CONSERVATION AND LIVELIHOOD DEVELOPMENT IN BRAZIL NUT-PRODUCING COMMUNITIES IN A TRI-NATIONAL AMAZONIAN FRONTIER

By

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To Vanessa Sequeira (1970-2006)
A bright light in the world of Amazon conservation and development,
and a friend and colleague who enriched many lives.

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LIST OF ABBREVIATIONS

ACCA	Association for the Conservation of the Amazon Watershed
ACERM	Association of Extractivists of the Manuripi Reserve
ACEBA	Association of Extractivists of Bolpebra
ASCART	Association of Brazil nut Producers of the Tahuamanu Reserve
ASECAMB	Association of Brazil nut Extractivists of Madre de Dios
AOPEB	Bolivian Association of Organic Ecological Producers
CAPEB	Agroextractivist and Agropastoral Cooperative for Producers of Brasiléia and Epitaciolândia
CAEX	Agroextractivist and Agropastoral Cooperative for Producers of Xapuri
CIRCLE	Patch circularity index
COINACAPA	Integral Cooperative of Rural Agroextractivists in Pando
COOPERACRE	Cooperative of Acre
CONTIG	Patch contiguity index
CIFOR	Center for International Forestry Research
ENN	Euclidean Distance to Nearest Neighbor
FAO	Food and Agriculture Organization
FLO	Fair Trade Labelling Organizations
FSC	Forest Stewardship Council
GIS	Geographical Information Systems
IBNORCA	Bolivian Quality and Normalization Institute
IDB	Inter-American Development Bank
IFOAM	International Federation of Organic Agriculture Movements
IMAFLORA	Institute of Forest Management and Certification and Agriculture
IMO	Institute for Marketecology

ISEAL	International Social and Environmental Accreditation and Labeling
LULCC	Land Use Land Cover Change
MAP	Madre de Dios, Peru, Acre, Brazil, Pando, Bolivia
NGOs	Non-Governmental Organizations
NP	Number of patches
NSF-HSD	National Science Foundation Human Systems Dynamics
NTFPs	Non-Timber Forest Products
REDD	Reduced Emissions from Deforestation and Degradation
RIL	Reduced Impact Logging
RONAP	Organic Collectors of Amazon Nuts of Peru
PEMD	Special Project of Madre de Dios
PEN	Poverty and Environment Network
WHO	World Health Organization
WWF	World Wildlife Fund

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CONSERVATION AND LIVELIHOOD DEVELOPMENT IN BRAZIL NUT-PRODUCING COMMUNITIES IN A TRI-NATIONAL AMAZONIAN FRONTIER

By

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This dissertation examines the relationship between forest conservation, forest dependence, and livelihood development of extractive communities in the tri-national frontier region of Madre de Dios, Peru, Acre, Brazil, and Pando, Bolivia in Western Amazonia. While the focus of the dissertation is on Brazil nut (*Bertholletia excelsa*), this regionally-important non-timber forest product (NTFP) is used to illustrate broader issues related to community-based forest management. This study assessed community-based forest management from three different perspectives: (1) an analysis of land use land cover change in community-managed forests through the use of satellite and survey data; (2) an exploration of the causes and effects of Brazil nut thefts, and resolution of such thefts; and, (3) a comparison of the environmental and economic outcomes of organic, Fair Trade, and Forest Stewardship Council (FSC) certification of Brazil nuts. The first set of results demonstrated minimal deforestation and extremely high forest income dependency in extractive communities. In 2000–2005, deforestation occurred in already fragmented areas and along roads, with most deforestation in Acre and least in Pando. From 2002 to 2007, higher agricultural

income was positively correlated with reported forest clearing at the household level in Pando and Madre de Dios, whereas higher Brazil nut income was correlated with less forest cleared. In Acre, government aid, larger households, and higher value of livestock assets were correlated with forest clearing. The second set of results highlighted more Brazil nut thefts in Pando when compared with Acre, likely due to land titling processes in Pando that disregarded traditional forest use, settlement patterns that disconnected producers from their forest resources, and higher nut dependence. Both threat of theft and resource dependence affected nut harvest regimes in Pando. The third set of results showed that organic and Fair Trade Brazil nut certification schemes were associated with better post-harvest practices and higher prices, while producers certified by the FSC in Peru adopted practices related to pre-harvest planning and tree health. These findings contribute to our understanding of the role of community-based forest management in tropical forest conservation and livelihood development.

CHAPTER 1
INTRODUCTION

This dissertation examines the relationship between forest conservation, forest dependence, and livelihood development of extractive communities in Western Amazonia. While the focus of the dissertation is on Brazil nut (*Bertholletia excelsa*), this regionally-important non-timber forest product (NTFP) is used to illustrate broader issues related to community-based forest management. The research is presented as three separate papers prepared for publication in academic journals. Each paper can be read as an independent document, which addresses a unique aspect of the overarching study. The first paper entitled "Conservation in an Amazonian tri-national frontier: patterns and trends of land cover change in community managed forests" provides an overview of forest cover change in road accessible communities from 1986–2005 and explores the patterns and drivers of recent deforestation. The second paper entitled "Property rights devolution to tropical forest communities: implications for non-timber management, income generation and forest conservation" investigates the effects of property rights devolution, settlement patterns, and resource dependence on Brazil nut thefts, along with the harvest and management implications of such thefts. The third paper entitled "Does certification lead to better management and improved incomes? A comparative analysis of three certification schemes applied to Brazil nuts in Western Amazonia" compares the environmental and economic benefits associated with different nut certification schemes. Each paper is the result of collaborations with colleagues at the University of Florida and with research partners in Western Amazonia. While this dissertation represents my original work, select collaborators will be recognized for their contributions as co-authors on the individual publications. For that reason, the first person plural (we) is used in this dissertation to recognize these collaborators' supporting roles.

Statement of the Problem

Tropical forests are renowned for their biological diversity and role in regional hydrology and global climate regulation (Laurance, 1999; Fearnside, 1997) as well as for their contributions to rural livelihoods (Wunder, 2001; Sunderlin et al., 2005). Community-based forest management is considered an important strategy for promoting conservation and livelihood development in the tropics. Rural communities now own or manage one-quarter of the world's tropical forests due to recent devolution of government-owned lands and formal recognition of customary rights (White and Martin, 2002; Sunderlin et al., 2008a). The goals of community-based forest management on national and international levels are to promote ecologically-sustainable management practices, increase the socioeconomic benefits gleaned from tropical forests, and promote greater access to forest resources (Charnley and Poe, 2007). Recent studies have shown that community-managed forests can be equally, if not more, effective in maintaining forest cover than strict protected areas (Carrera et al., 2004; Nepstad et al., 2006, Ellis and Porter-Bolland, 2008; Bray et al., 2008). That said, many researchers have highlighted the tremendous challenges associated with community-based forest management, including the oversimplified definition of "community" (Agrawal and Gibson, 1999), lack of attention to the multiple levels of governance that affect community management of natural resources (Berkes, 2007), discrepancies between formal and customary resource rights (Fortmann and Bruce 1988; Meinzen-Dick and Mwangi, 2008), difficulties in linking communities to markets

(Schmink, 2004; Scherr et al., 2005), and challenges in balancing conservation with livelihood development through forest-based activities (Kusters et al., 2006).

Although forestry has long focused on timber-dominated models, in the late 1980s, community management of non-timber forest products (NTFPs) began to gain widespread attention as a way to reconcile seemingly contradictory conservation and development goals for forest-dwelling communities in the tropics. NTFP extraction was thought to be less ecologically destructive than other land-use practices, such as clearing land for agriculture and pasture, or harvesting timber (Arnold and Ruíz-Pérez, 2001). Enthusiastic studies presented over-inflated potential revenues from NTFPs compared with more environmentally-destructive land uses (Peters et al., 1989). Notably, more recent comparative studies on an integrated global set of NTFP cases show that rarely are NTFPs able to meet both conservation and development goals, and that an inverse relationship between the two is usually more reflective of reality (Belcher et al. 2005; Kusters et al., 2006). While NTFPs may be debunked as "silver bullets" for reconciling conservation and development goals, they are still considered important "safety nets" for rural communities (Angelsen and Wunder, 2003) and essential components of diverse forest-based livelihood systems, which span multiple scales from households to communities to landscapes (Ehringhaus, 2006).

Non-indigenous, extractive communities, whose principal livelihood activity is collection of forest products, occupy nearly one-third of forests in the MAP tri-national frontier region in Western Amazonia, which is comprised of the states of Madre de Dios, Peru, Acre, Brazil, and Pando, Bolivia (ZEE, 2006; INRA, 2009; SPDA-INRENA, 2003). We focus our comparison on these three adjacent areas, because while resident communities have a similar natural resource base, their property rights systems, specific livelihood strategies, and forest management regimes are different. Also, construction of the Interoceanic Highway, an extension of the Brazilian BR-317 into Peru and Bolivia, is changing conditions in this formerly remote region, by providing regional access to Pacific ports. Many extractive communities in the MAP region produce Brazil nuts, which are collected primarily from mature forests. The combined ecological and economic characteristics of *Bertholletia excelsa* make it a species with the potential to promote forest conservation while contributing to rural livelihoods. In this dynamic context, it is essential to examine the role that Brazil nuts play in communities' conservation of forests and livelihood development, illuminate the institutional challenges associated with this product's short- and long-term management, and examine how market-based mechanisms, such as certification, can add value to Brazil nut-rich forests to promote their conservation.

Sample of Communities

This research focuses on communities in the Brazil nut-rich MAP region in Western Amazonia. In collaboration with the Center for International Forestry Poverty and Environment Network (CIFOR PEN) (http://www.cifor.cgiar.org/pen/_ref/home/index.htm) and fellow PEN partner Angelica Almeyda from Stanford University, two annual village and household-level socio-economic and environmental questionnaires were applied to a total of 453 households in 44 communities in Madre de Dios, Acre, and Pando from June 2006 through October 2007 (Appendices A, B, C, and D). These communities represented both extractive communities and colonist farmer associations. Additionally, over a 12-month period, four quarterly household questionnaires were conducted with 244 households and three trimestral surveys conducted with 209 households (Appendices E and F). These questionnaires, which were designed to quantitatively assess the role of forest income in rural livelihoods, were based on the work of Cavendish (2000). In addition to the PEN questionnaires, in 15 of the extractive communities, Brazil nut management practices were evaluated from January 2006 through September 2007 (Appendices G and H). We also evaluated nut management practices in two additional extractive groups, the Chico Mendes Agro-Extractive Settlement Project (commonly known as Cachoeira) in Acre and ASCART (Associación de Castañeros de la Reserva Tambopata) in Madre de Dios, which were not included in the PEN study, but had unique Brazil nut production histories. In the extractive communities, we collected 216 training samples in the dry season (June-Sept) of 2006, and 236 in 2007, in forest and non-forest (including agriculture, pasture and residential) areas for use in satellite image analysis. Based on the unique objectives of each paper, along with available data, we used different subsamples of extractive communities from the larger set and provided clear justifications for our selection.

Land Use Land Cover Change in Community Managed Forests

The first paper (Chapter 2) provides a comparative land use land cover change (LULCC) analysis in community-managed Brazil nut-rich forests along roads in Madre de Dios, Acre, and Pando. While these three adjacent areas have a similar natural resource base, we explore how historical processes, policy changes, and livelihood strategies have differentially affected forest conservation by communities. Our overall research question in this chapter is: What is the relationship between forest clearing and sources of livelihood income in extractive communities of Brazil nut-rich forests in the MAP region?

This study highlights the utility and challenge of combining spatial and survey data to understand the patterns and trends of *observed* deforestation and potential drivers of *reported* forest clearing in community-managed forests. The specific objectives of this study are: (1) to compare trends of deforestation and reforestation in extractive communities in neighboring Madre de Dios, Acre, and Pando over a 20-year period (1986–2005); (2) to analyze the spatial patterns and causes of deforestation at the pixel level (i.e., 30 x 30 m) in these communities during the final time period (2000–2005); and, (3) to analyze the socioeconomic causes of reported forest clearing at the household level in 2002–2007. This research illustrates broader issues related to the role of rural communities in tropical forest conservation.

Property Rights Security of Brazil Nut Producers

The second paper (Chapter 3) examines the phenomenon of Brazil nut thefts that occurs in extractive communities in Pando, but not in Acre. Our overall research question in this chapter is: What are the causes and effects of Brazil nut thefts, and how can such thefts be resolved?

In this chapter, we focus our comparison on the adjacent areas of Pando and Acre because, while they have a similar natural resource base, their property rights systems, settlement patterns, and dependence on Brazil nuts by local communities differ. We first introduce the study region and ecological and economic characteristics of Brazil nut. We next highlight important historical processes and policy changes that have shaped settlement patterns and property rights for communities in Pando and Acre. We then present results of field studies on reported thefts of Brazil nuts and explore the causes of such thefts, along with their harvest and management implications. Our specific objectives are to evaluate: (1) the extent that Brazil nut thefts occur in forest-dwelling communities in Pando and Acre; (2) the financial value of these thefts; (3) the causes of such thefts; (4) how threat of theft affects Brazil nut harvest and management practices; (5) how thefts are resolved; and, (6) producers' perceptions of participatory mapping as one way to resolve Brazil nut thefts.

Certification of Brazil Nuts Promotes Better Management and Increases Income

The third paper (Chapter 4) compares organic, Fair Trade and Forest Stewardship Council (FSC) certification, and addresses the challenges associated with the different schemes as applied to Brazil nuts in Pando, Acre, and Madre de Dios. Our overall research question in this chapter is: What are the environmental and economic benefits associated with different Brazil nut certification schemes?

In this chapter, we first provide an overview of Brazil nut ecology and best management practices for this product, as outlined by regional government and non-governmental organizations (NGOs). We next present the three main nut certification schemes available to regional producers. We then present results of fieldwork that highlight associations between the different Brazil nut certification schemes and management and income generation outcomes for producers. Our specific objectives are: (1) to identify performance of Brazil nut "best management practices" by producers in the three countries; (2) to analyze differences in management practices between certified producers and noncertified producers in each country; (3) to quantify economic benefits associated with producing certified nuts; and, (4) to explore producers' perceptions of the benefits and costs of Brazil nut certification.

Importance of the Study

Together these papers contribute to a broader understanding of the conservation and livelihood benefits associated with community-based forest management in

Western Amazonia. Theory and methods from the fields of forestry, geography, and economics were used to develop this research in response to pertinent conservation and development concerns. The comparative approach between three countries allowed for constant reflection on how differing historical processes, policy changes, and livelihood strategies shaped three unique community forest management contexts. This study highlights the relationship between forest conservation and forest income dependence by communities in a global context. The results of this research also have application for government agencies and NGOs in Western Amazonia interested in supporting community-based forest management, and can provide new insights to Brazil nut producers through the tri-national comparison. Most importantly, this dissertation highlights how community management of a high-value NTFP can promote conservation and livelihood development on dynamic tropical forest frontiers.

CHAPTER 2
CONSERVATION IN AN AMAZONIAN TRI-NATIONAL FRONTIER: PATTERNS OF LAND COVER CHANGE IN COMMUNITY-MANAGED FORESTS

Introduction

Community-based forest management is considered an important strategy for promoting conservation and livelihood development in the tropics. Rural communities now own or manage one-quarter of the world's tropical forests due to recent devolution of formerly government-claimed lands and formal recognition of customary rights (White and Martin, 2002; Sunderlin et al., 2008a). The goals of community-based forest management on national and international levels are to promote ecologically-sustainable management practices, increase the socioeconomic benefits gleaned from tropical forests, and promote greater access to forest resources (Charnley and Poe, 2007). Recent studies have shown that different types of community-managed forests can be equally, if not more, effective in maintaining forest cover than strict protected areas (Nepstad et al., 2006; Ellis and Porter-Bolland, 2008; Bray et al., 2008). That said, many researchers have highlighted the tremendous challenges associated with community-based forest management, including the oversimplified definition of "community" (Agrawal and Gibson, 1999), discrepancies between formal and customary resource rights (Fortmann and Bruce, 1988; Meinzen-Dick and Mwangi, 2008), difficulties in linking communities to markets (Schmink, 2004; Scherr et al., 2005), and challenges in balancing conservation with livelihood development through forest-based activities (Kusters et al., 2006).

Communities' roles in tropical forest conservation are largely based on the social, political and economic contexts in which they are embedded. Much of the literature on deforestation by smallholders has focused on its multi-scalar and interacting drivers (e.g., Wood, 2002; Schmink, 1994). Proximate socioeconomic causes of deforestation include infrastructural development, agricultural expansion, and timber extraction; whereas underlying drivers include demographic, economic, technological, policy, institutional, and cultural factors (Geist and Lambin, 2002). Of 152 case studies on the drivers of tropical deforestation, economic factors were present in 81% (Geist and Lambin, 2002). Economic returns associated with different land uses often affect small producers' decisions about whether to maintain standing forest or convert it for agricultural or pastoral uses (Angelsen 2006 in Chomitz 2007). Economic models of deforestation have shown that tropical deforestation is higher when land is more accessible, prices are higher for agricultural products and timber, off-farm income opportunities are lower, and long distance trade opportunities are higher (Kaimowitz and Angelsen, 1998; Pfaff, 1999; Lambin et al., 2001; Angelsen 2006 in Chomitz 2007). It is essential to understand the broader context in which forest-based communities are embedded, along with their diverse livelihood strategies, to appreciate their decision-making in regards to forest conservation.

The Amazon is the largest tract of contiguous tropical forest in the world, alone containing half of global biological diversity and one-fourth of its primary productivity (Soares-Filho et al., 2004). In the approximately 300,000 km^2 border region of Madre de Dios, Peru, Acre, Brazil, and Pando, Bolivia (MAP region) in Western Amazonia, communities own or manage nearly one-third of regional forests (ZEE, 2006; INRA, 2009; SPDA-INRENA, 2003). Many of these communities base their livelihoods on Brazil nuts (*Bertholletia excelsa*), the most important non-timber forest product (NTFP) in the region. These Brazil nut-producing communities share the landscape with recently settled colonist farmers, cattle ranchers, and loggers. Although the entire region is characterized by lowland wet tropical forest vegetation, settlement histories, patterns of deforestation, public policy, and socio-economic development vary considerably from one country to the next (www.map-amazonia.net). Construction of the Interoceanic Highway, an extension of the Brazilian BR-317 into Peru and Bolivia, is changing conditions in this formerly remote region, by providing regional access to Pacific ports (Figure 2-1). In Acre, forest conversion has been rapid, extensive, and largely driven by establishment of cattle ranches (Souza et al., 2006). In Madre de Dios, the deforestation process has been slower and patchier than in Acre, and dominated by small farms, although recent paving has concentrated land ownership and increased deforestation (Chavez, 2009). In Pando, deforestation has been minimal, with most land conversion occurring in close proximity to population centers and along the Brazilian border (Marsik et al., in review).

Our overall research question is: What is the relationship between forest clearing and sources of livelihood income in extractive communities of Brazil nut-rich forests in the MAP region? To address this question, we present a comparative land use land cover change (LULCC) analysis in community-managed forests along roads in Madre de Dios, Acre, and Pando. While these three adjacent areas have a similar natural resource base, we explore how historical processes, policy changes, and livelihood strategies have differentially affected forest conservation by these communities. Through combining spatial and socioeconomic analyses, the specific objectives of this study are: (1) to compare trends of deforestation and reforestation in extractive communities in the MAP region over a 20-year period (1986–2005); (2) to analyze the spatial patterns and causes of deforestation at the pixel level (i.e., 30 x 30 m) in these communities during the final time period (2000–2005); and, (3) to analyze the socioeconomic causes of reported forest clearing at the household level in 2002–2007. This study illustrates broader issues related to the role of rural communities in tropical forest conservation.

History of Settlement in the MAP Region

The history of colonization and settlement by mostly non-indigenous extractive populations in the MAP region began in the late 19th century during the first boom of natural rubber (mostly *Hevea brasiliensis*, but also *Castilla spp.*). Immigration to rubber estates in the Western Amazon, into Pando and what is now Acre (which at the time was officially Bolivian territory; Barham and Coomes, 1996) greatly expanded in the 1880s after Edwin Heath, a North American doctor, discovered the connection between the upper and lower Beni River (Fifer, 1970). Immigration to Madre de Dios for rubber began a bit later (1893-1895) when Fermín Fitscarrald, a Peruvian explorer who had his rubber base in Iquitos, discovered connections between the Urubamba and Manú-Madre de Dios Rivers (Fifer, 1970).

