 2010; Sartorius, 2006; Könnölä and Unruh, 2007; MacKinnon et al., 2002), emphasises the importance

of understanding the incentives and disincentives that shape interactions between actors (Meuss, et al., 1999; Lundvall, 1992). These incentives and disincentives, in turn, are shaped by institutions (Nicholson, 1993). These are "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction … [reducing] uncertainty by providing a structure to everyday life" (North, 1990: 3). Institutions shape innovation in three ways: (i) influencing the availability of information and resources; (ii) shaping incentives; and (iii) establishing the basic rules of social transactions (Nicholson, 1993).

FIGURE 2

The IAD Framework



Source: adapted from Ostrom (2005).

The IAD framework, as presented in Figure 2, analyses the interaction between different stakeholders or actors in an "action arena", where actors interact in a bounded environment, constrained by context-exogenous variables such as biophysical and material conditions, attributes of the community, institutions and rules-in-use (Ostrom, 2005). The framework is particularly concerned with the change in patterns of interaction that are affected and effected by their context, leading to certain outcomes. These outcomes, and the process of achieving outcomes, may then be evaluated according to chosen criteria such as economic efficiency, sustainability, economic productivity, social equity and others (Gibson et al., 2005; Ostrom, 2005: 66–67).[5]

As Figure 2 shows, the process of evaluation is iterative. The outcomes alongside the interactions may loop back to the exogenous variables as the actions take place in a repetitive

manner—the outcomes further influencing action arenas, modifying actors and the situation. In turn, and over time, outcomes may also influence context (Ostrom, 2005).

The focal unit of institutional analysis is the action arena. This is a "social space where individuals interact, exchange goods and services, engage in appropriation and provision activities, solve problems, or fight" (Ostrom et al., 1994: 28) . An actor is the individual, or a group functioning as a corporate actor, who takes action (Gibson et al., 2005: 27). An action situation occurs when two or more actors interact to jointly produce an outcome (Ostrom, 2005). Action arenas are stages for social bargaining (such as a meeting, the implementation of a policy, a supply chain) in which actors may choose to cooperate or not (Di Gregorio et al., 2008).

Exogenous variables constrain action situations and order actors' relationships, especially patterns (Ostrom, 2005; Ostrom et al., 1994). These are presented by the framework in three "context clusters" (Steketee, 2010), including the characteristics of the biophysical and material world, a social dimension embedded in the cultural world, and the rules used by actors.

The first set of exogenous variables are biophysical and material conditions. They represent the physical world in which action arenas are located, affecting the "physical possibility of actions, the producibility of outcomes ... and the knowledge of actors' (Ostrom et al., 1994).

The second group of exogenous variables are attributes of the community, such as "the values of behaviour generally accepted in a community; the level of common understanding that potential participants share (or do not share) about the particular types of action arenas; the extent of homogeneity in the preferences of those living in a community; the size and composition of the relevant community; and the extent of inequality of basic assets among those affected" (Ostrom, 2005: 26–27).

Third, rules refer to "the set of instructions for creating an action situation in a particular environment" (Ostrom, 2005: 17). Rules can be formal (laws, regulations and so on) and informal (how things are done, cultural and religious codes of conduct). They define what actions are "required, prohibited, or permitted and the sanctions authorised if the rules are not followed" (Ostrom et al., 1994: 38).

Finally, the framework describes three successive and interrelated levels of outcomes: operational, collective choice and constitutional choice (Ostrom et al., 1994). Operational-level outcomes include the results of day-to-day activities that affect the physical world directly. Collective choice-level outcomes are the rules created by decision makers to shape operational-level activities. Finally, constitutional-level outcomes are the results of decisions about how collective-choice actors are selected and which patterns of interaction will define the relationship among participants of the collective-choice body (such as voting rules, representation). Actors may move among the different levels, looking for the best outcomes within a given set of rules, or bargaining to shape collective or constitutional-choice rules to their benefit. The analysis in this chapter focuses on the collective-choice level.

This rather open and wide framework needs to be properly contextualised so that the important details can be populated systemically and the interaction between the central stakeholders can be analysed. The contextualisation of elements forming variables is of prime importance and requires rigour in their collection. In order to discuss how the variables have formed, the next section discusses the methodology used in the data collection.

5 METHODOLOGY

The research strategy of this chapter is framed by the methodological structure presented by Eisenhardt (1989), with elements from Bryman et al. (2003) and Saunders et al. (2000). This has been designed to provide a research structure with internal and external validity (Ghauri et al., 1995). The methodological approach herein follows the steps presented by Eisenhardt (1989), which have been defined as the initial phase, the cases (including historical analysis and case study), the data analysis and the conclusion.

