EFFECTIVENESS OF A NON-GOVERNMENTAL ORGANIZATION (NGO) EXTENSION PROGRAM FOR FOREST CONSERVATION AND SUSTAINABLE AGROFORESTRY IN SOUTHERN BAHIA, BRAZIL

By

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This study provides an evaluation of the Jupará Agroecology Project**,** an integrated conservation and development project (ICDP), as a strategy for sustainable agriculture and forest conservation in the vicinity of a protected area. The Jupará project was launched in 1995 in partnership with WWF, and provided extension services to 35 communities. Jupará set the following program goals: implementation of target agroecological practices, organic certification, increased family incomes, and maintenance of 30% of the community area in forest and 40% in agroforestry systems.

This study addresses the following research questions: Are families that participated in the Jupará project meeting these goals? How do family dynamics and size of landholding influence project implementation? Are project results consistent in different types of communities?

Three communities were selected for analysis. A total of 65 household interviews were conducted with participating and non-participating families. GPS points and basic vegetation data for five land cover types were collected for each household. A participation score was assessed for each family and multiple regressions were used to analyze the effect of participation and other socioeconomic variables on program outcomes such as use of agroecological practices, farm income, and forest and agroforestry cover. For one community, analysis of Landsat imagery was used to verify land cover distributions and to assess change in land cover over time.

Results of interview data show that participation in the Jupará program positively influences the implementation of agroecological practices and farm income, but does not influence land cover distribution or the maintenance of forest reserves by individuals.

Successfully implemented agroecological practices included the use of organic fertilizers and composting, contour erosion barriers, diversification of agroforestry systems, and the elimination of burning and agrochemicals.

For two of three communities, much of the forest cover was converted to agroforestry long before the Jupará project began. One community reported an average of 8% forest cover, and the second reported 35%, including a community reserve. Many farmers maintain no forest reserve. The third community maintains 40% of its total area as a community-managed reserve.

Analysis of Landsat data showed that the overall distribution of forest, agroforestry, and open areas remained almost constant between 1986 and 2001; however, forested areas increased on participants' lots, indicating that participants may be more likely to allow forest regrowth to create forest reserves.

CHAPTER 1
INTRODUCTION

All around the world, conservationists have observed that long-term and large-scale conservation of endangered ecosystems will require the participation of their residents (Murniati et al. 2001; Schwartzman et al. 2000a; Schwartzman et al. 2000b). Conservation programs have used various strategies to enlist local participation in conservation efforts, including strategies for sustainable agriculture, extraction of non-timber forest products, ecotourism, and payments for environmental services. Projects which include both a conservation component and an economic development component have come to be known as “Integrated Conservation and Development Projects” or ICDPs.

ICDPs have been criticized for being expensive to implement and for focusing on development and producing too few tangible conservation results (Brandon et al. 1998; Brechin et al. 2002). A close examination of literature on such projects, however, reveals that few ICPDs have been rigorously evaluated. To understand the most effective ways to involve local people in conservation efforts, it is important to understand the strengths and weaknesses of past projects, as well as the results these projects have produced or failed to produce.

This thesis developed out of the long-term collaboration between Dr. Robert Buschbacher and a small conservation NGO in Ilheus, Brazil, Jupará, *Assessoria para o Desenvolvimento Agroecologico de Comunidades Rurais* (Organization for Agroecological Development in Rural Communities), and the practical need for an evaluation of some of Jupará's ongoing projects. Jupará works primarily with land reform communities, and also some traditional rural communities, throughout the Atlantic Forest of Southern Bahia. Land reform communities are communities established relatively recently, within the last 30 years, through a government land reform program which donates farmland to landless workers. Traditional communities also exist in this region. In these cases, land has been passed down from father to sons for many generations.

In 1995, Jupará began collaborating with WWF to promote diversified agroforestry, organic agriculture, and forest conservation in communities in the buffer zone of the Una Biological Reserve. Concrete outcome goals were set at the start of the project, including the implementation of organic agricultural practices and the maintenance of 30% of each community's area in natural forest reserves and 40% in agroforestry systems. As with many conservation projects, funding constraints prevented any rigorous evaluation or monitoring of the extent to which these outcome goals were met (Buschbacher in prep.).

The Jupará project has been ongoing for more than 10 years and offers a suitable example for an in-depth analysis of the outcomes of a conservation and development project in a critical conservation area, the Atlantic Forest. This research examines the success of the project at the level of individual families in several different communities. Household interviews were carried out in three communities, and a remote-sensing analysis of land cover change at the property level was conducted in one of the three communities.

This thesis is presented in three parts. Chapter 2 was written as an independent document, suitable for eventual publication. It focuses on the contribution of this research toward a better understanding of the function of integrated conservation and development projects in the buffer zones of protected areas, as well as innovation adoption by smallholders. Within this framework, chapter two describes the Jupará project in greater depth, including its outcome goals, and presents interview data collected in two of the three study communities, Fortaleza and Lagoa Santa. Fortaleza is a 30-year-old land reform settlement and Lagoa Santa is a traditional agricultural community that has been in place for many generations. Farmers in these communities produce a variety of products in mixed agroforestry systems, including rubber, cacao, cloves, palm fibers, and fruit. Both participating and non-participating families were interviewed about their participation in the project, their use of the project's target agroecological practices, their land use patterns, including implementation of agroforestry and conservation of native forests, and a number of socioeconomic variables which might affect their ability to meet the project goals.

Chapter 3 is intended to complement Chapter 2 and to give readers an idea of Jupará'a future directions. Data was collected in a third community, Cascata, using the same methods presented in Chapter 2. Cascata's case is presented separately because this community is very different and not easily compared to the other two. Cascata is a new land reform community, about 8 years old, and entered the Jupará project more recently. The community is situated on a former cacao plantation, and rather than each family settling on an individual parcel of land, families live in a central area, with production areas located around the perimeter of the community. Farmers produce cacao almost exclusively. Each family is assigned a small parcel of cacao to harvest, but the processing and sale of cacao takes place collectively. This chapter focuses on Jupará's participation in the agrarian land reform movement. Recently, Jupará has focused their efforts on such newer land reform communities, often on cacao estates, and work in these communities offers opportunities and challenges which are distinct from those found in older communities.

Chapter 4 is also intended as an independent article suitable for publication. This chapter presents an analysis of land use change in Fortaleza using Landsat imagery from 1986, before the implementation of the Jupará project, and 2001, the most recent image available. GPS points collected in the field were used to identify areas of forest, agroforestry and forest regrowth, and cleared areas such as annual crops or pasture. Maps provided by INCRA, the federal agency responsible for land reform, were used to identify individual properties within the community. Land use change on participants' properties is compared with non-participants' and former participants' properties, and the community forest reserve area is also assessed. Land use observed on the imagery is compared to land use data collected through interviews.

Chapter 5 presents a brief conclusion synthesizing the results and conclusions of the three previous chapters.

CHAPTER 2
EFFECTIVENESS OF AN NGO EXTENSION PROGRAM FOR FOREST CONSERVATION AND SUSTAINABLE AGROFORESTRY IN TWO COMMUNITIES IN SOUTHERN BAHIA, BRAZIL

Introduction

In many developing countries, agriculture is the principal livelihood of the rural poor, accounts for a large percentage of land use, and is probably the single most powerful influence on environmental quality (Scherr 2000). The interrelated themes of agricultural growth, environmental quality, and rural poverty alleviation have been called the “critical triangle” of development objectives (Vosti et al. 1997). As rural populations grow, pressure on the natural resource base increases, leading to both environmental degradation and declining food security and human health. This is especially true where people’s access to land is limited to poor quality or environmentally fragile lands (Scherr 2000).

The “critical triangle” becomes even more important in the regions surrounding protected areas in the tropics. Parks and reserves can preserve only a very small percentage of fragile or endangered ecosystems, in the late 1990s, reserves encompassed around 5% of land worldwide, according to one estimate (Terborgh 1999). As Schwartzman et al. (2000b) point out, this small and often fragmented percentage is unlikely to conserve much biodiversity in the long term, and, as they state, “the rest of the forest is already inhabited.” Thus efforts to protect more biodiversity than that contained in parks will depend on local people and their ability to prosper in and around protected areas on a sustainable basis.

Working within this political and economic reality, projects have emerged to work with communities in the buffer zones of protected areas to improve natural resource management practices and intensify production systems in a way that increases incomes but directs use away from the core protected zone (Brechin et al. 2002; Murniati et al. 2001). These projects are known as "Integrated Conservation and Development Projects," or ICDPs.

The conservation component of an ICDP might include protecting forests or wildlife within a community, or avoiding the use of a nearby national park for hunting or extraction of resources. The development component usually includes a production strategy to help improve the livelihoods of the participants in an environmentally benign way. Development projects often include ecotourism or agroforestry.

This study presents a comprehensive evaluation of an ICDP for forest conservation and sustainable agroforestry, the Jupará Agroecology Project in Southern Bahia, Brazil. The study evaluates the adoption of agroforestry practices by families in two communities as well as the patterns of forest conservation or deforestation both on individual family lots and community-owned property. This research helps to better explain the effects of the intervention of an ICDP on the adoption of agroforestry practices by individual families, as well as family and community commitment to forest conservation.

Agroforestry Adoption

Literature on agroforestry adoption evaluates farmers' abilities to implement agroforestry systems and other conservation agricultural practices. Adoption studies sometimes evaluate the effects of a specific program or intervention (Bannister &

Nair 2003; Browder & Pedlowski 2000; Browder et al. 2005; Neupane et al. 2002). Many studies either assume that all farmers have been exposed to some specific new practice and correlate adoption of new practices with socioeconomic variables, or interview only adopters of a particular practice (Bannister & Nair 2003; Cooms & Burt 1997).

A review of agroforestry adoption papers, published between 1995 and 2001, by Pattanayak et al. (2003) reports that participation in extension programs was considered as an explanatory variable in only 10 of the 32 studies reviewed, but positively influenced adoption in 9 of these 10 cases. Adesina and Chianu (2002) in Nigeria, and Boahene et al. (1999) in Ghana both demonstrated that contact with an extension agent had a significant positive effect on farmers' adoption decisions. In another adoption study carried out in Nepal, Neupane et al. (2002) found that membership in an NGO positively influenced agroforestry adoption by males but negatively influenced adoption by females.

A Brazilian example of a project-based agroforestry study analyzes the Rondônia Agroforestry Pilot Project (Browder & Pedlowski 2000, Browder et al. 2005). The 2000 study compared successful agroforestry plots established through the project with unsuccessful ones and identified some of the causes of plot failure, including biophysical variables such as inappropriate plot location, and household-level variables such as lack of labor or family illness. The 2005 follow-up study compared successful participants with non-participants, and found that non-participating neighbors of successful participants were also likely to adopt agroforestry.

Most studies on adoption of agroforestry practices by smallholders in the tropics have focused not on a specific project intervention but on the relationships between other socioeconomic variables and a family's likelihood to adopt new practices. Variables that generally have a positive influence on a farmer's ability to adopt agroforestry practices include age of household head (Bannister & Nair 2003), education (Boahene et al. 1999; Neupane et al. 2002), size of landholding (Adesina & Chianu 2002; Cooms & Burt 1997; Scherr 1995), availability of labor (Adesina & Chianu 2002; Cooms & Burt 1997; Scherr 1995), male gender of farmers (Adesina & Chianu 2002; Cooms & Burt 1997; Scherr 1995), membership in community organizations (Browder & Pedlowski 2000; Neupane et al. 2002), socioeconomic level (Scherr 1995), agriculture as the primary source of income (Simmons et al. 2002), and secure land tenure (Adesina & Chianu 2002; Bannister & Nair 2003; Simmons et al. 2002).

Many of these studies take a general survey of a large number of households and compare groups of households, often adopters and non-adopters (Bannister & Nair 2003), or project participants with non-participants (Browder et al. 2005), or both (Browder & Pedlowski 2000; Neupane et al. 2002). This study offers a more in-depth assessment of a smaller number of households. Rather than comparing groups, we developed indices, based on detailed interviews, to measure the extent of participation and adoption by both participating and non-participating families. In addition, the effects of several other socioeconomic variables are considered, drawn from this literature on the adoption of agroforestry practices.

Several authors have identified a need for further research on agroforestry adoption in Latin America (Mercer 2004; Pattanayak et al. 2003). Despite the prevalence of agroforestry in Southern Bahia, few agroforestry adoption studies have been published on this region. Several studies simply describe the biophysical characteristics of common agroforestry systems in the region (Alvim & Nair 1986; Rice & Greenberg 2000). A few studies focus on the social aspects of agroforestry systems and adoption decisions. Alger and Caldas (1994) surveyed Bahian cacao farmers on their land use practices and attitudes toward conservation, and found that the poorest farmers on the smallest lots or with the poorest soils were more likely than farmers on better quality lands to continue to replace forests with subsistence crops rather than agroforestry, and are more likely to use bananas or fruit trees to provide shade for cacao than to use the traditional *cabruca* system, which maintains native trees for shade cover. Johns (1999) interviewed cacao producers on medium-sized farms on their attitudes toward the importance of shade cover, and found that farmers resisted removing shade trees, even when encouraged to do so by a government extension program. Trevizan (1999) interviewed cacao farmers in newly settled and older communities with respect to "environmental risks," including deforestation and destructive agricultural practices, and concluded that new settlements do not present significantly more environmental risks than older ones in terms of agricultural practices and deforestation.

In general, agroforestry adoption studies report farmers' adoption of one or several specific practices. While the practices themselves may be environmentally beneficial in terms of soil conservation, pest control, or reduction of agrochemical use within the agricultural system, these studies do not relate the use of sustainable practices within an agricultural system to a broader level of conservation across a farmer's property or across a community-wide landscape. This study takes the idea of agroforestry adoption one step further, by asking whether or not farmers who adopt agroforestry practices are likely to also conserve forests.

Integrated Conservation and Development Projects

Published reviews of ICDPs worldwide have yielded mixed results, and in many cases, criticism of the ICDP concept as a way to manage protected areas. Many have argued that conservation programs should not "become diluted with social goals like poverty reduction and social justice (Brechin et al. 2002)" and should simply focus on nature protection and leave the work of social development to other organizations (Brandon et al. 1998; Kramer et al. 1997). "What we know," writes (Brandon et al. 1998), "is that alleviating poverty will not necessarily lead to improvements in biodiversity conservation." Terborgh (1999) asserts that a successful ICDP will actually increase pressure on a protected area, by attracting newcomers to its perimeter.

Case studies support many of these claims. Kamugisha et al. (1997) published a collection of case histories of various programs surrounding four national parks in Kenya and Uganda and didn't find a single conservation and development program that they felt supported local livelihoods successfully enough to slow encroachment into parklands for grazing, water sources, and farmland. In a similar review of 20 ICDPs in Indonesia, Wells et al. (1999) stated that while monitoring and performance data are incomplete, very few Indonesian ICDPs can realistically claim to have enhanced biodiversity, and the most promising projects are unlikely to be financially feasible over the long term. The authors suggest "a strategic reorientation" of international biodiversity conservation funding. Similar assertions are made by Peters (1998) with reference to a project in Madagascar and Blom (1998), citing efforts in the Central African Republic.

Other authors are more optimistic. Murniati et al. (2001) demonstrated that families maintaining highly diversified agroforestry systems in the buffer zone of Kerinci National Park in Indonesia were less dependent on park resources than families with less diversified farms. Albers and Grinspoon (1997) offer a comparison of two national parks in China, one using a policing and punishing strategy, and the other using an ICDP involving agroforestry systems of rubber, tea, and the resin producing tree *Amomum villosum* along the park's perimeter. The ICDP controlled park degradation more effectively than the policing strategy. Browder (2002) applied the ICDP concept to the Rondonia Agroforestry Pilot Project in the Brazilian Amazon, and reported that in 50% of communities, the projects delivered tangible economic benefits. Preliminary environmental data show that regions adopting the agroforestry plots promoted by this ICDP had a lower deforestation rate than neighboring regions from 1995-1998.

Both supporters and critics of Integrated Conservation and Development Projects identify a need for improved evaluation and monitoring of projects (Brechin et al. 2002; Browder 2002; Johnson et al. 2001; Kamugisha et al. 1997; Kremen et al. 1994; Wells et al. 1999). Many projects simply have not been in practice long enough to determine their long term effects. If ICDPs are in fact an ineffective means of managing protected areas, then the next important step is to ask why. Is the IDCP approach a failure, or have we yet to develop adequate programs to pursue conservation and development goals equally well (Brechin et al. 2002)?

This research is unique in that it provides an in-depth evaluation of an ICDP by considering both the effects of the project intervention and of other causal variables drawn from agroforestry adoption literature. The analysis is carried out at the level of individual families in two communities and includes families who participated in the ICDP and families who did not. The Jupará project has been ongoing for more than 10 years in communities throughout Southern Bahia, and offers a suitable example for measuring the long-term outcomes for both conservation and development in a variety of types of communities.

Research questions

This project provides a comprehensive evaluation of the outcomes of one ICDP, the Jupará Agroecology Project, carried out in the region of the Una Biological Reserve in Southern Bahia, Brazil. Jupará, a Brazilian NGO, launched an extension program in 1995, in partnership with WWF, to promote diversified agroforestry, organic production, and forest conservation among agricultural communities in Una's buffer zone. The Jupará-WWF project set some very specific conservation goals for the communities in which it worked. Each community was expected to maintain 30% of its total area in forest cover (20% forest cover is required by Brazilian law), and 40% in agroforestry systems. The remaining 30% could be used for non-agroforestry crops, livestock, or other uses. Other goals included the appropriate use of agroecological practices, diversity of agroforestry systems, organic certification, and increased family income (Buschbacher in prep.).

Participatory mapping and interviews with producers in two Jupará communities were carried out in June – August 2005 to address the following research questions:

- Are families that participated in the Jupará Agroecology Project meeting project goals for forest conservation and use of agroecologial practices?
- Are results consistent in different types of communities, including land reform communities and traditional communities?
- How do family dynamics and size of landholding influence project implementation?

Study Area

The Atlantic Forest, which once covered much of the eastern coast of Brazil as well as parts of Argentina and Paraguay, is one of the world's most diverse ecosystems, and also one of the most endangered. Due to intensive human occupation, only about 7% of the forest remains intact, according to a recent mapping project (Hirota 2003). The region is home to 108 million people, or about 60% of Brazil's population (Hirota 2003). The Atlantic Forest Biome is on the Global 200 list of globally outstanding ecoregions, and is considered a Biodiversity Hot Spot. The region supports over 1600 species of terrestrial vertebrates and 20,000 species of vascular plants, and including more than 6000 endemic plant species and more than 500 endemic animal species (Mittermeier et al. 1999). Within southern Bahia, researchers have documented extremely high tree diversity (Thomas et al. 1998), and 50% of the known endemic bird species of the Atlantic Forest (Aguiar et al. 2003).

The cacao growing region of southern Bahia contains some of the largest remaining patches of Atlantic Forest, including the 11,000 hectare Una Biological Reserve. Currently about 6,500 km^2 of *Theobroma cacao*, a medium-sized understory tree, are planted in this region (Aguiar et al. 2003). Many maintain some of the original forest canopy or are interspersed with patches of natural forest (Alger 1998; Alves 1990; Buschbacher in prep.). This region's cacao agroforests have generated considerable interest within the conservation community for their potential to maintain forest-like landscapes and serve as biological corridors between blocks of otherwise fragmented forest (Alger 1998; Alves 1990; Greenberg et al. 2000; Pardini 2004). Researchers in many countries have demonstrated that while agroforestry systems are no substitute for intact forest, some wildlife species are able to use cacao-based systems to some extent as a corridor between areas of more suitable habitat, with more diverse systems providing more suitable habitat than less diverse systems (Alves 1990; Greenberg et al. 2000; Laurance 2004; Reitsma et al. 2001). Pardini (2004) carried out such a study on small mammals on fragmented areas of the Una Biological Reserve.