While the rubber industry in Pando and Acre focused on *Hevea brasiliensis*, most rubber production in Peru came from *Castilla spp.*, locally called “caucho” (Morcillo, 1982). Caucho was a lesser quality rubber and individual *Castilla* trees could only be tapped once, but its advantage was that it could be extracted during any season. This flexibility resulted in a highly mobile labor force, of primarily indigenous people in debt peonage, collecting caucho in areas away from rivers that were granted to rubber companies by the Peruvian government (Morcillo, 1982; Chibnik, 1994). In contrast, rubber was collected on private estates in Acre and Pando, requiring generally more stable relations between tapper and patron, as well as investments in estate infrastructure and tapper supplies (Barham and Coomes, 1996).

The tri-national boundaries between Brazil, Bolivia, and Peru were contested during the rubber boom. The 1903 border war between Brazil and Bolivia, in which the Brazilian rubber tappers in Acre had a major role in Brazil's victory, reestablished boundaries between these two countries, and the territory of Acre was ceded to Brazil (Fifer, 1970). In 1909, there were armed conflicts among Peruvian and Bolivian rubber tappers, which later resulted in a treaty that determined the Peru-Bolivia border equidistant along the Manuripi River from San Lorenzo (Peru) and Illampu (Bolivia). At this same time, Madre de Dios was created as a department with Puerto Maldonado as its capital (Morcillo, 1982).

When the price of rubber fell in 1912 in response to the high productivity of established rubber plantations in Malaysia, Amazonian rubber tappers began to diversify their livelihood strategies to include Brazil nuts and agriculture (Fifer, 1970; Barham and Coomes, 1996; Stoian, 2000). In 1931, the Bolivian Suarez Company introduced Brazil nut shelling, supported by a labor force dominated by women as the Chaco War (1932-35) drained male labor in Bolivia (Fifer, 1970). In Acre, a small Brazil nut factory was established in the town of Xapuri in 1933 (Kainer et al., 2003). In Madre de Dios, in addition to Brazil nuts, gold was exploited along the Inambari River (Morcillo, 1982). During World War II, there was a second, smaller rubber boom in which the U.S. partnered with Brazil through the Washington Accords, and recruited a second wave of Brazilian "rubber soldiers" to Acre (Sobrinho, 1992). Although Pando and Acre were legally separated, the border was porous, and more than 2000 Brazilian rubber tappers were employed by Suarez and Hermanos, who at the time controlled 80% of rubber production in the Brazil-Bolivia border region (Sobrinho, 1992). The only remaining rubber company in Madre de Dios was sold to the U.S. during World War II (Morcillo, 1982), and Brazil nuts continued to be a complementary seasonal activity to rubber tapping until the 1950s when nut exports surpassed rubber production. The first large price increase in the Brazil nut sector occurred in the 1990s (Stoian, 2000) when this product became the most economically-important NTFP in Amazonia.

Recent Policy Changes

Several important policy changes occurred at the national level in Peru, Brazil, and Bolivia, which created three unique contexts for community-based forest management. These include road development that has affected the entire region and diverse policies that are more specific to each country (Table 2-1).

Regional Road Development

The MAP region remained relatively inaccessible until the construction of major roads on all three sides of the border, which were designed to link these remote states to the rest of their respective countries (Figure 2-1). In the mid-1960s, an unpaved highway was constructed from the Andean highlands to Puerto Maldonado, the capital of Madre de Dios, to promote migration of the landless poor (Dourojeanni, 2006), and in 1979, Peru signed a contract with Brazil to construct an Interoceanic Highway (CTAR, 1998), which would link southern Brazil to ports on the Pacific. This Interoceanic highway has become one axis of the Andean Promotion Corporation's (CAF) massive Initiative for the Integration of Infrastructure in the South American Region (IIRSA) to facilitate exports to global markets leading toward regional development (IIRSA, 2005; Perz et al., 2008). With funding from Peru's Special Project of Madre de Dios (PEMD), construction of the highway from Puerto Maldonado to the town of Iñapari on the border with Brazil began in 1981 (Chavez, 2009). In the 1990s, segments of the unpaved highway were leveled and maintained, and ten years later, it was compacted and prepared for paving, which began in 2006 (Chavez, 2009).

The origins of the Interoceanic highway on the Brazilian side also occurred in the mid-1960s with construction of the BR-364 to the state of Rondônia from southern Brazil as part of a national military strategy to maintain control over the Amazon (Cowell, 1990). By 1984, the highway was paved to Porto Velho (the capital of Rondônia) through the Polonoroeste project funded by the World Bank (Cowell, 1990). The severely negative environmental and social consequences of this project caused the World Bank to suspend its funding in 1985 (Shankland, 1993). Despite initial successes of Acre's rubber tapper social movement to temporarily stop Inter-American Development Bank (IDB) funds for extension of this highway into Acre, the newly-paved BR-364 from Porto Velho in Rondônia to Rio Branco (the capital of Acre) was opened in 1992 (Shankland, 1993). In 1993, the Brazilian Congress voted to fund the paving of the next critical piece of the Interoceanic highway: the road that became known as the BR-317 from Rio Branco to the border of Peru. Its paving occurred piecemeal until completion in 2000 (Figure 2-1).

Recent international attention has focused on paving of the Peruvian portion of the Interoceanic highway, which was finally funded by CAF and the Brazilian and Peruvian governments with a budget of US $890 million (Perz et al., 2008). In 2006, the Brazilian government completed construction of a high-grade steel bridge across the Acre River to connect the Brazilian and Peruvian sides of this transportation corridor. As of 2009, pavement of the Interoceanic Higway from Iñapari to Puerto Maldonado was nearly complete and a long-awaited bridge over Peru's Madre de Dios River was under construction.

While Pando currently has only 30 km of paved road, national and international integration plans are underway. The terrestrial connection between Cobija, the capital of Pando, and La Paz is via the city of Riberalta in the department of Beni (Figure 2-1). The 1414 km segment from Riberalta to La Paz was constructed in the 1980s, and the 310 km segment from Riberalta to Cobija completed in 1992 (UNDP, 2003). There are four major river crossings along this route, most navigated by barge, but in 2006 a bridge was built across the Tahuamanu River in Pando. Another road in Pando, from Cobija through Manuripi National Wildlife Reserve to the Madre de Dios River, was improved in 1998 from a former horse trail (J. Rojas, pers. comm.; M. Zentano, unpublished data). Although this road was temporarily considered the most direct highway route to La Paz, it was never developed as such. A final road in Pando called the Bioceanica, which was completed in 2001, runs east from 19 km south of Cobija to Peru where it joins the Interoceanic highway (J. Rojas, pers. comm*.).* In 2004, Brazil funded construction of a bridge across the Acre River to Cobija, and as of 2009, the 86 km stretch of road from Riberalta to Guayaramérin (UNDP, 2003), which borders Rôndonia, Brazil, was being paved.

Madre de Dios, Peru

In Peru, recent agrarian and economic policies influenced settlement in Madre de Dios (Table 2-1). In addition to road development in the mid-1960s, an agrarian development program in the late 1980s led to thousands of colonists from the highlands arriving in Madre de Dios in 1985-1990 to cultivate small landholdings (Alvarez and

Naughton-Treves, 2003; Naughton-Treves, 2004). This program promoted access to rural credit from the Agrarian bank, secured land tenure, and led to the creation of farmers' cooperatives (Coomes, 1996). As inflation rates rose rapidly, colonists who benefited from agrarian credit began to raise cattle as a more secure investment than annual crops (Coomes, 1996). With new structural adjustment policies, implemented in 1990, agricultural credit dried up and lands along the Interoceanic highway were subsequently abandoned (Naughton-Treves, 2004). Throughout these periods, the Special Project of Madre de Dios (PEMD), which began in 1980, contributed to land use change through its support of infrastructure development, along with agricultural expansion and technical support (Dourojeanni, 1990; Chavez, 2009).

Beginning in 2000, forestry concessions and protected areas were consolidated in Madre de Dios with the development of the Forestry Law and formalization of Tambopata National Reserve and Bahuaja Sonene National Park. Prior to the Forestry Law of 2000, forest policies were limited and unregulated timber activity was the norm (Chavez, 2009). The law's implementation in 2002 established long-term concessions for both timber (5,000-10,000 ha management units) and Brazil nuts (~500 ha units), both of which required forestry management plans (SPDA-INRENA, 2003). Brazil nut concessions are managed by small producers, and most are located along the Interoceanic highway. Under the new protected area policy for Madre de Dios, a group of Brazil nut harvesters was allowed access to the buffer zone of Tambopata National Reserve during the nut harvest as long as they abided by strict regulations (SPDA-INRENA, 2003). Despite these radical changes in the forestry sector, long-term governance failures in Peru have been blamed for continued illegal logging activities in concessions, since producers' norms were unchanged when the new Forestry Law was implemented (Smith et al. 2006).

Acre, Brazil

In Acre, extractive communities have been affected by recent policies for forest-based development (Kainer et al., 2003). In response to the rubber tappers' struggle for secure land tenure and international pressure to halt Amazonian deforestation, the Brazilian government established the first official Extractive Reserve in Acre in 1990 (Schwartzman, 1989; Hall, 1997) (Table 2-1). Extractive Reserves have been championed as a viable and sustainable alternative to widespread deforestation in the Amazon (Allegretti, 1989; 1990). An important difference between Extractive Reserves and other Amazonian protected areas is that they were created "not despite but because of people" (Ehringhaus, 2006). Acre's rubber tappers used international environmental concerns about the Amazon to their advantage, portraying themselves as forest stewards (Schmink and Wood, 1992). The Extractive Reserve policy guaranteed usufruct rights to people engaged in traditional livelihoods based largely NTFP extraction (e.g. rubber, Brazil nuts, various fruits, and palms; Ehringhaus, 2006), while requiring residents to maintain at least 90% of their landholdings in forest cover (Fearnside, 2003). In 1990, the almost one million hectare Chico Mendes Extractive Reserve (CMER) was created in Acre from 42 former rubber estates. Households are spread throughout the mostly forested landscape, and the unique tree tenure legacy from the rubber era is still honored among extractivists. Reserve residents define individual property holdings by the number and distribution of rubber trails through the forest (Ankerson and Barnes, 2005), even though Brazil nut has replaced rubber as the most important commercial forest product (Wallace, 2004; Ehringhaus, 2006).

The Acrean state government, known as the Forest Government, assumed power in 1998 and is credited with several policy changes toward supporting forest-based communities. Acre's government has worked to re-stimulate the rubber economy, which declined after federal price supports were removed (Hall, 1997). They have accomplished this in two ways: (1) implementation of the Chico Mendes Law in 1999, which subsidized rubber tappers per kilogram of rubber produced (Kainer et al., 2003); and, (2) creation of a condom factory in Xapuri in 2006 to stimulate demand for locally-produced natural rubber. The government also performed Ecological-Economic Zoning (ZEE, 2000; ZEE, 2006), created two new agencies (SEFE and SEAPROF) responsible for timber management and smallholder production systems, experimented with payments for environmental services (Gomes et al., 2008; Bartels, 2009; SEMA, 2009), and pursued sustainable forest management initiatives at both the industrial and community scale (Kainer et al., 2003). Communities in Acre have been at the forefront of integrating sustainable timber extraction into their livelihoods (Rockwell et al., 2007) and are distinguished by being some of the first communities in the Brazilian Amazon to attain Forest Stewardship Council (FSC) certification (Humphries and Kainer, 2006).

There are clear challenges to forest-based development in Acre. Despite elimination of federal cattle subsidies in 1991, Acre's cattle economy has continued to expand with one of the highest growth rates in the Brazilian Amazon (Valentim et al., 2002); as of 2007, the state had approximately 2.7 million head of cattle (IDAF, 2007). An increase in small-scale cattle ranching has been observed in the Chico Mendes Extractive Reserve, even among rubber tappers who initially fought against cattle ranchers to maintain access to their forested landholdings (Gomes, 2009; Vadjunec et al., 2009). The viability of an Extractive Reserve model centered on NTFP-based livelihoods has been heavily critiqued (Browder, 1990; 1992). While timber management could potentially bolster forest-based livelihoods in Extractive Reserves, policy constraints, technical and governance complexity, and a polemic fit with conservation goals have delayed this process. Although Acre's Forest Government has been in power for more than ten years, the future of forest-based development in Acre is uncertain.

Pando, Bolivia

In Bolivia, the Forestry Law and the Agrarian Reform Law, passed in 1996, helped recognize forest-dwelling communities in Pando (Table 2-1). Although the Forestry Law focused on timber production by concessionaires and large landholders, it had several important implications for community-based forest management. In particular, establishment of an area-based land tax discouraged timber companies from maintaining large landholdings, making more forested land available to communities (Contreras and Vargas, 2001). Forest access was democratized by recognition of indigenous subsistence rights and creation of several avenues through which communities could participate in commercial forestry – an activity previously prohibited (Ruiz, 2005). In 2000 and 2004, modifications of the Agrarian Reform Law in northern Bolivia gave forest-dwelling communities legal rights to 500 ha per family, with the ultimate spatial area of a communal title determined by the official number of resident families (Ruiz, 2005; Cronkleton and Pacheco, in press). The Bolivian Agrarian Reform Agency (INRA) began implementing the titling procedure with little consultation from the communities themselves (Cronkleton and Pacheco, in press). While owners of rubber estates in Brazil went bankrupt or were forced to sell their lands in the 1970s, owners of private forested estates in Pando tried to maintain their privileged position (Stoian, 2000). Throughout the 1990s and early 2000s there was a struggle between these large landholders and peasant and indigenous communities to control forest resources and lands (Cronkleton et al., 2007).

Complementing this communally-held land in Pando, the 1.8 million hectare Manuripi National Wildlife Reserve was officially created in 1973 for biodiversity conservation, although it was not officially managed as such until 1999 (Miserendino et al., 2003; Kühne, 2004). In the Reserve, most land is held in large (1,000-80,000 ha) private estates (Kühne, 2004). Although cattle ranching by communities is still rare in Pando and found mostly closer to the urban center of Cobija, both large-scale cattle ranching and illegal logging occur within these estates (Kühne, 2004). There are nine communities in the Reserve, eight along main roads and the ninth located along the Madre de Dios River. Similar to communities outside Manuripi Reserve, families within the Reserve live in clustered settlements and only during the Brazil nut harvest season do they relocate to their often remote forest landholdings. While communities within the Reserve have received more government aid and forestry extension than other communities in Pando, their use of forest resources has been more heavily regulated by Reserve rules that prohibit timber harvest, limit hunting, and manage forest clearing.

Methods

This paper combines two analytical approaches to examine land use land cover change (LULCC) in Brazil nut-producing communities in close proximity to roads in the MAP region. The first approach is based on remote sensing methods using Landsat imagery data and spatial logistic regression to assess the patterns and trends of *observed* deforestation in 11 communities (3 in Madre de Dios, 4 in Acre, and 4 in

Pando), representing all three countries. The second approach is based on regression analysis of household-level data collected in the same communities to assess the potential drivers of forest clearing *reported* by nut producers. The LULCC analysis allows for a comparative contextual understanding of land cover change, which is complemented by a finer-scale analysis at the household level to illuminate the land use choices of individual Brazil nut producers that affect forest cover.

Sample Communities

The study sample included four communities (63 households) in Pando, four communities (59 households) in Acre, and three communities (28 households) in Madre de Dios (Figure 2-2). We selected these communities based on their close proximity to major roads, dominance of Brazil nut producers, and >90% cloud-free imagery available for the locations over the entire time series. The communities sampled in Pando comprise an area of 812 km^2. While two of the four communities are in Manuripi National Wildlife Reserve and the other two are outside, all have access to one of the three main roads in Pando. In Acre, the four sampled communities comprise an area of 686 km^2. All are located in the Chico Mendes Extractive Reserve where Brazil nut production is part of community livelihood systems (Wallace, 2004; Ehringhaus, 2006; Vadjunec et al., 2009) and are accessed by feeder roads of BR-317. In Madre de Dios, the three communities sampled comprise an area of 543 km^2. These communities form part of the group of Brazil nut-producing communities found along the Interoceanic Highway, which is known as the “Castaña Corridor” for conservation (ACA, 2008).

Remote Sensing Analysis

To examine land use land cover change in these communities, we acquired a set of land cover classification and change trajectory maps for the MAP region from 1986–

2005, which were produced through the University of Florida NSF-HSD project, "Infrastructure change, human agency, and resilience in social-ecological systems," following protocols described in Marsik et al. (in review). Each image date consisted of eight Landsat images that had been mosaicked together. To hone in on the 11 study communities, we clipped community polygons out of each classification and trajectory image using digital cadastral layers from the Agrarian Reform Agency in Pando, Bolivia and the Ministry of the Environment in Madre de Dios, Peru. In the Chico Mendes Extractive Reserve in Acre, Brazil, communities are defined as associations, and there are no official geographic data available that define association boundaries. Thus, for the four study communities in Acre, we created polygons using a derived buffer distance from the center of the community, based on the farthest household known to be affiliated with the association. A total of 25 images from the original classification mosaics were required to encompass the 11 communities studied in the three countries (Appendix I).

For the community subsets, we re-performed the 1996 classification due to visible inaccuracies in the mosaic classification at the local scale, since 1996 was a particularly wet year. Of the more than 200 training sample points generated from fieldwork in the dry season of 2006 (June through October), approximately 120 that could be calibrated to 1996 based on detailed field data on class age, were split based on a stratified random sample for respective use in the development of classification rules and accuracy assessment in the community subsets. Following the methods of Marsik et al. (in review), classification of forest and non-forest for each image year was performed using ENVI remote sensing software combining half of the training sample data with a stacked image (bands 457 from the masked image, local Moran's I spatial statistic applied to bands 457 at a spatial lag of one pixel [30 m], tasseled cap indices and a mid-infrared index [B5-B7/B5+B7]) for each year. The forest class included all mature forest and secondary regrowth older than 3-4 years of age. This inclusion of early secondary regrowth in the forest class was based on high leaf reflectance of this land cover, since secondary forest grows quickly in the region, especially in the first three years of succession (Uhl et al., 1987; Broadbent, unpublished data). Non-forest included agricultural, cleared, and residential areas. There was an acceptable level of accuracy in the 1996 classification with 86.61% overall accuracy and a Kappa statistic of 75.3%.

We recreated the 1991–1996 and 1996–2000 change trajectories for the community subsets, along with the cumulative change trajectory, based on the new 1996 classification. Trajectory classes were defined as stable forest (F-F), stable non-forest (NF-NF), deforested (F-NF), and reforested (NF-F). A cumulative change trajectory from 1986 to 2005 for the community subsets was created to assess overall change.

We also used the classification images to produce landscape metrics to quantify the patterns of recent deforestation in the community areas. After applying a filter to include only non-forest patches of an area equal to or greater than the normal area cleared by producers for agriculture (~1ha), we used Fragstats 3.3 (McGarigal et al., 2002) to generate non-forest patch metrics for 2000 and 2005. These metrics included patch area, circularity, contiguity and Euclidean distance to the nearest non-forest patch neighbor. Patch area and Euclidean distance to nearest neighbor are commonly used in LULCC studies (e.g., Southworth et al., 2002; Nagendra et al., 2004) as basic measures of patch size and patch distribution in the landscape, respectively. Circularity is an index that provides a good measure of patch elongation; this metric has a value of 0 for circular patches and approaches 1 as patches become more elongated (McGarigal et al., 2002). Contiguity provides a measure of patch shape based on connectedness of pixels within that patch; the contiguity index equals 0 for a one-pixel patch and approaches 1 as patch connectedness increases (McGarigal et al., 2002). We generated descriptive statistics for these patch metrics in non-forest patches in 2000 and 2005 and evaluated differences across dates and between countries

Survey Data

To understand the relationship between livelihood systems and forest clearing, two annual village and household-level questionnaires were applied in all 11 communities in Pando, Acre, and Madre de Dios from June 2006 through October 2007 in collaboration with the Center for International Forestry Research Poverty and Environment Network (CIFOR PEN; http://www.cifor.cgiar.org/pen/_ref/home/index.htm). These questionnaires enabled us to measure village access to markets and land tenure, along with household characteristics and assets. In the second annual household survey, we also asked households to report the amount (ha) of forest (mature and secondary regrowth > three years old) cleared within the previous five years.

Additionally, over a 12-month period, four quarterly household questionnaires were conducted with 63 households in Pando and 59 households in Acre, and three trimestral surveys conducted with 28 households in Madre de Dios, which allowed us to quantify annual income associated with different land uses. Quarterly/trimestral interviews focused on all cash and subsistence income derived from forests and other on- and off-farm activities, including agriculture, livestock, wage labor, as well as other sources of external economic support (See Table 2-2 for a more detailed explanation of income sources). Prices for subsistence products, which were never bought or sold, were estimated in community meetings where a willingness-to-pay price was determined. Based on all these data, we generated descriptive statistics for household characteristics, income and asset variables, along with amount of forest cleared, and evaluated between-country differences.