An important element presented by Yin (2003) is the relevance of the literature review in providing support to the case-selection step and helping to define the research questions. A shortlist of specific questions was tailored to investigate the main issues related to the case study. A questionnaire was used to foster discussion of the specific topic with selected stakeholders. Face-to-face interviews were held in northeast Brazil with small-scale family farmers and with refineries and technical specialists responsible for offering technical assistance to those farmers. A total 42 of interviews were conducted. The intent was to cover the vast number of stakeholders. An important aspect of the research ethics of the interview process was the privacy of the interviewees. The principle of informed consent has been respected, since guarantees of confidentiality and anonymity were offered (Frey and Oishi, 1995).

6 KEY CONTEXT OR EXOGENOUS VARIABLES

6.1 BIOPHYSICAL/MATERIAL CONDITIONS

The biophysical conditions vary by setting but the literature has generally identified two as important influences in patterns of interaction between actors: the geographical environment (ecosystems, climate) and characteristics of the resource (scarcity, distribution, predictability) (Di Gregorio, 2009; Stewart et al., 2009; Ngaido and Kirk, 2001). Erratic environments marked by duress or high uncertainty (that is, scarcity and uncertainty in the supply of ecosystem services, risk of natural threats) tend to encourage bounding and the formation of social capital. For instance, in many dryland areas with unpredictable rainfall, the physical environment creates pressure for people to consolidate higher-level institutional arrangements (see, for example, Ngaido and Kirk, 2001). The more dispersed the resources are, the more difficult it is to exclude others from using them. The more predictable the resource are, the more accurate can be the design of institutional arrangements to manage them (Di Gregorio et al., 2008).

6.2 THE ENVIRONMENT

Figure 3 indicates where the research was conducted. The state of Piauí is highlighted, as is the area of Guaribas, in the microregion of São Raimundo Nonato. Biophysical and material conditions in the region play a fundamental role. It is one of the most deprived areas of the country, partly because of the harsh weather, which includes arid climatic conditions with long dry seasons and erratic rainfall. Soil fertility is low, and erosion and desertification further threaten ecosystems and soil quality. Droughts and the poor quality of arable lands are particularly acute in Guaribas, Most lands are marginal and unused, since traditional cash crops such as soybeans, cotton and coffee cannot withstand the arid climate.

FIGURE 3

Case Study: Guaribas in the State of Piauí

Source: Google maps (2010).

Di Gregorio et al. (2009) suggest that a lack of alternatives would provide a powerful incentive to accept innovation, and thus would have a positive influence on acceptance of castor bean farming. Additionally, the harsh environment may have developed bounding and networking skills, a circumstance that also favours participation in collective action (Ngaido and Kirk, 2001)

6.3 THE RESOURCE

Castor bean, often grown and harvested through subsistence farming, thrives in harsh subtropical and tropical climates. Compared with food crops, the castor oil plant, requires simple agrarian practices and little economic investment. Castor bean can be grown on marginal lands, which are not competitive with lands used for food production. It is resistant to disease and is not threatened by animals because of its toxicity.

Castor has strong adaptive capabilities, growing on flatland and slopes, and develops better when grown in conjunction with other plants. It has a 50 per cent oil content and can yield up to 350–650 kilograms of oil per hectare without fertilisers. It needs only moderate rainfall (about 600 millimetres) and can withstand long periods of drought (Roetheli et al, 1991). The crop needs little maintenance during its growing periods but the oil seed has to be collected by hand. Its soil fertility requirements are very low, and thus it is ideal for replanting on marginal lands to prevent desertification and erosion. If the seeds are not used in biofuels production, their main use is for manufacturing lubricant and pharmaceutical oils.

All the above suggests that the crop can provide small farms with a viable income from lands that are currently non-productive. Additionally, the dispersal of the resource and the need for manual labour to handpick the beans reduces the risks that some farmers might be excluded from using the resource or that industry farms might co-opt production. Castor may not compete with food production, since the seed can be grown in conjunction with subsistence agriculture. Its toxicity may present a problem for mixed used of land, particularly coexistence with cattle or sheep in grazing lands. However, Roetheli et al. (1991) play down the

risk of animal poisoning, arguing that animals "sense" the bean's toxicity and do not feed on it. In essence, the biophysical conditions seem to have a positive influence on the development of interactions leading to innovation

6.4 ATTRIBUTES OF THE COMMUNITY

In addition to the scarcity of resources, droughts and soil infertility affecting agriculture, this part of the country has experienced a constant emigration of rural workers to urban areas. Human capital has been eroded in most communities because of the emigration of the young and most skilled labourers. Low natural and human capital makes Piaui one of the poorest areas of Brazil, with a very low human development index (HDI) and a high reliance on subsistence farming and informal economies. The lack of communications infrastructure further increases the vulnerability and isolation of rural communities. In particular, Guaribas has largely been known in Brazil as the country's poorest town, the one with the lowest modified human development index (MHDI) at 0.479; it has very low levels of education, wealth and longevity. The rural population relies on subsistence agriculture, transactions in the informal economy, and social benefits from the government.