Historically, cacao in Bahia was produced on large plantations with hired labor. Many of these plantations were planted under the *cabruca* system, in which some of the forest's original overstory trees were left for shade and the understory was cleared for cacao planting (Alves 1990). The cabruca system required smaller labor investments than clear-cut systems, and so was amenable to largely absentee estate owners (Ruf & Schroth 2004). On some estates, cacao is planted as a row crop, alone or with a single overstory species, often rubber or fast growing non-native trees that provide shade. The arrival of witches broom disease (*Crinipellis perniciosa*), a fungal disease, in 1989 (Alger & Caldas 1994), combined with a decline in cacao prices at around the same time, led to the abandonment of many plantations or to their conversion to pastures for cattle, and to the felling of remaining large trees (Alger

1998; Ruf & Schroth 2004; Trevizan 1998). Today much of the cacao produced in Bahia is produced by small and medium-sized landholders, because of the labor intensity required to control the disease (Rice & Greenberg 2000).

The cacao crisis in Southern Bahia helped facilitate the agrarian land reform movement in this area. High unemployment rates resulted in an increase in unemployed workers becoming involved in the land reform movements, including the Movimento dos Trabalhadores Rurais Sem Terra (MST) and others (Trevizan 1998). With little prospect of future earnings in cacao, owners of the once-lucrative cacao plantations were willing to sell their land to the Brazilian government for redistribution among landless settlers (Buschbacher in prep.).

Depending on the biophysical conditions of the site, many producers in Southern Bahia maintain diversified agroforestry systems rather than cabruca systems. These may include cacao, rubber, cloves, black pepper, guaraná, oranges and other fruit trees, and various palm species. Jupará has worked with both diversified producers and cacao producers, and with both agrarian reform settlements and traditional communities.

Jupará Project History

Jupará is a Brazilian community development organization with origins in the Catholic Church and the labor movement, which has been providing assistance to both agrarian reform communities and traditional agricultural communities in Southern Bahia since the 1980s. In 1994, Jupará entered into a partnership with WWF. WWF was interested in the conservation of forest fragments in the buffer zone of the Una Biological Reserve, and in particular the preservation of habitat for the golden headed lion tamarin (*Leontopithecus chrysomelas*), an endemic primate species. The Una Reserve was created specifically to protect this species, but studies have determined that the reserve is not large enough to guarantee the long-term survival of the golden headed lion tamarin (Deitz et al. 1994).

The Jupará-WWF project exemplifies the dual purpose of ICDPs, encompassing the main goals of both partner organizations; to develop a model for family agriculture that would both promote forest conservation among landowners in Southern Bahia, and improve the socioeconomic conditions of families living in the area (Buschbacher in prep.).

Beginning in 1995, Jupará formed several extension teams who began working in 36 communities in the area, providing training in community leadership and organization, and agroecological practices, such as the use of contour erosion barriers, green manures and cover crops, organic fertilizers and composting, integrated pest management, and diversification of agroforestry systems. Target practices are described in greater detail in Table 2-1. Agroforestry is the most common agricultural system for smallholders in Bahia, as most of the region's traditional cash crops are tree crops, including cacao, rubber, cloves, palm fiber and fruit. Therefore, the training was oriented more toward improvement of current agroforestry systems and the use of organic methods rather than actual agroforestry adoption. As a result of this training, 338 families in 14 communities received organic certification in 2002, including 9 settlements in which 100% of families received organic certification (Buschbacher in prep.).

Table 2-1. Description of target agroecological practices.

1. Use of Organic Fertilizers. Four types of organic fertilizers were promoted by Jupara: Commercial Organic Fertilizer – Jupará produces this fertilizer and sells it to farmers. Homemade Liquid Organic Fertilizer – A type of compost tea, using manure and other organic ingredients, that Jupará extensionists taught farmers to make for themselves. Compost – Composting of organic materials such as cacao shells and food scraps. Produces a small amount of fertilizer, usually used for cacao seedlings. Green Manures – Nitrogen fixing plants that are planted either between crops or during a fallow period and allowed to decay on site. Can be used to improve soil quality or control erosion; farmers also report using green manures to control ants. Species commonly used were canavalia *(Canavalia enisformis)* and pigeon pea *(Cajanus cajan)*.
2. Use of crop rotation. Rotation of the location of crops from year to year. An annual crop should be followed by a crop from a different family. In agroforestry systems, annual crops are gradually replaced by perennial and tree crops.
3. Multicropping. More than one species is planted in each field. Tree crops might be planted with annual crops or several tree crops planted together.
4. Mulching. Use of mulches such as leaves or cacao shells, usually around the base of trees, to add nutrients and control erosion.
5. Contour erosion barriers. Planting along the countour, with the creation of some kind of barrier to control erosion and gradually form terraces perpendicular to the slope. The barrier is usually created by piling up the organic residue (weeds and fallow vegetation hand cleared in preparation for planting) in contour rows. Typically, annual crops are planted in the cleared area between the rows of residue, and tree crops are planted in the rows. This way of treating the organic residue is an alternative to burning; it is labor-intensive but promotes long-term soil productivity.
6. Elimination of Agrochemicals. Agrochemicals commonly used in Bahia include chemical fertilizers and pesticides to eliminate leafcutter ants. Jupará hoped to replace these with organic products.
7. Elimination of Fire. Farmers in Bahia commonly burn to clear forest or clear fallowed fields for planting. Jupará hoped to replace burning with intensive, permanent agroforestry systems and the use of contour barriers.

The second stage of the Jupará-WWF program focused on commercialization of organic cacao. In July of 1998, a local cooperative called COOPASB (*a Cooperativa dos Pequenos Produtores e Produtoras Agroecologistas do Sul da Bahia*) was formed to assist with the commercialization of agricultural products. The first large sale of certified organic cacao for export was made in July of 2003 (Buschbacher in prep.). In 2005, Coopasb purchased 207 tons of organic cacao produced by local smallholders. Most of it was sold to Cargill, an international corporation that exports cacao from the region.

Prior to this study, a comprehensive evaluation of the extent to which Jupará communities are implementing organic agricultural practices and meeting the goals for land use and forest conservation had not yet been performed.

Jupará has worked in varying degrees of intensity in 36 communities, with extension efforts concentrated more intensely in those communities closer to the Una Reserve. These 36 communities represent a wide range of economic, social, and biophysical characteristics. Families within communities also differ in size, socioeconomic status, farming history, size and type of landholding, levels of participation in extension activities, and attitudes toward conservation. Given this range of variables, we expected to find varying level of success among families in meeting the conservation goals set forth by Jupará.

Selection of Study Sites

Two communities were selected for this evaluation, Fortaleza and Lagoa Santa (Figure 2-1). Jupará has worked in several types of communities including land reform settlements and traditional communities. Fortaleza is a 30-year-old land reform settlement, and Lagoa Santa is a traditional community that has existed for many generations. They were selected for this study because Jupará extension support has been consistent enough to provide a reasonable test of their intervention. Fortaleza, in particular, received a high level of extension support due to its location close to the community reserve, and Lagoa Santa was consistently involved in Jupará activities partly due to the efforts of one particularly dedicated community leader. In addition, the production systems in these communities are both based on mixed agroforestry systems and are similar enough to allow a comparison between the communities.

These communities have strong community leaders, which facilitated both continued participation in the Jupará project and the logistics of this research. The political climate in the region made it unfeasible for this researcher to conduct interviews in a community in which Jupará has not worked.

Figure 2-1. Location of study sites. Fortaleza and Lagoa Santa are shown in red.

Methods

Description of Study Sites

Fortaleza

Fortaleza is a land reform settlement in the municipality of Una, BA. Fifty families are settled on 1102 hectares, with an average lot size of 16 hectares (INCRA 2005). Approximately 250 hectares are in community areas, including a small forest reserve and a community cacao plantation. Families began settling the area in the mid 1970s. At that time, the area was completely forested. Most of the settlers in Fortaleza grew up on their parents' farms, usually also in Southern Bahia, or worked on nearby rubber plantations before settling there. INCRA (*Instituto Nacional de Colonização e Reforma Agraria*, the government agency responsible for land reform) officially divided the land and gave titles to these landholders in 1997. At this time, some families were moved from their original plot of land to a different plot, in some cases, a new, completely forested plot, and other families had a portion of their original land officially titled to a neighbor. In most cases, the male head of household received a title to his individual parcel of land. There are also a few female heads of household. In general, each farmer and his family work their own piece of land. Some farmers have organized a *mutirão*, or a workgroup for labor exchange in which they take turns working together in each member's field. Other than the *mutirão*, landholdings are individually managed.

Farmers in Fortaleza produce mainly rubber and cacao as cash crops, as well as some manioc, corn, fruit and vegetable crops for consumption. Few families own livestock beyond one mule, for hauling cacao, and a few chickens. On average, 47% of family income comes from agricultural production and 53% comes from off-farm sources, usually employment in the nearby town of Una, or retirement pensions. Most of the agricultural income comes from rubber. Nine families have received organic certification through the Jupará program.

Although this area has been settled for more than 30 years, it still lacks many basic services. Only a small part of the community has electricity, and bus service is sporadic at best. Water is obtained from springs along a small stream, sometimes at a considerable distance from the family's home, and basic sanitation is completely lacking.

Many of the original farmers in Fortaleza are getting older and have children who are married and beginning their own families. In some cases, the land has been unofficially divided among several sons. In one case, 23 people are surviving on the production of one 17 hectare parcel. In other cases, the children of these farmers work in Una or on nearby plantations. Recently Jupará has helped to organize a new group of landless rural workers, composed primarily of the sons and daughters of the farmers in Fortaleza. The group is petitioning INCRA to grant them title to a new settlement on a nearby piece of land. The group chose not to occupy the land and remain in Fortaleza with their parents, awaiting a decision from INCRA.

Lagoa Santa

Lagoa Santa is a traditional agricultural community located in the municipality of Ituberá. Lagoa Santa is a *quilombo* community, or a community that was originally founded by a group of escaped slaves. Families of the residents have farmed this land for several generations; as a result the landholdings have been divided several times among farmers' descendants, and landholdings tend to be small. Landholding size ranged from 2 to 25 hectares, with an average size of 9 hectares.

Many of the larger landholdings are shared by extended families. Little native forest remains in this area.

INCRA does not keep maps and records of older *quilombo* communities as it does for more recent settlements, so it is uncertain how many families live in Lagoa Santa and how much area the community encompasses. About 30 families are members of the community organization, but many other residents do not participate. Lagoa Santa is one of several *quilombos* in a cluster of small communities. Some members of these nearby communities participated in the Jupará project and several participants from the neighboring *quilombo* Campo da Amancio were also interviewed for this study to increase the sample size.

Farmers in Lagoa Santa maintain diverse agroforestry systems similar to those in Fortaleza, producing mainly rubber, cloves, *piassava* palm fiber for roofing material, and small amounts of cacao, black pepper, and manioc flour. On average, 67% of family income comes from agriculture and the remaining 33% comes from off-farm sources, including employment in Ituberá and on nearby plantations. Only one family maintains organic certification through the Jupará project.

Like Fortaleza, Lagoa Santa lacks electricity, potable water, basic sanitation, and regular public transportation services.

Field Methods

A total of 50 household interviews were conducted in June, July and August of 2005. Jupará staff presented me to each community at the start of my fieldwork, and I stayed in each community alone to conduct the interviews. I visited each community twice, first spending two weeks in each community, returning to Ilhéus to conduct preliminary data analysis, and then returning to each community for a second visit of about 10 days.

In Fortaleza, the fifty existing households were classified as participants, former participants, or non-participants. Current members of the COOPASB cooperative were considered participants, past members were considered former participants, and non-members were considered non-participants. All of the participants and former participants were interviewed, and of the remaining non-participants, a random sample of 10 was selected, for a total of 30 interviews. In Lagoa Santa, no map or list of present households existed, so households were sampled opportunistically for a total of 20 interviews, 10 with participants and 10 with non-participants.

Interview content included questions concerning family demographics, agricultural practices, and land cover distribution, as listed in Table 2-2. To assist participants in describing their property's land cover distribution and the size and age of agroforestry systems, a participatory mapping activity was carried out in which participants were asked to draw a map of their landholding. Annual family income was calculated by asking the respondent to list the products that he or she sells, their approximate market price, and quantity harvested per month or year.

For each household interviewed, the researcher also toured the property with the landowner to verify information obtained in the interview, and to collect GPS points and a brief description of each of the land cover types present on the property.

Table 2-2. Interview content

Explanatory Variables	Response Variables
Participation in: Community and regional trainings Jupará extension visits Demonstration plots and workgroups Women's development activities Health and environmental education activities Community organizations Leadership positions in community organizations **Family Characteristics:** Family size Workers on and off farm Number of years farming this site Years of primary education **Size of landholding**	**Agricultural practices, including use of:** Organic fertilizers Composting Green manures Contour erosion barriers Crop rotation Multicropping Mulching Chemical fertilizers Burning **Land cover types present:** Forest, agroforestry, *capoeira* (fallow areas and forest regrowth), annual crops, pasture **Income** Diversity of products On and off farm income

Data Analysis

Participation

To measure a family's level of participation in the Jupara program, participants were asked whether or not they had participated in a number of Jupara sponsored activities, and whether they had participated once, several times, or many times. Participants were also asked whether or not they were a present or past member of COOPASB or any other organization, and whether they had ever held a leadership position in any of these organizations.

Families' involvement in the Jupará program varied considerably. In order to consider participation as a continuous variable, rather than comparing groups of participants and non-participants, each activity was given a numeric score. Most activities were scored 1 for participating once, 2 for participating several times, and 3 for participating many times. Activities which were more difficult for farmers to participate in, such as traveling to attend a regional training event, or indicated a higher level of participation, such as joining the COOPASB cooperative, were more heavily weighted, as indicated in Table 2-3.

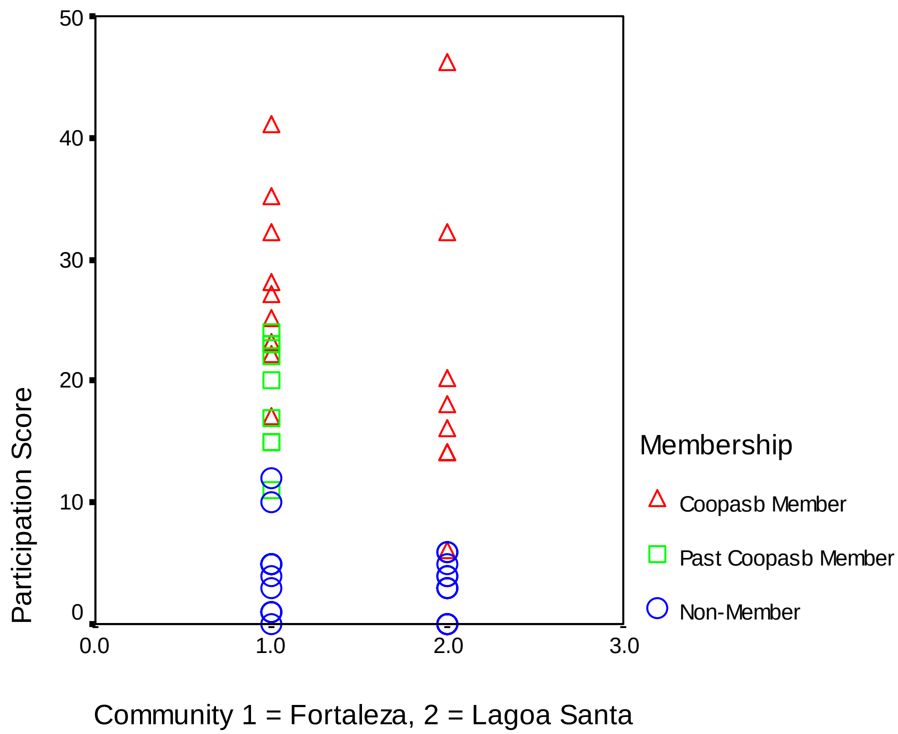
The sum of these was calculated to give an overall participation score for each family. The distribution of participation scores in Fortaleza and Lagoa Santa are shown in Figure 2-2.

Because the development of the participation score was somewhat subjective, the validity of the score was verified by producing 10 variations of the score and comparing them statistically to one another. Five scores were created based on the author's judgment of five possible ways of choosing participation criteria and weighting them, and five more were produced by randomly eliminating some components and weighting the components randomly. A correlation matrix was generated to compare the scores to each other, and showed that the scores were correlated, with $p<0.001$ in all cases. A second correlation matrix compared the rank of each family using the 10 participation scores; rankings were also highly correlated in all cases, $p<0.001$. Because the families' rankings changed little with each variation of the participation score, we can say that no matter which version of the score is used, families with high participation will consistently have a high participation score, and families with lower participation will score lower.

Table 2-3. Jupará sponsored activities and corresponding participation scores.

Regional Training in:	
Agroecology	0 = never, 3 = once, 4 = several times, 5 = many times
Women's Issues	0 = never, 3 = once, 4 = several times, 5 = many times
Other (health, cooperatives)	0 = never, 3 = once, 4 = several times, 5 = many times
Community Training in:	
Agroecology	0 = never, 1 = once, 2 = several times, 3 = many times
Women's Issues	0 = never, 1 = once, 2 = several times, 3 = many times
Other (health, cooperatives, theater, or environmental education)	0 = never, 1 = once, 2 = several times, 3 = many times
Received a visit from:	
An agronomist (male)	0 = never, 1 = once, 2 = several times, 3 = many times
An environmental educator (female)	0 = never, 1 = once, 2 = several times, 3 = many times
Visited another Jupara Community	0 = never, 1 = once, 2 = several times, 3 = many times
Participated in a Demonstrative Plot or community plot.	0 = never, 1 = once, 2 = several times, 3 = many times
Participated in a "Mutirao" (Community work group)	0 = never, 1 = occasionally, 2 = participated in the past, 3 = participating regularly now.
Member of Coopasb	0 = no, 3 = past member, 5 = current member
Member of another organization	0 = no, 1 = yes
Woman is also a member.	0 = no, 1 = yes
Has held a leadership position in one of these organizations	0 = no 3 = president 1 = all other leadership positions

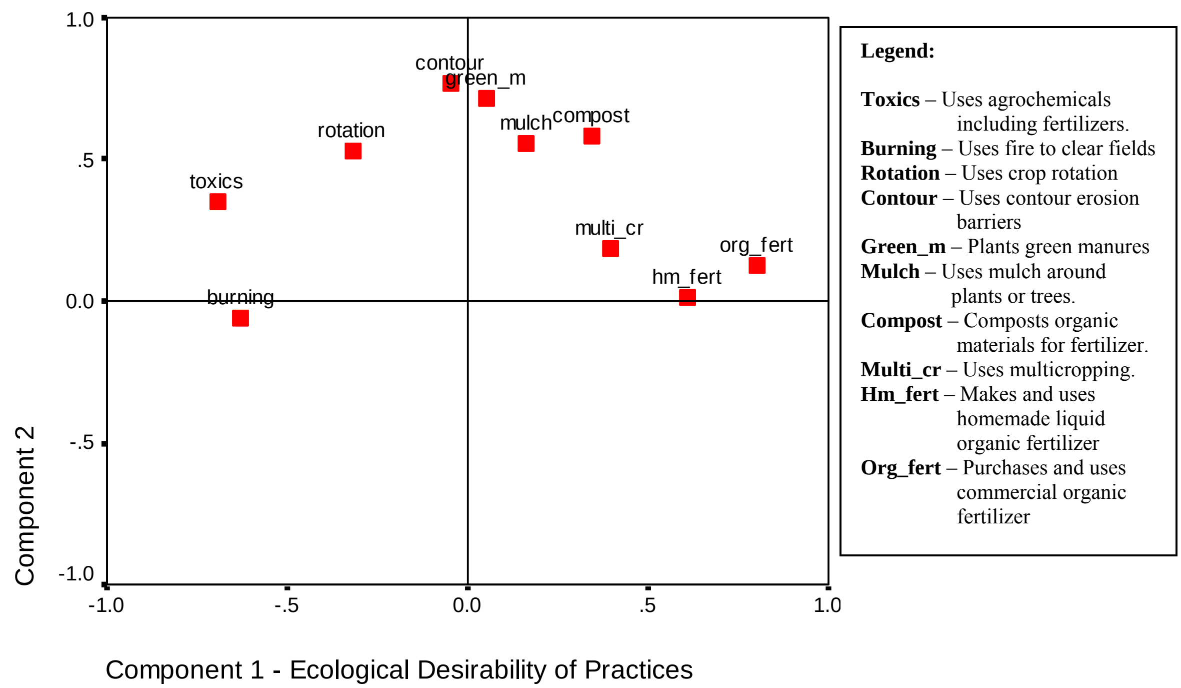
Figure 2-2. Range of participation scores in Fortaleza and Lagoa Santa.



