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## ANALYSIS

# Reversing deforestation? Bioenergy and society in two Brazilian models

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## ABSTRACT

Year after year, the deforestation rates in Brazil are alarming and this country is one of largest consumers of biomass energy in the world. In order to respond to this scenario, Brazil has developed a vast forest potential that, by the other hand, has attracted the attention of environmental groups that struggle to reduce the establishment of large-scale exotic species plantations. To respond to both pressures (the productive and environmental), the non-governmental and the private sectors have developed two innovative and independent forms of social participation for addressing this matter. The non-governmental sector created the Forest Replacement Associations and the private companies created the Small-Farmers Forest Partners Program. An overview and an analysis of both models is presented here.

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## 1. Introduction

Five hundred years of environmental history of Brazil were characterized by the severe destruction of its ecosystems (Ceccon et al., 1999; Ceccon, 2001). The deforested area in the three most important biomes — Atlantic Forest, Amazonia and Cerrado (savanna-like) add in total 2.7 million km<sup>2</sup> or roughly 31.7% of the national territory. More recently, since August 2003 to August 2004, 26,130 km<sup>2</sup> of forests were lost, an area that accounts to the 18.6% of the land deforested in all the earth in that year, as estimated by the Ministry of the Environment of Brazil (Ministério do Meio Ambiente, in Portuguese, MMA, 2005). The worst destruction affects the

Atlantic forest, since the colonial period until today; this ecosystem has lost 93% of its original covering estimated in 1.3 million of km<sup>2</sup>. Nowadays the Araucaria forests in the south of the country exist only in 2% of the original covering. The cerrado lost 50% or 1 million of km<sup>2</sup> of the original covering after 50 years of occupation. The Amazonia lost in the last 25 years, 15% of the forest or 551,000 km<sup>2</sup> (Camara, 2005).

Around 20% of energy used in the world proceeds from renewable sources with 13–14% coming from biomass and 6% from hydric resources. Biomass represents around 25 million of petroleum barrels per day (55 EJ year<sup>-1</sup>). Low and some mid-income nations depend most heavily on wood for fuel. Five countries – Brazil, China, India, Indonesia, and Nigeria –

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account for about half the firewood and charcoal produced and consumed worldwide each year (Hall et al., 2000).

In the 70s, the world petroleum crisis and the increase of the cost of its subproducts had a decisive impact in the Brazilian forest sector. It accelerated the search for hydrocarbon substitution using alternative sources of energy. The forest energetic plantations became one of the preferred (Arruda, 1996). Back to 1993, in Brazil, 282.31 million m<sup>3</sup> of forest biomass (timber) were consumed of which 237.9 million m<sup>3</sup> of this were used for energetic purposes (84,3%), while 44.4 million m<sup>3</sup> were destined to other uses (15,7%; Arruda, 1996). In absolute terms, the amount of biomass consumed in the last ten years stood relatively stable, between 240 and 260 million m<sup>3</sup> per year. By 1990, firewood was the third source of energy in Brazil; it represented 17% of consumed energy that year (Brito, 1990). Brazil is the only country in the world that has a large steel industry that uses wood charcoal in addition to carbon coke and this industry occupies the 27th place in job generation in Brazil (ABRAF, 2006). It was estimated that the number of jobs (direct and indirect) generated by the forest sector was 3,525,059 jobs in 2005 (BRACELPA, 2007). Regarding the UN's Human Development Index (HDI), the rural cities with significant forest activities presented a relative increase of this index between 1991–2000, in comparison with the capital cities. For example, in Minas Gerais state (where the steel industry is predominant) the increase in HDI in the capital was 6.1%, while the average of four rural cities with forest activities was 15.6% (ABRAF, 2006). If the wood fuel consumed in the industry sector (40% of total consumed) were effectively commercialized, the volume of resources would surpass US\$ 500 million annually (Brito, 1990).

To respond to the large demand on wood fuel, timber and pulp, Brazil has developed a vast forest potential. The large-scale forest plantations (basically of *Pinus* and *Eucalyptus* species) occupy around 5 million ha or around 1% of the national territory (Varnola and Del Lungo, 1995). Today Brazil is the seventh country with the largest area of forest plantations after China, India, Russia, United States, Japan and Indonesia (ABRAF, 2006).