The region is also a subject of intense political debate and media scrutiny. Rural inequality has been launched into mainstream political debate by militant landless peasant organisations, which advocate land invasions in an effort to reduce poverty. These groups are well organised and politically influential, and have a high capacity for bonding, bridging and linking to mobilise people and resources. Particularly strong in the northeast, they have endorsed the programme from its inception and pressured the government to bring forward its launch.

The government has taken Guaribas as the example that would show the effectiveness of some of the most important pro-poor government programmes, including the biodiesel initiative and the *Bolsa Família* conditional cash transfer programme. Because this is a very deprived area, an initiative that would foster the development of an economic activity linked to smallholders is of special interest. In essence, the attributes of the community also seem to have a positive influence on the development of interactions leading to innovation.

6.5 RULES

6.5.1 Formal Rules

In terms of "constitutional rules", the basic policy supporting the biodiesel programme rested on the following pillars:

(i) The government established a minimum percentage of biodiesel to be mixed with traditional diesel, providing demand for the newly formed biodiesel supply chain.

(ii) The production of biodiesel from different oil seeds is to be fostered from various regions of the country.

(iii) A wide range of producers are encouraged to take part in the biodiesel supply chain, including large-scale and small-scale producers.

(iv) Special economic instruments have been devised to make the activity attractive to small-scale producers, including the "social label" scheme.

The "social label" scheme is what IAD calls a 'collective choice-level rule". It is a regulatory instrument to foster the participation of small farmers in the biodiesel chain by giving a tax break to firms that buy at least the minimum stipulated amount from small-scale family farmers (PNPB, 2009). To do that, the firms have to set up individual contracts and provide technical assistance to the farmers. As predicted by IAD, therefore, "constitutional-level" rules shape "collective choice rules", which in turn influence "ordinary rules". In this case, the contracts shape relations between the oil producer (currently Petrobras, previously Ecodiesel) and small farmers. This contractual rigidity does not work well with vulnerable communities, which tend to distrust written contracts, especially when they have not been part of the negotiating process (Yakovleva, 2001). In general, economic incentives tend to work better with more educated and individualistic communities (Dryzek, 1994). The communities in the area do not have a long-term lived experience of benefitting from this type of incentive structure, and thus purely bureaucratic and top-down formal rules may be a constraint on farmers' engagement with the programme. Trust in contracts and similar arrangements is something that needs to be developed, given the subsistence nature of the farming and previous acquaintance of contracts that in some ways may have strengthened the farmers' more risk-averse nature.

6.5.2 Informal Rules

Many rural dwellers appear to be religious people. In the region in question, Catholic priests have significant political influence and have been responsible for organising associations of small-scale farmers. More generally, the Catholic Church is very active in the region and serves as an important stakeholder, a circumstance that has political implications. In São Raimundo Nonato, for example, the mayor is the local priest. Aside from the Church, associations of farmers and the landless are also very dynamic in rural Brazil and have pushed for the inclusion of small-scale farmers in the programme (for example, the *Movimento dos Sem Terra*). Most of the farmers taking part in the biodiesel programme are also part of these associations. Some of these farmers were not landowners until a few years ago. They received land from the central and local government as part of a broad strategy to redistribute land in the northeast. In fact, their participation in these associations helped them to receive land. They are members of local community associations that have an elected president and representatives that give them voice in these policy processes. There is solidarity among the members of the associations; they help each other in relation to work and other activities.

These types of relationships, however, must be situated in the context of the high level of inequality in the Brazilian countryside, where very large land owners have vast resources while small-scale farmers are deprived of land and financing. But the political leaders of the small farmers have also become closely linked to the state and central governments, which have adopted some of the discourse of the farmers' leaders. The central government praises equality and seeks to enhance opportunities for smallholders and poor families. It is worth noting that the farmers' environmental concerns are minimal and that they are more worried about short-term subsistence and economic gain.

The strength of embedded informal rules suggests a culture in which personal values and emotional bonds are paramount. These communities will favour tradition and common sense or lay knowledge over scientific wisdom and technical reassurances. Mutual respect and trust

need to be achieved to gain legitimacy as a source of advice. This can be only achieved through repeated interaction. To be successful, the interaction must be an empowering experience and must engage the farmers in decision making (Vazquez Brust et al., 2008).

7 ACTION ARENA ANALYSIS

7.1 ACTORS

7.1.1 Petrobras Biocombustíveis

Brazil's Petrobras has largely invested in biofuels to establish itself as a world player in that market and has set up a firm, Petrobras Biofuels (PBio), to take care of the business. Petrobras's substantial interest in entering the national biofuels market has important consequences, since PBio has become the central stakeholder dealing directly with small-scale farmers. As a new entrant in the market, PBio has invested heavily in building biofuels refineries in the northeast, including those at Candeias in Bahia, Quixadá in Ceará and Guamaré in Rio Grande do Norte. The company can now produce 171 million litres of biodiesel per year. Biodiesel in these refineries can be produced by processing vegetable oil from small- and large-scale farmers. Currently, the firm has contracts with 35,000 small-scale producers and aims to increase their participation because the refineries can absorb production from close to 59,000 small-scale family farmers (personal communication to authors).