Use of Agroecological Practices

Families were asked whether or not they were currently using a variety of traditional and innovative agroecological practices on their properties. Because the use of some practices tended to be highly correlated with the use of other practices, these data were reduced using a Principal Components Analysis (PCA). The first component of the PCA produced a continuum of practices, ranging from ecologically destructive practices on one end, such as burning and the use of chemical fertilizers, to more innovative and ecologically desirable practices on the other end, such as the use of organic fertilizers, as illustrated in Figure 2-3. Practices which were more commonly practiced and possibly easier to implement, such as crop rotation and mulching, fell somewhere in the middle. This scale is labeled the Ecological Desirability of Practices. The PCA produced a score somewhere along this continuum for each family. This scale of the Ecological Desirability of Practices was used in the subsequent analysis to represent the extent to which families had implemented agroecological practices.

Figure 2-3. Component plot for principal components analysis. Component one orders practices from ecologically destructive to ecologically beneficial.



Multiple Regressions

For each community, six stepwise multiple regression models were used to compare the effects of participation, using the index previously described, and nine other family attributes, on six outcome variables that represent Jupará's goals for conservation and adoption of agroecological practices. Family attributes included family size, ratio of farm and off farm workers to total family members, ratio of farm workers to total family members, age and education level of household head, size of landholding, years the farmer has farmed this plot, income, and percent of total income derived from farming. Outcome variables included the use of agroecological practices (Ecological Desirability of Practices score and number of practices implemented), percent of landholding in forest cover, percent of landholding in agroforestry, number of products produced for sale, and farm income.

Several other family attribute variables were considered but were found to be correlated with one or more of these variables and were eliminated. The Kolmogorov-Smirnov test was used to confirm that data were normally distributed.

Results

Comparison of communities

Descriptive data collected in the two communities reveals some similarities and differences between Fortaleza and Lagoa Santa (Table 2-4). Families in Lagoa Santa are slightly larger, have more farm workers, and earn a larger percentage of their income from farming than families in Fortaleza. Level of basic education in Fortaleza is slightly higher, though in Fortaleza, non-participants are generally more educated than participants, while in Lagoa Santa, participants have more years of education.

The most apparent difference between Fortaleza and Lagoa Santa is in the distribution of land uses. Participants in Lagoa Santa tend to have more land than non-participants, while in Fortaleza all landholdings are virtually the same size. Landholders in Lagoa Santa dedicate a larger percentage of their landholdings to agroforestry systems and have considerably less forested and fallowed areas than farmers in Fortaleza. Landholdings in Fortaleza are much larger than those in Lagoa Santa. In both communities, land use distribution between groups of participants and non-participants are similar.

Table 2-4. Descriptive statistics by groups for two communities. P=Participants, FP = Former Participants, NP = Non-Participants.

	Fortaleza					Lagoa Santa			
	P	FP	NP	All	Std.dev	P	NP	All	Std.dev.
Family Size									
Total Family Members	5.75	7.11	5.44	6.07	4.19	6.25	8.28	7.35	5.56
On-farm Workers	1.71	2.17	2.03	1.85	1.30	2.94	2.46	2.65	1.43
Off-farm Workers	4.04	4.94	3.42	1.23	1.00	0.28	1.25	0.86	0.83
Children living outside community	2.45	5.63	3.29	3.65	3.19	2.25	4.20	3.00	3.28
Average Age of all family members	25.55	29.54	26.80	27.28	21.9	22.05	26.68	29.31	10.68
Head of Household Age	55.00	55.11	51.67	52.17	13.3	47.13	59.83	52.60	11.15
Years of education									
Head of Household	1.58	1.22	2.78	1.83	1.91	2.88	1.00	1.75	2.75
Ages 18-30	7.70	5.92	7.46	7.00	3.37	4.39	6.71	5.04	3.22
Ages 31-50	6.75	3.75	2.36	4.07	3.11	3.17	2.20	2.73	3.12
Ages 51+	1.44	0.63	1.31	1.05	1.25	0.07	1.67	0.33	0.97
Years farming on current property	16.92	25.00	19.44	20.10	9.09	26.88	30.42	29.00	19.03
Family Landholding									
Total Area	16.42	16.06	15.24	15.96	1.30	11.81	7.85	9.43	7.40
Hectares Agroforestry	7.75	8.00	7.72	7.82	3.27	8.63	5.46	6.73	5.40
% Agroforestry	36.4%	33.1%	37.7%	39.1%	15.6%	75.8%	73.8%	74.6%	20.3%
Age of Oldest Agroforestry System	14.17	17.56	23.13	17.68	8.80	19.00	23.00	21.22	10.26
Age of Newest Agroforestry System	6.46	6.56	6.33	6.45	5.07	6.44	5.44	5.91	4.14
Hectares Natural Forest	3.58	2.56	3.00	3.10	3.45	1.63	0.77	1.11	2.67
% Natural Forest	36.4%	33.1%	37.9%	36.0%	17.9%	8.9%	7.4%	8.0%	15.2%
Years since most recent deforestation	9.75	12.00	12.83	11.40	7.20	8.20	16.75	12.00	9.74
Hectares Fallow and/or Forest Regrowth	1.79	2.22	3.39	2.40	2.17	0.91	0.58	0.71	1.06
% Fallow/Forest Regrowth	18.4%	10.8%	8.3%	12.3%	11.5	7.8%	8.8%	8.4%	10.4%
Hectares Annual Crops	1.71	1.42	1.25	1.48	1.38	0.91	0..81	0.85	0.97
% Annual Crops	6.4%	7.0%	8.3%	7.3%	6.5%	7.5%	13.6%	11.1%	14.4%

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Table 2-4. Continued

	Fortaleza					Lagoa Santa			
	P	FP	NP	All	Std.dev	P	NP	All	Std.dev.
Hectares Pasture	0.88	0.75	1.66	1.08	1.13	0.63	0.75	0.70	1.03
% Pasture	8.6%	3.9%	4.1%	5.4%	5.8%	3.2%	2.9%	3.0%	3.8%
Total Income in Brazilian Reis	6202	10659	10317	8700	4617	7721	10055	8581	4341
Farm Income	3153	4470	3912	3775	2290	3347	8861	5375	3716
Other Income	3127	6188	6405	4925	3689	4383	1193	3206	3717
% income from farming	50.9%	46.6%	36.8%	45.2%	26.3%	49.2%	92.7%	66.6%	30.8%

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Regression Analysis of participation and family attributes on program implementation

Fortaleza

Participation positively influenced the implementation of sustainable agricultural practices, as indicated by both the ecological desirability of practices score and the total number of practices implemented, as well as farm income, but did not influence land cover. Stepwise multiple regression analyses indicated a variety of significant relationships between the outcome variables and other socioeconomic factors, as illustrated in Table 2-5.

Table 2-5. Multiple regression models for Fortaleza.

Outcome Variable	Significant Predictors	B	t	Sig. (p)	R^2
Ecological Desirability of Practices Score	**Participation**	0.491	3.426	0.002	0.511
	Ratio of Farm workers/total family	0.353	2.558	0.017	
	Education	0.321	2.237	0.034	
# Organic practices	**Participation**	0.532	3.328	0.002	0.283
# Ag. Products	Education	0.494	3.113	0.004	0.321
	Size of lot	0.298	1.880	0.071	
% Agroforestry	Education	0.421	2.588	0.015	0.288
	Years on Lot	0.349	2.149	0.041	
% Natural Forest	Years on Lot	-0.466	-2.789	0.009	0.271
Farm income	% income from Agriculture	0.685	6.108	0.000	0.768
	Family size	0.397	3.660	0.001	
	Participation	0.377	3.275	0.003	
	Years on Lot	0.263	2.226	0.036	
	Size of Lot	0.211	1.769	0.090	

Predictors eliminated from all models: Ratio of total workers (on and off-farm) to total family members; Age of Head of Household

Lagoa Santa

Participation positively influenced the number of organic practices implemented, the diversity of agricultural products produced for sale, and farm income, but did not influence land cover. Other predictors were significant as indicated in Table 2-6.

Table 2-6. Multiple regression models for Lagoa Santa.

Dependant Variable	Predictor	B	t	Sig. (p)	R^2
Ecological Desirability of Practices Score	Education	0.508	2.505	0.022	0.259
# Organic practices	Ratio Farm workers/total family	-0.510	-2.780	0.013	0.440
	Participation	0.505	2.751	0.014	
# Ag. Products	**Participation**	0.793	5.531	0.000	0.630
% Agroforestry	Family Size	0.455	2.168	0.044	0.207
% Natural Forest	None significant				
Farm income	**Participation**	0.480	2.530	0.022	0.393
	Age of household head	0.362	1.910	0.073	
Predictors eliminated from all models:	Ratio of workers to total family members Years on lot % of income from agriculture Size of lot				

Use of Agricultural Practices

Multiple regression analyses examined overall implementation of agroecological practices, but did not assess which practices were implemented by farmers and which were not. Looking at each specific practice, we find that some practices were adopted by Jupará participants more often than non-participants, others were in use by virtually everyone, and others weren't adopted at all. These data help determine which practices are most acceptable, and which are most difficult to implement.

Fortaleza

Figure 2-4 shows the percentage of participants, former participants, and non participants in Fortaleza who adopted each of the practices. Some practices were seldom adopted by any group, including the use of green manures, homemade liquid organic fertilizer, and composting. Others, contour erosion barriers, use of commercial organic fertilizer, which is sold by Jupará, and abandonment of agrochemicals, were adopted by participants more often than non-participants. Participants eliminated the use of burning only slightly more often than non-participants. The remaining practices, crop rotation, mulching, and multicropping, were in use by participants and non-participants alike and may be considered traditional practices in Fortaleza.

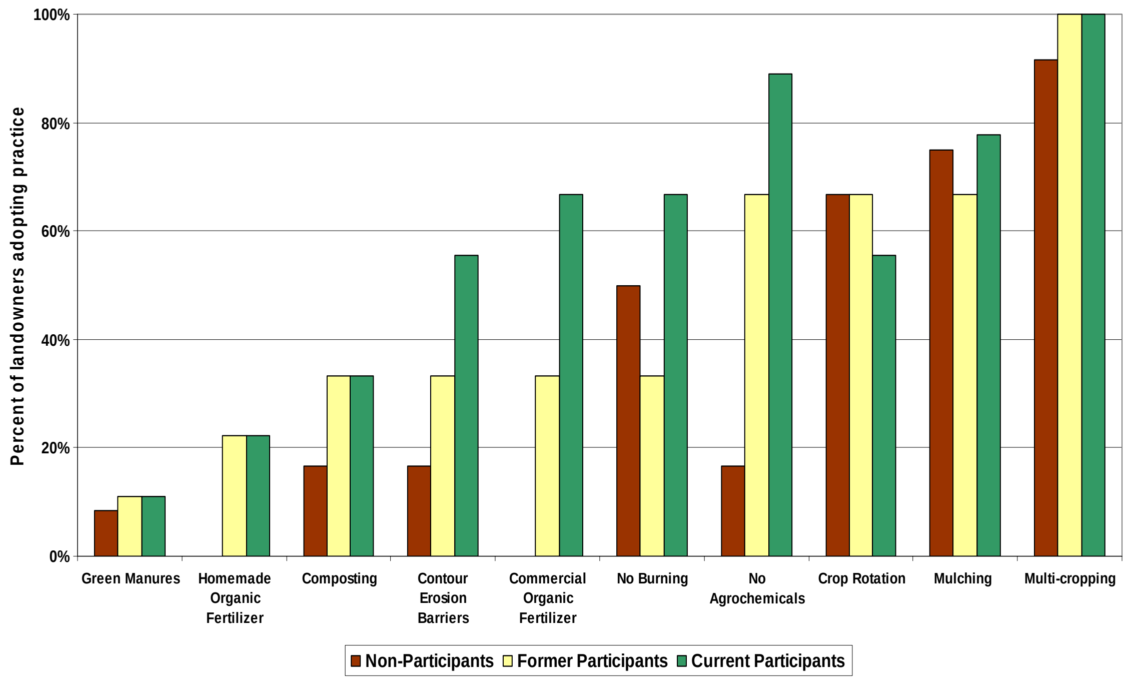


Figure 2-4. Adoption of agroecological practices in Fortaleza.

Lagoa Santa

Results were similar in Lagoa Santa, as shown in Figure 2-5. Green manures and homemade liquid organic fertilizer were the least adopted practices for all groups. Composting was adopted more often by non-participants. Contour erosion barriers, commercial organic fertilizer, and the elimination of agrochemicals were adopted more often by participants than non-participants. Around 40% of farmers in both groups had eliminated the use of fire, and crop rotation, mulching, and multicropping were used by almost all farmers in both groups.

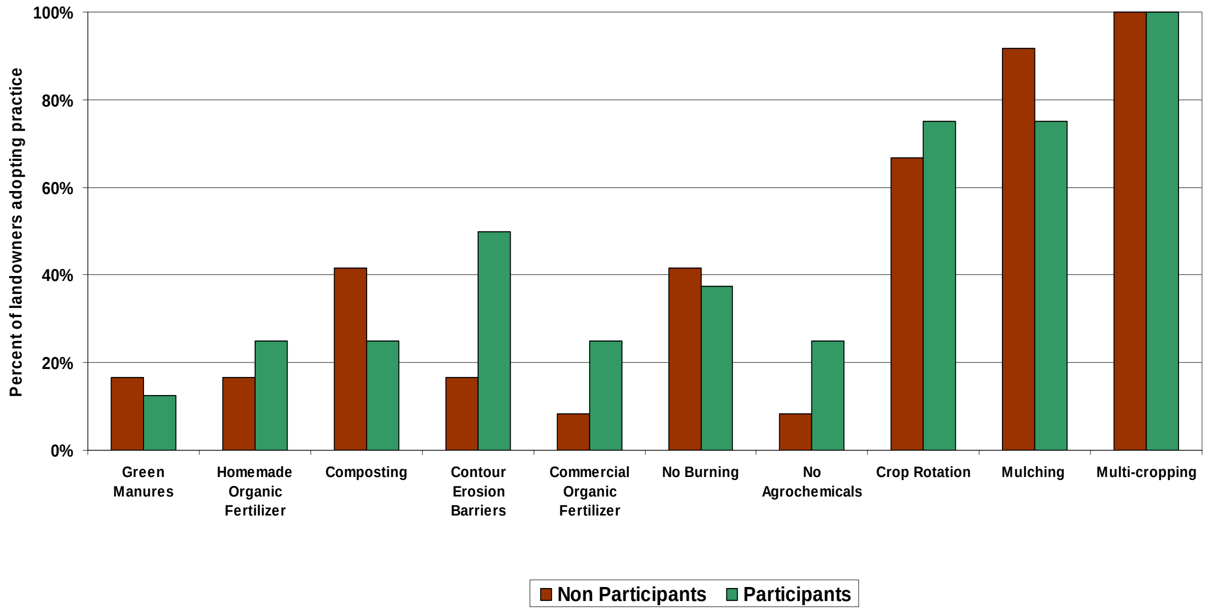


Figure 2-5. Adoption of agroecological practices in Lagoa Santa

Land Cover

Average reported land use distributions in Fortaleza (Figure 2-6) and Lagoa Santa (Figure 2-7) appear to be similar among groups of participants and non-participants, but different between the two communities. Lagoa Santa has much less forest cover and much more agroforestry. Graphs for Fortaleza are adjusted to include the community forest reserve.

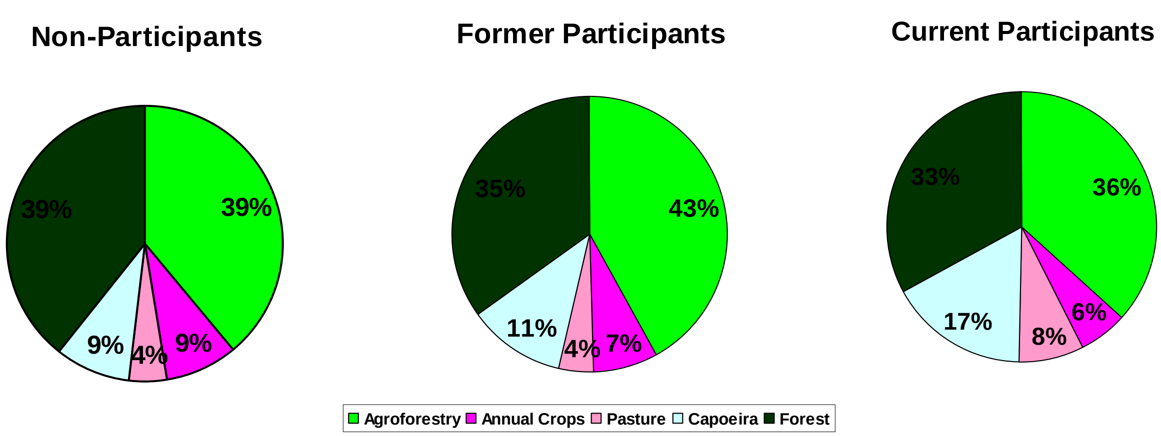


Figure 2-6. Land cover distribution in Fortaleza, as reported by farmers.

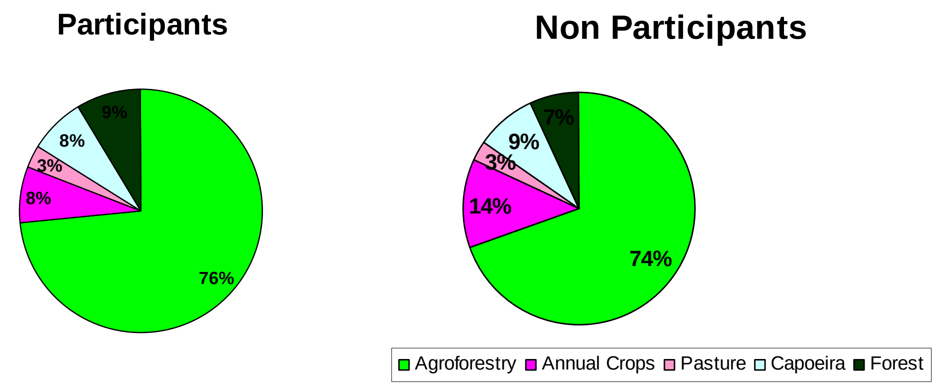


Figure 2-7. Land Cover Distribution in Lagoa Santa, as reported by farmers.