The *Eucalyptus* genus is the most widely employed and for this reason, their plantations occupy 65% of the total planted areas. Brazil has the second largest planted area with this species in the world (2.7 million ha) after India. However, in 2005 only 25% of *Eucalyptus* plantations were assigned to steel industry and 70% to cellulose and paper (ABRAF, 2006).

Due to the large areas devoted to monoculture forest plantations, environmental groups have always exerted considerable pressure to difficult the arbitrary and excessive establishment of large exotic species plantations in Brazil. In consequence, the most recent Brazilian Federal Constitution gave a special treatment to forest legislation. Since 1988, also the States and the municipal districts can pass legislation dealing with forestry (Machado, 1999). For this reason, forestry activity in some Brazilian states, faces very restrictive environmental legislation.

On the other hand, the Brazilian government has collected for more than 20 years a Forest Replacement Tax from small biomass consumers (those with a consumption less than 12,000 m<sup>3</sup> of wood per year), collected by the present Brazilian Institute of Environment (IBAMA, Instituto Brasileiro do Meio

Ambiente in Portuguese, IBAMA, 2006). The profits obtained with this tax should have been used in technical projects for forest plantations to replant what was consumed. However, forest replacement taxes were never enough for satisfying wood consumption demands. Also, according to the *Intersessional Experts Meeting on the Role of Planted Forests in Sustainable Forest Management Conference* to develop a policy which facilitates the involvement of small-scale farmers in plantation forestry is an important challenge for governments and so requiring that the non-governmental sector and the private sector to explore potential solutions and models involving small farmers (Kanowski, 2003). In order to meet the social and environmental challenges mentioned above, Brazilian private enterprises and Non-Governmental Organizations have developed interesting models involving small farmers. The present study discusses two of these models in this country.

## 2. The Forest Replacement Associations

### 2.1. Some history

The Brazilian Forest Law passed on 1965 established the obligatory replacement for all consumers of forest products. However, small consumers do not have to establish forest plantations themselves; instead, they pay a Forest Replacement Tax to the IBAMA, who should care the replacement activities, at least in theory. For more than 20 years the forest replacement tax was collected, but the replacement was never carried out sufficiently in pace intensity. Unconforming with this situation, a group of ceramists from Penapolis, São Paulo State, initiated in 1986 a civil disobedience movement to replace IBAMA as the collector of the Forest Replacement Tax. Without formal legal recognition, they created an association that began collecting the Forest Replacement Taxes and took responsibility for reforestation activities to supply locally their own consumption. Since then, other similar associations were created soon. After four years of successful, but "illegal" recovering activities, the São Paulo Department for the Protection of Natural Resources officially recognized these associations. Finally, in 1993, they were also recognized by IBAMA and officially authorized to collect the Forest Replacement Tax. The "Flora Tietê - Associação de Recuperação Florestal do Médio Tietê" (Middle Tiete Forest Replacement Association), was officially created as the first of the Forest Replacement Associations of Brazil (De Lima and Bajay, 1998).

#### 2.1.1. How the Forest Replacement Associations (FRA) operate

The Forest Replacement Associations are civil nonprofit entities, with the aim of executing, promoting and encouraging compulsive reforestation. The members are rural farmers, timber management business, small industrial and commercial firewood, timber consumers and other related institutions. Instead of paying the Obligatory Forest Replacement Tax to the IBAMA, the small consumers (such as pottery and ceramic industry, bakeries and others) pay a lower value to the FRA. With this money the FRA produce seedlings of exotic and native trees for forest replacement in the same region with lower associated costs. The reason is simple: to charge the tax, IBAMA considered the cost of seedlings and the

cost of soil preparation. The FRA produces only seedlings in a nursery near to its headquarters and distributes them to the farmers for free without charging for soil preparation. Besides paying less, the consumers see the immediate return of their money. According to Afrânio César Migliari of the Forest Replacement Associations Confederation of São Paulo State, many farmers that before dedicated exclusively their lands to agriculture and cattle breeding invest today in productive reforestation (Radiobras, 1997).