Modeling

Through use of the different datasets, two modeling approaches were used to explain deforestation in Brazil nut producing communities in the MAP region. Based on findings that most regional deforestation occurred recently (2000–2005), particularly along roads (Southworth et al., in prep; Appendix J), we chose to focus on the causes of deforestation since 2000. To explain deforestation at the pixel level, we used a binomial logit model in which the response variable was land cover trajectory class (F–F and F–NF) for the 2000–2005 time period. Following Geoghegan et al. (2001) and Chowdhury (2006), the response variable was categorized as “y equal to 1” if a forested pixel in the first date was deforested by the second date of a given time period and “y equal to 0” if a pixel remained forested between the paired dates.

Explanatory variables for this model were chosen based on previous tropical land use land cover change research that showed higher rates of deforestation closer to roads and in already fragmented landscapes (Kaimowitz and Angelsen, 1998; Chomitz and Gray, 1996; Mertens and Lambin, 2000). We used a road overlay for the region (Marsik et al., in review) to identify primary roads and digitized two additional roads in Pando that were not included in the initial overlay. Following methods outlined in

Mertens and Lambin (2000), we generated pixel-level variables in ArcGIS, including distance to road, distance to forest/non-forest edge, and a Matheron index, which is a measure of forest fragmentation. In our case, Matheron index values were log transformed to express a more normal distribution of residuals. Following Geoghegan et al. (2001) and Chowdhury (2006), a *pseudo* R^2 was reported, since a traditional R^2 measure of fit would not be not easily calculated in a categorical regression. Socioeconomic variables were not included in this model, because individual household parcels were not spatially defined in the study communities and socioeconomic data aggregated at the community level provided very little information in the pixel-level analysis.

To explore the socioeconomic drivers of deforestation at the household level, we used a multivariate regression model where the parameters were estimated using ordinary least squares (OLS) regression. In this model, the response variable was total amount of forest reported to have been cleared by individual nut producers from 2002–2007. The response variable of forest cleared (ha) was log transformed to express a more normal distribution of residuals. Potential explanatory variables were chosen based on findings in the literature that show the influence of household characteristics, income sources, and assets on deforestation (Kaimowitz and Angelsen, 1998; Chowdhury, 2006; Perz et al., 2006; Caldas et al., 2007; Godoy et al., 2009; Wyman and Stein, in press). Household characteristics included size, life cycle location (number of adults, number of children, number of elders, age of household head, and length of residency in the community), accessibility (distance to village center and distance to nearest city), and years of education. Income and asset variables included annual cash and subsistence income derived from different land uses in 2006-2007, along with material and livestock assets. We first searched for univariate relationships between potential explanatory variables and the log of the forest reported cleared, considering a country factor together with its interaction. This process guided our selection of more relevant variables ($p \leq 0.10$) to be included in the multivariate OLS regression to explain reported forest clearing from 2002–2007 with country as a fixed effect.

Results

Land Cover Change

Forests dominated community-held lands in Madre de Dios, Acre, and Pando in 1986, 1991, 1996, 2000, and 2005 (Table 2-3). Of the total 543 km^2 area of sampled Brazil nut-producing communities in Madre de Dios, forests covered 98.0% of the area in 1986 and declined slightly to 95.1% by 2005. Of the 686 km^2 total sampled area in Acre, 99.3% was covered by forests in 1986, 98.2% in 1991, and 97% in 1996. It remained stable in 2000 at 97.1%, but in 2005 declined to 94.4% – the lowest percentage of forest cover among all countries in the time series. In Pando, the percentage of forest cover was the highest of all countries in all years. Of the 812 km^2 sampled in Pando, 99.6% was forested in 1986 and declined only to 97.7% by 2005.

Examination of land cover change trajectories allowed for a more dynamic understanding of forest cover change from 1986 to 2005 (Figures 2-3) and during the individual time periods (Figure 2-4a,b and Table 2-4). Overall, while forest cover remained fairly stable from 1986 to 2005, there was a tendency toward deforestation in all countries (Figure 2-3). Over the 20-year period, 3%, 5%, and 2% of land tended toward deforestation in communities sampled in Madre de Dios, Acre, and Pando, respectively (Table 2-4). In Madre de Dios, the area deforested increased slightly between the first (1986–1991) and second (1991–1996) time periods and remained at more or less the same level in subsequent time periods (1996–2005). This finding contrasts with Acre and Pando where deforestation also increased between the first and second periods, but decreased in 1996–2001 and increased again in 2000–2005 (Table 2-4, Figure 2-4a). In this most recent period, the area deforested in communities in Acre nearly tripled to 2,360 ha from 844 ha in the previous period (Figure 2-4a).

Reforestation was also observed in all three countries throughout the time series (Table 2-4, Figures 2-3 and 2-4b), although the total area that underwent reforestation was always less than the area deforested in each country and time period. In Madre de Dios, the reforested area steadily increased from one time period to the next. This trend contrasts with Acre and Pando, where the area reforested increased steadily prior to 2000, but then decreased in 2000–2005.

Patterns of Deforestation

According to the results of binary logit models for each country, all three pixel-level variables (distance to road, distance to forest/nonforest edge, and Matheron index) explained the presence or absence of deforestation ($p<0.001$) and showed consistent coefficient signs across the three countries (Table 2-5). While it seemed that these models performed poorly as seen by the relatively low *pseudo*-R^2 values across countries (0.22 – 0.26), *pseudo*-R^2 values of approximately 0.25 are considered acceptable for this type of analysis (Geoghegan et al., 2001; Chowdhury, 2006).

Differences in the spatial pattern of patches were observed across years and between countries, even though patch areas did not differ significantly. In 2000 and 2005, there were relatively fewer non-forest patches in Pando when compared to Acre and Madre de Dios, especially given the larger area sampled in Pando (Table 2-6). In 2000, non-forest patches in Pando were more circular ($p=0.017$) and less contiguous ($p=0.019$) than those in Acre and Madre de Dios, and patches in Madre de Dios were much closer together ($p=0.009$). From 2000 to 2005, the number of non-forest patches increased in Pando and Acre, whereas in Madre de Dios, the number decreased. In this period, non-forest patches in Madre de Dios became less contiguous ($p<0.001$) and more isolated ($p<0.001$), whereas patches in Acre became more contiguous ($p<0.001$) and closer together ($p=0.020$).

Household-level Variables and Reported Forest Clearing

Comparative household characteristics, income and assets

Despite a similar natural resource base, household characteristics in the communities in the three countries were quite different. Household size and number of adults were the only variables in this category that did not differ between countries (Table 2-7). In Madre de Dios, households were more advanced in their life cycles than in Pando and Acre: there were more elders ($p<0.001$) and some evidence of fewer children ($p=0.06$) in the Peruvian households, household heads were older ($p=0.003$), and they had been residents of the community longer ($p<0.001$). In terms of accessibility, there was a between-country difference in household distribution ($p<0.001$) with households in Madre de Dios most clustered in village centers along roads, households in Pando relatively close to village centers, and households in Acre spread throughout the forest. There was also a difference in years of education ($p<0.001$) between countries with people sampled in Acre the least educated and those sampled in Madre de Dios the most educated.

As expected, forest income in all three countries comprised the greatest share of total income, followed by income from crops (Figure 2-5). In Pando and Madre de Dios, wage income was third, while in Acre, third place was "other" income, which is largely comprised of government aid. There were also substantial differences among countries in terms of Brazil nut income, business income, and other income (Table 2-7). While there was no difference in livestock income between countries, livestock assets differed (p=0.044) with Acrean producers having the greatest value of livestock assets, largely from cattle, producers in Pando the second-most (largely due to a few households in one community with large numbers of cows), and producers in Madre de Dios the least. There was also a between-country difference in amount of land (p=0.025); the largest landholdings were in Acre and the smallest in Madre de Dios. In the end, total cash and subsistence incomes did not differ among the three countries.

Explaining reported forest clearing

Households in all three countries reported clearing relatively little forest from 2002 to 2007 (Table 2-7). Producers in Acre reported clearing the most and producers in Madre de Dios, the least, although none of these differences were statistically significant (p=0.676). In the exploratory analysis of each potentially relevant variable regressed on the amount of forest cleared, several variables correlated with reported amount of forest cleared at p≤0.10 (Appendix K). The multivariate regression model revealed that while only a few variables predicted the reported amount forest cleared, this model performed well with a R^2 of 0.585 (Table 2-8) based on similar goodness-of-fit values observed in other studies (e.g., Walker et al., 2000; Godoy et al., 2009). In Madre de Dios, income derived from Brazil nuts (p=0.002) was negatively correlated with forest clearing. More income derived from crops (p=0.008) and larger household sizes (p=0.051) were positive predictors of forest clearing in Peru. In Acre, the most important predictors of forest cleared were larger household size (p=0.024) and more income from “other” sources (p=0.039), followed by less crop income (p=0.048). There was some evidence that households with more livestock assets (p=0.062) and younger household heads (p=0.087), and those that were located closer to cities (p=0.092) cleared more forest in Acre. In Pando, the strongest positive predictors of forest clearing were income from crops (p<0.001) and income from livestock (p=0.004). More income derived from Brazil nuts also explained less forest cleared in Pando (p=0.007).

Discussion

This study provides insights into the patterns and trends of land cover change in Brazil nut-producing communities in the MAP region, and explores spatial and socioeconomic explanations for recent deforestation. As we demonstrated through a land use land cover change analysis, there was minimal deforestation in studied communities from 1986 to 2005. That said, a deforestation trend occurred in all three countries, with a higher probability of deforestation in already fragmented areas along roads. In this tropical forest frontier where road infrastructure is being developed rapidly, it is worth exploring the patterns and drivers of deforestation, however minimal, since many communities are highly dependent on Brazil nut-rich forests for their livelihoods while conservationists emphasize the biodiversity and carbon benefits of these forests.

Forest Cover Patterns and Trends

In general, our LULCC results in Brazil nut communities from 1986 to 2005 reflect those of the region-wide study for the same 20-year period. Southworth et al. (in preparation) also observed mostly stable forest cover from 1986–2005 with most deforestation along roads, as well as higher deforestation in Acre relative to Madre de Dios and Pando. There is one important difference in our study for the 20-year period in Acre: we observed a much higher percentage of stable forest from 1986–2005 in extractive communities in Acre (95%) when compared to the entire regional landscape where approximately only 82% of forests remained (Southworth et al., in preparation). This finding complements other studies, which highlight the role of the Chico Mendes Extractive Reserve as a buffer for deforestation and fire (Brown, 2004), and substantiates the claim that reserve residents have generally not exceeded their legal 10% limit on deforestation (Vadjunec et al., 2009).

More interesting patterns emerge through an examination of separate time periods within each country and comparison between countries. In comparing our findings from individual time periods with other land use land cover change studies in Madre de Dios, we noted several important differences. For instance, our finding that deforestation increased between the first (1986–1991) and second (1991–1996) time periods contrasts with several other studies in Madre de Dios (Alvarez and Naughton-Treves, 2003; Naughton-Treves, 2004; Chavez, 2009), in which greater deforestation along the Interoceanic highway was observed during 1986–1991, due to agricultural credits, and slowed in 1991–1997 when Peruvian structural adjustment policies were implemented (Naughton-Treves, 2004). This difference could be due to the fact that Alvarez and Naughton-Treves' study area was in the province of Tambopata, which is closer to the city of Puerto Maldonado where farmers had access to greater agricultural credits, and the Chavez study did not focus on Brazil nut producers, but rather was focused in an area north of Iberia, which was a nexus of the PEMD's agricultural extension work.

Also, our observation that deforestation in Peruvian communities did not drastically increase during 2000–2005 contrasts with the region-wide LULCC study (Southworth et al., in preparation) and could be explained by several factors. First, landholdings of sampled communities are mostly comprised of Brazil nut concessions, which are relatively large areas reserved for forest product extraction, when compared to the small agriculturally-zoned landholdings also found along the Interoceanic Highway. Second, the five-year trajectory likely masked annual changes in forest cover in concession areas. For instance, preceding the implementation of the Forestry Law of 2002 in Madre de Dios, there was much insecurity surrounding fate of forest access. This insecurity, combined with leveling of the Interoceanic Highway in 2001, promoted land invasions and deforestation (Chavez, 2009). After implementation of the law, deforestation slowed within timber and Brazil nut concessions from 2002 to 2004 with regrowth occurring in previously deforested areas (Chavez, 2009; Oliveira et al., 2007). An annual land cover change analysis would be needed to tease out these changes, especially in our community sample where Brazil nut concessions are abundant. Our finding that the number of non-forest patches in Madre de Dios decreased from 2000 to 2005 likely corresponds to abandonment of many settlements. The increased distance between the fewer non-forest patches in 2005, however, likely indicates a few more recent clearings farther in the concessions.

In Acre, the drop in deforestation during 1996–2000 and subsequent increase in 2000–2005 were also observed in other land use land cover change studies in the Chico Mendes Extractive Reserve (Ludewigs, 2006; Vadjunec et al., 2009). While the drop could reflect a lag from the creation of the Reserve and an end of land conflicts between rubber tappers and ranchers, the subsequent increase in deforestation can certainly be attributed to the adoption of cattle by rubber tappers (Gomes, 2001; Gomes, 2009; Vadjunec et al., 2009). Forest conversion to pasture was seen in the increased number of non-forest patches from 2000 to 2005, decreased distance between them, and greater contiguity of these patches. The decrease in reforestation in Acre in the final time period was a sign that rubber tappers in the Chico Mendes Extractive Reserve are less likely to allow successional re-growth of fallows as they increasingly convert early secondary forest to pasture despite the efforts of Acre’s Forest Government to add value to standing forest (Gomes, 2009; Vadjunec et al., 2009).

In Pando, while deforestation was minimal over the 20-year period, the observed increase in deforestation between the first (1986–1991) and second (1991–1996) time periods was likely due to leveling of the road from Cobija to El Sena in 1992. This infrastructure project has been associated with increased migration to community areas and clearing along both primary and secondary roads (J. Rojas, pers. comm.). The much later increase in deforestation (2000–2005) was likely due to the completion of the Bioceanica road and creation of pastures in the one community in the study near the city of Cobija where multiple households had invested in cattle.

Reported Forest Clearing

The household-level economic drivers of forest clearing in the studied Brazil nut-producing communities reflect certain patterns observed in other tropical forest frontiers, in general, and in the Amazon in particular. Agricultural expansion – which includes permanent cropping, cattle ranching, shifting cultivation, and colonization – has been considered the most important cause of tropical deforestation (Geist and Lambin, 2002).

In Pando, crop income was the main positive predictor of reported forest cleared from 2002 to 2007. Among smallholders in the Amazon, conversion of forest for planting of subsistence annual crops is a common non-forest land use, especially early on in a household's life cycle (Perz et al., 2006). Crop income was also the main positive predictor of forest clearing in Madre de Dios where households were older and had resided for longer on their landholdings. In Madre de Dios, crops included perennials (e.g. fruit trees), which was expected among households that were more advanced in their life cycles (Perz et al., 2006). In Acre, the negative correlation between crop income and forest cleared was possibly a chance finding due to the fact that forest cleared for pasture in that context is much greater than forest converted for swidden agriculture.

Income from livestock was an important predictor of forest clearing in Pando, whereas in Acre, there was some evidence that livestock assets and not income from livestock predicted forest clearing. As households build capital, purchase of cattle has been considered an important way to reduce risk through diversification (Faminow, 1998; Mertens et al., 2002; Perz et al., 2006), and accumulation of cattle has been positively correlated with forest clearing in Western Amazonia (Vosti et al., 2003; Caviglia-Harris and Sills, 2005). The finding in Pando makes sense as higher amounts of deforestation were reported by households that generated substantial income from the sale of cattle. In Acre, livestock income was only minimally important, likely because cattle are not consumed or sold regularly, but rather used as a form of savings among residents of the Chico Mendes Extractive Reserve; a producer may sell a calf or two when members of the household are sick, and livestock assets provide ongoing sources of milk, cheese, and eggs, which diversify rural diets (Wallace, 2004).

In Acre, government aid (“other” income) was an important economic predictor of forest clearing. Interestingly, in current discussions in Brazil on Reduced Emissions from Deforestation and Degradation (REDD), Brazilian government aid programs, specifically family welfare (*bolsa da familia*), are used as models for planned environmental service payments to smallholders (SEMA, 2009). If indeed such government aid is currently being used by extractive households to accumulate livestock and clear more forest, similar payment structures under REDD could have a comparable effect, depending on how they are structured and monitored. Interestingly, while compensation for avoided deforestation has been considered an economically-viable alternative to cattle raising in Panama (Coomes et al., 2009), the results of a linear program model in Acre showed that additional income from payments for environmental services could lead to increased deforestation by small producers, unless accompanied by agroforestry assistance (DiGiano, 2006).

In terms of forest conservation, the finding that greater income from Brazil nuts was correlated with less forest cleared in Madre de Dios and Pando quantifies the potential of this product to promote both forest conservation and livelihood development. That said, this relationship may only hold true in areas where Brazil nut comprises a large share of the total income. In Acre where the proportion of income from Brazil nuts was much lower and livelihood systems were more diverse, there was little association between nut income and forest cleared. In scenario modeling in a colonist site in the Western Brazilian Amazon, adding value to forests through Brazil nut income was not considered a viable way to dissuade producers from converting Brazil nut-rich forests to pasture, since higher financial returns associated with non-forest land uses dominated those from traditional extractive forestry (Vosti et al., 2003). Also, notably, forest income aside from that earned from Brazil nuts (e.g. fuelwood, game) was not correlated with forest clearing in any of the three countries.

Many studies have highlighted relationships between household characteristics and forest clearing (Kaimowitz and Angelsen, 1998;, Chowdhury, 2006; Perz et al., 2006). In our study, in both Madre de Dios and Acre, household size was positively correlated with reported forest clearing. This finding reflects work in the Eastern Amazon (Perz et al., 2006) where larger households were found to deforest more based on subsistence needs and greater labor availability. That said, more specific household-level demographic life cycle variables were not correlated with reported forest cleared. For instance Eastern Amazonian households with more children and elderly members allocated more land to cultivation of annual crops based on increased subsistence needs (Perz et al., 2006), which was not observed in our study. While higher education levels have been found to decrease deforestation through greater involvement in off-farm wage activities (Irwin and Geoghegan, 2001; Chowdhury, 2006; Godoy et al., 2009), in our context where wage earning opportunities were minimal, education did not explain forest clearing. That said, producers in Madre de Dios who were more educated than their counterparts in Acre and Pando did glean more income from entrepreneurial business activities (Table 2-8). In the exploratory analysis, business income was inversely correlated with forest clearing (p=0.025; Appendix K), possibly following similar logic to wage income above, but did not remain a strong explanatory variable in the multivariate model and was dropped from the final analysis. Finally, household accessibility, in terms of distance to village center or distance to city did not explain forest clearing in the multivariate model. This finding may be due to the fact that these communities have minimal connections to formal markets; they are primarily engaged in subsistence activities with the sale of forest or agricultural products generally performed through intermediaries.

Differences in Observed vs. Reported Deforestation

An important caveat to this study is that we used two separate models based on different datasets to understand recent observed (via satellite imagery) and reported (via household surveys) deforestation in the sampled communities. There are advantages and limitations associated with combining these approaches. The main advantage is that the remote sensing analysis provided an important spatial context for understanding and comparing the patterns and trends of deforestation between the three countries, while the household-level analysis allowed us to go deeper in our exploration of the socioeconomic drivers of deforestation. Although we believe these approaches complement each other, there was some discrepancy associated with observed versus reported deforestation data at the household level. For instance, for Pando, while mean reported forest cleared was 6.5 ha from 2002 to 2007, observed deforestation from the 2000–2005 trajectory image was 8.34 ha per household. In Acre, this discrepancy was larger with a difference of 6.6 ha of reported forest cleared versus 24.84 in the country samples. Through a closer examination at the community level in Acre, we saw that most of this difference was in the southern portion of one community, where some extractive households were interspersed with colonist farmers; when the community boundary was estimated, inevitably some of these colonist lands were included in the community area. In Madre de Dios, while the mean reported forest clearing was 5.27 ha, observed forest clearing was actually lower at 2.68 ha per household. Notably, in the Peruvian context, the number of households attributed to each community was an approximation, since community associations are not as well defined there as they are in Acre and Pando, which could be the reason for this lower observed deforestation. Discrepancies between observed and reported deforestation could also be due to the fact that there was a two-year difference in the examined time periods. Future planned research that combines the 2002–2007 survey data with an annual land cover change analysis from the same years (using newly available Landsat imagery) will allow for better comparison of the satellite and survey data to understand the rates, patterns, and causes of deforestation in extractive communities in MAP.