These figures report the average of the reported land use distributions. This can be deceiving, especially in Fortaleza. On, average, the land use goal of 30% forest appears to be met. However, these averages reflect the fact that some farmers on newer lots have more than 30% of their area still forested, while others have no forest at all. Figure 2-8 shows the percentage of landowners meeting land use goals in each community. In all groups, 55% or less of the farmers interviewed meet the goal for forest cover. The goal for each property is 12.5% in Fortaleza after the community reserve is accounted for, and 30% in Lagoa Santa.

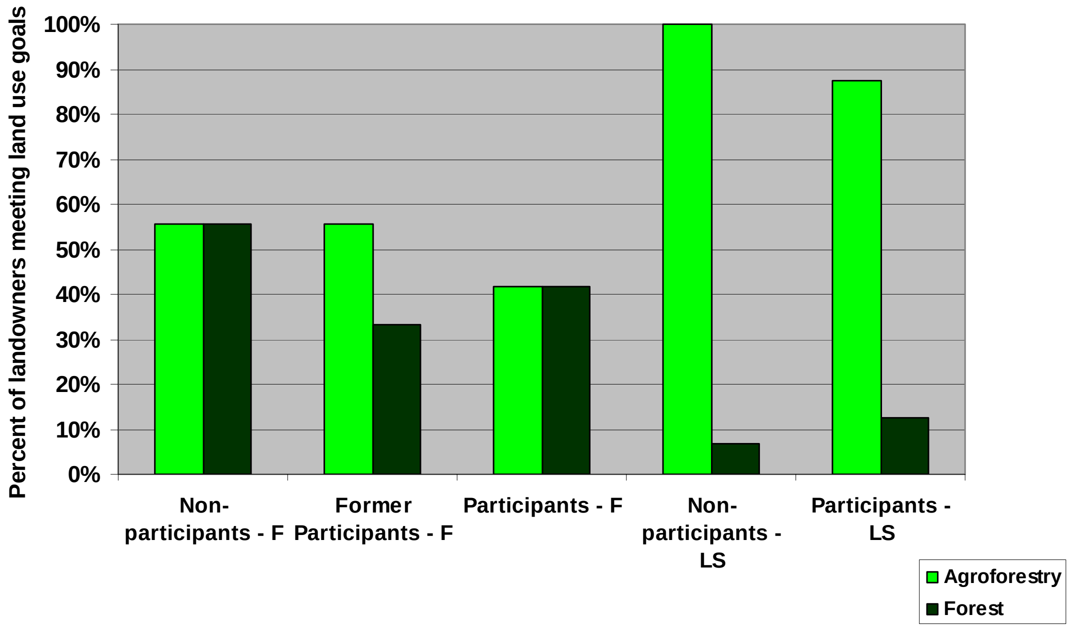


Figure 2-8. Percentage of landowners meeting land use goals in Fortaleza (F) and Lagoa Santa (LS) for Agroforestry and Forest.

Discussion

Agroecological Practices

The Jupará Project was successful in teaching agroecological practices such as the use of organic fertilizers, composting, and contour erosion barriers, and reducing or eliminating the use of agrochemicals and fire. Multiple regression analyses indicate that participation in Jupará had a highly significant effect on the implementation of organic practices on a scale defined by the Ecological Desirability of Practices Score in Fortaleza, diversity of agricultural products in Lagoa Santa, and number of organic practices implemented in both of these communities.

In addition to participation in the Jupará program, availability of farm workers, as measured by ratio of farm workers to total family members, and educational level of the household head, also positively influenced the use of agroecological practices. In Fortaleza, education significantly influenced the diversity of agricultural products for sale and the area of agroforestry systems established. The fact that education was often a significant influence on more than one of these outcome variables might indicate that in addition to extension services, rural communities benefit from access to basic education.

In both communities, some practices were implemented more often than others. Practices tended to fall into one of three categories: practices implemented by almost everyone, practices implemented by almost no one, and practices implemented more often by participants than by non-participants. Almost all of the farmers interviewed were using crop rotation, multicropping, and mulching. These three practices might be considered traditional practices in these communities, since they are used even by those who had no contact with the Jupará program. Participating farmers may also have been influenced by their non-participating neighbors to adopt some practices, especially in Fortaleza, where the program was very visible, even to non-participants.

Green manures, homemade liquid organic fertilizer, and compost were among the least utilized practices. Green manures were used by less than 20% of both participants and non-participants in all three communities. This practice may not have been as vigorously promoted as some of the others, as many farmers had never even heard of the practice, and seeds were not readily available. The few farmers who did report using green manures reported using them as a pest control method against leaf-cutter ants, rather than as a source of fertilizer.

Compost was used by less than 40% of farmers, and homemade liquid fertilizer was used by only around 20% of farmers. Many farmers explained that these two techniques required the availability of manure, and most of them do not have livestock, so manure is not easily accessible. Some farmers compost kitchen scraps and agricultural wastes such as the outer shells of cacao pods, but generally there is not enough compostable organic material available to produce enough compost or compost tea to depend on it as a main source of organic fertilizer.

In Fortaleza and Lagoa Santa, the elimination of agrochemicals, the use of commercial organic fertilizer, and the use of contour erosion barriers are practiced much more often by participants than not participants. In this case, Jupará produces the commercial organic fertilizer and sells it to farmers. While it appears to provide a satisfactory replacement for chemical fertilizers for farmers who choose it, it is slightly more expensive than chemical fertilizer, requires a larger quantity per hectare, and thus is more difficult to transport. Many farmers stated this expense and difficulty of transportation as primary reasons for not using the commercial organic fertilizer.

Contour erosion barriers are labor intensive and require some technical expertise to create. Increased use by participants might indicate that Jupará was successful in providing this technical expertise and motivating farmers to invest in a labor intensive but ecologically beneficial process.

Contour erosion barriers should reduce the use of fire, as a permanent vegetative barrier is planted on top of the erosion barrier, so the use of fire would destroy the established barrier. Disappointingly, 60% of farmers in Lagoa Santa still burn their fields before planting, and project participants are as likely to burn as non-participants. In Fortaleza, 50% of participants, 67% of former participants, and 33% of non-participants, burn. Many of the same farmers implementing contour erosion barriers on one part of their property may be using fire somewhere else. However, burning was measured as a yes or no variable, and these data do not describe the type of burning practiced. Most respondents reported using fire only to clear recently fallowed areas for planting, and not as a means of clearing forest.

These data also indicate that eliminating the use of fire as a management tool may be the most difficult of Jupará's target practices to implement.

Income

Families participating in the project tended to have higher levels of farm income than those not participating, and in Lagoa Santa, participating families produced a greater diversity of products for sale. While it's possible that participation in the extension program enabled families to create more productive farms, it's also possible that those with already productive farms, or those most dependent on farm income, were more likely to participate in the program.

Family size, lot size, number of years farming the lot, and age of household head were also all positively correlated with farm income in one or more communities, according to the linear regression models. In both Fortaleza and Lagoa Santa, total income was higher for non-participants than for participants, but farm income was higher for participants than non-participants. Thus, participants tended to derive a higher percentage of their total income from agriculture, especially in Lagoa Santa, where participants earned 92.7% of their income from agriculture, while non-participants earned only 49.2% of their income from agriculture. This may indicate that those who depend highly on agriculture for their livelihoods have a greater incentive to invest in a program such as Jupará, while those earning a portion of their income from an off-farm source may be too busy to participate, or, since generally they are already earning an equal or higher income through wage labor than they would earn farming, they may not feel that such an investment is necessary.

Land Cover

Participating families did not conserve more forest or implement more agroforestry systems than non-participating families. In Fortaleza and Lagoa Santa, extensive conversion of forest to agroforestry had already occurred before the program began, and the ten-year period of the program may not be a sufficient length of time for changes in land cover patterns, such as the regrowth of secondary forests, to develop in response to changes in practice initiated by the Jupará program.

Farmers in Fortaleza are meeting Jupará's goals of maintaining a minimum of 40% of the area in agroforestry and 30% of natural forest more often than farmers in Lagoa Santa. In Fortaleza, 20% of the community's total area is conserved as a forest reserve. To maintain a total of 30% forested, individual farmers would have to conserve an additional 12.5% of the individual landholding in natural forest. On average, 19% of each individual landholding is forested, with 43% of farmers maintaining at least 12.5% forested. The multiple regression model demonstrated that the factor most affecting forest cover is the number of years the family has been farming the lot ($p=0.009$). Forest cover decreases with time, and families with large amounts of forest cover are those who were moved to new, forested lots when INCRA officially delineated the properties in 1997, as shown in Chapter 4. Most farmers reported settling on a completely forested lot at some point in the past, and converting it to agriculture over a period of several years.

In Lagoa Santa, the area has been used for farming for many generations. After several generations of dividing the land among family members, some lots are very small and most are completely invested in intensive agriculture and agroforestry; on average, 75% of lots are in agroforestry systems. Due to this long history of agricultural use, it's not surprising that Lagoa Santa has less forest cover remaining, on average 8% of each lot, though many farmers have no forest at all. There is no community forest reserve in Lagoa Santa, and only 2 farmers meet the goal of conserving 30% of the land in natural forest. Some farmers stated that they are maintaining an area of forest regrowth as their reserve, and on average 8.4% of lots were in forest regrowth. Farmers reported an average of 12 years since the most recent deforestation on the site, so it is likely that most of the deforestation in this area occurred before the Jupará program began working in the region.

Additional analysis of a time series of satellite images is provided in Chapter 4 to more fully understand the changes in land cover patterns before and after the Jupará program.

Success of the Jupará Agroecology Project

Based on these results, was Jupará an effective integrated conservation and development project? Are families meeting the project goals?

Results of this program evaluation are in agreement with several other published ICDP evaluations (Browder 2002; Perz 2004): development goals seem to be met more frequently than conservation ones. In both communities, participation in the Jupará program influenced the implementation of more sustainable production practices and enabled farmers to meet the requirements for organic certification, though the certification itself wasn't actually maintained in all cases.

Participating farmers have higher farm incomes than non-participating farmers, which may or may not be a result of participation in the program. The commercialization aspect of the Jupará program hasn't been fully implemented. Currently they buy and sell only organic cacao through the Coopasb cooperative. In communities where farmers produce mainly cacao, an effective commercialization system is in place. For other farmers with more diverse systems, as in Fortaleza and Lagoa Santa, commercialization is more difficult, as it is more difficult to market smaller quantities of many things, and for some products, little market exists for organic certified products.

Generally, these two communities are not meeting the program goals for forest conservation. Fortaleza has a small community reserve, encompassing about 20% of the community's total area, but less than half of the farmers there are able to maintain the expected amount of forest on their individual properties. Lagoa Santa has no forest reserve, and only two farmers meet the goal of 30% forest cover. Data presented here offer no indication that farmers participating in this project conserve more forest than non-participants.

These results are consistent with Alger and Caldas' 1998 finding that Bahian farmers on smaller lots are less likely to conserve forests than those on larger lots. Jupará'a goals for forest conservation are particularly challenging, then, since all farmers interviewed had landholdings smaller than 20 hectares. In Lagoa Santa, lots are smaller on average than in Fortaleza, and less forest remains.

However, this study did not consider the quantity of forest present at the start of the Jupará project. Many farmers stated that their property was entirely deforested and converted to agriculture years before they realized that deforestation was a problem, and expressed regret at this loss. Obviously, people cannot be expected to conserve something they don't have in the first place. In order to fully justify an integrated conservation and development project like the Jupará project, monitoring is needed before, during and after the project. It is difficult to evaluate project outcomes if we don't have any baseline data on land cover or agricultural practices at the start of the project. Analysis of satellite imagery might be one way to understand when most of the forest loss occurred, as well as to observe trends in forest regrowth.

Finally, we have to make sure that both environmental and development goals of ICDPs are realistic. It simply is not realistic to expect a family of 10 to survive on three hectares of land, as was the case for one family in Lagoa Santa, and still maintain 30% of their three hectares in a natural forest reserve. In an evaluation of a USAID funded project in Madagascar, Peters (1998) recognizes this top-down approach to defining goals and expectations as one of the major weaknesses of integrated conservation and development projects. He suggests giving local people a participatory voice in defining project objectives, as their perspective on what might be feasible and important might differ greatly from the perspective of USAID, or in this case, WWF.

Browder (2002) makes the important point that ICDPs often lack functional linkages between specific development activities and desired conservation outcomes. Results of the Jupará project support this criticism. While the use of organic agricultural practices may contribute to overall ecosystem health and develop a mindset of environmental stewardship among participants, organic agriculture and resulting increased incomes do not necessarily prevent deforestation.

In southern Bahia specifically, Alger (1998) points out that promoting agroforestry by itself does not conserve biodiversity, in fact, it can result in further fragmentation of existing forest fragments. In areas with many small farmers, the law requires only a small forest reserve on each farm, and reserves on individual farms don’t conserve much biodiversity if farms and family reserves are disconnected from each other. Conservation in communities of smallholders will require landscape-level participatory planning to unify forest reserves and maintain connectivity between them, and this community process will likely occur separately from the family-level process of implementing organic agriculture.

CHAPTER 3
CONSERVATION AND AGRARIAN REFORM IN SOUTHERN BAHIA, THE CASE OF CASCATA

Introduction

"You have probably passed by an encampment in your car or on the bus. Maybe you have seen a march of the landless people. Certainly you have seen on television, or in a newspaper or magazine, news of land conflicts or occupations," write Stedile and Sérgio (1993) in *A luta pela terra no Brasil* (The Fight for Land in Brazil), a small book intended to explain to the wider Brazilian public the basic ideology of the MST (*Movimento dos Trabalhadores Rurais Sem Terra,* The Landless Rural Workers Movement). Groups of rural landless workers, living in makeshift plastic tents and awaiting settlement by the Brazilian government, are indeed a common sight along the highways in many parts of Brazil.

Brazil has the second most unequal distribution of land in the world, behind only neighboring Paraguay (Domingos 2002). Eighty-nine percent of farms are less than 100 hectares in size and equal 20% of the total land area. One percent of farms are more than 1000 hectares in size, and equal 45% of the land area (Domingos 2002).

Conflicts over land tenure have been present throughout Brazilian history and continue today. Historically, land reform in Brazil has occurred on lands considered unproductive, often on forested or ecologically fragile lands, leading to further environmental degradation and deforestation as settlers carve out an agricultural livelihood from forested land. Teófilo and Garcia (2003) found that of the land appropriated by INCRA between 1997 and 1999, only 21% of it was in agricultural use before occupation, often because its soil, topography, or market access was poorly suited for agriculture.

In recent years, an outbreak of Witches' Broom Disease has changed the dynamics of this process in Southern Bahia. As productivity of cacao plantations decreased, large landowners were more willing to sell their lands for redistribution through land reform. Higher quality lands are now available for settlement, and the violence once characteristic of land invasions is decreasing (Buschbacher in prep.).

In addition to their work in agricultural extension, Jupará has been highly involved in the rural land reform movement in Southern Bahia, and changes in the land reform process have led to changes in Jupará's community work. The agricultural extension project described in Chapter 2 was originally conceived to function in traditional agricultural communities and older, well established land reform communities in which each family managed an individual unit of land. In recent years, the project has been adapted to also function on resettled cacao estates, where production strategies tend to be more collective. This chapter explains Jupará's involvement in the land reform movement and presents the results of the agroecology extension project on a newly settled cacao estate, Cascata.

Jupará and Land Reform

INCRA (*Instituto Nacional de Colonização e Reforma Agraria*, or National Institute of Colonization and Agrarian Reform) is the federal agency responsible for land reform in Brazil and has an office in each Brazilian state. INCRA is responsible for the purchase of the land from its original owner, assessing how many families should be settled onto the property, and deciding who those families will be.

Both INCRA and the communities involved depend greatly on a handful of land reform NGOs to facilitate the land reform process. The MST (Movement of the Landless Workers), and the CPT (Catholic Pastoral Commission of the Land) are some well-known examples. Many other organizations also exist and function similarly, such as MLT (Movement for the Struggle of the Landless) and MSLT (The Land Liberation Movement.)

In addition to providing agricultural extension services in established communities, Jupará also provides support to a number of "encampments," or communities in the process of acquiring land on which to settle. In southern Bahia there are many of these encampments, basically communities living in black plastic tents along the highways, indicating their intention to settle on the adjacent land. These people are unemployed plantation workers, sons and daughters of farmers whose landholding is too small to support them, or even city dwellers looking for a better life. The political process involved in the formation of a new land reform community is complicated and often takes years.

Most encampments receive assistance from a land reform NGO in applying to INCRA for settlement. According to Cullen et al. (2005), only 5% of land reform projects in Brazil were initiated by INCRA. The other 95% were initiated by land reform NGOs, who organized a group of settlers and petitioned INCRA's cooperation.

Settlement is a community process. When land is settled, INCRA grants an *Emissão de Posse*, or right of land use, to the community association rather than to individuals. Generally a community will work with only one land reform NGO, and these NGOs tend to differ in their philosophies in how a community should be managed.

These communities will often live for a number of years in an encampment until they are granted a piece of land, so community organization is very important, both before and after settlement. The land reform NGOs assist with this organizational process and with the development of community leaders.

The Jupará extensionists have an extensive and complex history of work with land reform over the past 10 years. When they began working with encampments in the mid 1980s, the process usually involved the violent occupation of a piece of land, usually forested land or land of poor soil quality, that was considered “socially unproductive” by Brazilian law and thus eligible for reappropriation, whether the landowner wanted to give up this land or not. Some of these lands were known as “latifundos,” a term which refers to very large rural landholdings, parts of which are often left fallow or forested. Any land which was not currently dedicated to the active production of agricultural goods, or did not generate employment for local workers, was considered eligible for land reform. According to a 1993 MST report, 180 million hectares were classified as “latifundos” in Brazil. Redistribution of these lands is the focus of the agrarian reform movement (Stedile & Sérgio 1993).

In 1989, Witches Broom Disease broke out in the cacao plantations of Bahia, and led many plantation owners to stop investing in the labor and fertilizer inputs necessary for cacao production. Lack of care, fertilization, and pruning allowed the disease to spread even more rapidly through the plantations, further reducing their productivity. This change facilitated the land reform movement in southern Bahia. Unemployment of former plantation workers resulted in an increase in the number of workers and families becoming involved in the land reform movements of the time, the MST and others, including Jupará (Trevizan 1998). With little prospect of future earnings in cacao, owners of the once-lucrative cacao plantations were willing to sell their land to the Brazilian government for redistribution among landless settlers, with much less violent conflict than in previous years (Buschbacher in prep.). For this reason, the Jupará extensionists sometimes referred to Witches' Broom Disease as "*a santa vassoura da bruxa*," or Saint Witches' Broom. Management of the disease is labor intensive and can be carried out more effectively by smallholders than by large plantation owners. Most of the recent land reform settlements are on former cacao plantations. Families receive a small area of established cacao, which they clean and prune, replant cacao where necessary, and eventually bring back into production.

Land reform in Bahia continues to evolve and many families continue to await resettlement, while living under black plastic and depending on food aid from the government, churches, and NGOs. While this process is happening throughout Brazil, according to MST's website (www.mst.org.br) (MST 2006), in 2003 Bahia had more encampments than any other state, with 20,000 MST-sponsored individuals awaiting resettlement.