After observing the successful performance of FRA in São Paulo, The New Frontiers of Cooperative Program (NFCP, Programa Novas Fronteiras do Cooperativismo in Portuguese) joined the Development United Nations Program, to promote and stimulate the creation of FRAs all over the country. Beyond organizing informative conferences and workshops about the role and potential of FRAs, the NFCP, together with the Agriculture Ministry, distributed kits with a manual on how to create a FRA and how to build the nursery for seedlings. The FRAs produce in average 150 thousand of seedlings per month mostly of *Pinus* and *Eucalyptus* genus. In addition, the technicians of the FRA follow the development of plantations and offer technical assistance if necessary during the first five years. This is the minimal time for the tree to reach the state necessary to produce firewood (PNFC, 1997). The results of this action are encouraging: In 2000 there were a total of 17 FRAs in Sao Paulo, 12 FRAs in Rio Grande do Sul State, 4 in Bahia State, 3 in Mato Grosso State and 7 in other states (De Lima and Bajay, 2000). The first Forest Replacement Association in Mato Grosso was created in 1995, followed by two more associations and the formation of some reforestation companies after some initial corruption problems, steps are being taken to establish an effective accountable system (Viana, 2002). The Federation of Forest Replacement Associations of Rio Grande do Sul State, were responsible, in 1999, of the plantation of 31,7 million of the trees mainly of *Pinus*, *Eucalyptus* and *Acacia* genus (Süffert et al., 2007).

According to the NFPC/São Paulo, the positive results of the FRAs are now visible. Firstly, since the firewood consumption is inevitable, the wood coming from reforestation replaces the supply of raw material avoiding the deforestation of the native forests. Moreover the activity associated to reforestation has an important social impact because it favors the creation of jobs. For example, in the Ribeira valley region (São Paulo), the FRA employed 10 women in the seedling production (Radiobras, 1997).

Regarding the environmental advantages, the plantations are scattered in many small farms. Before the introduction of the FRAs, the reforestation was concentrated in only one large area and was managed by one owner. In addition, the environmental impact of large monocultures was largely reduced (Ceccon and Martinez-Ramos, 1999).

Even that there are not scientific studies demonstrating specifically the positive role of the FRAs, in the deforestation reduction rates, the Forest Institute of São Paulo, through forest inventories realized since 1962, concluded that the preserved area of natural forest in São Paulo today, is 3.8% higher than 10 years ago. This is equivalent to 126,000 ha more of native forest and there is a visible reversal in the tendency of deforestation (Fioravanti et al., 2004). In addition, according to the Forest Inventory of Sao Paulo State, there were a

reduction of around 10% in the deforestation rate, comparing the 60s with the 90s decade: between 1962 and 1971–73 there was a reduction of natural forest cover of 39.45% and between 1971–73 and 1990–92 the reduction was 29.2% (Kronka et al., 1993). Moreover, the percentage of wood charcoal consumption from native forests in Brazil was reduced between 1993 (56.1%) and 2003 (45.8%) while the consumption by planted forest increased in the same period (43.5 in 1993 to 58.2% in 2003; ABRAF, 2006). Due to the work developed by the FRAs, two basic social objectives, the improvement of life quality and the environmental sustainability seems to be in the good track.

### 2.1.2. Some lessons drawn

Nowadays the FRAs in São Paulo State give seedlings and free technical assistance but not other inputs, such as fertilizers, herbicides, insecticides, etc. Also, the FRAs do not support the farmers in the forest cutting, transportation and marketing (De Lima and Bajay, 1998).

Most of the plantation promoted by the FRAs are homogeneous using exotic species (mainly *Pinus* and *Eucalyptus* genus) and are planned mainly for supplying raw material for energy usage (De Lima and Bajay, 1998; Suffer et al., 2007). It is important to stand out that the homogeneous reforestation as promoted by the FRAs not necessarily has to be made using exotic species only; some other special recoveries might be solved using native species. The choice must be made according to specific demands and technological availability.