Conclusion

This study illuminates the relationship between forest conservation and forest dependence in extractive communities in Western Amazonia. Overall, we found that extractive communities in the region were extremely forest income dependent and had deforested only a minimal portion of their landholdings from 1986 to 2005. While this general land cover change pattern mirrored the findings of a region-wide study for the same 20-year period (Southworth et al., in preparation), there was much less deforestation in the extractive communities in Acre when compared with the surrounding landscape. There was also less deforestation in the final time period (2000–2005) in communities in Madre de Dios when compared with the region-wide study. Although these communities may currently be located beyond the agricultural frontier, given current and planned infrastructural expansion throughout the Amazon

(Fearnside, 2002; Nepstad et al., 2002; Soares-Filho et al., 2006; Perz et al., 2008), deforestation in and around these communities will likely increase in the future.

A regional approach to forest conservation hinges on promoting the livelihood development of forest-dwelling communities (Kaimowitz and Sheil, 2007; Sunderlin et al. 2008b; Chhatre and Agrawal, 2009). Although we observed that agricultural income was positively correlated with forest clearing in Pando and Madre de Dios, and some evidence that increased livestock assets explained forest clearing in Acre, these land uses were performed on a small scale, generally for subsistence purposes. That said, the trend of not allowing swidden fallows to regenerate and instead converting them to pasture for steady accumulation of cattle, as seen in the Acre, could have negative conservation implications in the future. Such implications are especially relevant for the future of Brazil nut, since fallows have been observed to be favorable regeneration sites for this long-lived species (Cotta et al., 2008). The inverse relationship observed between Brazil nut income and forest clearing in Madre de Dios and Pando reinforces the need to continue bolstering the Brazil nut sector to promote forest-based livelihoods and the conservation of Brazil nut-rich forests in Western Amazonia.

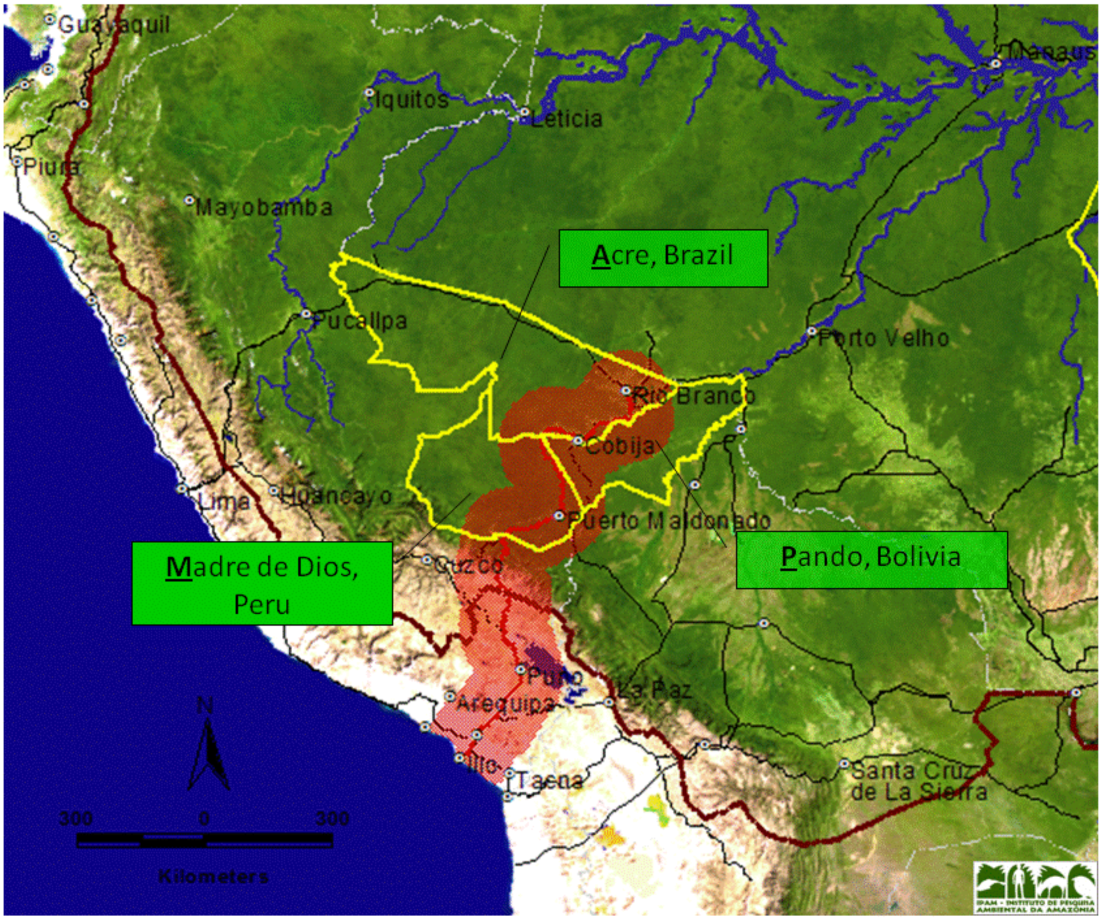


Figure 2-1. Map of Madre de Dios, Peru, Acre, Brazil and Pando, Bolivia (MAP region) with most recent portion of Interoceanic Highway and 100 m buffer in red.

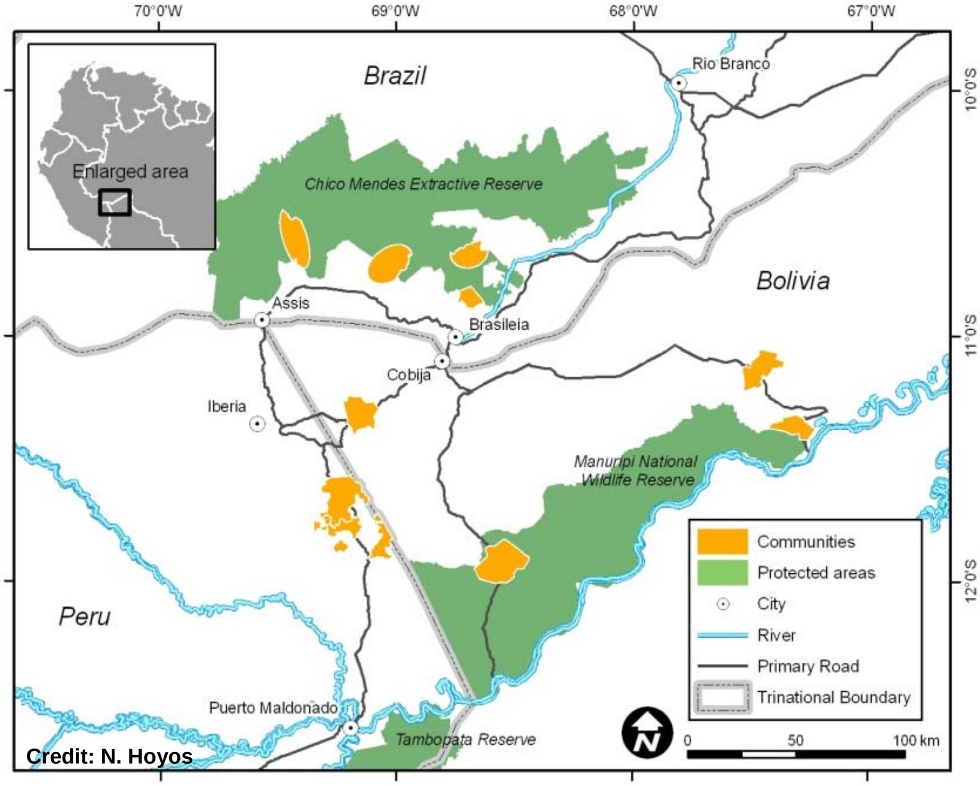


Figure 2-2. Map of communities sampled in Madre de Dios, Acre and Pando.

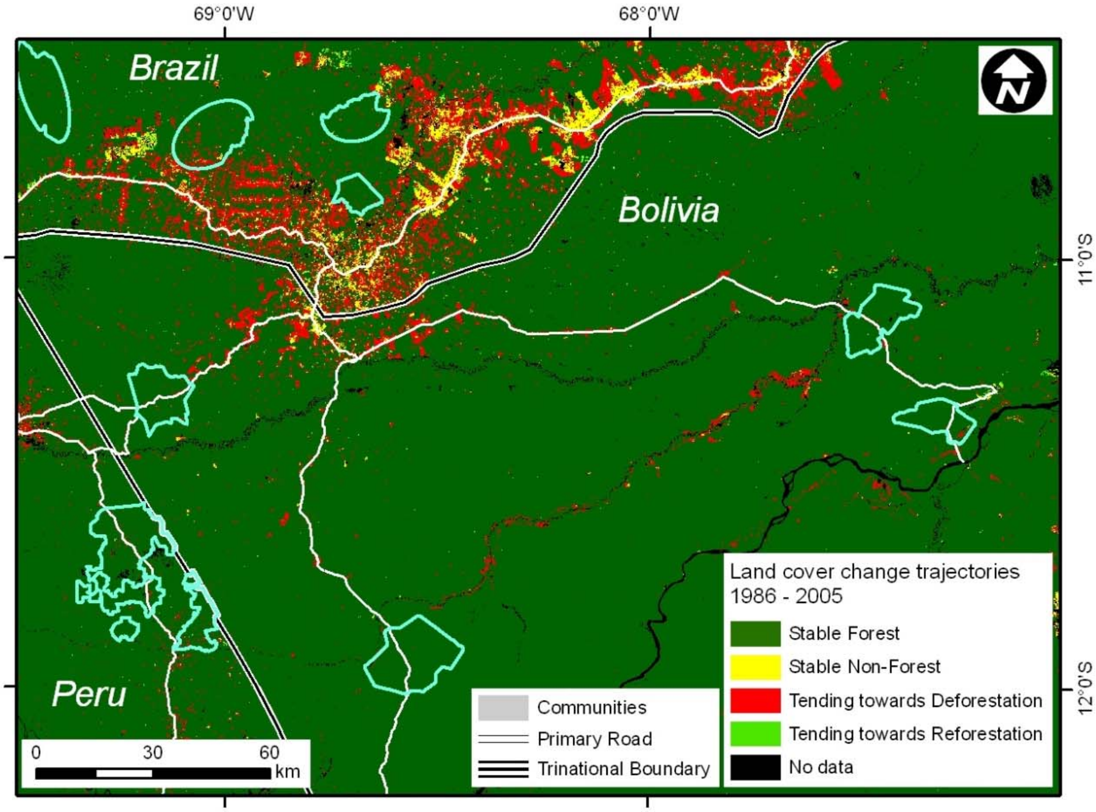


Figure 2-3. Land cover change trajectories 1986-2005 in select communities.

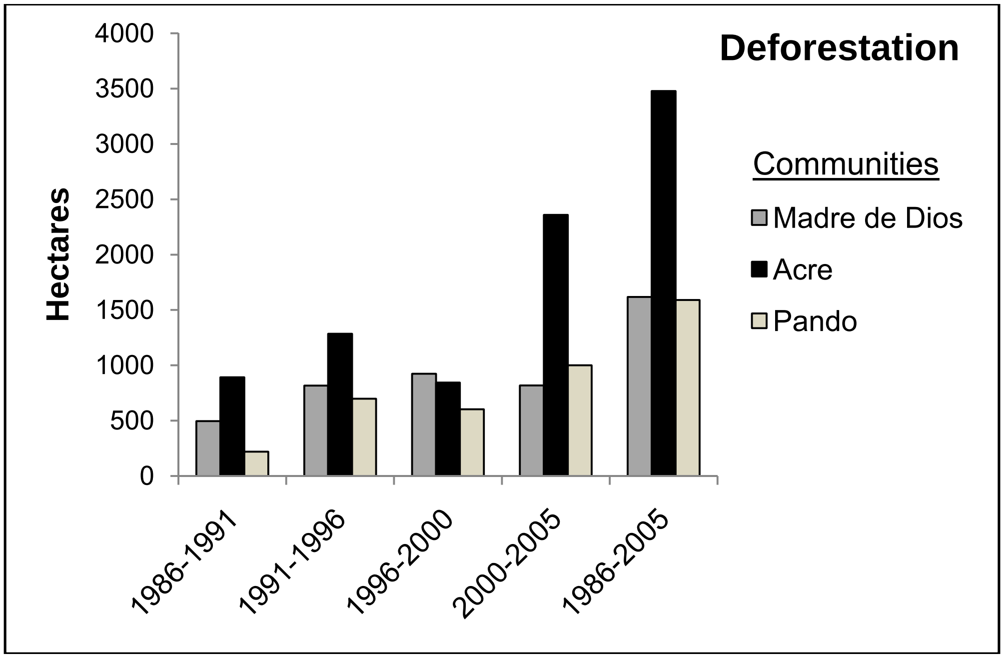


Figure 2-4a. Area deforested in paired-date time periods in Brazil nut producing communities in MAP.

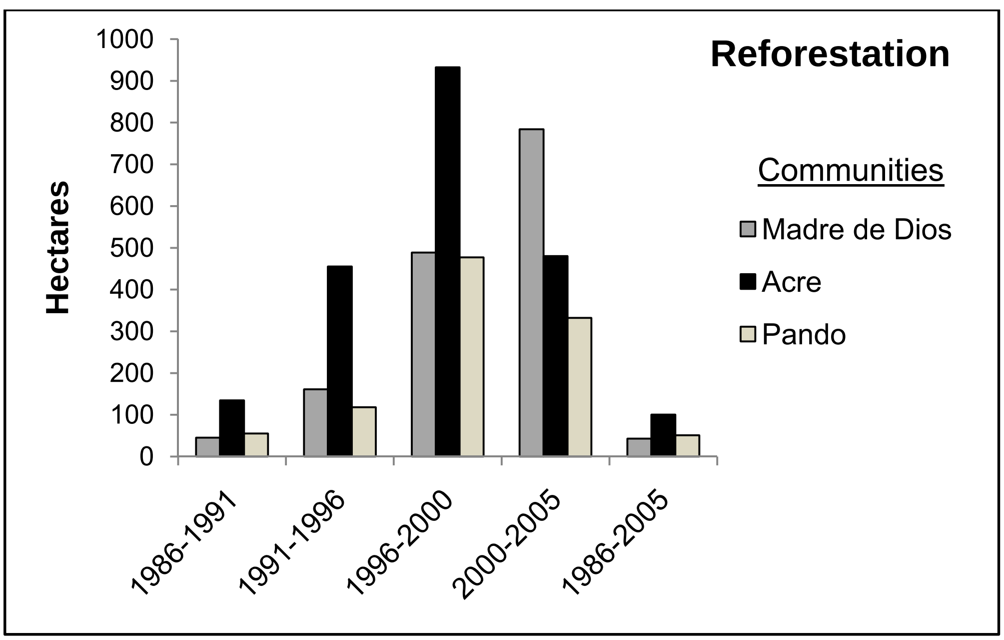


Figure 2-4b. Area reforested in paired-date time periods in Brazil nut producing communities in MAP. Note different y-axis scale in comparison with Figure 2-4b, reflecting more deforestation when compared with reforestation.

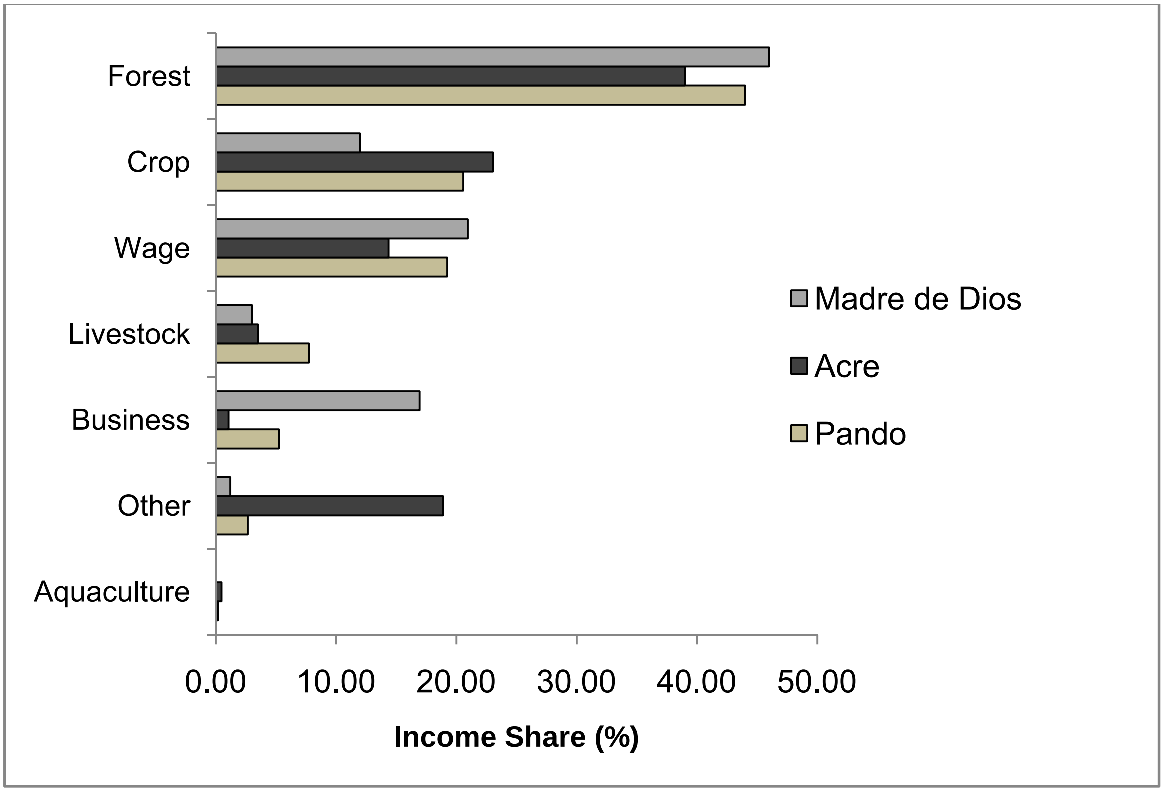


Figure 2-5. Income share distribution among sampled households in the three countries.

Table 2-1. Policy events relevant to each land use land cover change time series in Madre de Dios, Peru, Acre, Brazil, and Pando, Bolivia over the 1986-2005 study period.

Landsat image time series	Madre de Dios, Peru	Acre, Brazil	Pando, Bolivia
1986–1991	Agricultural credits under Agrarian Reform (1985-1990)	Federal cattle subsidies (1980s-1991) Creation of Alto Jurua (1989) and Chico Mendes Extractive Reserves (1990)	Opening of Cobija-Riberalta road through Pando (1980)
1991–1996	Structural adjustment (1990-2000) Interoceanic highway leveled, maintained (dry season only) (1990s)	Completion of paved BR-364 from Porto Velho to Rio Branco (1992) Paving of BR-317 (1993-2000)	Leveling of Cobija-Riberalta road through Pando (1992)
1996–2000	Structural adjustment (1990-2000) Interoceanic highway leveled, maintained (dry season only) (1990s)	Paving of BR-317 (1993-2000) Acre Forest Government (1998-Present) Chico Mendes Law (1999)	Agrarian Reform Law (1996) Forestry Law (1996) Opening of Cobija-El Chive road through Manuripi Reserve (1998) Re-designation of Manuripi National Reserve (1999)
2000–2005	Forestry Law (2000; implementation of concessions in 2002) Formalization of Bahuaja Sonene National Park and Tambopata Reserve (2000) Interoceanic highway compacted and prepared for paving (2003-2006)	Acre Forest Government (1998-Present) Ecological-Economic Zoning (2002) Proambiente (2004)	Construction of Bioceanica Road (2001) Community land titling by INRA (2004-2009)

Table 2-2. Description of cash and subsistence income categories. Inputs were discounted from net income calculations.

Income category	Description
Forest	All raw and processed products collected in forests, including wild plants, fruits, seeds, game (mammals, fish and insects), fuelwood and timber.
Crop	Grains, fruits and vegetables cultivated in swidden-agriculture plots and home gardens.
Livestock	All livestock (chickens, pigs, sheep, cattle) slaughtered or sold. Livestock assets, which are domestic animals owned, are not included in this category.
Aquaculture	Fish raised in ponds.
Wage	Payments for both on- and off-farm labor.
Business	Earnings from on- and off-farm businesses, including transport services for forest products.
Other	Remittances, government payments (pensions, environmental service) and non-governmental donations.

Table 2-3. Regional land cover in select Brazil nut producing communities 1986-2005.