Cascata, a Land Reform Settlement

Most recently, Jupará's work has focused on newer land reform settlements, usually on former cacao plantations. In addition, Jupará has worked with encampments, or groups of people awaiting settlement through the land reform process. Extension services are provided before the community is settled on the landholding, and landholders have had Jupará support for the entire period of land ownership. Often potential landowners are from urban areas or are former plantation workers, and have little experience in agriculture and the decisions involved in land management. Extension programs in encampments focus on community organization, environmental education, and sustainable agriculture and land management, so that when future landowners actually receive their own plot, they are prepared to make environmentally and economically sound decisions. Typically, communities which have recently passed through the encampment process are more unified than older communities, and usually all families participate in the Jupará project. Often residents live in the workers' houses left behind by the plantation owners, so all community members live in a central residential area, with agricultural areas located outside of the residential area.

Cascata is one cacao plantation community that began collaborating with Jupará while still an encampment. Many differences in the production strategies, biophysical characteristics, age of the community, and level of participation in extension activities in Cascata make it difficult to compare directly with older communities like Fortaleza and Lagoa Santa. A small number of interviews were also conducted in Cascata, in order to understand how the project may work differently in different community types, and in order to compare Jupará's past projects with their current and future directions.

Site Description

Cascata is located in the municipality of Ubaitaba, Bahia. Cascata was an abandoned cacao plantation that was sold for land reform. Forty families were settled there in 1998. The land titles were granted not to individuals but to the community association, although each family was assigned an area of 4-5 hectares of the plantation to maintain and harvest. In addition, about 180 hectares of Atlantic Forest were designated as a community forest reserve.

Cascata farmers produce cacao almost exclusively. Most of the land was planted in cacao already, and little open area was available for planting manioc and other food crops. Each family harvests cacao from its individual area. Cacao seeds must be fermented and dried before sale, and this process is done collectively in a communal area, using infrastructure left behind by the plantation owner. The entire community landholding is organic certified and the cacao is marketed through the Jupará cooperative. In order to receive the higher organic price, the cacao must also be top quality, which depends on correct fermentation and drying, so the community decided to designate a few community members to complete this process in hopes of a more uniform and higher quality product.

In comparison to Fortaleza, Lagoa Santa, and other local smallholder communities, the standard of living in Cascata is quite high. Unlike in the older communities studied, very few Cascata residents work outside of the community. A few have off-farm income from retirement pensions. The community is located along a major highway, allowing for easy access to public transportation, local markets, secondary education and health services. Because Cascata was established on a former plantation, much of the infrastructure was already in place, including a dozen workers houses where families are now living, a large building for meetings and events, a church and school, production areas for processing cacao, and a large cacao dryer. Additional houses were constructed to accommodate additional families. Families enjoy well-constructed brick homes, electricity, running water, modern sanitary facilities, and even a public telephone. All of the residences are located in the central community area and the cacao plantation areas surround this central area. In Fortaleza and Lagoa Santa, every family lives on its own piece of land, and residents are fairly isolated from their neighbors. Cascata's centralized model greatly facilitates community organization and cooperation.

Methods

Twelve households were randomly selected for household interviews, as described in Chapter 2. Data was collected on participation in the Jupará program, use of target agroecological practices, land use patterns, and other socioeconomic conditions that might affect a family's ability to meet project goals.

As in Fortaleza and Lagoa Santa, a participation score was calculated for each family and data were entered into linear regression models.

Descriptive statistics were compiled for each of the three communities including a number of factors, including family characteristics and land use patterns. A MANOVA analysis was used to assess differences across communities. Tamhane T2 Post-Hoc Test was used to test the statistical difference between each pair of communities. MANOVA was selected for its ability to compare multiple dependant variables in three or more categories while taking into account possible correlations between the dependant variables.

Results

Participation

Although Cascata entered the project later, participation in Cascata was comparable to participation in the other two communities (Figure 3-1).

In Cascata, all families participated in the Jupará project (Figure 3-1) and all maintain organic certification, and are utilizing, at minimum, the organic practices required for certification. Cacao agroforestry was already established when residents received their plots, and a community forest reserve sets aside 40% of the community's total area in natural forest. Because little variation in participation, practices, or land cover existed among families interviewed, linear regression models showed no significant effect of participation on agricultural practices, farm income, or land cover.

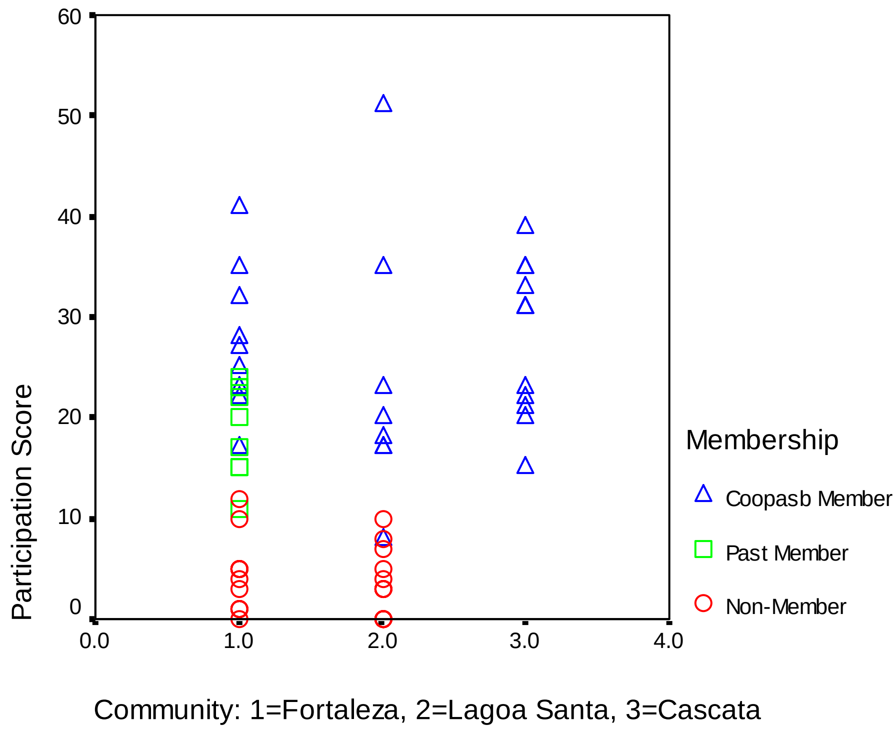


Figure 3-1. Range of participation scores in Fortaleza, Lagoa Santa, and Cascata.

Therefore, only descriptive statistics are presented here. Table 3-1 presents household data collected in Fortaleza, Lagoa Santa, and Cascata and allows for comparison between Cascata and older communities. On average, Cascata residents have more years of education, fewer off-farm workers, and a larger percentage of income coming from agriculture than Fortaleza and Lagoa Santa residents. Cascata has a smaller family landholding size than Fortaleza and a similar size to Lagoa Santa. Including the community forest reserves, Cascata has more forest and less area in annual crops than the other two communities.

Table 3-1. Descriptive statistics by groups for three communities. * indicates statistically significant difference (p≤0.05) between communities as measured by MANOVA analysis. Statistical relationships are shown between each community, Fortaleza (F), Lagoa Santa (L) and Cascata (C) as measured by Tamhane T2 Post-Hoc Test.

	Fortaleza		Lagoa Santa		Cascata		Statistical Relationship
	Mean	Std.dev	Mean	Std.dev.	Mean	Std.dev.	Between Communities
Family size							
Total family members living in community	6.07	4.19	7.35	5.56	5.33	1.87	
On-farm workers	1.85	1.30	2.65	1.43	2.06	1.00	
Off-farm workers*	1.23	1.00	0.86	0.83	0.54	0.69	F = L = C < F
Children living outside community	3.65	3.19	3.00	3.28	2.56	3.60	
Average age of all family members	31.76	12.8	29.31	10.68	32.40	13.32	
Head of household age	54.03	13.3	55.60	11.15	52.92	15.48	
Years of education							
Head of household*	1.83	1.91	1.75	2.75	4.67	2.90	F = L < C > F
Ages 18-30*	7.00	3.37	5.04	3.22	10.60	5.35	F > L < C > F
Ages 31-50*	4.07	3.11	2.73	3.12	11.45	14.20	F > L < C > F
Ages 51+*	1.05	1.25	0.33	0.97	3.43	3.39	F > L < C > F
Years farming on current property*	20.10	9.09	29.00	19.03	5.72	2.90	F = L > C < F
Family Landholding							
Total area*	15.96	1.30	9.43	7.40	10.13	4.49	F > L = C < F
% Agroforestry*	39.1%	15.6%	74.6%	20.3%	46.1%	12.6%	F < L > C = F
Age of Oldest Agroforestry System	17.68	8.80	21.22	10.26	Unknown		
Age of Newest Agroforestry System	6.45	5.07	5.91	4.14	Unknown		
% Natural Forest (includes community reserve)*	36.0%	17.9%	8.0%	15.2%	40%	0%	F > L < C = F
Years since most recent deforestation	20.10	9.09	18.91	16.09	Unknown		
% Fallow/Forest Regrowth	12.3%	11.5	8.4%	10.4%	6.2%	6.8%	
% Annual Crops*	7.3%	6.5%	11.1%	14.4%	1.9%	2.5%	F = L > C < F
% Pasture	5.4%	5.8%	3.0%	3.8%	2%	0%	

Table 3-1. Continued

	Fortaleza		Lagoa Santa		Cascata		Statistical Relationship
	Mean	Std.dev	Mean	Std.dev.	Mean	Std.dev.	Between Communities
Total Income in Brazilian Reais	8700	4617	8581	4341	7330	4021	
Farm Income	3775	2290	5375	3716	4919	3545	
Other Income	4925	3689	3206	3717	2413	3535	
% income from farming*	45.2%	26.3%	66.6%	30.8%	74.5%	31.3%	F = L = C > F

Adoption of Agroecological Practices

As in the other two communities, farmers implemented some practices more often than others. In Cascata, the preferred practices differ slightly (Figure 3-2). Green manures, homemade liquid organic fertilizer, composting, and contour erosion barriers were implemented least often, and crop rotation was also implemented less often than in the other two communities. As in Fortaleza and Cascata, mulching and multicropping are used by most farmers. All properties in Cascata obtained organic certification as a group, so 100% of farmers have replaced chemical fertilizers with the commercial organic fertilizer that Jupará sells, as chemical fertilizers are strictly prohibited. Only one farmer reports burning his field, and others stated that burning is also prohibited.

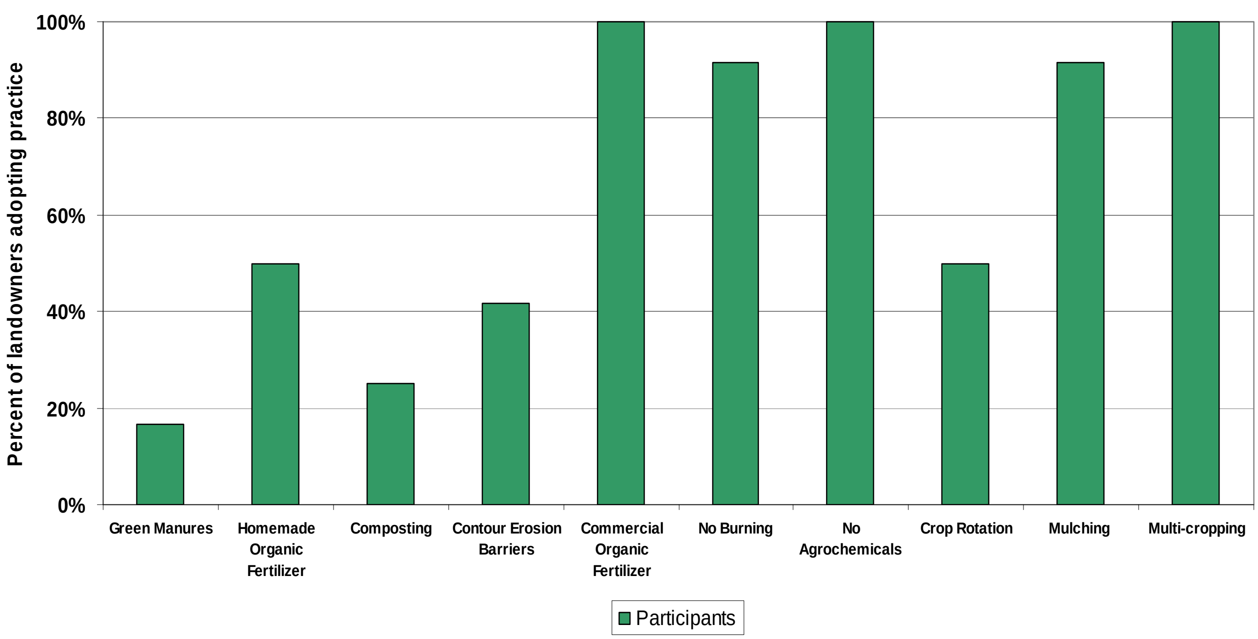


Figure 3-2. Adoption of agroecological practices in Cascata.

Land Use

The entire Cascata settlement meets Jupará's land cover goals of 30% natural forest cover and 40% agroforestry. Two large community forest reserves encompass 40% of the community's total area. Most of the other 60% of the settlement was already planted in cacao agroforestry, although in poor condition. Each family received a parcel already planted in cacao, and some farmers also have a small area for annual crops, usually where cacao trees have died of Witches Broom Disease. There is also a small community pasture area for work animals and some communally owned cattle. Figure 3-3 shows the distribution of land use in Cascata, including the community managed forest reserve.

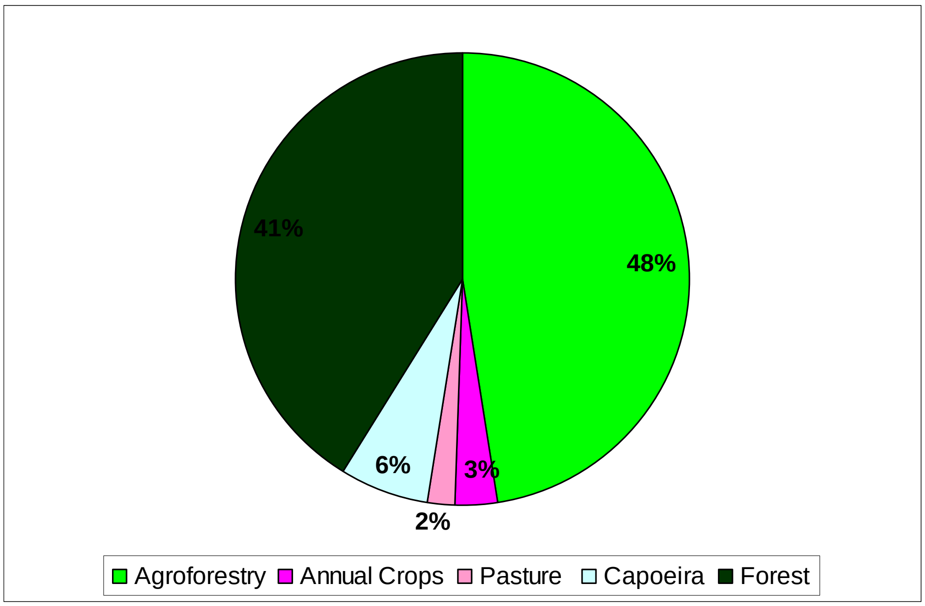


Figure 3-3. Land Use Distribution in Cascata.

Discussion

Agroforestry and Conservation in Cascata

Jupará considers Cascata to be one of their greatest success stories. This community is very different from Fortaleza and Lagoa Santa and may not be directly comparable. In Cascata, all families participate in the Jupará program and sell products through the Jupará cooperative. One hundred percent of families are organic certified and as such are *required* to use only organic fertilizers. All interviewees reported eliminating chemical fertilizer and using a commercial organic fertilizer, and only one farmer reported using fire. For this reason, there may not be enough variation in levels of participation or agricultural practices to show significant results here.

Preferred agricultural practices are slightly different in Cascata than in the other communities. Fewer farmers reported using crop rotation, probably because this is usually done at the beginning stages of establishing an agroforestry system, and most Cascata farmers received already established plots. This can be a challenge in communities on established estates, as there is little open area in which to plant annual crops for household consumption. Homemade liquid organic fertilizer was more popular here than in the other communities, possibly because the community association owns several cows, so manure is readily available to use in preparing the homemade fertilizer. A biogas project is underway to compost manure and produce methane gas to power a cacao dryer, but as of the time of these interviews, farmers were not yet using the compost produced by that project. Knowing that different types of communities prefer different agroecological practices, Jupará extensionists can adapt future extension programs to promote the practices most fitting to each type of community.

In Cascata, two large forest reserves conserve 40% of the settlement's total area in primary Atlantic Forest. Farmers have access to only as much land as they can use for agriculture; the forested land is strictly off-limits to agricultural activity. This is perhaps the best scenario to ensure long-term forest conservation. Forested areas are large and contiguous, rather than fragmented into smaller family-owned forest reserves as in Fortaleza. Because the farming system in Cascata is intensive and permanent, and was already established when farmers took possession of the land, Cascata farmers may feel less need to clear forests than farmers in other communities. Soil quality is also better in

Cascata than in the other two communities, which allows for more intensive cacao production on relatively small parcels.

Community members in Cascata have hopes of one day benefiting from their forest reserve as an ecotourism destination. In addition to the forest reserve, Cascata has several other unusual resources that might make it a suitable ecotourism site in the future, including a beautiful waterfall with a large pool suitable for swimming, and a large community house, originally the plantation owner's home, that might provide suitable guest rooms, as well as optimal location along a major road with frequent bus service. Although ecotourism is only an idea now, the presence of these resources may provide an additional incentive to conserve forests and other natural resources.

Future Directions for Jupará

Jupará's current work focuses mainly on communities like Cascata: new land reform settlements on former cacao estates. While it is important to recognize the need for extension services to improve both livelihoods and conservation practices in *all* rural communities, regardless of age, location, or production strategy, communities like Cascata are in many ways the ideal places for Jupará's work, especially from a conservation perspective. There are several reasons for this.

First, Cascata and communities like it tend to be highly organized. Community members live close together in a small residential area, rather than in isolated homes on individual landholdings. This facilitates the participation of most, if not all, community members, and makes it easy to organize meetings and activities. Some important management decisions, such as the designation of community reserves and organic certification of the entire estate, are made collectively rather than individually.

Secondly, the biophysical conditions on abandoned cacao estates tend to be much more suited for agriculture than those of older land reform settlements. Historically, the best lands were occupied by wealthy estate owners, and settlers invaded poorer lands. Many settlements still exist on these lands, and in several cases, agriculture has proven inviable given the poor soil quality. In Cascata, landowners can produce cacao, a crop that is demanding in soil nutrients but produces a lucrative product, with a minimum of fertilizer inputs. Cacao is also advantageous because there is a market for organic cacao.

Finally, by actively participating in the land reform process, Jupará is able to gain access to these communities before they are settled on the land and begin educating future farmers before destructive practices are in place. In many cases, new settlers have little farming experience, and it may be easier to teach agroecological practices to a new farmer than to change the well-established practices of a veteran.

Also, as facilitators of the land reform process, Jupará extensionists are able to choose landholdings to target for land reform, and are currently working to choose areas that have conservation value. In this way, larger remaining patches of Atlantic Forest can be preserved as community reserves within new settlements.