One of PBio's main aims is to establish itself as the central player in the international market. The company sees the biodiesel market as central to breaking into the lucrative European and American markets, which also mandate minimum biodiesel requirements. In this respect, the investment in small-scale family farmers may have positive effects for the firm's image and for the production of biofuels in general. Recently, the adverse social and environmental externalities of biofuels production, especially in Asia, has created a negative perception of biofuels in the European markets (T & E, 2010). The participation of small-scale farmers in the biodiesel value chain may help diffuse criticism, while enhancing the corporate social and environmental image of the Petrobras Group. The firm has also taken a strategic approach to engaging with a wide range of potential suppliers. The investment in several sources of feedstocks for biodiesel, including soy, sunflower and castor beans, may reduce risks of reliance on a single supplier and a single type of feedstock.[6]

7.1.2 The Small-Scale Farmers

Small-scale farmers have been central to the establishment of the programme. The intention of including them in the new market process is the result of a grassroots movement that arose around the time when President Lula was first elected. Representatives of small-scale farmers' associations and other social movements were the programme's initial proponents. Brazil's small-scale farming sector has had very a good relationship with the central government, because several local leaders were later offered positions in ministries related to social security and small-scale development, and they helped design and implement the programme. Despite their evident influence in setting up the initiative, however, small-scale farming in Brazil has particular characteristics that are important to an understanding of the extent to which these farmers can participate in the biodiesel supply chain. Generally, farmers in Brazil's

most deprived areas do not have longstanding experience of producing commercially viable crops. They tend to rely on subsistence farming, supplemented by conditional cash transfers from the government, such as *Bolsa Família*. Others can market part of their production in informal economies and local markets, but there is no link to national and international markets. Most of the farmers are illiterate or only partly literate

7.1.3 Technical Assistance

The technical assistance provided to small-scale farmers comes from staff hired by Petrobras and local authorities to provide agricultural aid to farmers in the regions. In the region where the research for this paper was conducted, EMATER-PI is the major player. It is a branch of the Brazilian government in the region. In the state of Piaui, rural extension services began in 1966, when the state branch of the national EMATER was founded. Several important rural extension projects were developed in the 1970s, but during the 1980s the institution was underfinanced. In order to focus resources, EMATER-PI concentrated on helping small-scale farmers and working with local communities. Several cooperatives were formed to help market the farmers' products.

7.2 PATTERNS OF INTERACTION

7.2.1 The Relationship between Petrobras and Small-Scale Family Farmers

The relationship between Petrobras and the farmers is formally dictated by a multi-year contract between the two parties. In contrast to what has happened on previous occasions, the contract is generally negotiated by a local association and national representatives of agricultural farmers, an arrangement that makes such contracts more acceptable locally.

Technical assistance is provided by Petrobras in conjunction with EMATER-PI. Petrobras guarantees that technical specialists will visit farms on a regular basis to provide information on planting and maintaining crops. The specialists have to be able assess how production is developing, so that any potential problems can be corrected. Petrobras also needs an estimate of production.

Petrobras provides free seeds and bags for the farmers to store the seeds. The most important aspect of the contract is that Petrobras guarantees a minimum price for each farmer's output. This price, for example, was set on the price paid on the Irece's castor exchange in 2009. If the price at the time of the trade is higher, the smallholder receives the operative price. This reduces uncertainty about the production of oil-producing bean crops.

The contracts allow Petrobras Biocombustíveis to calculate the production of castor for the next five years, and to understand how far it can rely on this source of oil. For the farmers, PBio is a monopsonist, a circumstance that poses long-term risks for this new relationship. If the firm cannot provide additional investment to small-scale family farmers in the future, or if there is no technical assistance from other institutions, farmers may be economically vulnerable and may not have the incentive to produce more seeds for biodiesel.

As regards the individual decision about whether to take up the production of castor, the opportunity costs related to food crops needs to be considered. It should be noted, however, that the technical assistance given by government bodies and the Petrobras

specialists prioritises a technique that combines castor with bean production—that is, an intercropping technique. This may help diffuse some of these individual choice uncertainties. Here, the intercropping system is a crucial element in the biodiesel programme. The technical assistance is supporting this production model, which intercrops castor with *caupi* bean seeds, for a wide range of regions in the northeast. This increases the productivity of castor while minimising the potential for food-versus-fuel issues.

7.2.2 The Relationship between EMATER and Small-Scale Farmers

From 2003 onwards, Piaui state reorganised the technical assistance so as to focus more closely on small-scale producers, to take account of gender and race issues, and to respond to the needs of semi-arid regions. The aim is to provide greater help for those in need. EMATER-PI works directly with producers and their families, seeking ways to increase the productivity of small-scale farmers and boost the marketing of their output. It now operates in 223 towns, with 16 regional and 78 local offices. EMATER takes research knowledge from the Brazilian Agricultural Research Corporation (EMBRAPA), which is linked to Brazil's ministry of science and technology.