Land cover area (km^2) Percent of coverage in parentheses	1986	1991	1996	2000	2005
Madre de Dios, Peru					
Forest	532.42 (98.0)	527.92 (97.2)	521.37 (96.0)	517.02 (95.2)	516.68 (95.1)
Non-forest	1.26 (0.2)	5.75 (1.1)	12.30 (2.3)	16.65 (3.1)	17.00 (3.1)
No data	9.44 (1.7)	9.44 (1.7)	9.44 (1.7)	9.44 (1.7)	9.44 (1.7)
Acre, Brazil					
Forest	681.12 (99.3)	673.55 (98.2)	665.26 (97.0)	666.14 (97.1)	647.35 (94.4)
Non-forest	3.20 (4.7)	10.78 (1.6)	19.07 (2.8)	18.18 (2.7)	36.97 (5.4)
No data	1.30 (0.2)	1.30 (0.2)	1.30 (0.2)	1.30 (0.2)	1.30 (0.2)
Pando, Bolivia					
Forest	808.25 (99.6)	806.60 (99.4)	800.80 (98.7)	799.54 (98.5)	792.86 (97.7)
Non-forest	0.75 (0.09)	2.40 (0.3)	8.20 (1.0)	9.46 (1.2)	16.14 (2.0)
No data	2.72 (0.3)	2.72 (0.3)	2.72 (0.3)	2.72 (0.3)	2.72 (0.3)

Table 2-4. Regional change trajectories in select Brazil nut producing communities.

Change trajectory area (km^2) Percent of cover class in date 1 that transitioned (or not) in date 2 in parentheses	1986–1991	1991–1996	1996–2000	2000–2005	1986-2005
Madre de Dios, Peru					
Stable forest (F-F)	527466 (99.1)	519758 (98.5)	512132 (98.2)	508839 (98.4)	516248 (97.0)
Deforestation (F-NF)	4951 (0.9)	8162 (1.5)	9238 (1.8)	8180 (1.6)	16169 (3.0)
Stable Non-forest (NF-NF)	801 (63.8)	4141 (72.0)	7416 (60.3)	8814 (52.9)	824 (65.7)
Reforestation (NF-F)	455 (36.2)	1611 (28.0)	4887 (39.7)	7840 (47.1)	431 (34.3)
No data	9437 (n/a)	9437 (n/a)	9437 (n/a)	9437 (n/a)	9437 (n/a)
Acre, Brazil					
Stable forest (F-F)	672206 (98.7)	660700 (98.1)	656817 (98.7)	642548 (96.5)	646346 (95.0)
Deforestation (F-NF)	8917 (1.3)	12852 (1.9)	8438 (1.3)	23595 (3.5)	34777 (5.0)
Stable Non-forest (NF-NF)	1853 (57.9)	6215 (57.7)	9742 (51.1)	13377 (73.6)	2195 (68.6)
Reforestation (NF-F)	1347 (42.1)	4555 (42.3)	9326 (48.9)	4803 (26.4)	1005 (31.4)
No data	1302 (n/a)	1302 (n/a)	1302 (n/a)	1302 (n/a)	1302 (n/a)
Pando, Bolivia					
Stable forest (F-F)	806050 (99.7)	799618 (99.1)	794771 (99.2)	789535 (98.7)	792347 (98.0)
Deforestation (F-NF)	2200 (0.3)	6987 (0.9)	6029 (0.8)	10009 (1.3)	15903(2.0)
Stable Non-forest (NF-NF)	196 (26.1)	1213 (50.6)	3427 (41.8)	6134 (64.9)	240 (32.0)
Reforestation (NF-F)	554 (73.9)	1183 (49.4)	4773 (58.2)	3322 (35.1)	509 (68.0)
No data	2722 (n/a)	2722 (n/a)	2722 (n/a)	2722 (n/a)	2722 (n/a)

Table 2-5. Binomial logit models of deforestation in Brazil nut communities during period 2000-2005. Unit of observation: the pixel (30 x 30 m) (n=888,323 in Pando, n=740,224 in Acre, and n=573,233 in Madre de Dios). All variables significant at $p<0.001$.

	Madre de Dios, Peru		Acre, Brazil		Pando, Bolivia	
Variable	Coeff.	Z-stat	Coeff.	Z-stat	Coeff.	Z-stat
Pixel level						
Dist. to road	-0.00006588	-17.64	-0.00003133	-26.83	-0.00006901	-13.43
Dist. to F/NF edge	-0.0002818	-13.71	-0.0016679	-67.44	-0.0006416	-42.94
Matheron index (log)	0.9851	97.70	0.63409	96.32	0.78888	89.63
Pseudo R^2	0.26		0.24		0.22	

Table 2-6. Non-forest patch metrics in 2000 and 2005: NP (number of patches); AREA (size); CIRCLE (circularity index); CONTIG (contiguity index); ENN (Euclidean distance to nearest neighbor). Within country significance levels between years are provided in the table (detailed p=values for significant variables in text). Significant differences between countries in each year (2000 and 2005) are described in the text only.

Location	Year	NP	AREA (ha)	CIRCLE (0-1)	CONTIG (0-1)	ENN (m)
Madre de Dios	2000	367	4.11 (0.62)	0.52 (0.01)	0.53 (0.01)	213.73 (18.29)
	2005	343	4.00 (1.11)	0.50 (0.01)	0.46 (0.01)***	356.06 (36.51)***
Acre	2000	392	4.19 (1.17)	0.51 (0.01)	0.51 (0.01)	307.04 (21.28)
	2005	494	7.13 (1.48)	0.52 (0.01)	0.57 (0.01)***	248.17 (14.86)*
Pando	2000	216	3.81 (0.93)	0.54 (0.01)	0.47 (0.02)	260.35 (34.33)
	2005	251	4.72 (1.14)	0.53 (0.01)	0.46 (0.02)	206.09 (17.75)

Notes: *** ($p \leq 0.001$); ** ($p \leq 0.01$); *($p \leq 0.05$); +($p \leq 0.10$).

Table 2-7. Descriptive statistics of household characteristics, income, assets and reported forest clearing in Brazil nut-rich communities in Madre de Dios, Acre, and Pando.

	All	Madre de Dios, Peru	Acre, Brazil	Pando, Bolivia	
Variable	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	p-value
Outcome					
Cleared forest (ha)	6.30 (0.57)	5.27 (0.67)	6.60 (0.66)	6.50 (1.17)	0.676
Household characteristics					
Size	5.37 (0.22)	5.07 (0.439)	5.36 (0.37)	5.49 (0.33)	0.785
Life cycle location					
Number adults (age 15-65)	3.03 (0.13)	3.14 (0.38)	3.12 (0.21)	2.90 (0.18)	0.686
Number children (age <15)	2.20 (0.15)	1.50 (0.23)	2.21 (0.25)	2.46 (0.23)	0.06
Number elders (age >66)	0.18 (0.36)	0.43 (0.12)	0.03 (0.02)	0.19 (0.58)	<0.001
Age of household head (yrs)	43.70 (1.20)	51.57 (2.98)	40.29 (1.66)	43.37 (1.85)	0.003
Length of residency (yrs)	18.87 (1.24)	29.68 (3.13)	16.86 (2.01)	16.21 (1.61)	<0.001
Accessibility					
Distance to village center (min)	39.84 (3.86)	2.86 (1.79)	73.59 (6.81)	27.04 (4.39)	<0.001
Distance to city (min)	225.40 (8.81)	117.32 (3.06)	260.83 (17.68)	239.08 (9.47)	<0.001
Education (sum yrs)	20.52 (1.28)	34.29 (3.42)	11.72 (1.01)	22.30 (1.89)	<0.001
Household income (USD per capita)					
Forest income	542.07 (38.15)	547.87 (113.95)	488.09 (43.54)	592.34 (64.38)	0.461
Brazil nut income	278.24 (35.54)	290.58 (110.74)	137.68 (26.76)	418.49 (60.62)	0.001
Crop income	256.36 (36.24)	142.92 (42.55)	290.97 (66.11)	274.91 (56.61)	0.303
Livestock income	66.95 (24.56)	36.03 (29.13)	44.26 (33.60)	103.53 (48.27)	0.454
Aquaculture income	3.52 (1.64)	0.00 (0.00)	6.09 (3.96)	2.63 (0.94)	0.361
Wage income	225.34 (32.13)	249.95 (65.29)	181.28 (60.02)	257.20 (42.60)	0.525
Business income	72.34 (24.95)	202.13 (60.65)	13.35 (9.08)	70.15 (51.96)	0.020
Other income	113.00 (22.10)	14.39 (8.64)	238.39 (49.83)	35.60 (7.48)	<0.001
Total income	1279.58 (82.24)	1193.3 (163.58)	1262.44 (131.60)	1336.36 (135.81)	0.808
Assets (USD per capita)					
Total land (ha)	496.22 (32.77)	371.21 (71.72)	602.95 (64.05)	459.36 (39.80)	0.025
Material assets	417.43 (51.24)	243.62 (37.74)	488.12 (60.13)	427.36 (99.26)	0.246
Livestock assets	489.47 (97.66)	115.91 (45.22)	769.81 (170.69)	402.53 (157.96)	0.044

Table 2-8. Results of multivariate regression model with the most important measured variables that explained log amount of forest cleared from 2002-2007 (R^2=0.585). All variables were measured using country as a fixed effect. Households were the unit of observation (n=125). Actual p-values for significant variables included in text.

	Madre de Dios, Peru		Acre, Brazil		Pando, Bolivia		
Variable	Coeff.	*t*-Statistic	Coeff.	*t*-Statistic	Coeff.	*t*-Statistic	F-Stat
country	1.31	1.29	2.159	5.94***	1.404	3.70***	<0.001
country*crop income	0.001893	2.69**	-0.000416	-2.00*	0.000822	3.55***	<0.001
country*Brazil nut income	-0.000699	-3.21**	0.000041	0.10	-0.000685	-2.73**	0.001
country*hh size	0.1124	1.98*	0.0775	2.29*	0.0038	0.10	0.002
country*livestock income	0.00226	0.86	0.000360	0.77	0.00342	2.95**	0.012
country*livestock assets	-0.00111	-1.00	0.0001555	1.89+	-0.0000825	-0.87	0.157
country*distance to city	-0.00827	-1.09	-0.001177	-1.70+	-0.00098	-0.83	<0.001
country*hh head age	0.01151	1.44	-0.01316	-1.73+	0.00835	1.40	0.016
country*other income	-0.00033	-0.12	0.000558	2.09*	0.00043	0.29	0.296

CHAPTER 3
FORMALIZING PROPERTY RIGHTS OF TROPICAL FOREST COMMUNITIES: IMPLICATIONS FOR NON-TIMBER MANAGEMENT, LIVELIHOODS AND CONSERVATION

Introduction

Local communities may help determine tropical forest fates. Communities now own or manage one-quarter of the world's tropical forests due to recent devolution of government-owned lands and formal recognition of customary rights (White and Martin, 2002; Sunderlin et al., 2008a). Such transfers of forest ownership and management rights to local control have the potential to promote both conservation and livelihood development in remote tropical regions (Sunderlin et al., 2005) where rural people often depend on forest resources for their economic well-being (Belcher et al., 2005). Secure property rights are considered an important base for allowing communities to attain desired economic benefits from land and resources (de Soto, 2000). Although devolution of property rights to community control may not always promote forest conservation (Gould, 2006; Tacconi, 2007), forest-dependent communities with secure rights may be more likely to place greater emphasis on long-term forest management and conservation (McKean, 2000; Colfer, 2005).

The process by which property rights are formalized can affect the security of communities' rights to forest resources. A common way to designate public lands for community use is to grant communal land titles, creating a sense of order in contested tropical forests. Much caution is needed, however, during the process of formalizing communities' often complex customary rights to land and resources. Communities manage natural resources both as common-pool and private assets (Ostrom, 2003), with rights governed by local institutions often adapting over time (Gibson et al., 2000).

Such complex property rights can be perceived as "webs of interest," made up of overriding, overlapping, complementary, or contested interests between multiple actors. Formalizing communal tenure may be akin to "cutting the web" (Meinzen-Dick and Mwangi, 2008) if customary rules are overturned, and can result in unsustainable resource use if community members are unsure which rules apply and are insecure about long-term ownership (Fitzpatrick, 2006). Furthermore, granting titles to land often ignores traditional tree tenure systems common in tropical forests (Fortmann and Bruce, 1988), resulting in discrepancies between formal and customary rights. These arguments are not meant to diminish the importance of land titling, communal or otherwise, but rather highlight the need to involve local people in developing formal tenure rules and regulations that promote effective local management of land and resources (Hayes, 2007).

Shifts in property rights, such as formal transfers to community control, combined with rapidly changing values of forest resources can result in forest-based conflicts (de Jong et al., 2006). While rising resource prices may increase demand for property rights security (Demsetz, 1967), costs of enforcing rights to increasingly valuable land and resources may become prohibitive (Fitzpatrick, 2006); legitimate users may be excluded while others gain control (Meinzen-Dick and Mwangi, 2008). During such transitions, contradictory policies may also promote conflict. In the Eastern Brazilian Amazon, violent conflicts between landowners and squatters ensued when incompatible, legal rights were granted to each of these groups on lands that were rapidly increasing in value (Schmink and Wood, 1992; Alston et al., 2000). In northern Bolivia, overlapping land titles were granted to communities, timber concessions, and private individuals, which resulted in conflicts (Ruiz, 2005). Such conflicts have indirectly led to deforestation and resource overexploitation, and adversely affected the livelihood benefits obtained from contested resources (Alston et al., 2000; Ruiz, 2005; de Oliveira, 2008, Yasmi and Shanz, in press).

A simple, yet common manifestation of forest-based conflicts is theft of forest resources, especially when demand for forest products is high and local access and exclusion rights are weakened (Koning et al., 2007). In criminology, theft is defined as the taking of another person's property without their consent (Allen, 2005). In the context of property rights transitions in tropical forests, resource thefts could be the result of malicious intent or simple confusion over the new property rights systems in place. In either case, the "proprietor," as defined by Schlager and Ostrom (1992), is one who can effectively exclude others from their property, while maintaining withdrawal and management rights to resources.

Given the uncertainties and conflict associated with property rights transitions, participatory mapping is one strategy for empowering local communities to negotiate and strengthen customary tenure systems (Peluso, 1995; Alcorn, 2000; Chase Smith et al., 2003; Chapin et al., 2005). Participatory mapping is often used by non-governmental and research organizations to facilitate individuals or groups of people in spatially representing real-world features through hand drawn sketch maps (Lynam et al., 2007) and/or computerized maps using GIS and remote sensing (Chapin et al., 2005). Documentation of customary rights through mapping may help rural communities: (1) clarify boundaries, which may enhance their power of exclusion and decrease conflicts; and, (2) improve planning and access to government support

(Cronkleton et al., 2007). Working with rural communities to understand and negotiate their property rights through participatory mapping may also help communities manage their forests better.

Through comparative research in forest-dwelling communities in neighboring Pando, Bolivia, and Acre, Brazil, we examined the phenomenon of Brazil nut thefts. Brazil nut (*Bertholletia excelsa*) is the most important non-timber forest product (NTFP) in Western Amazonia, and individual trees are considered key livelihood assets by forest dwellers in both countries. We focused our comparison on these two adjacent areas, because while they have a similar natural resource base, their property rights systems and dependence on the nuts by local communities are different. Our overall research question in this chapter is: What are the causes and effects of Brazil nut thefts, and how can such thefts be resolved?

We first introduce the study region and ecological and economic characteristics of Brazil nut. We next highlight important historical processes and policy changes that have shaped settlement patterns and property rights for communities in Pando and Acre. We then present results of field studies on reported thefts of Brazil nuts, and explore the causes of such thefts, along with their management implications. Specifically, we ask: (1) To what extent do Brazil nut thefts occur in forest-dwelling communities in Pando and Acre? (2) What is the financial value of these thefts? (3) What are the causes of such thefts? (4) Does threat of theft affect Brazil nut harvesting and management practices? (5) How are thefts resolved? and, (6) What are producers' perceptions of participatory mapping as one way to resolve such thefts? This comparative study illustrates broader issues related to the role of property rights security, livelihoods, and management of tropical forests by rural communities.

Study Region

In the approximately 220,000 km^2 border region of Acre, Brazil and Pando, Bolivia in Western Amazonia, many non-indigenous extractive communities – whose principal livelihood activity is collection of forest products – were granted formal rights to their traditional landholdings through recent devolution of public and private lands. These communities share the landscape with indigenous groups and more recently settled farmers, cattle ranchers, and loggers. Although the entire region is characterized by lowland wet tropical forest vegetation, settlement histories, patterns of deforestation, public policy, and socio-economic development vary considerably from one country to the next (www.map-amazonia.net). Construction of the Interoceanic Highway, an extension of Brazilian BR-317 into Peru and Bolivia, is changing conditions in this formerly remote region, by providing regional access to Pacific ports (Figure 3-1). In Acre, forest conversion has been rapid, extensive, and largely driven by establishment of cattle ranches (Souza et al., 2006). In Pando, in contrast, deforestation has been minimal, with most land conversion occurring in close proximity to population centers and along the Brazilian border (Marsik et al., in review).

Brazil Nut Bridging Forest Conservation and Livelihood Development

Brazil nut is currently the most important non-timber forest product (NTFP) in Western Amazonia. It is collected primarily from mature forests and its combined ecological and economic characteristics make it a species with the potential to promote forest conservation while contributing to the livelihoods of rural communities. At maturity, Brazil nut trees are giants in upland forests of this region, emerge above the forest canopy, attain up to 3 m in diameter, and live for centuries. Because of its massive size and high relative densities, this species provides important ecological structural and functional roles at the local and landscape scale (Zuidema, 2003) Its large, woody fruits fall to the ground during the wet season and retain the approximately 25 seeds (here referred to as nuts) inside. The scatterhoarding agouti (*Dasyprocta spp*.), one of the few animals that can gnaw through the hard fruits, plays an instrumental role in seed dispersal and burial. People access the nuts by gathering the heavy fruits in large piles and using machetes to break them open. The nuts are put in large sacks and carried out of the forest. Although Peres et al. (2003) suggested that decades of commercial harvesting may leave insufficient juvenile recruitment to ensure future generations, populations in the Western Amazon appear to be viable over the medium-term under a range of harvest intensities (Zuidema and Boot, 2002; Wadt et al., 2008). Harvested nuts can be counted on as a seasonal contribution to local livelihoods as there is little variability in fruit production at the population level across years (Kainer et al., 2007). The nuts fetch relatively high prices on local, national, and international markets, particularly because of increased demand and consequent higher prices since 2003. Western Amazonia is the current center of the Brazil nut economy, employing tens of thousands of families during the primary collection season (January–March; Bojanic, 2001). Because of Brazil nut's regional economic importance, Brazilian, Bolivian, and Peruvian legislation prohibit felling the trees.

History of Forest Extraction

The history of colonization and settlement by non-indigenous extractive populations in Acre and Pando began in the late 19th century during the first boom of natural rubber (*Hevea brasiliensis*), and has since been shaped by distinct changes in policy and market demands (Table 3-1). Immigration to rubber estates in the Western Amazon, into Pando and what is now Acre (which at the time was officially Bolivian territory; Barham and Coomes, 1996) exploded after the 1870s, which is also when Bolivian entrepreneur Nicolas Suarez began his dominance of the Bolivian rubber industry (Fifer, 1970). The border conflict between Brazil and Bolivia (1899-1903), in which the Brazilian rubber tappers in Acre had a major role in Brazil's victory, reestablished the boundaries between the two countries; the territory of Acre was ceded to Brazil in 1903 (Fifer, 1970). When the price of rubber fell in 1912 in response to establishment of rubber plantations in Malaysia, Brazilian and Bolivian rubber tappers began to diversify their livelihood strategies to include Brazil nuts and agriculture (Fifer, 1970; Barham and Coomes, 1996; Stoian, 2000). In 1931, the Suarez Company introduced Brazil nut shelling, dominated by a female labor force because Bolivian men were engaged in the Chaco War (1932-35) (Fifer, 1970). During World War II, there was a second, smaller rubber boom in which the U.S. partnered with Brazil through the Washington Accords, and recruited a second wave of Brazilian "rubber soldiers" to Acre (Sobrinho, 1992). Although Pando and Acre were legally separated, the border was porous, and more than 2000 Brazilian rubber tappers were employed by *Suarez and Hermanos*, who at the time controlled 80% of rubber production in the Brazil-Bolivia border region (Sobrinho, 1992). Brazil nuts continued to be a complementary seasonal activity to rubber tapping, although in the 1950s, nut exports surpassed rubber production, and the first "official boom" of the Brazil nut sector occurred in the 1990s (Stoian, 2000).

Rubber Industry Sets the Stage for Brazil Nut Extraction in Western Amazonia

Although the rubber industry did not promote long-term economic development in the Amazon (Weinstein, 1983; Barham and Coomes, 1996), it was critical in setting the stage for current Brazil nut production in terms of both harvester settlement patterns and forest product market chains. In Acre and Pando, communities were formed by families of rubber tappers that continued to live in the forests even after the price of rubber dropped. In Acre, these people maintained their traditional isolated distributions throughout the forest even as the lands beneath them were either sold off or abandoned by the traditional rubber estate owners to cattle ranchers (Sobrinho, 1992). In contrast, families in Pando tended to congregate as rubber lost value. This settlement pattern was reinforced as municipal governments provided infrastructure and services in response to Bolivia's 1994 Popular Participation Law. The formation of concentrated communities in Pando meant that forest landholdings were occupied only during the Brazil nut harvest season (Cronkleton et al., 2007; Figure 3-2).