CHAPTER 4
EFFECTS OF AN NGO EXTENSION PROGRAM ON LAND USE CHANGE ON SMALL FARM PROPERTIES IN THE ATLANTIC FOREST OF SOUTHERN BAHIA

Introduction

The use of remote sensing technology has become a common method for assessing land use and land cover change (LULCC) in many areas of the world. Researchers have used satellite imagery to observe vegetation patterns at a landscape-wide scale, and also to observe changes over time through analysis of a time series of images. Remote sensing plays an important role in monitoring tropical deforestation in regions such as the Brazilian Amazon (McCracken et al. 2002), Mexico's Yucatan Peninsula (Vance & Geoghegan 2002), and Southeast Asia (Rindfuss et al. 2002).

While remote sensing is a powerful tool, it allows us to examine only the physical, spatial, and temporal aspects of land cover change. Many researchers have paired remote sensing studies with on-the-ground data collection, including interviews of local landowners, in order to better understand the social, economic, and political drivers of deforestation and other land cover changes. Although interviews may take place at the level of households or individual landholdings, remote sensing analyses are commonly broader in scale, encompassing entire regions, watersheds, protected areas and their buffer zones, or villages. In one example, Sunderlin et al. (2000) used satellite imagery to observe a nationwide trend in deforestation following an economic crisis, and a survey of 5000 households in Cameroon to help explain this change, but households were not linked to a specific location on the landscape.

Although landscape-wide studies are useful for determining broad-scale trends in land cover change, understanding region-wide habitat availability for a particular species, assessing the connectivity of landscape elements, or planning future protected areas, many land use decisions are made at a much finer scale. Especially in developing countries where small-scale agriculture is common, individual landowners make decisions about which crops to plant and where, whether or not to convert forest to agriculture, which trees to cut, how much fertilizer and pesticide to use, and how to manage water resources. A comprehensive understanding of the forces driving land use and land cover change requires an understanding of the household-level decision making process (Rindfuss et al. 2002).

Very few LULCC studies have focused specifically on change at the household plot level, due in part to methodological difficulties inherent in identifying the precise location of a small farm plot on a satellite image. Several studies in the Brazilian Amazon have linked households with specific plots of land (McCracken et al. 2002; Walsh et al. 2002). These studies have been facilitated by the fact that plots in most newer Amazonian settlements are of a uniform size and shape, and characterized by a "fishbone" pattern of deforestation, allowing for easy identification of each landholding on the satellite image. McCracken et al. (2002) initially used digital property maps obtained from INCRA, the government agency responsible for delineating new settlements. They found that these maps were often inaccurate or incomplete, since their purpose was simply to identify which plots belonged to whom, not to conduct detailed GIS analyses. They were able to develop a suitable farm property grid for 402 households using a combination of the INCRA maps, GPS points collected in the field, and mathematical interpolation of GIS layers.

In some study regions, no property maps are available, and properties may be irregularly shaped or not legally owned by the user. In these cases, researchers have had to create property maps using GPS points collected in the field, combined with sketch maps of the property and identification of key landscape features visible on the image. This method is time and labor intensive. Walsh et al. (2002) employed this method, along with a base maps of roads, to identify 418 landholdings in the Ecuadorean Amazon.

Vance and Geoghegan (2002) used GPS points and participatory mapping to outline 188 properties within the *ejido* systems in Quintana Roo and Campeche, Mexico.

In other regions, landowners reside in one place, while agricultural activities occur somewhere else. This was the case in northeastern Thailand, where Rindfuss et al. (2002) selected 310 villages and experimented with various methodologies to link households to their field plots. This process is even more difficult and labor intensive when agricultural plots do not contain the dwelling unit.

In each of these studies, researchers interviewed parcel owners and compiled data on socioeconomic conditions and land use decisions of each family. These data were then related to land cover data in order to better understand why different families might make different land use decisions.

This study will employ a combination of these methods to carry out a property-level study of land use change in Fortaleza, a rural settlement near Una, Brazil, and to further develop the methodology for such research. As noted by previous researchers, difficulties in accurately identifying individual properties limit the accuracy of results.

Thirty household interviews were conducted in June and July of 2005, as part of an evaluation of the Jupará Agroecology Extension Program. Through a partnership with WWF, Jupará has been working in the area since 1995 to promote organic agroforestry and forest conservation. Specific program goals included the implementation of agroecological practices and maintenance of 40% of each landholding in agroforestry and 30% in natural forest cover. Taking into account a large community forest reserve, individual landholders were expected to maintain 12.5% of their own landholding in a forest reserve, to maintain 30% of the overall community landscape in forest cover.

Results of the program evaluation interviews indicated that while many participants have implemented organic agricultural practices, only 42% of participants, and 43% of all farmers interviewed, have maintained a forest reserve equal to at least 12.5% of their property.

Interview data offer only a snapshot of one point in time. Many landowners report that although the area was almost completely forested when the first settlers arrived in the 1970s, extensive deforestation had occurred before the Jupará program began in 1995. More recent settlers reported significantly more remaining forest cover than those who had been living in Fortaleza for longer periods of time. Knowing the distribution of land cover types that landowners report at present, this remote sensing analysis was designed to assess the extent of forest cover in the community before and after the Jupará project. Images from 1986, well before the project began, and 2001, the most recent image available, were analyzed to address the following research questions:

- How has forest cover changed in Fortaleza between 1986 and the present?
- How much forest cover was present before the Jupará program began?
- Is the program asking landowners to conserve something that wasn't present to begin with?

- Are program participants more likely to allow forest regrowth than non-participants?
- Is land cover data reported in interviews consistent with land cover data observed on satellite images?

Study Region

Fortaleza

Fortaleza is a land reform settlement near Una, BA. Fifty families are settled on 1102 hectares, with an average lot size of 16 hectares (INCRA 2006). Approximately 250 hectares are in community areas including a forest reserve and a small community cacao plantation. Families began settling the area in the mid 1970s. At that time, the area was completely forested. Most of the settlers in Fortaleza grew up on their parents' farms or worked on nearby rubber plantations before settling there.

INCRA (*Instituto Nacional de Colonização e Reforma Agraria*, the government agency responsible for land reform) officially divided the land and gave titles to these landholders in 1997. At this time, eight new lots were created along the westernmost perimeter of the community, in an area that had been a part of the community forest reserve. By locating families along the perimeter of the reserve, INCRA hoped to avoid invasion of this land by outsiders. Eight families were moved from their original plot of land to one of these new, completely forested plots, and other families had a portion of their original land officially titled to a neighbor.

In most cases, the male head of household received a title to his individual parcel of land. Farmers in Fortaleza produce mainly rubber and cacao as cash crops, as well as some manioc, corn, fruit and vegetable crops for consumption.

Of the 50 families settled in Fortaleza, nine are currently members of Jupará and COOPASB, Jupará's agricultural cooperative. Nine families were formerly members and dropped out, and the remainder of residents may have participated in some Jupará training events but never formally joined the cooperative. For the purposes of this analysis, we compare members, former members, non-members, and families on new lots. The families on new lots are also non-members but are analyzed separately due to the more recent process of land cover change on these lots.

The Atlantic Forest of Southern Bahia

Fortaleza is located in the Atlantic Forest Region of Southern Bahia, Brazil, and has been targeted for conservation efforts due to it's proximity to the Una Biological Reserve. Figure 4-1 shows the location of the study site and the reserve. The Una Reserve encompasses about 11,000 hectares of what remains of the Atlantic Forest ecosystem (Buschbacher in prep.). The Atlantic Forest, which once covered much of the eastern coast of Brazil as well as parts of Argentina and Paraguay, is one of the world's most diverse ecosystems, and also one of the most endangered. The first mapping of the Brazilian Atlantic Forest was undertaken in 1990 with the participation of IBAMA (Instituto Brasiliero do Meio Ambiente e dos Recursos Naturais Renováveis, or the Brazilian Institute of the Environment and Renewable Natural Resources) and the Fundação SOS Mata Atlantica (SOS Atlantic Forest Foundation), a prominent Brazilian NGO. According to this project, the Atlantic Forest originally covered 15% of the Brazilian national territory, and has been reduced to a mere 7% of its original area, or about 1% of the Brazilian National Territory. The Atlantic Forest is home to 108 million people, or about 60% of the population of Brazil (Hirota 2003).

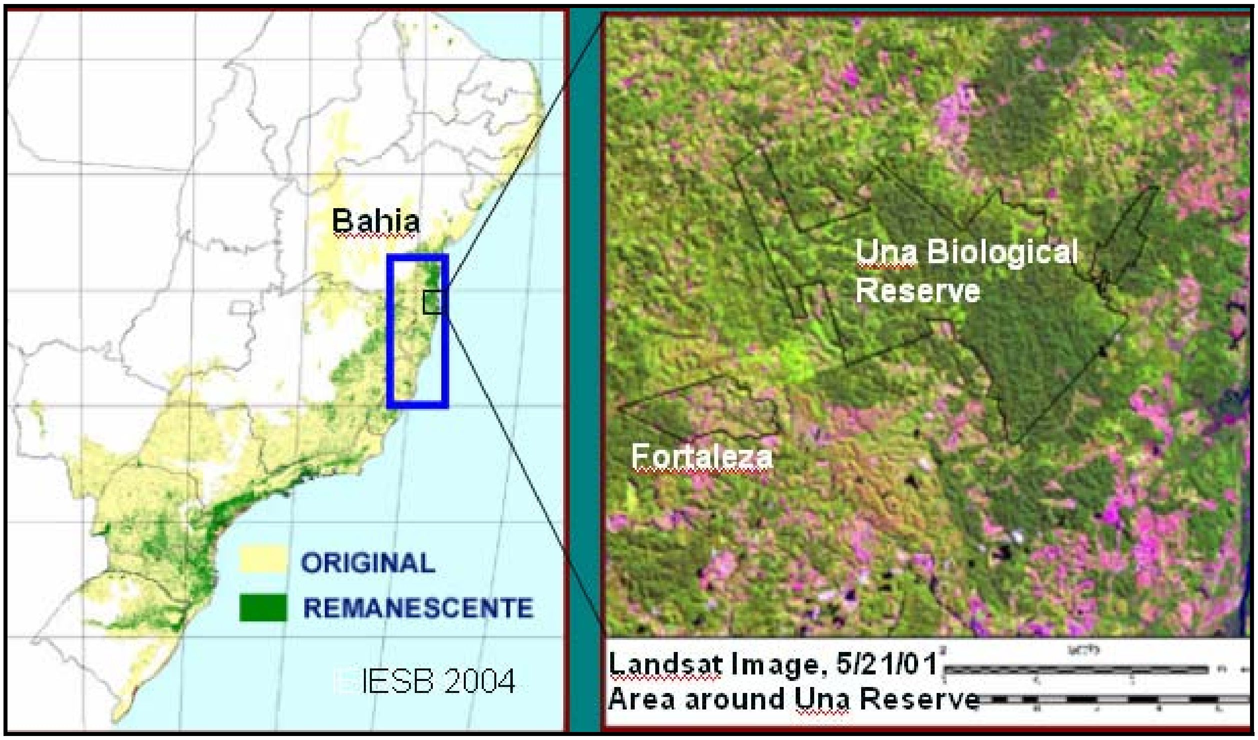
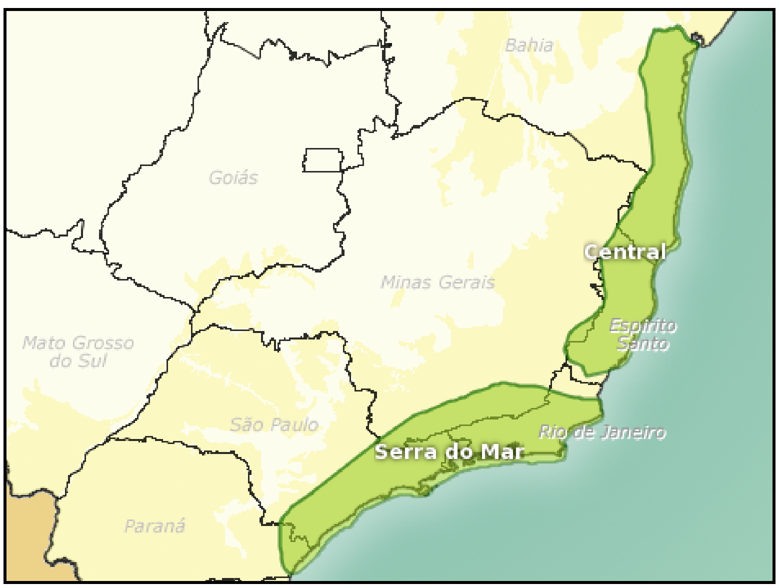


Figure 4-1. Location of study site. The blue box indicates the Southern Bahia region with the original extent of the Atlantic Forest shown in yellow and remaining forest in green. The smaller black box indicates the area around Fortaleza and the Una Reserve. May 2001 Landsat image of the reserve and Foratleza is shown on the right.

The Atlantic Forest Biome is on the Global 200 list of globally outstanding ecoregions, and is considered a Biodiversity Hot Spot (Mittermeier et al. 1999). The region supports over 1600 species of terrestrial vertebrates and 20,000 species of vascular plants, including more than 6000 endemic plant species and more than 500 endemic animal species (Mittermeier et al. 1999).

In order to set priorities for conserving what remains of the fragmented Atlantic Forest, two biodiversity corridors have been designated; the Serra do Mar Corridor, which extends southwest of Rio de Janeiro through Minas Gerais, Sao Paulo, and Paraná states, and the Corridor Central, in Southern Bahia and Espiritu Santo (Figure 4-2) (Aguiar et al. 2003). The Una Reserve and Fortaleza fall within the Central Corridor.

Within the Central Corridor, researchers have documented extremely high tree diversity (Thomas et al. 1998), twelve endemic primate species (Pinto 1994) and 50% of the known endemic bird species of the Atlantic Forest (Aguiar et al. 2003). The Central Corridor encompasses almost 12 million hectares, and about 12% of its total area is covered in native forest (Conservation International 2006). The corridor contains at least 40 protected areas, 70% of which are state-owned. The average protected area size in the region is 93.13 km^2 (Aguiar et al. 2003). Financial resources needed to enforce protected areas and establish new ones are limited, so an emphasis on privately owned protected areas and community managed ones, like the community reserve in Fortaleza, is essential for the long-term conservation of the Atlantic Forest.



http://www.corredores.org.br/?area=c

Figure 4-2. Location of the Central and Serra do Mar Corridors.

The Central Corridor includes the cacao growing region of Southern Bahia. Currently about 600,000 hectares of *Theobroma cacao*, a medium-sized understory tree, are planted in this region (Buschbacher in prep.), many maintain some of the original forest canopy or are interspersed with patches of natural forest (Alger 1998; Alves 1990; Buschbacher in prep.). This region's cacao agroforests have generated considerable interest within the conservation community for their potential to maintain forest-like landscapes and serve as biological corridors between blocks of fragmented forest (Alves 1990). Researchers in many countries have demonstrated that while agroforestry systems are no substitute for intact forest, some wildlife species are able to use cacao-based systems to some extent as a corridor between areas of more suitable habitat, with more diverse systems providing more suitable habitat than less diverse systems (Alves 1990; Greenberg 1998; Greenberg et al. 2000; Laurance 2004; Reitsma et al. 2001). Pardini (2004) carried out such a study on small mammals on fragmented areas of the Una Biological Reserve. For this reason, conservation programs like the one implemented by Jupará, targeting cacao producers and producers of other agroforestry crop such as rubber, cloves, palms, and fruit, are important to maintain connectivity of the region's remaining forest fragments.

Remote sensing studies in the Atlantic Forest

The presence of extensive agroforestry further complicates remote sensing studies in this region. In regions such as the Amazon and Mexico's dry tropical forests, land cover can usually be divided into forested and non-forested, as annual crops or pastures for livestock are common land uses. Agroforests, on the other hand, can be extremely difficult to separate from natural forests and forest regrowth, especially in the case of *cabruca* systems, in which cacao is planted in the shade of natural forest overstory trees (Lemos Costa 2000; Saatchi et al. 2001), or very old agroforestry systems. Fortaleza residents harvest rubber and cacao from agroforestry systems that may be more than thirty years old, although these are usually not *cabruca* systems but mixed plantations of rubber, cacao, and other fruit species.

Only a few remote sensing studies have been carried out in the Atlantic Forest region. Lemos Costa (2000); Saatchi et al. (2001), and Araujo (1997) all carried out broad scale classifications of the Southern Bahia region using Landsat Imagery and NDVI (Normalized Difference Vegetation Index). NDVI is a vegetation index commonly used as a measure of plant biomass. Lemos and Araujo both defined forested areas, agroforests and open areas by assigning a characteristic range of NDVI values to each. Use of NDVI alone, however, may be unreliable, because NDVI has been shown to be ineffective in classifying uneven aged, humid tropical forests where the biomass can be very high (Sader et al. 1989).

Several other studies have relied on more expensive, higher resolution imagery to distinguish between similar land cover classes like forests and agroforestry, such as IKONOS imagery (Guanes Rego & Koch 2003), SIR-C Radar imagery (Saatchi et al. 2001), and CASI imagery, which is similar to an aerial photograph (Olson 1998). Due to the financial constraints of this study, this approach was not considered.

Methods

Interviews

A total of 30 household interviews were conducted in Fortaleza in June and July of 2005. The fifty existing households were classified as participants, former participants, or non-participants in the Jupará project. Current members of the Jupará's agricultural cooperative, Coopasb, were considered participants, past members were former participants, and non-members were considered non-participants. All of the participants and former participants were interviewed, and of the remaining non-participants, a random sample of 10 was selected, for a total of 30 interviews. Interview content included questions concerning family demographics, agricultural practices, and land cover distribution, and participation in Jupará training activities.

Participatory Mapping and Training Points

For each household interviewed, the researcher also toured the property with the landowner to verify information obtained in the interview, and to collect GPS training points and a brief description of each of the land cover types present on the property for use in image classification. Farmers reported five land cover types: Forests, Agroforestry, "*Capoeira*," which includes forest regrowth and fallowed areas, Annual Crops, and Pasture. To assist participants in describing their property's land cover distribution, a participatory mapping activity was carried out in which participants were asked to draw a simple sketch map of their landholding, including agroforestry systems and forested areas, areas of annual crops and pastures, roads, waterways, and houses. A representative sketch is shown in Figure 4-3. GPS points were collected along the perimeter and corners of these sketches, and at other important landscape features, to assist in placing the property boundary on the image.

Image Processing

Landsat images from September 11, 1986 and May 23, 2001 were acquired from the University of Maryland's Global Land Cover Facility (University of Maryland 2006). Image dates were chosen based on availability of cloud-free imagery, and seasonal differences in vegetation may influence results somewhat. The most recent Landsat images (2003-present) are affected by an equipment malfunction and were not used for this study.