8 OUTCOMES/ EVALUATION

As mentioned earlier, the biodiesel programme was designed to improve the livelihoods of small-scale farmers in the region. Evidence from interviews indicates that family farmers may make a 20 per cent gain in income. Because of the low level of incomes/revenues involved, this seems to be a significant opportunity for them to enhance their material conditions.

Productivity levels, however, are far below targets. The average productivity of small-scale farmers is only 30 per cent of the figure estimated in pilot studies as being achievable under proper conditions.

The government has acknowledged that production has not been at anticipated levels. After the programme's first year, therefore, the government cut by 50 per cent the minimum percentage of feedstock that producers have to buy from family agriculture in the region in order to secure tax benefits.

Insufficient supply suggests a fundamental failure in the system of incentives to foster participation in (and the continuity of) the programme. It also points to potential governance problems affecting the implementation of sustainable innovations. Consequently, the business model of innovative land use is neither efficient (costs of the large-scale design, bureaucracy, technical support and subsidies support largely offset productivity benefits), nor effective (limited participation leads to a modest impact on reducing poverty, vulnerability and environmental deterioration).

Analysis of IAD factors reveals institutional arrangements that create disincentives and affect the outcomes of interactions between farmers, technical assistance and Petrobras. Analysed in isolation, biophysical/material conditions seem to provide incentives for participation in the programme. When these are considered in conjunction with attributes of the community and rules, however, the interviews disclose powerful disincentives.

8.1 ATTRIBUTES OF THE COMMUNITY, INFORMAL RULES AND PERCEPTIONS OF CASTOR PRODUCTION

The informal rules of land use in Brazil's northeast are important, since they respond to local traditions and affect how small-scale farmers perceive their participation in the programme. In general, these farmers have traditionally focused on subsistence production for their families. Hence some farmers are cautious about taking up another crop that might not provide an assured economic stream for the family; those farmers also indicated that this was their first experience with a commercial crop and they were unsure about the economic return.

Dryland communities are highly risk- and uncertainty-averse. They perceive any change as a threat to their survival if it entails trading off resources used for subsistence, including time. The more radical the innovation and the more uncertainty there is about its impact on subsistence livelihoods, the greater the resistance. In theory, other economic opportunities would improve the farmers' livelihoods, but if they perceive that they do not have enough material resources (including time) they will resist taking up other crops to complement their production of subsistence crops. Family farmers are usually unwilling to trade the time they devote to crop subsistence for another crop that is to be sold, since they may not have enough resources. During the interviews, many farmers indicated that their priority is a steady food supply for their families, and that they would prefer to focus on food crops that can be used for subsistence rather than oil-bearing crops for commercial use.

The physical characteristics of the castor bean seem to an important issue that increases uncertainty and creates a need for additional resources. In areas where small-scale farmers focus mostly on livestock production (specifically, sheep and goats), they are not interested in producing castor because the bean is toxic if eaten and can poison humans and animals. Hence the need to invest time in physically separating animals from castor bean plantations, and to prevent children from coming into contact with the seed. Note, however, that the toxicity of castor facilitates storage because pests are deterred.

Other farms have considered the economic return on biodiesel production to be low relative to the risks and time invested. Given the low level of productivity and the low price offered in recent years, the activity is considered to have low economic returns on the labour invested. Most of these farmers do not possess any machines and the techniques involved in agricultural production are fairly primitive, thus heightening concerns that time devoted to the crop will affect subsistence activities.

There are also ingrained perceptions of the bean as a bad weed lacking in value, something to be avoided or destroyed. Shifting perceptions of castor from pest to valuable good requires changing deeply held beliefs and is a process that takes time, trust and repeated positive experiences.

8.2 ACTION ARENA: RULES

8.2.1 Legal Rules

The contracts proposed by Petrobras (and Ecodiesel before that) are an institutional innovation for small-scale farmers who traditionally trade in informal economies and follow informal rules; in the early years they showed some resistance to signing the contracts. Most of them are illiterate or only partly literate, and they do not have a proper grasp of the legal significance

of the signed contracts. The present contracts are for five years, and for some farmers this is a lengthy period during which they must commit significant time and labour to meeting the contractual requirements. When farmers have to commit to five-year contracts, therefore, a substantial trust factor has to be considered. Even when they agree to sign a contract, it is unclear to what extent they see it as a legitimate instrument or feel bound by it. In the first phase of the project, some small-scale farmers did not comply with the contracts that they had signed. Contracts are usually negotiated between local associations and national representatives of farmers, and typically there is no mechanism to involve small farmers individually in the negotiations. Thus the patterns of interaction have been shaped largely by rules designed without the farmers' direct involvement.