In extractive communities in Acre and Pando, customary rights to land were largely based on tree tenure. In Acre, these continued to be defined by the location of rubber trees and the trails leading to them, whereas in Pando, proprietorship was increasingly defined by the distribution of Brazil nut trees (Ankerson and Barnes, 2005; Cronkleton et al., 2007). In both places, Brazil nut market chains from the forest to middle men to processors to international markets paralleled those of the rubber trade. During the 1990s, two important property rights policy changes occurred at the national level in Brazil and Bolivia: establishing Extractive Reserves in Brazil, and passing a new Forestry Law and Agrarian Reform Law in Bolivia, designed to formally recognize property rights of communities. The origin of these policy changes and how they were implemented in Acre and Pando have important consequences for extractive activities in the region today.

Recent National Policies Designed to Devolve Rights to Extractivist Communities

Extractive Reserves have been championed as a viable and sustainable alternative to widespread deforestation in the Amazon (Allegretti 1989; 1990). An important difference between Extractive Reserves and other Amazonian protected areas is that they were created “not despite but because of people” (Ehringhaus, 2006). In 1990, the Brazilian government established the first official Extractive Reserves in Acre in response to the rubber tappers’ social movement to secure land tenure coupled with international pressure to halt Amazonian deforestation (Schwartzman, 1989; Hall, 1997). Acre’s rubber tappers used international environmental concerns about the Amazon to their advantage, portraying themselves as forest stewards (Schmink and Wood, 1992). The Extractive Reserve policy guaranteed usufruct rights to people engaged in traditional livelihoods based largely on collection of NTFPs (e.g. rubber, Brazil nuts, various fruits, and palms; Ehringhaus, 2006), while requiring residents to maintain at least 90% of their landholdings in forest cover (Fearnside, 2003). NTFP extraction is considered less ecologically destructive than other land-use practices, such as clearing land for agriculture and pasture, or harvesting timber (Arnold and Ruíz-Pérez, 2001), thereby embedding conservation goals within the Extractive Reserve model (Fearnside, 2003). Critiques of this conservation model focus on the possibility of NTFP over-exploitation; the uncertain economic viability of NTFPs (Browder, 1990; 1992); NTFP intensification in plantations or replacement by synthetic substitutes (Homma, 1992; Dove, 1994). These factors could eventually cause people in reserves to use the land in more ecologically-destructive ways, such as for cattle ranching and commercial agriculture (Gomes, 2001; Salisbury and Schmink, 2007; Gomes, 2009). Importantly, certain NTFPs, such as Brazil nut, have the potential to contribute to livelihood development. Wholesale Brazil nut prices in the United States more than doubled from 2000 to 2005 ($2.04 to $4.38/kg dry weight, respectively; Red River Foods, unpublished data), suggesting that this NTFP could contribute to rural poverty alleviation, but only if producers secure an equitable share of market value.

In 1990, the one million hectare Chico Mendes Extractive Reserve (CMER) was created in Acre from 42 former rubber estates. Households are spread throughout the mostly forested landscape, and the unique tree tenure legacy from the rubber era is still honored among extractivists. Even though Brazil nut has replaced rubber as the most important forest product (Wallace, 2004; Ehringhaus, 2006), reserve residents still define individual property holdings by the number and distribution of rubber trails through the forest (Ankerson and Barnes, 2005).

In Bolivia, the Forestry Law and the Agrarian Reform Law, both passed in 1996, affected forest-dwelling communities in Pando. Although the Forestry Law was focused on timber production, it had several important implications for community management of NTFPs. In particular, establishment of an area-based land tax discouraged timber companies from maintaining large landholdings, making more forested land available to communities (Contreras and Vargas, 2001). Forest access was democratized by recognition of indigenous subsistence rights and creation of several avenues through which communities could participate in commercial forestry – an activity previously prohibited (Ruiz, 2005). In 2000 and 2004, modifications of the Agrarian Reform Law in northern Bolivia gave forest-dwelling communities legal rights to 500 ha per family, with the total area of the communal title determined by the official number of resident families (Ruiz, 2005; Cronkleton and Pacheco, in press). The Bolivian Agrarian Reform Agency (INRA) began implementing these reforms and titling procedures with little consultation from the communities themselves. While owners of rubber estates in Brazil went bankrupt or were forced to sell their lands in the 1970s, owners of private forested estates in Pando tried to maintain their privileged position (Stoian, 2000). Throughout the 1990s and early 2000s there was a struggle between these large landholders and peasant and indigenous communities to control forest resources and lands (Cronkleton et al., 2007).

Complementing this communally-held land in Bolivia, the 1.8 million hectare Manuripi National Wildlife Reserve was officially created in 1973 for biodiversity conservation, although it was not officially managed as such until 1999 (Miserendino et al., 2003; Kühne, 2004). While most land in the reserve is held in large (1,000-80,000 ha) private estates (Kühne, 2004), there are also nine reserve communities, eight along main roads and the ninth located along the Madre de Dios River. Similar to communities outside the Manuripi Reserve, families within the reserve live in clustered settlements, and only during the Brazil nut harvest season do they relocate to their often remote forest landholdings.

Recently, local non-governmental and research organizations in Pando have supported communities in participatory mapping of Brazil nut stands. This mapping is seen a way to empower rural people through documentation and clarification of customary resource rights, and in many cases comply with the technical norms for Brazil nut management in Bolivia (Ministério de Desarrollo Sostenible, 2006). Individual

Brazil nut trees are mapped and numbered, their proprietor is identified, and final maps are returned to communities to allow them to visualize and negotiate customary tree tenure with other harvesters and government officials.

Methods

Field Evaluation of Brazil Nut Harvest and Management Practices

Brazil nut harvest and management practices were evaluated in eight communities in Pando and four in Acre. We interviewed 189 households (131 in Pando, 58 in Acre) and participated in the 2006 and 2007 Brazil nut harvests. In Pando, communities were chosen to represent differences in market access (river vs. road) and distance to major market centers, and were located both within (4) and outside (4) of the Manuripi National Wildlife Reserve. In Acre, the four communities sampled differed in their distance to central markets, but all were in the Chico Mendes Extractive Reserve and had access to secondary roads (Figure 3-3). Large distances between households in Acre extended field survey time, precluding an equal sample size between the two countries.

In communities with <30 families, all available families participated in the study; in larger communities (>30 families), representative samples were chosen at random from lists of total households generated through consultation with community leaders. Harvest and management practices were categorized by: (1) initial harvest date; (2) harvest method and overall harvest duration; and, (3) management practices designed to (a) promote regeneration (e.g., protection of seedlings from fire), (b) enhance fruit yield (e.g., vine cutting), and (c) meet certification standards (e.g., nut drying). These management variables were chosen from local literature on best management practices (e.g., Wadt et al., 2005) and the first author's participation in the 2006 Brazil nut harvest.

We also recorded apparent lack of management, as well as intentional or unintentional practices that may have adverse effects on the species (e.g., cutting into the tree's vascular tissue to increase fruit production). During the 2006 and 2007 harvests, we collected data on reported nut thefts based on informant accounts of where and how many nuts were stolen by whom, and what, if anything, was done to resolve the matter. Finally, in three communities from our sample in Pando that had mapped their Brazil nut stands in 2005 or 2006, nut harvesters free-listed perceived costs and benefits of the mapping exercise.

Quantification of Rural Livelihoods

In collaboration with the Center for International Forestry Research Poverty and Environment Network (CIFOR PEN; http://www.cifor.cgiar.org/pen/_ref/home/index.htm), we conducted two annual village and household-level socio-economic and environmental questionnaires and four quarterly household questionnaires with the same 189 households from June 2006 through August 2007. We quantified land tenure and access variables through the village and household-level annual surveys. Quarterly interviews over a 12-month period focused on all subsistence and cash income derived from forests and other on- and off-farm activities, including agriculture, livestock, wage labor, and other sources of external economic support. We used this detailed evaluation to calculate total household income and analyze the relative contribution of Brazil nut to household livelihoods in Pando and Acre.

Data Analysis

To understand basic quantitative differences between Brazil nut-producing households in Pando and Acre, we generated descriptive statistics for: (1) household characteristics, land tenure, access and income; (2) incidence, type and financial costs of nut theft; and, (3) nut harvest and management practices. We then performed several analyses to evaluate variables that predicted, or were predicted by, presence or absence of theft. For these analyses, the dataset included measurements from 171 of the total 189 households (125 in Pando and 51 in Acre) that had robust records over two consecutive years (2006 and 2007). Therefore, this dataset corresponds to repeated measures with two time points.

Potential quantitative explanations for theft

In the first analytical stage, we searched for relationships between reported incidence of theft and possible predictor variables for both countries with the two years of data combined. For discrete variables, such as road or river access, Brazil nut tree mapping status, and perceptions of property rights security, chi-square tests were used. For continuous variables, such as distance to market, distance from households to individual nut stands, and income derived from Brazil nuts, logistic regressions were fitted. This process guided our selection of potentially relevant variables ($p \leq 0.10$) to be included in a more complete, single model to analyze theft.

For this, we developed a stepwise generalized linear model based on a binomial distribution and a logit link where model response was presence or absence of theft. Autocorrelation of the errors was evaluated because these data contained repeated measures, but was not statistically significant and therefore dropped from the analysis. Models were fitted using the software SPSS Statistics GradPack 17.0 (2008).

Potential quantitative implications of theft on harvest and management

In the second analytical stage, we searched for relationships between reported incidence of theft and possible harvest and management response variables across four subgroups comprising country x year combinations. Again, for discrete variables, such as Brazil nut harvest method and specific management practices, chi-square tests were used. For continuous explanatory variables, such as length of harvest and amount of nuts collected, ANOVA tables were obtained. Again, this process guided our selection of potentially relevant variables ($p \leq 0.10$) to be included in a model that combined data from all countries and years to investigate presence or absence of theft as explaining harvest and management practices.

We modeled each individual selected response variable considering a year and group factor, together with its interaction. Year and group were assumed to be fixed effects. The group factor was a categorical variable formed by three classes: (1) observations with theft in Pando; (2) observations without theft in Pando; and, (3) observations without theft in Acre. Thefts in Acre were so rare (only 11 reported over a 2-year period) that a fourth potential class (i.e., observations with theft in Acre) was not statistically viable for inclusion in the model. In this analysis, the presence of autocorrelation among observations was relevant and therefore incorporated into the model as a random effect. The continuous and discrete responses were fitted by using a linear mixed model and a generalized linear mixed model, respectively, as implemented in GenStat v.11 (Payne et al., 2007).

Results

Comparative Household Characteristics, Land Tenure, Access and Income Data

Overall, while households in Pando and Acre were similar in terms of size, land area, and time lived in the community, they differed significantly in their access to markets and forest resources (Table 3-2). While more than half of households sampled in both places had access to roads from village centers, communities in Pando were located much farther from market centers ($p<0.001$). Also, in Pando, distance from households to individual Brazil nut stands was greater than in Acre ($p<0.001$). This reflects the concentrated nature of communities in Pando, which contrasts with the more diffuse spread of Acrean forest-based households.

While total income was similar, income derived from forests and Brazil nuts was greater in Pando (Table 3-2). Forest income made up 63% of the total share in Pando, whereas in Acre, 42% of household income came from forests (Figure 3-4). Similarly, Brazil nut income, as a subset of forest-based income, contributed significantly more to household livelihoods in Pando than in Acre (Table 3-2). In Pando, Brazil nuts alone contributed 43% of the total income share, whereas in Acre, Brazil nuts contributed just 14% (Figure 3-4). Reported mean (and SD) volume of nuts per household in Pando was 6187(±7590) kg in 2006 (n=125) and 4508(±3856) kg in 2007 (n=115). In Acre it was much less at 1807(±1844) kg in 2006 and 1812 (±1737) kg in 2007.

Frequency of Reported Brazil Nut Thefts

Theft of Brazil nuts was reported much more frequently in Pando than in Acre ($p<0.001$). In Pando, 61% of 125 households and 45% of 115 households reported nut thefts in 2006 and 2007, respectively. In Acre, only 14% of 51 households and 9% of 42 households reported nut thefts in 2006 and 2007 harvests, respectively. While we may have expected fewer thefts in Acre due to the smaller sample size, our findings were reflected in data gathered in a separate extractive community in Acre with only 4% of 26 households reporting nut thefts in 2007 (Duchelle, unpublished data). In both Pando and Acre, most thefts were of nuts were from the forest floor, rather than of sacks or storage areas (Figure 3-5), suggesting that some reported thefts were due to confusion over customary tree tenure, rather than outright stealing.

The people who reportedly stole nuts were members of the same community, members of neighboring communities, or, at least in Pando, temporary workers employed in private estates or communities during the harvest season (Figure 3-6). In Pando, half of all thefts were reputedly committed by members of the same community (45% in 2006, 52% in 2007). In Acre, the 11 cases of thefts were reportedly perpetrated by other harvesters from the same and neighboring communities. Thefts by hired migrant workers, such as those observed in Pando, did not occur in Acre where there was no wage labor for nut collection or neigboring private estates with migrant workers.

Financial Value of Brazil Nut Thefts

In Pando, reported volumes of Brazil nut thefts were substantial (Table 3-3), comprising 22% of the total combined harvest in 2006 and 2007. This annual loss, which averaged US$719 (range $11-$5750), is considerable given that mean annual combined subsistence and market income per household in Pando at this time was US$5394 (SD±$4764); mean income loss was 13%. Also, in Pando, 69 kg of nuts is equivalent to a day's labor (paid upon sale of the nuts), so the estimated mean theft of 1498 kg per year represents the loss of approximately 22 days of household labor. In Acre, with minimal reported thefts and proportionately less income from Brazil nuts, financial consequences of thefts were far less important.

Quantitative Explanations of Brazil Nut Thefts

Results of the stepwise generalized linear model showed that access variables were the most important quantitative determinants of Brazil nut theft (Table 3-4). Households with nut stands farther away from the home tended to experience increased theft of nuts ($p<0.001$), as did households in communities further from markets ($p=0.001$). While there may have been a slight tendency ($p=0.132$) for households with greater income derived from Brazil nuts to be more vulnerable to theft, total landholding ($p=0.311$), Brazil nut mapping ($p=0.524$), and river versus road access ($p=0.602$) were not significant in explaining incidence of nut theft.

Quantitative Implications of Theft on Brazil Nut Harvest Regimes

Brazil nut harvest regimes were distinctly different in Pando and Acre. Harvest began much earlier and lasted much longer in Pando than in Acre (Figure 3-7). The year x group analysis to compare harvest and management patterns across countries and levels of theft showed a significant difference between both harvest start date and duration of harvest in Pando versus Acre ($p<0.001$), as well as quantity of nuts collected ($p=0.007$). No country-level differences were detected within Bolivia, however, when comparing households that directly experienced theft with those that did not (Table 3-5).

Also, harvesters reported the use of three different collection methods: (1) collect as many fruits as possible in one day, breaking them open for immediate transport of nuts from the forest; (2) collect and group fruits from one trail into piles, leaving them in the forest for one to several days and then returning to open them; or, (3) over the course of several days or weeks, collect and group all fruits from one's landholding and then return to open them later. Notably, 96% of Bolivian collectors, whether they experienced theft or not, gathered, opened and transported nuts in the same day, whereas Brazilian producers engaged in a variety of collection methods that did not depend on rapid transport of nuts out of the forest (Figure 3-8). Most Bolivian producers indicated threat of theft as the main reason they transported nuts out of the forest early in the season and as quickly as possible.

With the exception of the collection practices described above, no correlations were found between incidence of theft and implementation of any other specific management practices (e.g., protecting seedlings from fire, vine cutting) in Pando and Acre. This suggests that despite threat of theft, people felt enough proprietorship over their Brazil nut stands to manage for future fruit production and tree growth.

Resolution of Thefts

Brazil nut thefts were generally unresolved, meaning victims of thefts never received compensation for their losses. In Pando, only 17% of the 76 cases of theft in 2006 and 6% of 52 cases in 2007 were resolved. Of the 11 cases reported in Brazil, in 2006 and 2007 combined, only two were resolved. Resolution usually involved discussions between the two conflicting parties, with full or partial success in the return of stolen nuts. In some cases, community officials mediated the disputes. In one extreme case in Pando, where workers of a former private estate owner stole an estimated 4600 kg from a newly-titled community, a municipal official helped resolve the issue. The officer attended a community meeting, and exercising his authority, ensured that the money from the stolen Brazil nuts was returned and re-distributed to the whole community.

Community Perceptions of Participatory Mapping in Pando

Among producers who mapped their Brazil nut stands with local non-governmental organizations, most of those interviewed perceived mapping as moderately to highly beneficial (76%, n=45). The main perceived benefit was new knowledge of the stands (35%; i.e. number of trees, limits), followed by perceived reduction in theft (29%), and increased efficiency of nut collection because trails and trees were more clearly identified (12%; Figure 3-9). Twenty percent felt that mapping had no effect on securing tree tenure or reducing Brazil nut thefts, and only a few producers thought their mapping experience was negative (4%). Common negative perceptions that emerged, even among those who generally categorized the process as beneficial or neutral, included the idea that newly cleaned and more visible trails from the mapping process made it easier for hired collectors, generally from outside the community, to enter into Brazil nut stands to steal nuts, actually increasing the incidence of thefts as opposed to decreasing it. There was also criticism of the use of nails to secure numerical identification markers into trees; many producers felt this reduced fruit production. Finally, producers who had customary rights to more trees and/or forest feared that by making their relative wealth transparent throughout the community, they risked losing a portion of their area to those with less, if property rights were to be made more equitable.

Discussion

We found a much greater incidence of reported Brazil nut thefts in Pando, Bolivia, than in the adjacent state of Acre, Brazil. Whereas it is difficult to confirm causality, distinct historical events and policy changes that led to different country and harvest contexts, combined with the results of our quantitative analyses, suggest that two main differences may explain the variation. First, there was a clear contrast in the timing and process of formally recognizing property rights of rural communities in Acre and Pando. Second, different settlement patterns and degrees of economic dependence on Brazil nuts may have either discouraged or inadvertently encouraged nut thefts in the forest, as supported by our quantitative results. As a result, both threat of theft and economic dependence on Brazil nuts have important implications for management and conservation of Brazil nut rich forests in Western Amazonia.

Comparative Timing and Process of Property Rights Formalization

Whereas Acre and Pando have similar forest ecosystems and extractive histories, the differing outcomes of land tenure reforms in the two places are based on when and how property rights were devolved to local communities. A clear distinction has been made between top-down decentralization and bottom-up approaches that are motivated by social movements and local governments (Larson et al., 2007) with “demand from below” considered an important component of effective decentralization measures (Larson and Soto, 2008). In Acre, the Extractive Reserve model was a response to a bottom-up, successful political struggle by rubber tappers to secure property rights. As a result, customary tenure of dispersed household settlements throughout the forest was recognized when land rights were formally devolved. The inner boundaries of individual landholdings continued to be as well defined among extractivists as they were during the rubber era. The outer boundary of the Chico Mendes Extractive Reserve was relatively undisputed when the reserve was created, because claims contested by large landholders were mostly settled by the federal government and heavily regulated by the Brazilian environmental protection agency (C.V. Gomes, pers. comm.). At the time of this field research (2005–2007), residents of the Reserve had more than 15 years to adjust to the property rights supported by reserve creation. Reserve co-management with the Brazilian Government also helped secure their rights to land and resources. Both bottom-up demand for land reform from the social movement and the relative longevity of the Extractive Reserve are key to relatively secure land tenure within the Reserve today.

In contrast to the well-established Chico Mendes Extractive Reserve in Acre, communities in Pando only recently emerged from a struggle with private estate owners to have their customary property rights recognized by the government. Additionally, this formalization of rights was handed down from the state in older communities that had managed their Brazil nut groves communally for many years via internal norms and rules. In many cases, communal titles granted by the government were incongruent with traditional boundaries of the communities' seasonal forest use (Cronkleton et al., 2008), and maps presented to communities lacked geographic features that were familiar to residents, causing boundary problems to go unnoticed (Cronkleton et al., 2007). Our data showed the greatest proportion of thefts in Pando was presumed to be by members of the same community. Throughout Pando, such intra-community conflicts occurred as the titling process created the expectation that the government would rearrange internal resource access so that everyone could have a 500 ha plot, undercutting the traditional tree tenure system. Also, in newly-formed communities that only recently had land rights devolved from a large landholder, rights to specific Brazil nut trees were ill-defined among residents. Additionally, there was often abrupt incorporation of landless people into communities to access land and municipal services; these newcomers were probably unaware of customary management systems. In sum, the more recent, top-down process of formalizing communal tenure in Pando may have resulted in greater property rights insecurity.