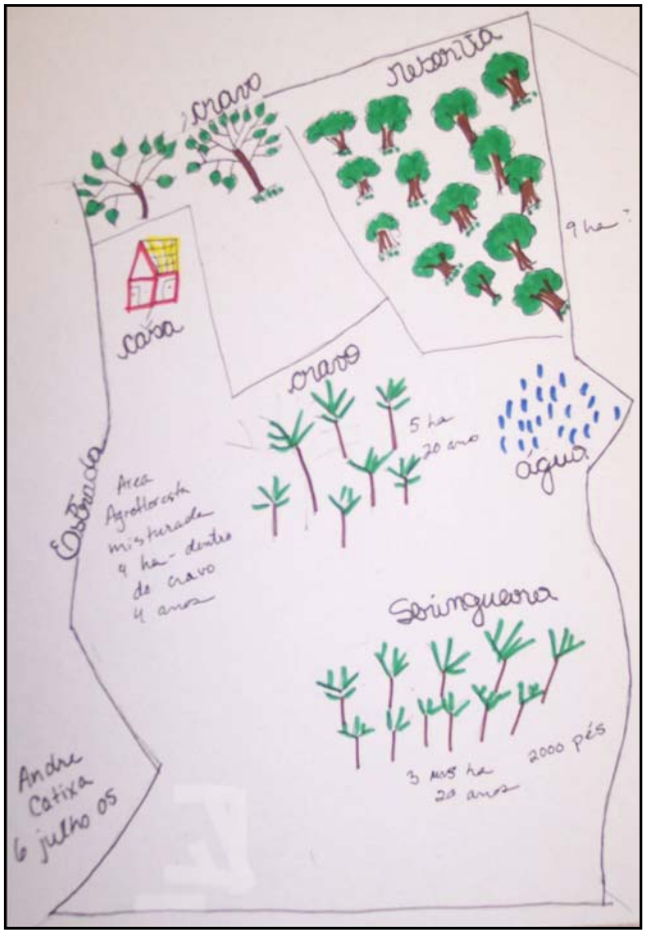


Figure 4-3. Property sketch created by a community member.

Images were subset to a manageable size. The 2001 image was georectified to a map of waterways provided by IESB (Instituto de Estudos Socioambientais do Sul da Bahia). Fortaleza is located in a very rural area, roads are not paved and are not visible on the image. The 1986 image was then georectified to the 2001 image. Images were calibrated to remove differences in haze and light angle between the two image dates. An NDVI layer and a texture layer were added to the original image, to provide additional information for image classification.

The most difficult part of a property-level remote sensing study is locating the properties on the image. INCRA in Salvador provided a digital map of Fortaleza. The map included only the community outline, roads, and streams; individual property outlines were not included, and UTM coordinates appeared to be off by a factor of 1000. Jupará provided a photocopy of another map, also produced by INCRA, which did include property boundaries. This photocopied map was scanned and georectified in Erdas Imagine, using points extracted by hand and multiplied by 1000 from the digital map. The scanned, georectified map was then traced with a mouse to create an independent vector layer that could be projected on top of the image. This multistep process created some error in the location of property boundaries, and some GPS points collected in the field did not fall into the correct property polygons. INCRA maps are not particularly accurate to begin with, as noted by other researchers (McCracken et al. 2002), since their main purpose is simply to keep records of who owns which lot, not to conduct scientific research. Accuracy of this analysis also depends on the accuracy of the IESB map used for image georectification. Additional GPS data from the field could improve the accuracy of this map. However, the location of several large landscape features, such as the community forest reserve and a large cleared ranch just to the south of the community boundary, confirm that the vector layer is in approximately the correct location.

The vector layer was projected onto the images and images were subset again to include only Fortaleza. Images were classified using methods of unsupervised classification (Jensen 2005). Computer-generated classes were identified as Forest, Agroforestry and Forest Regrowth, Cleared Areas, and Clouds and Shadows, based on training points collected in the field and general knowledge of the landscape. Farmers reported five land cover categories, but since some of these are difficult to separate on the image, images were classified into only three classes, plus clouds and shadows. “Forest” on the image could include forest and some mature forest regrowth or very old agroforestry systems. “Agroforestry and Forest Regrowth” were one category for the purposes of image classification, and include agroforestry and regrowth that farmers reported as “*capoeira*.” “Cleared Areas” include annual crops, pastures, and some recently fallowed *capoeiras.*

Classifications were imported into ArcGIS and separate layers were created for each land use class for each image date. Clouds and shadows were eliminated from the analysis. The vector layer was modified so that each landholding was a separate polygon with its own identification number. Using the zonal statistics tool, the area of Forest, Agroforestry/Regrowth, and Cleared Areas within each polygon was calculated for the 1986 and 2001 classifications. Percent change in each land cover type between 1986 and 2001 was calculated for each polygon.

Results

Land Use Classifications

Classifications of 1986 and 2001 images show areas of forest, agroforestry or regrowth, and open areas within property polygons and communal areas (Figures 4-4 and 4-5). Areas in which the land use changed from the 1986 image to the 2001 image are highlighted in Figure 4-6. Properties were divided into several categories for the purposes of this analysis. Table 4-1 shows distribution of Forest, Agroforestry (AF), and Cleared Areas for property owners who participated in the Jupará program, former Jupará participants, and non-participants. Lots which were not yet in use in 1986 were analyzed separately and are labeled New Lots. (All of the families on new lots were also non-participants, but results for non-participants on new lots are not included in results for non-participants on older lots.) The community reserve was also analyzed separately.

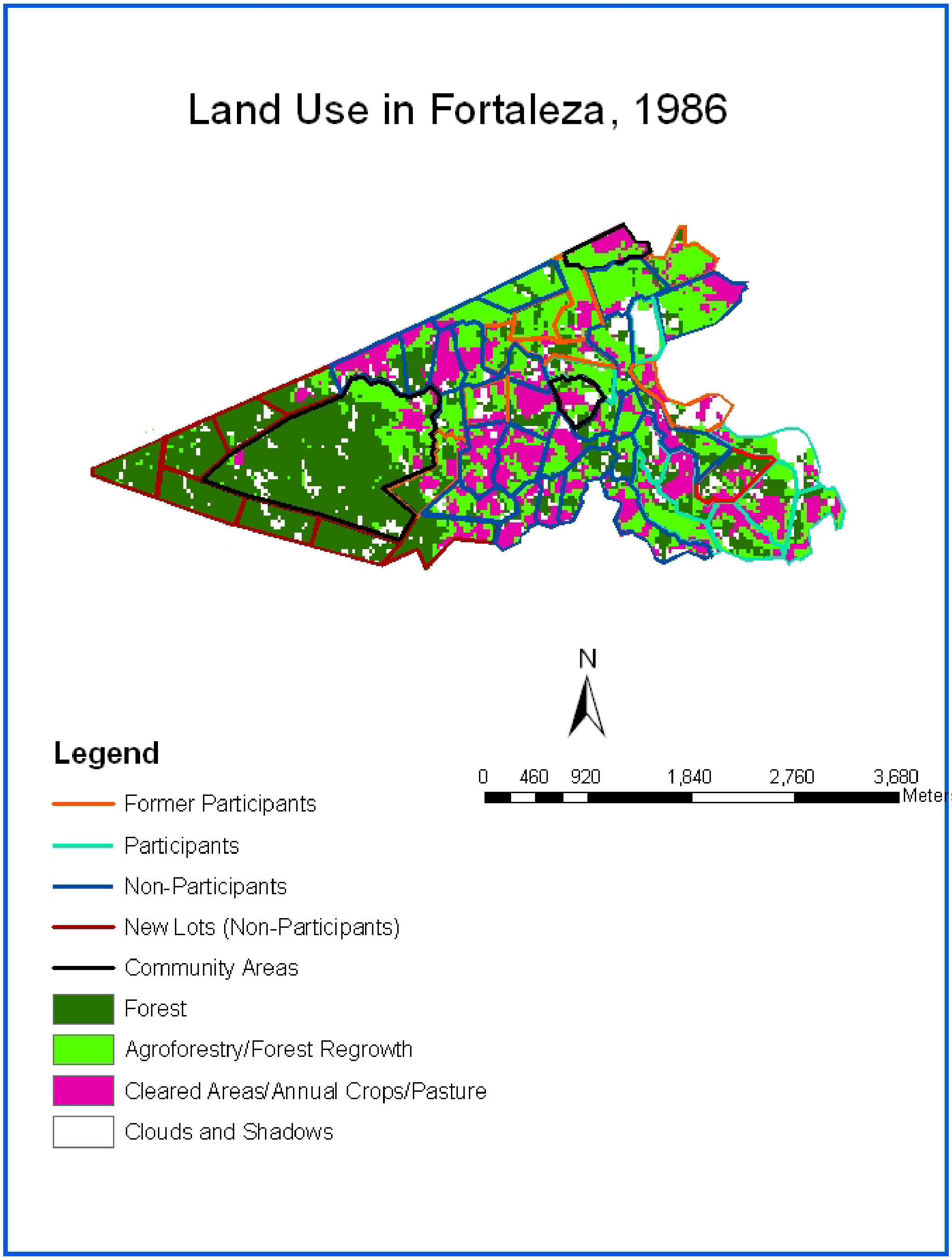


Figure 4-4. Land Use Classification for Fortaleza, 1986.

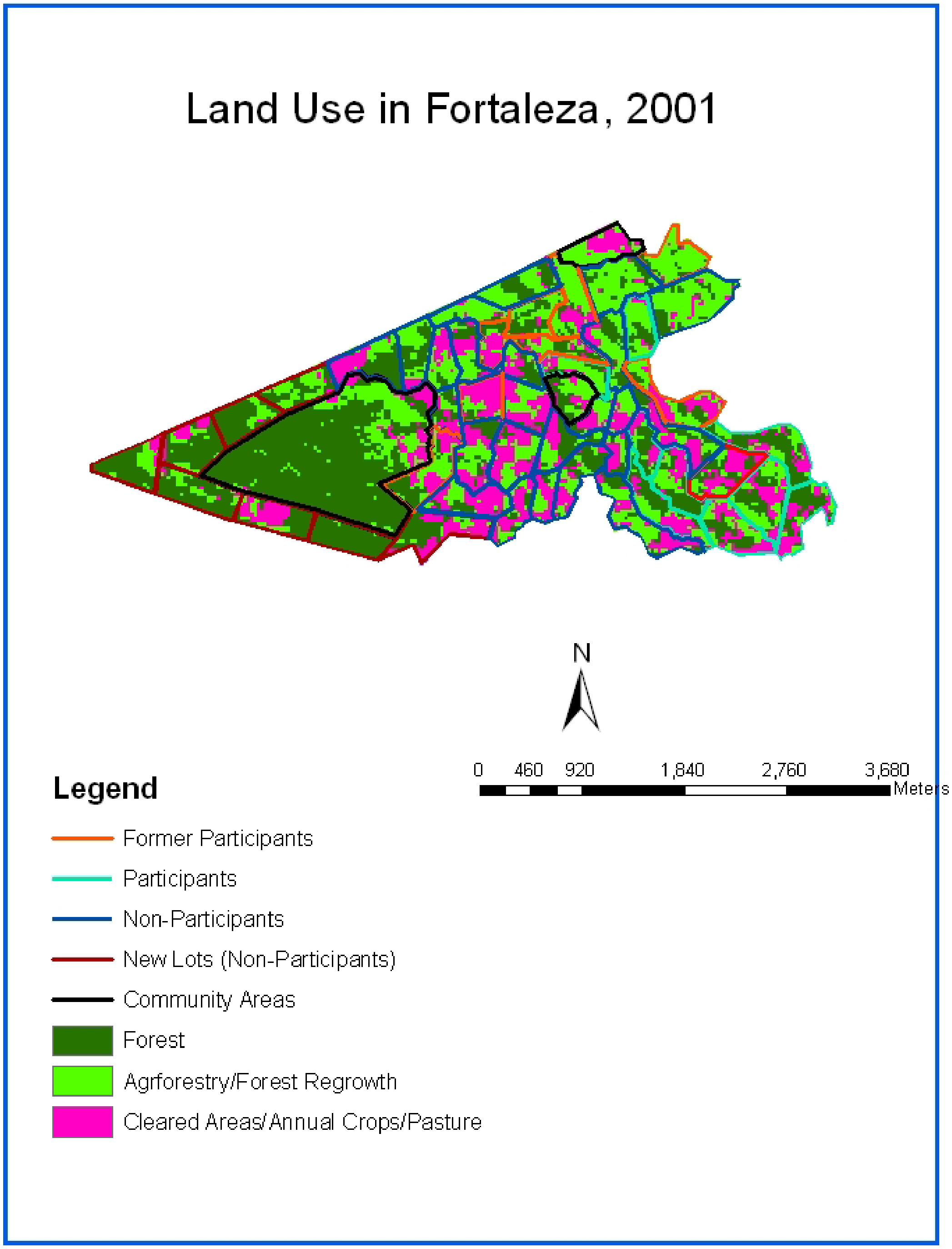


Figure 4-5. Land use classification for Fortaleza, 2001

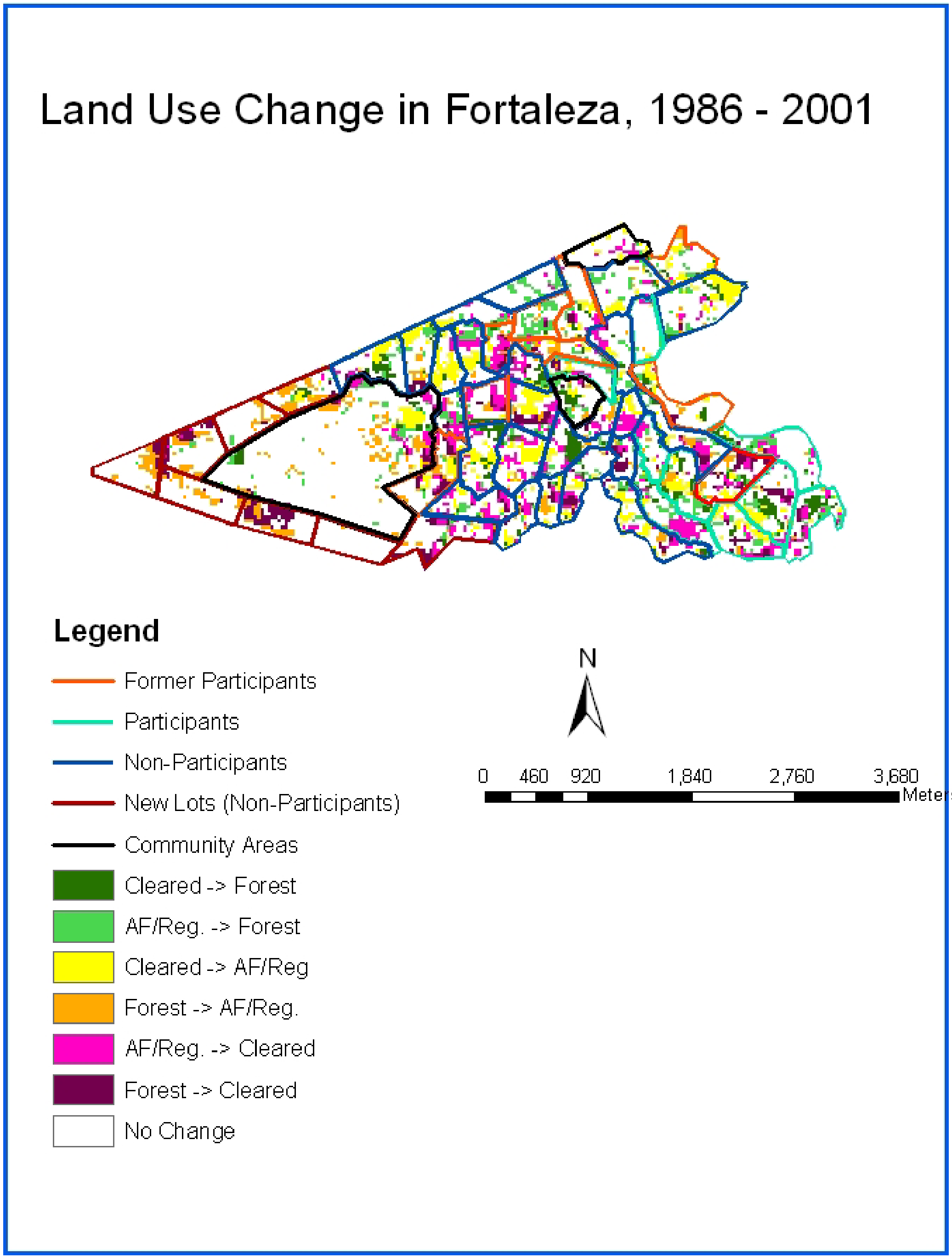


Figure 4-6. Area of Land Cover Change in Fortaleza,1986 - 2001

Table 4-1. Land use change in Fortaleza, 1986-2001.

	Forest 1986	Forest 2001	% Change in Forest	AF/R 1986	AF/R 2001	% Change in AF/R	Cleared 1986	Cleared 2001	% Change in Cleared
Non-Participants	16%	24%	8%	40%	46%	6%	38%	34%	-4%
Former Participants	25%	27%	2%	50%	48%	-2%	21%	25%	5%
Participants	14%	34%	20%	44%	35%	-8%	41%	35%	-5%
New Lots	84%	16%	-68%	5%	16%	11%	7%	28%	22%
Community Reserve	81%	78%	-3%	14%	16%	2%	5%	6%	1%
Total	32%	31%	-2%	35%	39%	3%	28%	31%	2%

Figure 4-7 shows the percent change in each cover class for lots owned by participants, former participants, and non-participants, as well as on new lots and within the community forest reserve, and for the entire community area. The overall quantity of these three land use classes remained essentially the same in Fortaleza between 1986 and 2001, but the spatial distribution of forest patches, agroforestry, and cleared areas have changed. Several new lots have been settled in what was once a forested area, forest cover has decreased in these areas as well as in the community forest reserve. Meanwhile, forest cover has increased on older agricultural lots. Forest cover increased by 20% on lots owned by Jupará participants, compared with a 9% increase on non-participants' lots, and 2% increase on former participants' lots. In addition, the land cover maps show that much of the increase in forest cover occurs along two riparian areas.

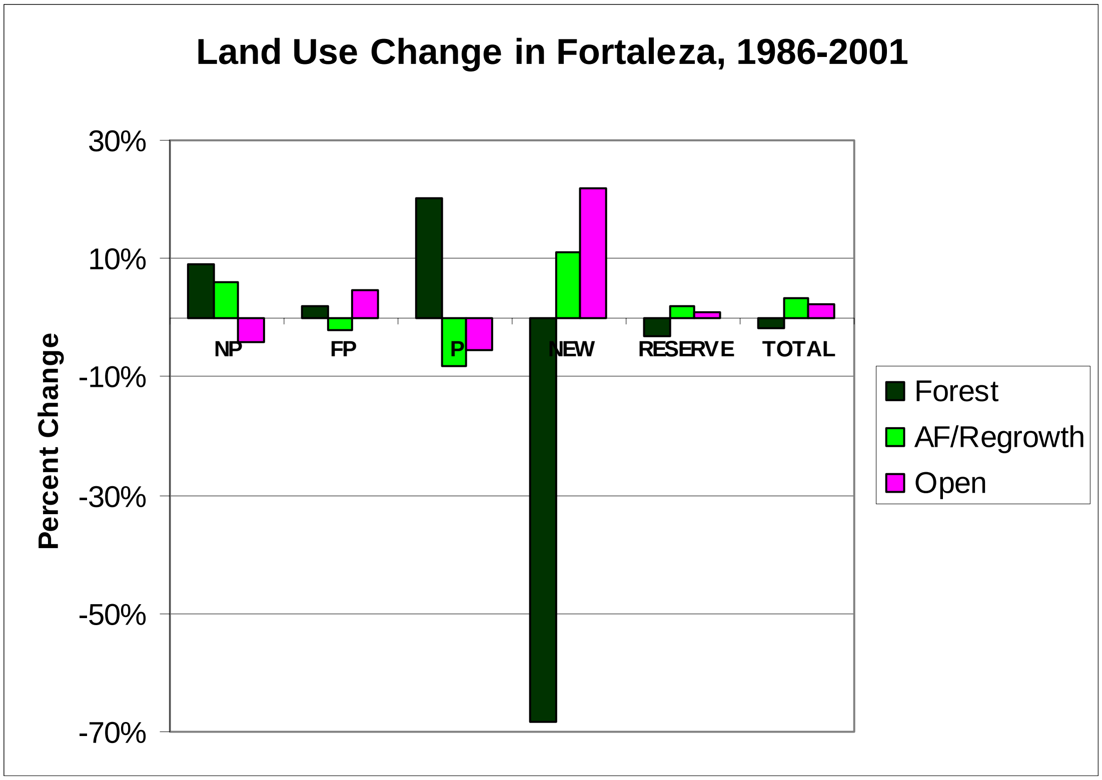


Figure 4-7. Land use change in Fortaleza on properties owned by non-participants (NP), former participants (FP), and current participants (P) in the Jupará project, as well as on newer lots and within the community forest reserve.