8.2.2 Economic Rules

The initial programme design anticipated that small-scale farmers would organise themselves in local groups so as to advance in the biodiesel supply chain by forming biodiesel extracting companies. In deprived areas of the country, however, farmers are distributed over large rural areas, which poses a serious logistical obstacle to organising, selling production and accessing technical assistance. The farmers' geographical dispersion brings about their spatial and also social isolation. They are poorly organised and very few of them belong to local associations that can mobilise to protect their interests and express a single voice. To date, only one local association in Irece, Bahia, has managed to secure state funding to buy a crusher, though this is not currently in operation. Farmers have indicated that it is more convenient for them to sell their produce to middlemen than to sell to the oil producer (owned by Petrobras), because a middleman usually goes directly to the farm and pays the farmer in cash at the moment of the transaction. The oil producer takes up to a week to pay farmers, since the produce has to be delivered to the factory. This is a crucial disincentive for cash-strapped small-scale farmers who have had to invest in advance in the production of feedstocks. But the prices offered by middlemen are typically lower than can be obtained in the factory, and thus the farmers benefit less.

The lack of farmers' organisations and their lack of experience with commercial activities has led to several of them defaulting on credit. A number of farmers that assumed financial obligations in the first phase of the programme have not been able to repay the loans. Capacity to predict future earnings is very limited, and some farmers do not understand the financial and legal terms requested by financial institutions. Credit default has been a significant problem in the northeast, not only in castor production but also in the case of other crops. Obviously, the poor economic performance of first-mover, castor-producing farmers is also a disincentive for potential new entrants who have doubts about the programme's benefits. Time is needed to build a relationship of trust between small-scale farmers and Petrobras.

8.2.3 Informal Rules

All informal rules seem to act against the programme. A distrust of science appears to be embedded in rural Catholicism, and the grassroots landless philosophy is marked by a distrust of economic instruments and bureaucracy. Traditionally, castor is seen as a poison weed. The farmers' history of reliance on informal trade makes economic instruments and contracts difficult to understand. Isolated communities tend to be suspicious of outsiders'

intentions and knowledge (Benn et al., 2008). Communities that depend on subsidies are very conservative; they tend to assign more importance to potential losses than to potential benefits, and thus regard innovation as a risk (Moody, 2007). Religious values also emphasise pastoral experiences, trust and human contact. This is not an incentive to stay in a programme when the implementation mechanisms are largely devoid of a direct relationship between Petrobras and the farmers. Negative experiences of economic losses, inadequate technical assistance and exclusion from decision making only reinforce existing prejudices.

8.3 INTERACTIONS

As a result of the programme's institutional design, it has no arenas for small farmers to strike a bargain with policymakers. Additionally, institutional and cultural arrangements prevent small farmers from forging links with mechanisms that allow them to engage with external agencies, both in terms of links between poor groups and those in authority or between small-scale producers and global supply chains. Thus small entrepreneurs are unable to create the bonds with outsiders required to draw on resources and influence policies to support innovation (Pretty, 2003). This lack of 'linking capital' is a powerful disincentive to sustainable innovation and entrepreneurship. It reduces community governance (Tickamyer and Duncan, 1990, Pretty, 2003) and helps perpetuate chronic poverty (Di Gregorio, 2009).

Indeed, the only action situation for interaction between farmers and "outsiders" was the technical assistance programme. The interviews indicated that technical assistance has been a serious problem in the past four years. In some areas it has been very modest or non-existent. Farmers have tended to rely on traditional production techniques instead of embracing novel techniques. This has been the case with the techniques proposed for castor cultivation when additional labour is required and when those methods confront traditional beliefs. According to proponents of the new techniques, productivity could be improved by a factor of 10, but this may contradict some popular beliefs about castor production. One example is the need to plant two seeds close together so that when both plants are half-grown the weaker of them dies. This enhances the productivity of the second year and is a characteristic of the hybrid seed distributed, but it may be difficult for farmers to endure until the second year.

In the interviews, the following reasons emerged for the link between low productivity and the means of production used by small-scale farmers.

- Inadequate technical assistance for soil management. Farmers have only limited knowledge of proper soil management technologies. Technical assistance did not address this problem satisfactorily. When (if) guidelines were provided, they were generic and failed to offer practical advice for particular soil productivity problems. EMATER is currently working on a proposal for soil correction to increase productivity. Petrobras is financing the project.
- Farmers in the programme were often dealing with technical assistance for the first time. Some farmers indicated that before the involvement of Petrobras, EMATER-PI was not present in the area. Other indicated that it is not a straightforward matter to follow the technical recommendations. They also clearly showed that they are not used to following instructions from outsiders.

- Other areas simply lacked proper technical assistance. Some farmers appear to want to keep to traditional farming techniques that have been part of their culture for many years.