Settlement Patterns and Resource Dependence Influence Theft

The distinct spatial distribution of forest-dwelling communities in Acre versus Pando contributed to observed differences in Brazil nut thefts. This finding was supported by our quantitative result that distance of household to Brazil nut stand most strongly explained theft. In Acre, through creation of the Chico Mendes Extractive Reserve, households maintained their traditional dispersed spatial distribution throughout the forest, allowing them close access to and daily interactions with their forested landholdings (Allegretti, 1990). These nut collectors walk their properties to hunt, tap rubber, work their agricultural fields, and travel to neighboring households. They constantly monitor their land and resources, dealing with disputes quickly. In Pando, in contrast, the 1994 Popular Participation Law encouraged the concentration of rural families in settlements to access municipal government education, health, water, and electricity services. This policy had the unintended result of removing families from day-to-day monitoring of their forest resources. Those allotted harvest areas far from village centers experienced more nut thefts, likely by members of neighboring communities and migrant workers. In Pando, disputes might only manifest themselves during the Brazil nut harvest period, which contrasts markedly with the year-round patrols of Acrean extractivists of their forested landholdings.

Additionally, households in communities farther from markets were more vulnerable to theft. This result may be due to a combination of three factors: (1) weak enforcement of local rights by government agencies may be exaggerated in communities distant from main markets where these organizations are based; (2) the most remote, riverine community in the Pando sample had the most internal conflicts, due to recent *de facto* devolution of rights to community members from the resident estate owner; and (3) due to more infrastructure in Acre, sampled Brazilian communities, where there was less reported nut theft overall, were closer to markets than those sampled in Pando.

In addition to differences in spatial settlement patterns, higher relative dependence on Brazil nuts in Pando (versus Acre) may also have influenced theft of this high-value resource. Economic dependence on Brazil nuts was one of the main quantitative differences observed between Pando and Acre. Due to more livelihood options in Acre, Brazil nuts were relatively less important economically, and considered just one of many seasonal income and subsistence activities. Although we found only weak statistical evidence that increased income from Brazil nuts explained theft, the relatively high value of this one product in Pando is undeniable. Indeed, when a dramatic rise in nut prices in 2005 occurred, violent conflicts ensued over Brazil nuts that resulted in deaths of several people in Pando (El Deber, 2005); no such response occurred in neighboring Acre.

Implications of Theft Threat and Economic Dependence on Brazil Nut Harvest and Management

The difference in threat of Brazil nut theft seemed to be reflected in the use of different harvest practices in Pando and Acre. The low incidence of nut thefts in the Chico Mendes Extractive Reserve in Acre allows harvesters to be flexible in their collection method. Acrean harvesters typically are less concerned with potential theft of nuts, and thus begin their harvest after most fruits have fallen to the ground. Harvesting later in the fruit-fall season allows them to concentrate their efforts and collect all nuts within a few weeks. They then transport nuts out of the forest all at once using draft animals, which overall is an easier and more efficient practice. In contrast, harvesters in Pando gather, open, and transport nuts from a subset of their trees in one day, and then repeat this process throughout their stand until all trees have been visited. They are also compelled to collect nuts early in the season, which is a dangerous and sometimes fatal practice as the heavy fruits are still falling from trees up to 50 m tall. This collection method is also relatively inefficient. Nuts must be carried on the harvesters' shoulders, and then often by motorcycle to a storage area or temporary hiding place. During our field research, they consistently reported that these procedures diminished the possibility that their gathered fruits could be stolen. Although our data showed no differences in harvest methods between households that did or did not experience thefts, we conclude that the general climate of resource insecurity in Bolivia forces all harvesters to manage their stands as if thefts could occur at any time.

The extended Brazil nut harvest in Pando can also be attributed to rural households' heavy economic dependence on this one product; they need all the cash they can get from their nut stands. Two ecological studies that measured Brazil nut harvest intensity by humans in Acre and Pando, respectively, support this difference in economic dependence. Wadt et al. (2008) reported nut collection intensities of 45% and 71% of fallen fruits harvested at two sites in the Chico Mendes Extractive Reserve in Acre, which is much lower than the estimated 93% collection intensity reported at sites in Pando by Zuidema and Boot (2002). Producers in Pando visit the same trees many times over the harvest season because fruit fall naturally occurs over a period of weeks to months. Although speculative, the Brazilian harvest method may allow a longer period for the scatterhoarding agouti to both consume and disperse nuts, potentially influencing long-term sustainability of the overall Brazil nut production system. Also, nut prices are generally higher later in the season as middlemen and companies attempt to fill their yearly quotas. This dependence on Brazil nuts in Pando is likely not only a reason for nut thefts, but also enhances the negative effects of thefts on households as their vulnerability increases with economic dependence on this one product.

Ecological and economic trade-offs exist between Brazil nut harvest systems in Pando and Acre. Although extending the nut harvest season in Pando to collect as many fallen fruits as possible may not promote optimal regeneration over the long term, clearing fallows for pasture, as observed in Acre, has its own implications, since these fallows provide favorable regeneration sites for *B. excelsa* (Cotta et al. 2008). Different harvest systems in Acre and Pando also have market consequences. A main impediment to international Brazil nut sales is contamination by aflatoxins, which are both toxic and carcinogenic. When European importers raised their quality standards for Brazil nuts in 1998, access to the European market was imperiled (Newing and Harrop, 2000). Nuts transported out of the forest just after fruit fall, as in Bolivia, are less likely to be contaminated because aflatoxins are caused by the fungus *Aspergillus*, which thrives under hot and humid conditions (Hudler, 1998). In Acre, fruits that fall in December and are not collected until February or March, appear to have higher risk of *Aspergillus* contamination (Souza Álvares et al., 2009). Organic and Fair Trade certification of Brazil nuts, through the sale of an aflatoxin-free product and affiliation with cooperatives, have been important in stabilizing and even increasing the price producers receive for nuts and encouraging better management throughout the Western Amazon (See Chapter 4). Interestingly, collection earlier in the season is now being promoted as a "best management practice" in Acre as one step towards attaining certification, which may alter harvest regimes.

Participatory Mapping to Promote Property Rights Security

Participatory mapping of Brazil nut stands may be a good way to help promote local property rights security. In one case in Pando, community members worked together to determine agreed upon customary ownership of trees and trail networks, which allowed mediation over internal resource disputes to begin during the mapping process itself (Figure 3-10). Such negotiation of customary rights can be considered akin to that undertaken by harvesters in Acre on a daily basis as their day-to-day relationship with the forest and with each other in the forest setting is much stronger. Final map products allowed communities to visualize “hot spots” of conflict as the proprietors of individual trees and trails were clearly identified. In one case, when a Bolivian producer realized that most of his Brazil nut stand fell within the bounds of another community, he became an official member of the neighboring community to resolve this issue. In another situation, new community lands were leveraged based on traditional collection areas delineated through the mapping process.

Producers’ perceptions of distinct mapping experiences can help guide regional expansion and adaptation of mapping initiatives. For instance, although the mapping processes in Pando were considered beneficial overall, a common negative perception was that nailing of metal identification markers in adult Brazil nut trees prior to 2006 was to blame for the low fruit production and even the “drying up” and death of some; in reality, there was a natural decrease in Brazil nut production region-wide in the harvest season of 2006 (Kainer et al., 2007) that became even more pronounced in 2007. Because natural production rose to extremely high levels in 2008 (L.H.O. Wadt, pers. comm.), this misconception may be debunked. Nevertheless, such misconceptions must be addressed for mapping to be effective in helping bridge the gap between formal and customary tenure.

Conclusion

Several important lessons can be learned from this comparative study in Western Amazonia. First, the outcome of land tenure reforms depends on the timing and process of property rights formalization in local communities. In Pando, as demand for clear property rights increased with rising prices of Brazil nuts, granting communal titles using a top-down approach sometimes had the unanticipated consequence of enhancing property rights insecurity in any particular community. Bolivian government agencies were unable or unwilling to resolve tenure conflicts that arose from competing interests either within communities or between communities and other, more powerful actors (Cronkleton et al., 2007). In the case of Pando, such insecurity appeared to take the form of a high incidence of nut theft. In contrast, in Acre, land conflicts and resource thefts are currently rare among extractive communities. The external Extractive Reserve boundary was strongly enforced and customary internal boundaries left flexible to accommodate traditional forest use. These Acrean harvesters were considered co-managers of land and resources with the Brazilian federal government as they were central to the bottom-up reforms that resulted in creation of the Extractive Reserve system. That said, property rights security does not necessarily translate to forest conservation as producers in Acre exercise their rights to convert small portions of their forested landholdings to pasture. Second, different settlement patterns and market forces appear to have either discouraged or inadvertently encouraged nut thefts in forests. In the case of Pando, people are much less connected with their forested landholdings except during the nut harvest. This lack of physical connection combined with a product that is in high demand may increase the likelihood of conflictive situations.

The threat of Brazil nut theft in Pando, along with high economic dependence on this one product, locks collectors into a management regime that is clearly dangerous and perhaps detrimental to long-term viability of future Brazil nut tree populations. Additionally, given the relatively high proportion of rural household income derived from Brazil nuts in Pando, forest-dwelling communities are more vulnerable to the negative effects of a stolen harvest. Collectors unable to glean sufficient income from nuts are likely to turn to other land uses, which may involve converting Brazil nut-rich forests to agriculture or pasture. Nonetheless, earlier collection already practiced in Pando may have the benefit of allowing access to certified markets, as seen in a recent push in Acre for producers to adopt such practice. As further research explores the effects of collection on Brazil nut regeneration and aflatoxin contamination, property rights security is an important base from which communities can choose whether or not to incorporate such recommended practices in their harvest and management regimes. Participatory mapping is a potentially important tool for communities in dealing with tenure conflict, visualizing traditional forest use systems, and leveraging integration of traditional practices into formal land titling processes and decision-making. This activity may allow governmental and non-governmental organizations to play an important supporting role in smoothing property rights transitions. As trends continue to designate forests for legal use by local communities, it is essential to understand and address resource conflicts, their causes and potential solutions to promote long-term management of the world's tropical forests.

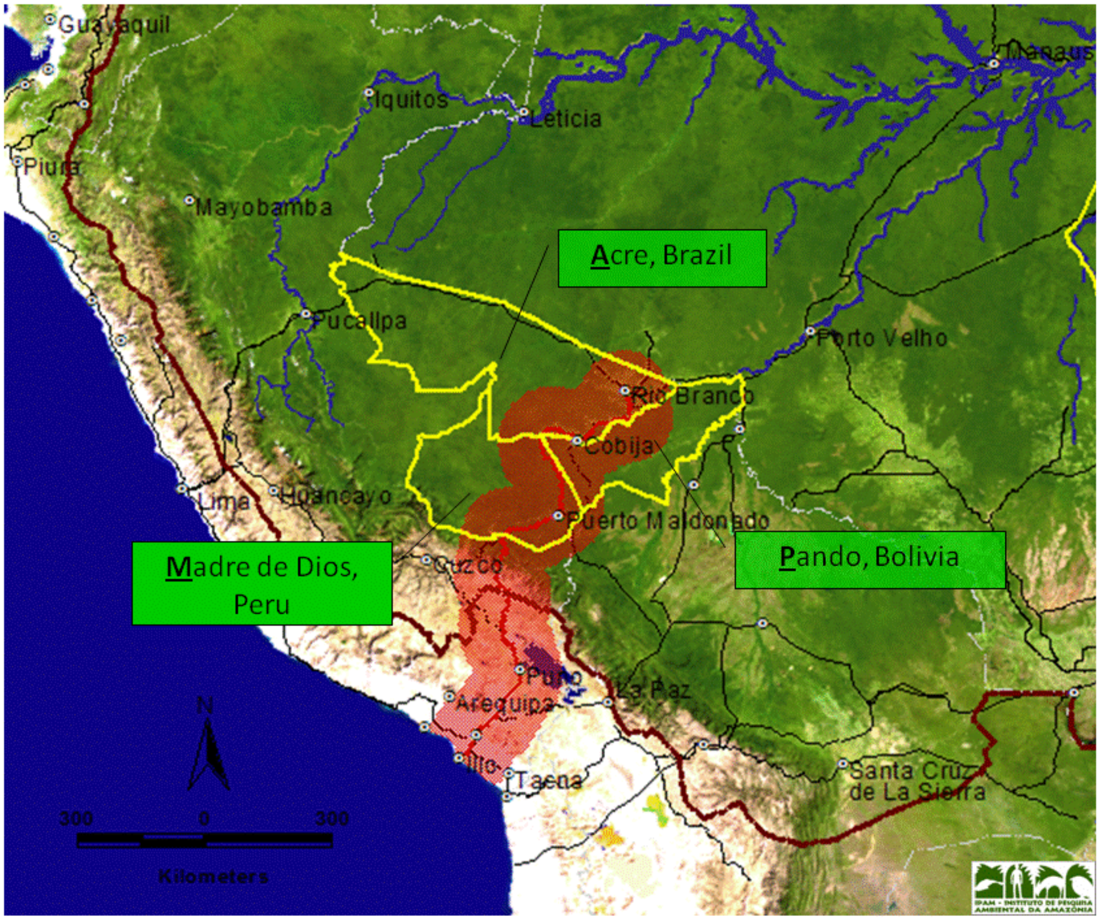


Figure 3-1. Map of Madre de Dios, Peru, Acre, Brazil and Pando, Bolivia (MAP region) with Interoceanic Highway and 100 m buffer in red.

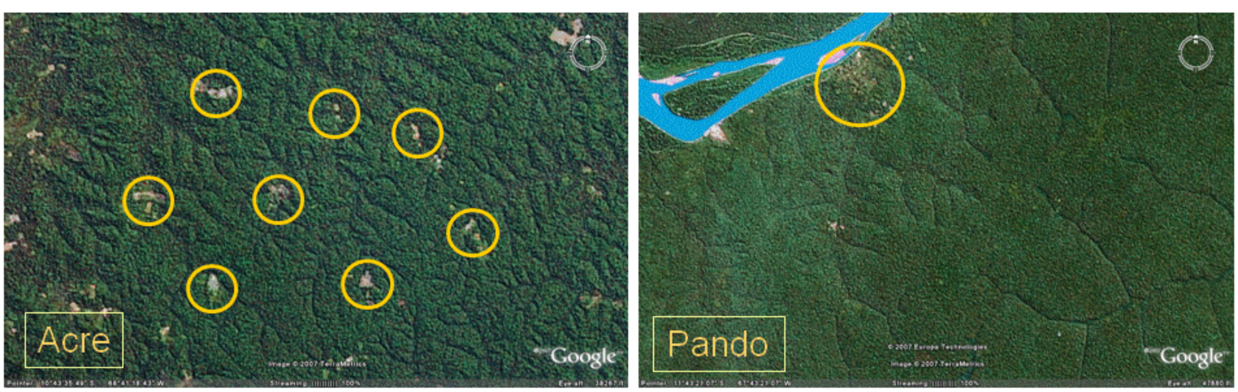


Figure 3-2. Google Earth images from July 2007 of forest dwelling communities in Acre, Brazil (left) and Pando, Bolivia (right). Note contrast between dispersed pattern of household clearings in Acre's Chico Mendes Extractive Reserve (households circled) and a concentrated community settlement in Pando (community circled).

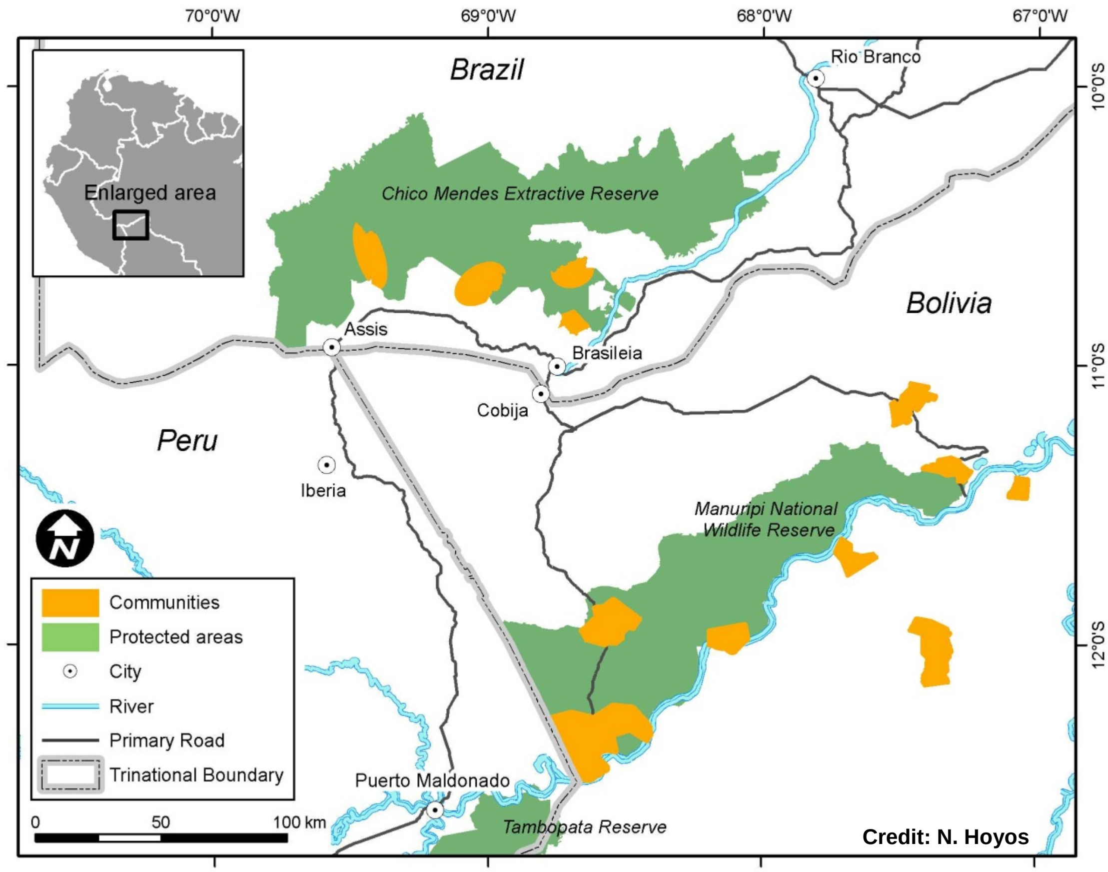


Figure 3-3. Map of communities sampled in Acre and Pando.

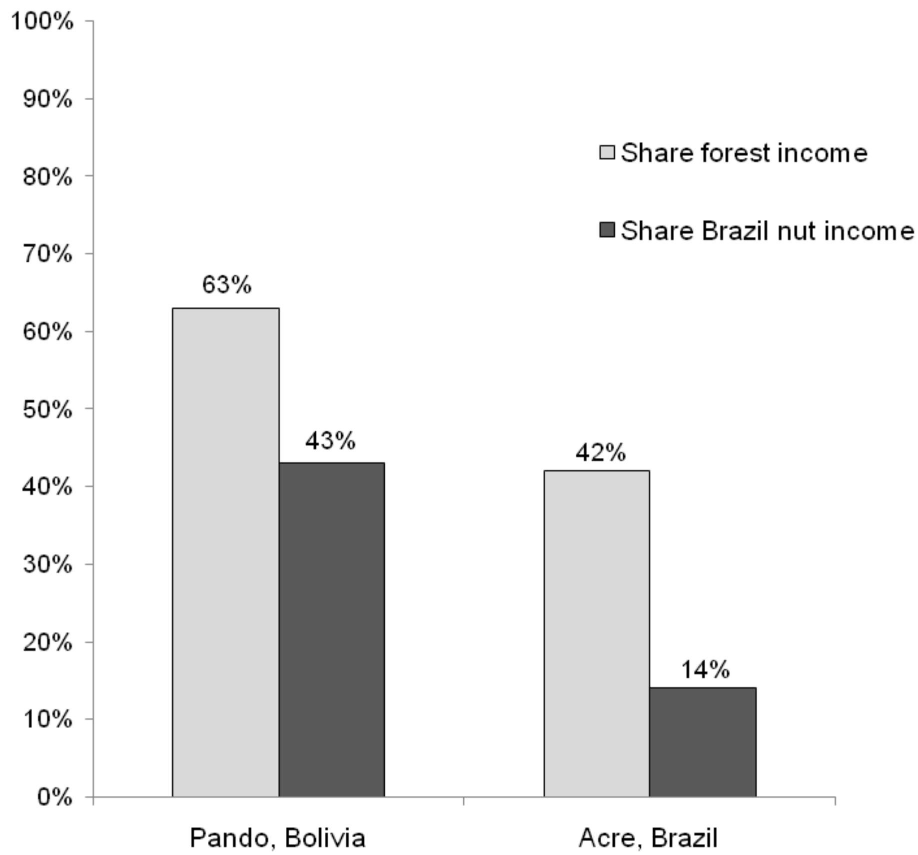


Figure 3-4. Share of total household income derived from the forest (%) and from Brazil nuts alone (%). Income includes both cash and subsistence values. Values reflect households in Pando, Bolivia (June 2006-June 2007) and Acre, Brazil (August 2006-August 2007).