There is a common agreement that there is still much room for improving the performance of the FRAs. For example, it is necessary to address the level of the reforestation tax, which currently seems not to be in line with the cost of reforestation (De Lima and Bajay, 1998). Moreover, competition among farmers exists for selling their forest production, because FRA's operational territory is in many cases not well defined and overlaps with neighboring FRA's. Therefore, there is a necessity to integrate the programs of research with the particular strategies and needs of consumers. One first initiative could be identify the main problems faced by associates of the program to carry out the plantations while promoting research to solve them. A survey carried out with small farmers in Minas Gerais, Brazil, revealed that it was most important to research on agroforest systems using *Eucalyptus*, because small farmers often had small land surface and, in this case, *Eucalyptus* associated with crops could make the forest plantations more attractive economically for the farmers, since they would serve to save work force in the plantation maintenance while helping in the production of food. In this case, it was very important to identify which agriculture crop would offer the best advantages while associated with the *Eucalyptus* (Ceccon, 1999, 2005; Ceccon et al., 1999). A potential way to explore this is that consumers engage closely with some of the programs. In summary, it is essential that these programs are integrated and articulated among them. New approaches such as mixed plantations, plantations with multiples species, agroforestry and small farm silviculture are generating interest. Finally, the FRAs are audited by the State Department of Natural Resources Protection (Departamento Estadual de Proteção de Recursos Naturais in Portuguese) and there is some degree of concern regarding the transparency of some

FRA administrative operations and the lack of enough state resources to carry out the audits efficiently. It is important to remark that the Sao Paulo State (source of FRAs) has a deficit of 500,000 ha of planted forests, because the consumption had exceeded the increases of plantation areas, even though changes have occurred in the structure of the consumption of forest products (Florestar Estatístico, 2005). It is clear that steps have to be made towards the improvement of these aspects.

### 3. The Small-Farmers Forest Partners Program

#### 3.1. Some history

It is generally accepted that the *Eucalyptus* genus was introduced in Brazil in 1904 by Edmundo Navarro de Andrade, as a substitute for native forests aimed to provide wood crossties for the railroad companies. He pioneered the establishment of the first commercial plantation of that genus in the country in São Paulo State. From 1909 to 1965, about 470,000 ha of *Eucalyptus* were planted in Brazil, both by the government and by private companies (Couto and Betters, 1995). Despite of this colossal project, little, if anything, was known about the silvicultural and ecological needs of the introduced *Eucalyptus* species in Brazil. *Eucalyptus* was established across the country in a variety of soil and climatic conditions. Availability of land and low land prices stimulated most of the reforestation projects at that time. Ecological zoning or use of certified seeds of the correct provenance to ensure the success of the plantations was not considered as important issue (Golfari, 1978).

Since 1965, with the introduction of fiscal incentives for reforestation, the planted area increased from 500,000 to 3 million ha. By that time, criticism concerning the alleged harmful effects of the *Eucalyptus* on the environment grew. *Eucalyptus* were said to adversely affect the soil, the water cycle, wildlife, biodiversity, and local vegetation (Ceccon and Martinez-Ramos, 1999). These concerns were being expressed in Mexico, India, Portugal, Spain, and the United States where *Eucalyptus* also had been introduced (Couto and Betters, 1995; Ceccon and Martinez-Ramos, 1999).

In the late 1970s, Lamberto Golfari, an expert from the Food and Agriculture Organization (FAO) of the United Nations (UN) introduced the ecological zoning concept as an aid for reforestation with *Eucalyptus* and *Pinus* (Golfari, 1978). He established a network of species and provenance trials to compare *Eucalyptus* species and provenances in the various regions in Brazil. Currently, Golfari's ecological zoning for reforestation with *Eucalyptus* is being improved and refined by state owned research institute EMBRAPA and the Federal University of Viçosa, resulting in a new technology that incorporated more climatic, ecological and edaphic variables (Tristão, 1992; Reis and Reis, 1993). With ecological zoning and the introduction of new species and provenances combined to better silvicultural and management practices, productivity of the *Eucalyptus* plantations during the 1980s improved substantially (Reis and Reis, 1993).

In 1988, the fiscal incentives offered for reforestation were eliminated by the law 7714/88, closing a very important chap-

ter on the development of the Brazilian forestry sector. As a consequence, this sector has to be restructured and the actors involved had to reduce enormously the investment on research and development. At the same time, most of them had to implant "total quality programs" looking for the certification for their product (Reis and Reis, 1993).

Currently, as stated before, local governments can pass legislation dealing with forestry issues with independence of the federal level (Machado, 1999). As a consequence, according to Couto and Betters (1995), in the São Paulo State forest companies are not allowed to use controlled fires as a management tool in any phase of plantation. Also in Espírito Santo State, the companies cannot buy new lands to establish *Eucalyptus* plantations. They only can operate on land that they already own and improve its productivity or engage in Small-Farmer Forestry Partnership Programs (SFFPP) to increase their supply of wood.