Another area of conflict relates to the intercropping system. During the interviews, farmers expressed their preference for being able to chose the most appropriate crop for intercropping, since some prefer to use maize instead of beans. Maize has a more stable market and a reputation as a less risky crop. EMATER-PI's opposition to maize, however, relates to the competition for light and nutrients that maize poses for castor, since they are plants of a similar size. In principle Petrobras is not against the use of maize, but the technical specialists are instructed to request additional space between the crops so that the castor bean plants have enough space and natural resources to develop.

With Embrapa's support, EMATER has been promoting intercropping castor with a bean that is not a common species. Farmers have indicated that they are not used to that variety, and at the beginning they were unsure about the results. Intercropping with traditional local varieties is not recommended because of the growth pattern, which is horizontal rather than vertical and which threatens the growth of the castor plants. Local varieties are also easier to peel manually.

Farmers have also tended to feel excluded from decision making that affects their livelihoods. As mentioned earlier, farmers want to decide which crop would be most appropriate for intercropping because they recognise that such choices may affect their subsistence.

As a result of all the above, mistrust on the part of some farmers may raise doubts about the quality and longevity of the technical assistance provided to them. This might have cascade effects and raise concerns about the usefulness of scientific advice, heightening previous uncertainties and suspicions about the project.

Some farmers believe that the technical services are geared more towards audit purposes than towards providing practical support in the field. Hence they view them as a monitoring mechanism rather than as a tool for training and collaboration.

9 DISCUSSION AND CONCLUSION

An interesting finding is that there are very few action situations where the two main actors (Petrobras and the small farmers) directly interact in a pattern of repeated contacts. The most common pattern in the institutional relationship suggests that the interaction between Petrobras and small farmers has been mediated by third parties. These third parties can act as representatives of farmers' interests (*sem terra*); exploit entrepreneurship opportunities in the supply chain (middleman), since they have been delegated as agencies by Petrobras (Embrater); or play a mediation role as a form of regulatory imposition (oil producers obliged to buy from small farmers). In many cases, third-party actors do not directly benefit from the programme's success.

Technical assistance is the only action situation in which farmers interact with outsiders. In theory, this programme is an opportunity to create bonds through repeated contact between farmers and technical specialists. Physical contact and oral communication also

fit better with the attributes of the community and its reliance on informal rules and implicit commitments. Repeated contact can create trust. Positive experiences of advice enhance the legitimacy of specialists and the innovations they endorse, therefore reducing uncertainty. Good results also have a demonstration effect and can act as a positive display to attract more participants.

In this respect, the results of technical assistance have been somewhat disappointing. Rather than creating trust, the assistance has reinforced distrust and doubts about the programme. The community's attributes negatively shaped its assessment of the castor initiative and created a disincentive to join it. Despite a scientific assessment that the programme is highly beneficial, therefore, the farmers' perceived growing castor bean as a high-risk activity with uncertain consequences for their subsistence economies. Again, technical assistance could have been tailored to change this perception, but it was provided without adaptation to the needs of small farmers and without a mechanism to counterbalance the disincentives arising from community attributes and rules. For instance, farmers were expected to form commercial associations but they received no legal or business training and support, even when it was evident that many were only partly literate.

Assistance was perceived as a tool for control and monitoring, disguised as advice. Crucial in forming this perception was the technical specialists' resistance to engaging small farmers in decision making. Farmers wanted to decide what crop would be the most appropriate for intercropping, but the experts imposed their views.

Monitoring of others is one of Ostrom's (1980) design principles for the successful management of shared resources, and this is much easier to do when there is observability. Observability of resource use is another factor that helps mitigate conflict by increasing transparency and reducing suspicion. We suggest that both monitoring and assistance roles are crucial for the successful management of innovation (Ostrom, 1980), but the roles have to be transparent. Ambiguity creates suspicion and mistrust.

Nakao et al. (2007) emphasise how challenging it is for companies to make social and economic benefits compatible in the long term. Not only may it be the case that benefits are not attained by all stakeholders, but certain groups—such as those who are particularly vulnerable—may be negatively affected by a firm's activities (Walley and Whitehead, 1994). But if vulnerable stakeholders are "engaged" in entrepreneurial initiatives, their cooperation and honest adaptation can influence companies to make their economic goals more compatible with those stakeholders' needs (Wall and Marzan, 2006). To this end, there is an urgent need for more vulnerable groups to join the other stakeholders and the companies themselves in directing Petrobras's activities towards cooperative actions (Pater and van Lierop, 2006).

How can Petrobras engage its more vulnerable stakeholders, such as small farmers, in a way that empowers them while also contributing to sustainability? Several studies have pointed to the importance of stakeholder networks (Rowley, 1997; Roloff, 2008) and their strategies to influence (Frooman, 1999) in shaping company behaviour. Hence, if a company is to contribute to sustainability (in this case by breaking the vicious circle of poverty and lack of integration), the stakeholder management model it uses must take integrated and entrepreneurial approaches to stakeholder networks and strategies of influence. Those approaches must give priority to innovative solutions that reduce environmental deterioration and social vulnerability (Vazquez Brust et al., 2009). The quantity and quality

of entrepreneurship within stakeholder networks is a key resource for the development of innovative and sustainable solutions (Bruggman and Prahalad, 2007). Hence Petrobras should identify and engage entrepreneurs in community, political or economic networks related to small farmers.