Comparison with Interview Data

The participants in this study reported a land use distribution similar to the one observed on the Landsat image. Figure 4-8 shows the average land use distribution reported by interviewees, and Figure 4-9 shows the community-wide distribution observed on the 2001 classification. The interview data included additional classes which are difficult to discern on satellite imagery; forest regrowth and fallows are a separate category, and open areas are divided into annual crops and pastures.

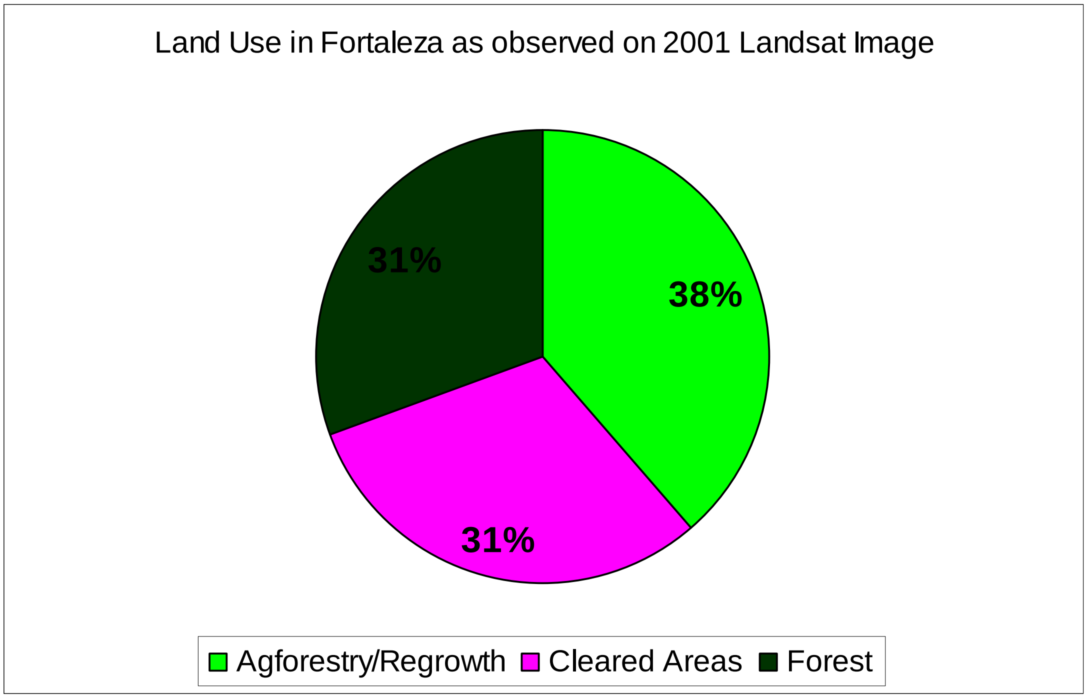


Figure 4-8. Distribution of land uses in Fortaleza as measured by classification of 2001 Landsat data.

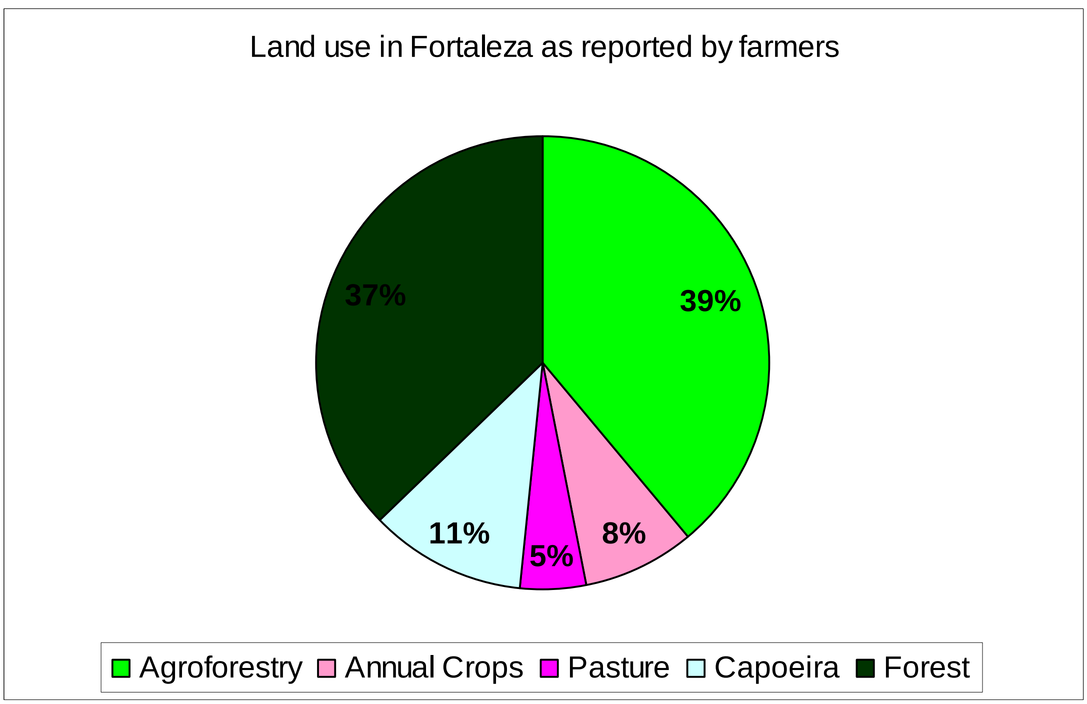


Figure 4-9. Distribution of land uses in Foratleza as reported by farmers interviewed in 2005.

Discussion

Remote Sensing Analysis

This analysis shows that the overall proportions of forest, agroforestry or forest regrowth, and open areas in Fortaleza were nearly the same in 2001 as in 1986, with slight increases in agroforestry (3%) and open spaces (2%), and a slight decrease in forest (-2%). However, analysis of the satellite imagery reveals that the spatial distribution of forest patches has changed considerably since 1986. In the eastern part of the community, where settlers have been present longest, and where little forest existed in 1986, we see regeneration of forested areas, especially in two riparian corridors which run north-south through the community. Areas classified as "forest," then, include not only the remaining original forest but some areas of forest regrowth. Once the secondary forest reaches a certain stature, it becomes indistinguishable from mature forest on the satellite image.

In some areas of the community, riparian zones are marked by a steep decline toward a small stream, and farmers might find these sloped areas unsuitable for agriculture. Many interviewees cited the protection of water resources as a main reason for conserving forest. Most families depend on natural springs along this stream as their source of drinking water, and several farmers told of incidences in which streams had dried up after the removal of a forest patch, and reappeared as the forest was allowed to regenerate.

Alternately, GPS points collected in the field suggest that a few of these areas that appear to be "forested" are actually mature agroforestry systems, which appeared as young trees in 1986 but are now large enough to be mistaken for forest in the Landsat classification. Some farmers reported agroforestry systems more than 30 years old that included some very large trees, primarily rubber (*Hevea brasilensis*), shade species planted with cacao, and a few very large fruit trees including jackfruit (*Artocarpus heterophyllus*) and mango (*Mangifera spp.*).

The eight westernmost lots in the community were not yet settled in 1986 and were still completely or mostly forested. INCRA officially demarcated and titled the entire community in 1997, and at that time several families were relocated to the perimeter of this forested area. According to local residents, INCRA reasoned that by locating families around the perimeter of the community forest reserve, invasion of this land by non-community members could be prevented. Unfortunately, most of the relocated families were granted completely forested land, and so had no choice but to deforest it. Sixty-eight percent of the forest on these lots had disappeared by 2001.

Within the community forest reserve, we also see a 3% decrease in forest cover. This could be accounted for by the fact that a lot on the edge of the reserve was used to build a second school in the mid 1990s. A visit to the area does indicate some level of human disturbance and removal of logs, and some families along the perimeter of the reserve may be using land actually located within the reserve. Although some degradation is evident, the community forest reserve is still by far the largest patch of forest in the community, and still the easiest way to conserve forest in Fortaleza, as no one person has autonomous decision-making power for this land, and the community has established an expectation for conservation of the area.

A landowner-by-landowner analysis of the lots in the eastern part of Fortaleza offers good news for the effectiveness of the Jupará program. Current program participants appear to be far more likely than non-participants to allow forest regrowth on their properties (or the development of very old agroforestry systems). Forest cover increased by 20% on participants' lots, compared to an 8% increase on non-participants' lots, and a 2% increase on former participants' lots. Participants had the least forest in 1986 (14%) and have the most forest of any group now (34%). Participation in a conservation program may be only one factor influencing this change. Location of the lots along steep or riparian areas may also be a factor. Some of the participants were among the first settlers to arrive in Fortaleza in the 1970s, so the development of very old agroforestry systems or regeneration of more mature forest patches may be a pattern that develops only after many years of settlement.

Comparison with Interview Data

By interviewing farmers, we can get a more specific idea of the possible land uses within each of the three categories observable on the image. Interview data represents the mean of a sample of 30 farmers, while the image analysis includes all 50 properties in Fortaleza, the community reserve, and two smaller community areas.

Farmers reported a land use distribution fairly consistent with the distribution observed through image analysis. Farmers reported slightly more forest and agroforestry than appeared on the image, and slightly less cleared area. This could be because some young agroforestry systems or recently fallowed areas appeared as cleared areas on the image classification, or because cleared areas actually decreased between 2001, when the image was collected and 2005, when the interviews were conducted. Interview data are based on a representative sample of 30 households, weighted so that participating and non-participating households are proportionately represented, while the Landsat classification generated data for all landholdings; this could also explain slight discrepancies. Overall, the results were similar, and this serves to confirm both the accuracy of data reported by farmers and of our Landsat classification.

Jupará Program Goals

At the start of the extension program, Jupará program leaders, along with WWF partners, set goals for forest conservation in participating communities. In Fortaleza, the goal was to maintain 30% of the community's total area in natural forest. The community reserve protects about 20% of the total area. On the remaining 80% of the land, each farmer would have to conserve 12.5% of his or her own plot, to reach the overall goal of 30% forest cover. Of the 30 farmers interviewed, 14 of them, or 46%, report that their property meets this goal, when only original forest cover is considered. According to the image classification, which includes forest regrowth as well as original forest cover, 46 of the 50 properties, or 92%, meet this goal. The image analysis used a broader definition of "forest:" regrowth areas that farmers usually define as "*capoeira*" were included here, and very old agroforestry systems may also be included. Including both the reserve and forested areas on individual lots, 31% of the community area was forested in 2001, indicating that Fortaleza does meet Jupará's conservation goal, when areas of regrowth are taken into consideration.

Areas of regrowth may not provide the same conservation benefits as the original forest, as regrowth areas are likely to be more fragmented and include a different species composition, and may or may not provide suitable wildlife habitat. At the same time, it is important that conservation programs like Jupará set goals that are attainable, in order to maintain the enthusiasm and participation of local residents. Adopting a broader definition of forest conservation may make goals more attainable, especially in an already deforested area like Fortaleza. Lots that were settled in the 1970s included little forest cover in 1986, so regeneration of forested areas is really the best that conservationists can hope for in this case. Regrowth areas and very old agroforestry systems can provide important environmental services, such as the protection of water sources, and can act as corridors between areas of remaining Atlantic Forest. The tendency of participants to allow forest regrowth to a greater extent than non-participants indicates that the Jupará program has succeeded in instilling this conservation ethic in Fortaleza.

Directions for Further Study

The accuracy of this assessment could be improved by returning to the field and collecting additional GPS points in Fortaleza, especially in areas of forest regrowth. A random sample of these areas could be visited to determine whether they are in fact areas of forest regrowth or very old agroforestry, and the age of the regrowth or agroforestry. Additional fieldwork could also help to more accurately locate properties on the satellite image. Walking the perimeter of a few representative properties with a GPS might be one way to accomplish this.

The community forest reserve also merits further research. While forest cover is increasing outside of the reserve, the remote sensing analysis indicates some degradation of the reserve itself. Who is using this area? Do users have the permission of the larger community to use this community resource? Community reserves are one effective way to set aside some of the larger fragments of remaining Atlantic Forest. The agrarian reform movement is constantly establishing new communities throughout Southern Bahia, and many include a community forest reserve. An in-depth study of the management of these reserves in well-established communities such as Fortaleza might allow planners to more appropriately select areas for community reserves and create management plans for the long term-conservation of these reserves.

CHAPTER 5
CONCLUSIONS

As with any large project, the Jupará Agroecology Project had its strengths and weaknesses. The project did have a notable impact on the use of organic agricultural practices in the three communities studied, as shown in Chapters 2 and 3. The project also had many qualitative benefits that were not necessarily captured here, including improving community organizations, developing leaders, strengthening women's participation in agriculture and community organizations, and improving farmers' attitudes toward conservation. Almost all of the farmers interviewed, participants and non-participants alike, spoke very highly of the program and its benefits to the community. Specific comments from participants included the following:

> "I learned to preserve nature, to work in an agroecological system, and to stop killing insects that could be beneficial." - Aloisio, Lagoa Santa

> "I learned to speak in an assembly and not be timid. I gained knowledge of both agriculture and commercialization." -Andre, Lagoa Santa

> "I learned to dialogue better with people. If you have a problem, you can discuss it with others and know that it's not so serious." -Maria, Fortaleza

Interview data indicated that the project may not have consistently met its goals for forest conservation in Fortaleza and Lagoa Santa. In Cascata, the forest conservation goal was met through the establishment of a large community reserve. The remote sensing analysis in Chapter 4 helps present a clearer picture of the dynamics of land use change in Fortaleza. Although the overall amount of forest cover remained almost constant between 1986 and 2001, forest cover increased on older family lots and decreased within the forest reserve area as some parts of the reserve were converted to family lots after properties were reassigned by INCRA. All of the project participants were situated on older lots and had little natural forest left to conserve when the project began in 1995, but we do see a trend in forest regrowth in Fortaleza, and it appears that project participants are allowing more forest regrowth on their properties than non-participants.

This research could be strengthened by designing similar remote sensing analyses for Lagoa Santa and Cascata, and for the regional landscape. Each community has a distinct land use history, and each could offer an independent and interesting land use and land cover change study.

The land use data presented here also highlight the importance of collecting baseline data when a project like this begins, in order to set feasible conservation goals and more accurately monitor progress toward these goals. Communities are very large, and some kinds of agroforestry systems and forests in this region may look alike at first glance. It would be easy for an extensionist attending a community meeting or visiting a limited number of families to misestimate the distribution of land uses if no rigorous data collection were carried out. Jupará's original conservation goals, which seem to have been set somewhat arbitrarily, may not have been very feasible if little forest was left to conserve in the target communities. Goals might have included the establishment of forest reserves by allowing forest regrowth, rather than, or in addition to, conserving existing forests. The participatory mapping activity indicated that many farmers had never given much thought to the overall landscape of their farms and the spatial arrangement of land uses. A similar activity at the outset of a conservation program would allow farmers to conceptualize what is present and plan changes that might be possible for future years. The use of remote sensing is also an excellent tool for conservation planning, when this technology is available. Collecting baseline data could allow Jupará and other conservation organizations to focus their efforts on communities where conservation goals are most likely to be met. Communities involved in this project were selected mainly based on their proximity to the Una Reserve, or in some cases, their longstanding relationship with Jupará and involvement in past Jupará projects.

Jupará also hoped to increase family incomes. Participating families do tend to have higher agricultural incomes than non-participating ones, but this could be because wealthier families, or families depending more heavily on agriculture for their income, tended to participate in the project more often than other families. When fieldwork was completed in 2005, farmers in Cascata were marketing their cacao collectively through the Coopasb cooperative and receiving a higher price because the cacao was organic. Cargill, an international exporter of various agricultural products, was the main buyer of Coopasb's organic cacao. In 2006, Cargill decided to stop offering a premium price for organic certified cacao, and this year Cascata farmers sold their organic cacao to local buyers for the same price as non-certified cacao.

Farmers in Fortaleza and Lagoa Santa did not report an increase in income as a result of participation in the cooperative. Most did not regularly sell products through the cooperative. Coopasb has been most active in the marketing of organic cacao, which is advantageous for cacao communities like Cascata, but less advantageous for communities with mixed production, like Fortaleza and Lagoa Santa. Perhaps in the future they will be able to increase the marketing opportunities for organic products other than cacao, but due to a combination of organizational and market factors, efforts to date have not been successful.

Jupará's current work in Cascata and other communities on cacao estates has been highly successful both in terms of conservation and production of organic cacao. By providing environmental education and other support services to encampments, Jupará gains access to these communities early and begins educating future farmers before any land use decisions are made. In addition, by participating actively in the land reform process, Jupará contributes to decisions about where new communities are placed and is able to request areas of conservation value and preserve some of these areas as community reserves. Because these communities are newer to the project, long-term evaluation of conservation outcomes will be necessary in the future. As we saw in Fortaleza, community forest reserves can also experience degradation over the long term if a specific management and monitoring plan is not in place.

Jupará faced a number of challenges and limitations, budgetary and otherwise, that sometimes limited their impact in communities. Some farmers complained that extension support was sporadic or inconsistent, which was often due to budgetary limitations. WWF funds were provided for only a limited time span, and when this funding came to an end, Jupará struggled even more to fulfill commitments in a large number of communities with limited staff and resources. They have worked in more than 30 communities since the project began and now receive numerous requests from interested communities, especially encampment communities. In some cases, they have been successful in training community members as extensionists and having members of new settlements volunteer to offer support to encampments. Although it is difficult to turn away interested farmers, it might be beneficial to limit the number of communities so that a smaller number of communities could be served more effectively.

Jupará is not the only conservation and development organization in Southern Bahia. Other local resources include several other conservation and land reform NGOs, a university, a government-run cacao research center (CEPLAC), and several corporations including Cargill, a large exporter of cacao and other products. Historically, Jupará's efforts to collaborate with other organizations have been less than successful, including one collaboration effort that resulted in half of the participants in Fortaleza dropping out of the project after a conflict between Jupará and another NGO. Collaborations with other organizations could strengthen Jupará's efforts in the regions, if these organizations are selected carefully and expectations are clearly defined.

The results of this project support many of the statements made by other authors concerning integrated conservation and development projects (ICDPs). ICDPs do involve local residents and promote a conservation ethic that outright purchase of land or establishment of off-limits protected areas might not (Schwartzman et al. 2000). At the same time, ICDPs often lack functional linkages between specific development activities and desired conservation outcomes (Browder 2002). The use of organic agroforestry and resulting increased incomes do not, on their own, prevent deforestation (Alger 1998). Forest conservation requires a related but separate process of landscape-level planning, especially in fragmented ecosystems like the Atlantic Forest, and in smallholder communities where landholdings are small. In addition, Jupará supports a third and equally challenging process, that of agrarian land reform. Through adequate support of all three of these processes, agrarian reform, organic agriculture implementation, and landscape conservation planning, Jupará has great potential to influence the development of communities that are both financially stable and environmentally aware. This will require careful planning and continuous monitoring, appropriate selection of communities, and use of a variety of local resources.

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BIOGRAPHICAL SKETCH

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