In Brazil, private companies often have their own lands for *Eucalyptus* large-scale plantations (Couto and Betters, 1995). However, in the last decade there was a significant increase in the price of land surrounding forest companies. Simultaneously, there was an increase of the costs of wood charcoal (for steel companies) or stems (for pulp and paper companies) transportation to the companies steel plant sites (Couto and Betters, 1995). On the other hand, the rapid forest growth rates are generally coupled with the excessive use of site resources, which raises questions regarding both plantation ecological impacts and the sustainability of wood production (Singh and Kohly, 1992; Lima, 1993; Ceccon and Martínez-Ramos, 1999). For this, as mentioned above, several governmental restrictions emerged on large plantations mainly in southeastern Brazil. Also, the international and national community exerted considerable pressure on countries with large forest plantations. Organizations such as the World Bank and the Inter American Bank started linking loans to the obligation of considering environmental aspects in the projects for which they were seeking funds. Some European countries are refusing to import forest products from tropical countries if the products originated from forest companies that do not comply with their specifications regarding environmental widely accepted code (Siqueira, 1990).

In 2005, the enterprises within the Brazilian Association of Planted Forest Producers (ABRAF, Associação Brasileira de Produtores de Florestas Plantadas in Portuguese) developed Small-Farmers Forest Partners Programs in more than 400 municipalities in several states, counting 258,000 ha of planted forests, that expanded around 16% of the area in relation to 2004. There was a direct participation of 9736 small and medium farmers in these programs. Relating to the enterprises, in 2005, 81.2% of the planted areas were their own, 7.9% were leased and 10.9% were available through the Small-Farmers Forest Partners Programs (ABRAF, 2006).

#### 3.2. How the Small-Farmer Forestry Partnership Program operates

With so many restrictions introduced by law, the companies involved in reforestation had innovated on new models for plantation management. Some forestry companies are adopting the strategy of forming partnerships with small local



farmers for forest biomass production. There are different versions of the Small-Farmer Forestry Partnership Program: (i) donation or sale of tree seedlings; (ii) anticipated fees to the farmer for forest plantation; (iii) leasing of land by the enterprises; (v) partnerships (Radiobras, 1997). The most common are the partnership programs, where farmers provide land and the workforce, while the forest companies provide support with *Eucalyptus* seedlings, fertilizers, and technical assistance. After the harvest, a part (circa 21%) of the economic return is given proportionally to the initial investment made by both parties. The farmer can sell the remaining timber to the company that offers the best price (Ceccon, 1999).

On the signing of the contract between the industry and farmers, capital is provided in the form of inputs, equivalent to US\$ 350/ha. This is then repaid in the form of “n” cubic meters of wood in the future, based on the market price on the signing date of the contract. In general, the farmer uses between 18 and 30% of the total wood production in order to pay back the loan (Carneiro de Miranda, 1998). The per-farm area contracted typically ranges from less than 2 ha (Riocell Co.) up to about 50 ha (Bahia Sul Co.). The average per-farm area planted with trees represents from 10 to 30% of the average total of farm area (Larson and Rodrigues, 1994).

### 3.2.1. Benefits for the companies

The SFFPP is highly advantageous for the companies mainly because the transportation costs are reduced since the plantations are near to the steel mills. Also they do not need to spend money on land acquisition, infrastructure and staff (Ladeira, 1992; Sungsumarn, 1993). Furthermore, the plantations can be part of the Integrated Forest-Industry Plan (PIFI, in Portuguese) that demands to the large consumers to have 100% of their wood supplies coming from their own reforestation. All this combined results in considerably savings. It is estimated that a SFFPP will reduce the company costs to about one quarter of the original budget if the plantation has to be made with their own resources and administration (estimation made for a 6 years-old plantation including capitalized interests, see Capitani et al. (1992). Compliance with environmental and forest regulations, e.g. consuming sustainable fuel wood, carries a significant public relations value. Other benefits include the reduced risk of shortages owing to a guaranteed supply of wood charcoal near industrial plants and the strong, positive image that the industries project in the region by supplementing the incomes of local farmers.