The role of networks is also highlighted by the literature on governance. Adger et al. (2006) argue that the success of governance arrangements depends on the perception of a fair distribution of cost and benefits, demonstrated by the ability of various institutions to command trust among stakeholders. But trust is costly; it is created by repeated interactions and can quickly be destroyed by barriers to information and decision making. Bridging and boundary organisations are essential. They serve as intermediaries between arenas or levels (constitutional, collective, ordinary) and facilitate the coproduction of knowledge (Cash et al., 2006). They provide an arena for the development of linking capital and trust building through vertical and horizontal collaboration and collaborative learning processes. Bridging organisations can arise from coalitions or can build on existing institutions with high levels of social legitimacy across sectors (such as the Church). A boundary organisation could have contributed to all three important design failures in the biofuels programme: lack of arenas for engagement of final users; lack of mechanisms to build linking capital and entrepreneurship; and lack of mechanisms to offset institutional constraints.

In Brazil's northeast the community stakeholders' network includes highly resourceful groups that (though involved in the design of the biodiesel programme) had a negligible role in its implementation but can still play the role of boundary or bridging organisations. In particular, Petrobras should engage the Catholic Church, the *sem terra* grassroots movements and universities to create incentives for innovation. These organisations are part of community networks, but they also "bridge" those networks with political and economic networks. Each of these stakeholders has particular resources (legitimacy and mobilisation skills, knowledge) and commands trust at different levels (constitutional, collective, operational). The former two are powerful "informal rule makers" at the "collective-action level" and thus can help Petrobras to engage and empower small farmers.

Recent changes in the biofuels programme indicate that Petrobras is moving in the right direction to increase participation. There is evidence of more action situations and opportunities for engagement. Petrobras has begun to deal directly with small-scale farmers in the northeast, creating a new relationship. The firm has hired technical assistance, distributed seeds, and signed several contracts with small-scale farmers to pay a minimum price for castor bean. It is also fostering the creation of local associations and the use of various biodiesel sources, including sunflower and cotton, to include more farmers.

In summary, our analysis suggests that political and economic drivers shaped the design and implementation of the programme, but institutional and socio-technical innovation failed to take off because prevailing institutional arrangements created disincentives for small farmers to participate. As a result, the programme's primary and secondary effects have been disappointing as regards income generation, social inclusion, biodiversity loss and deforestation. A chief source of disincentives is small-farmers' lack of engagement in the programme design and the dominance of institutional and cultural arrangements that exclude small farmers from mechanisms that would link them to external agencies. This suggests the need for policy intervention based on repeated interactions and community governance mechanisms, building trust and common understanding about potential course of action.

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NOTES

1. Corotaton et al. (2010) analysed the global distributional and poverty effects of large-scale expansion in biofuels Overall, their results show a slight increase in poverty and inequality, with significant regional differences. Large-scale biofuels expansion is strongly associated with an increase in poverty and inequality in sub-Saharan Africa and, to some extent, in India, Russia and China. In general, there is a positive relation between biofuels expansion and GDP in Thailand, Brazil, Argentina, Indonesia and developed countries. This is partly because increases in rural wages help reverse internal migration to urban centres, thereby reducing inequality.

2. There are important differences in terms of sustainability impact between biofuels generation 1 (such as ethanol) and generation 2 (such as biodiesel). That discussion is beyond the scope of this paper. See, for instance, Zapata and Nieuwenhuis (2009) for more information about the debate in Brazil.

3. Recently. drastic changes have been observed in the programme. First, the social label scheme began to be monitored by the National Agency for Natural Gas, Petroleum and Biofuels (ANP) and some of the most important refineries have been excluded from the benefit, making Petrobras the only certified company to benefit from the social label scheme. Second, Petrobras, following the political will of the central government, has revamped the relationship between small-scale farmers and refineries.

4. Steketee (2010) argues that "sustainable development requires institutions which will encourage individuals to see their individual self-interest aligned with the common good. Institutions are central to collective action strategies, since they constrain or expand possible choices in decision-making."

5. Gibson et al. (2005) suggest following one or more of the following criteria: (i) economic efficiency; (ii) equity; (iii) adaptability, resilience and robustness; (iv) accountability; (v) conformance to general morality; and (vi) sustainability.

6. Despite the large investments that the firm is making in the market, the castor seed it buys is not presently turned into biodiesel because it has greater value for the cosmetics and pharmaceutical industries. Aside from that, the interviews have revealed that there is a technological barrier to mixing biodiesel produced from castor beans with biodiesel produced from soy. According to interviews held at the Candeias refinery in Bahia, where PBio has a research laboratory, these technological hurdles could be overcome in the next few months, but currently they prevent the full integration of small-scale and large-scale farmers.

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