### 3.2.2. The social benefits

The main social benefit, perhaps, is the emergence of new sources of income for the small farmers and opportunities of work force occupation. Also, local partners can benefit from high-quality planting materials, technical assistance, quality control, investment resources for expansion and marketing and business expertise (Scherr, 2004).

There is an extra profit due to the use of otherwise idle lands under the productive point of view. Also, there is the possibility of using part of the produced wood to supply the small-farmer own wood demands and with the extra of having a guaranteed market for selling the surplus wood. In addition, the small farmers may engage in agroforestry practices by associating the planted trees with valuable agricul-

ture crops in the first years of the tree plantation. This last would increase the advantages of the partnership program (Sungsumarn, 1993; Couto and Betters, 1995; Ceccon, 1999). In addition, the agroforestry practice can eliminate the need for weed control operations and reduce the overall cost of *Eucalyptus* plantation maintenance for the farmer (Couto and Betters, 1995).

The SFFPP, without the association with crops, can generate a profit of approximately US\$ 200 ha<sup>-1</sup> year<sup>-1</sup> for the small-farmer out from a land that is not usually productive under agricultural crops (Carneiro de Miranda, 1998). Also, the concentration of land ownership by forestry companies is reduced and so a highly political sensible issue is lessened. Finally, the lower cost of wood production makes the final product (steel, pulp, etc.) more competitive and profitable, which may imply macro-economic benefits for the region and/or the country.

### 3.2.3. Benefits for the environment

Scattered small plantations embedded within the agriculture and natural forest mosaic landscape reduces drastically the environmental impacts of large plantations (Ceccon and Martinez-Ramos, 1999). On the other hand, due to a larger offer of wood from small-farm plantations, there is the potential for an improvement of the local environment because of the reduced pressure to cut natural forests.

## 3.3. Some lessons drawn

It is often cited that in many cases the relationship among enterprises and small farmers generate unsustainable patterns of resource exploitation and unfair profits for the farmer communities (Viana et al., 2002).

At the present, technical assistance given to farmers is not always adequate, e.g. in selecting the most appropriate areas for planting. Also, in some regions, there are difficulties with seedling and fertilizer distribution and supply. There may be problems with certain environmental precautions such as avoiding acute slopes and preventing fire (Capitani et al., 1992). In some cases there is an abuse in the land use because lands that are agricultural-grade are diverted to forest production (Assis et al., 1986). An already explored solution for this last case is the adoption of agroforestry systems, at least in the first years of the plantation (Couto and Betters, 1995; Ceccon et al., 1999; Ceccon, 2005).

The Brazilian small farmer is usually decapitalized and in many times do not have the means to invest in the items not subvented by the partner-companies, such as the rent of the tractor, pesticides, work force, etc. (Ceccon, 1999). Small farmers also face unpredictable risks that may result in the loss of the forest production. A good example is termite attacks (very common in Brazil) that obligate the farmer to spend already-scarce resources in solutions that not always work (Ceccon, 1999). As a matter of fact, it is impossible to ignore the financial difficulties that face the Brazilian medium and small farmers, with very low levels of income and standards of living that prevent the access to modernization (Nora, 1997). For the foregoing reasons, small farmers are eager to be incorporated in these partnerships because they would access modern technology and may indeed obtain some financing for

a significant part of the plantation costs. The attractiveness of the SFFFP for small farmers increases substantially because of the possibility of associating the tree plantation with annual agriculture crops (Cecon, 1999).

#### 4. Conclusions

Forest plantations for the production of biomass have a considerable impact on the regional economies in Brazil and involve from large-scale consumer industries to small farmers. Because of this, they have attracted special attention from the non-governmental sector, environmental groups, private companies and the government. As a consequence, new models have been introduced that promotes social participation and are environmentally more sustainable for forest biomass production. These two models, forest associations and partnerships have contributed substantially for the increase in the labor market, creation of new income sources for the local population while having a potential role in the reduction of deforestation, in the environmental preservation and the more rational use of natural resources. In Brazil, credit acquisition and adequate forest-agricultural management are usually the main difficulties that companies and small farmers confront. These two models despite various problems are alternatives worth imitating and improving by other countries facing similar conditions and perspectives, like Nicaragua (Moreno, 2001).

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