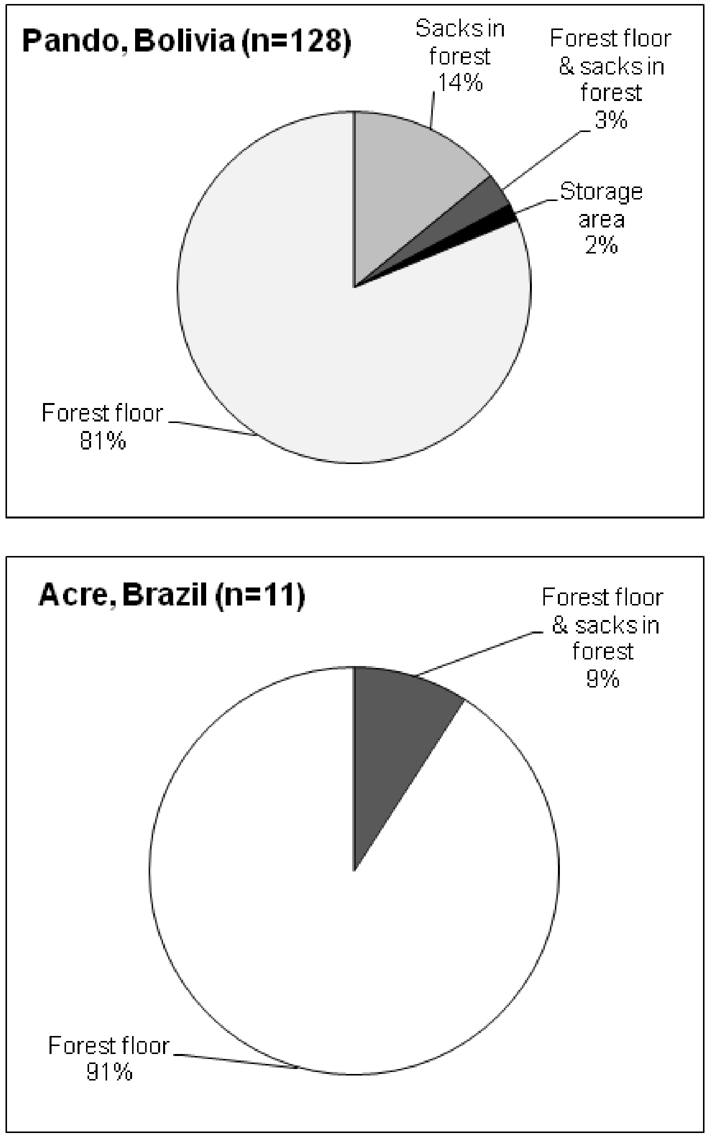
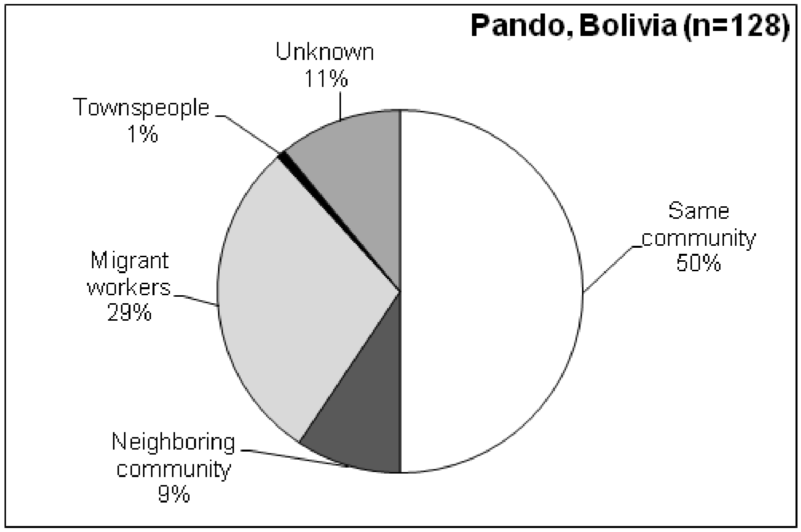


Figure 3-5. Where Brazil nuts were reportedly stolen (% of total incidents). Sample includes only those households that experienced Brazil nut thefts in 2006 and 2007.



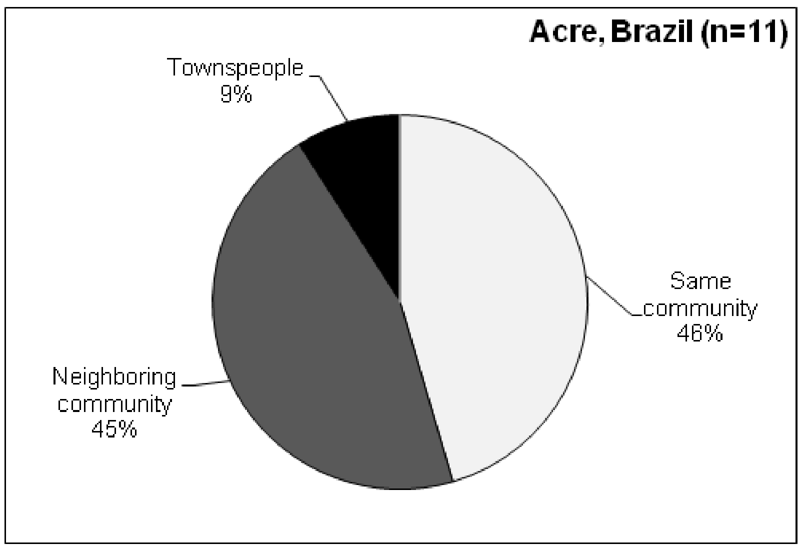


Figure 3-6. Suspected perpetrators of Brazil nut thefts in 2006 and 2007 (% of total incidents). Sample includes only those households that experienced thefts.

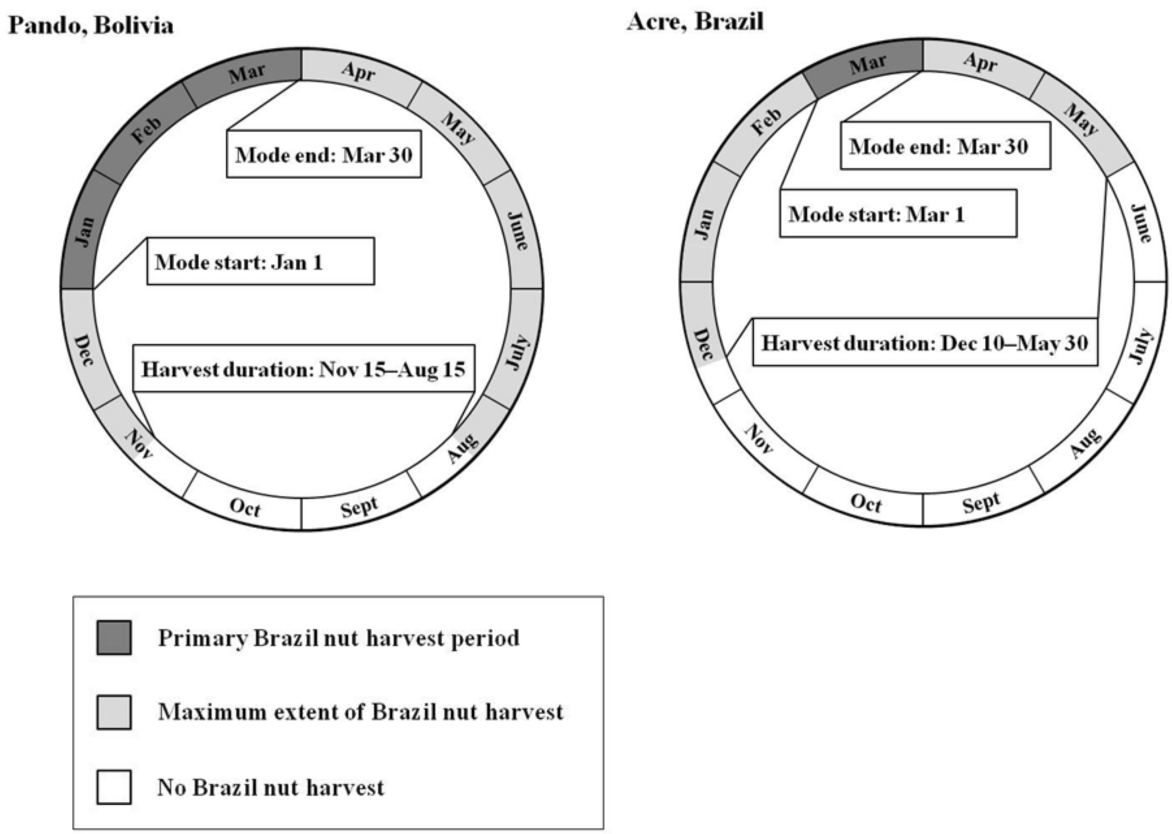


Figure 3-7. Modal start and end dates of Brazil nut harvest, and harvest duration, in Pando and Acre in 2006 and 2007. Primary harvest period (dark gray) is when most producers report the beginning and end of harvest. Extended harvest period (light gray) is indicated by earliest and latest harvest dates.

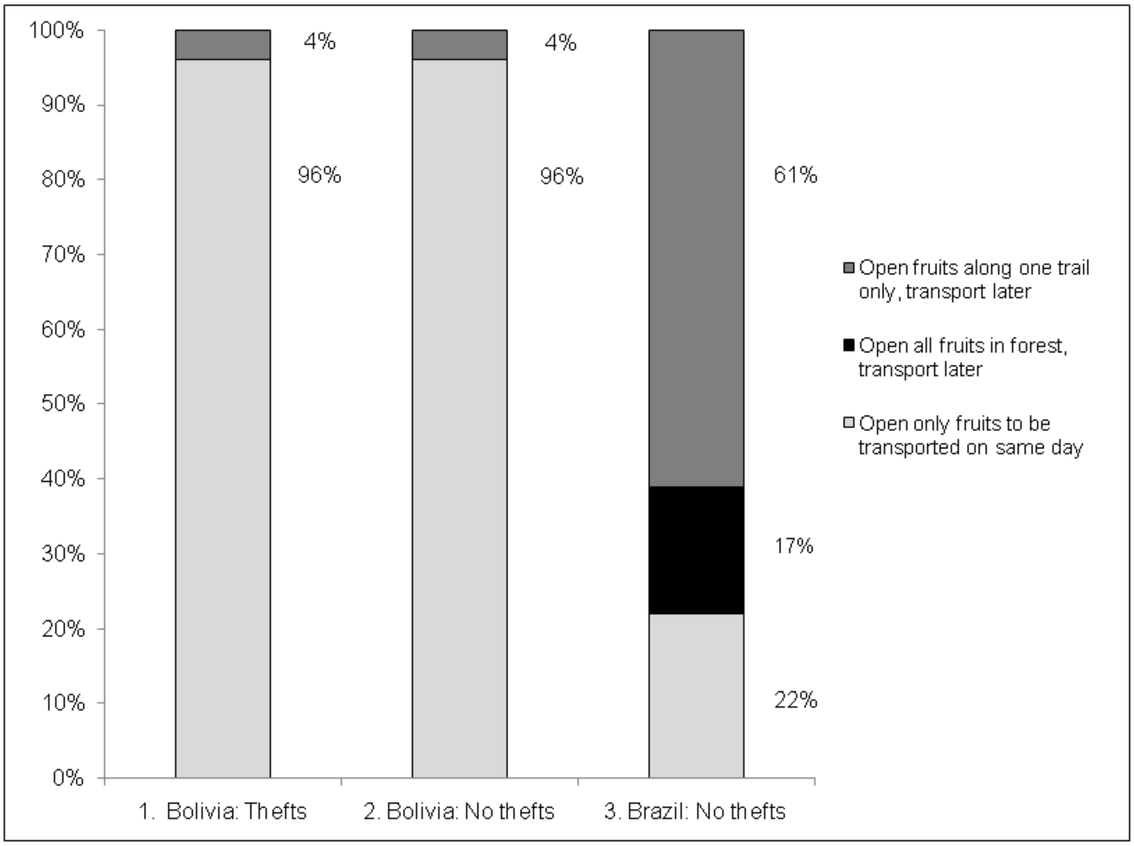


Figure 3-8. Percentage of households using specific Brazil nut harvest methods among 3 groups: (1) Bolivia without nut thefts; (2) Bolivia with nut thefts; and (3) Brazil without nut thefts. In every case the proportion of households implementing these methods in Brazil was statistically different when compared to proportion of households in Bolivia ($p<0.001$). There were no differences observed in harvest methods employed by the Bolivian groups (with or without Brazil nut thefts).

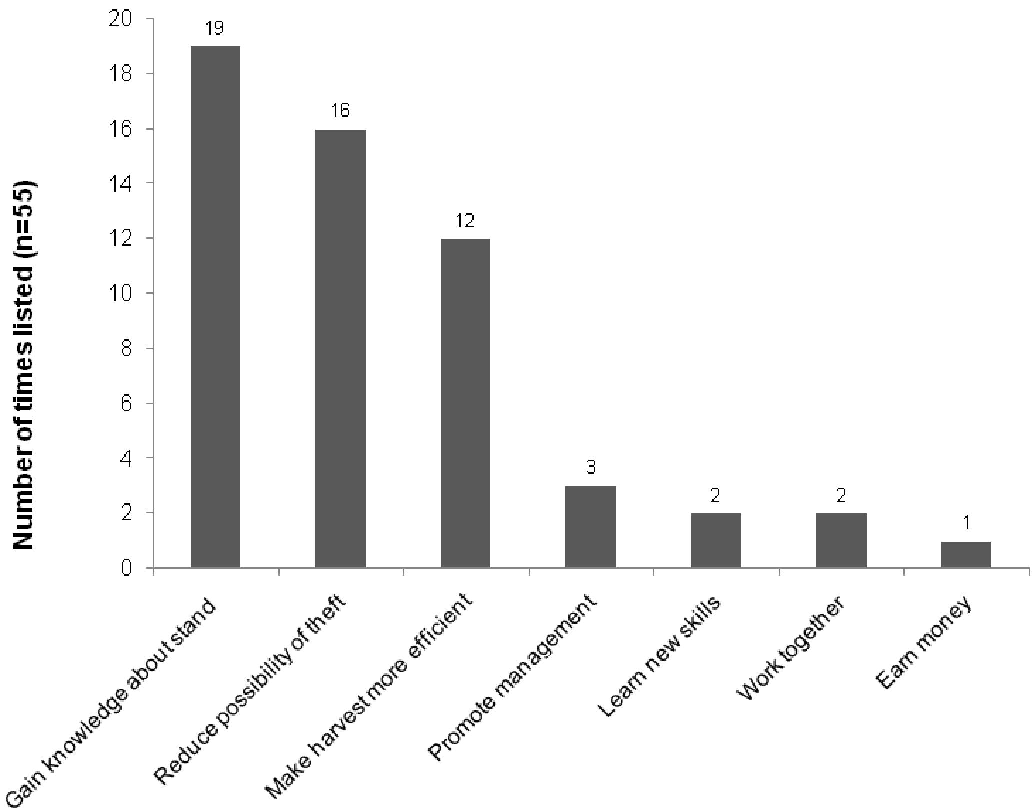


Figure 3-9. Free-listed benefits of participatory mapping in Pando, Bolivia (45 producers; 55 benefits given).

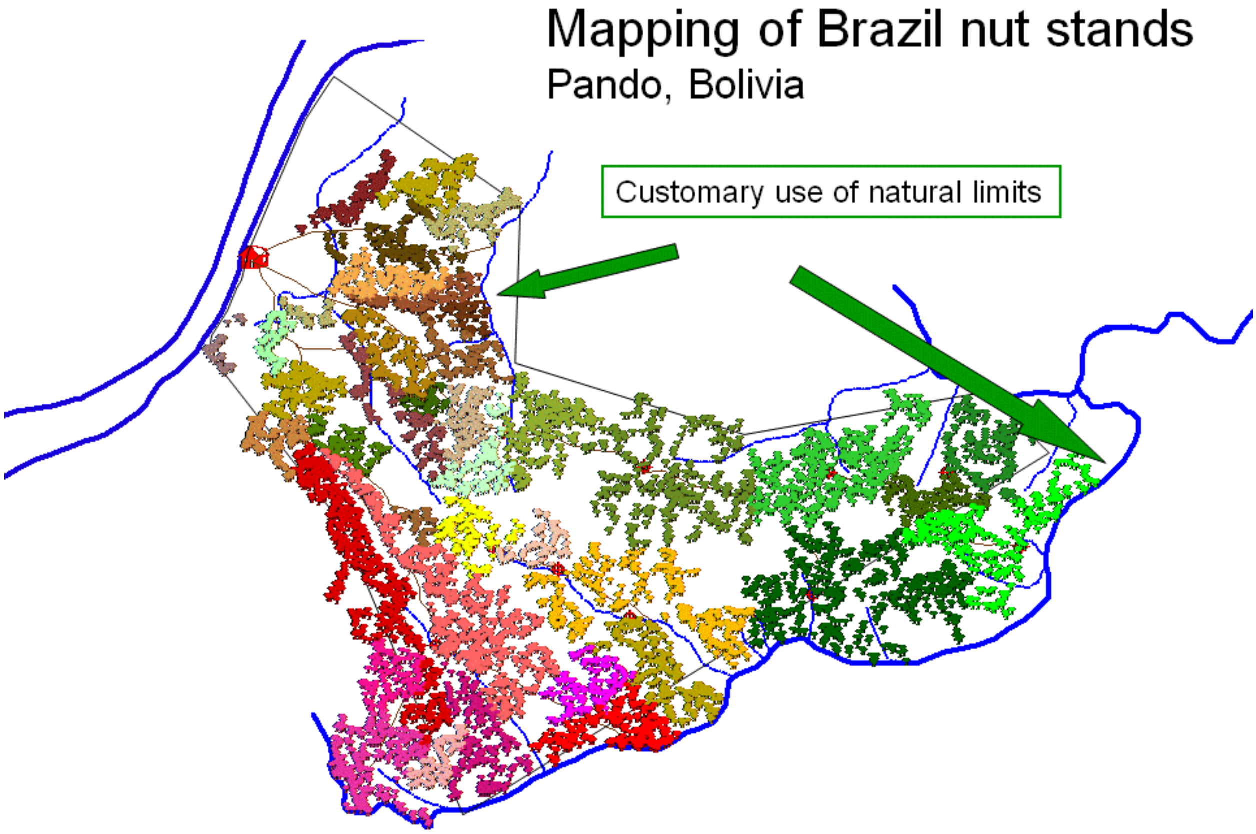


Figure 3-10. Example of a participatory map of individual Brazil nut trees in Pando. Note that official polygons are often incongruent with traditional use areas. Each color represents the Brazil nut stand of an individual household.. *Courtesy of Cronkleton et al. 2008.*

Table 3-1. Important historical events and relevant forest policy changes in Acre, Brazil, and Pando Bolivia. These events continue to affect property rights, the diversity of forest products currently exploited, and ultimately, the frequency of Brazil nut thefts.

Acre, Brazil	Pando, Bolivia
1876-1910: Rubber boom (migration to region)	
1903: Acre ceded from Bolivia to Brazil	1870s: Nicolas Suarez founds Suarez Hermanos rubber company
1910-1940: Decline in rubber economy; land-use diversification	
Former rubber estates diversify production to include Brazil nut harvesting and agriculture	1931-35: Suarez Co. introduces a Brazil nut shelling company by a mostly female labor force
1940-1945: Renewed demand for rubber	
1942: Brazil-U.S. Washington Accords to recruit Brazilian rubber tappers to Amazon	Suarez and Hermanos control 80% of rubber production in Brazil-Bolivia border
1950-90s: Brazil nuts replace rubber as main forest product	
1986: Removal of Brazilian subsidy for rubber that had been extended to Bolivian producers	
1990s: New policies for extractivist communities	
1990: Extractive Reserves	1996: Forestry Law and Agrarian Reform Law

Table 3-2. Descriptive statistics of household characteristics, land tenure, access and income in Pando and Acre.

	Pando, Bolivia		Acre, Brazil		
Variable	N	Mean (SD)	N	Mean (SD)	p-value
Household characteristics					
Size (# people)	125	6.0 (2.8)	51	5.4 (2.9)	0.159
Land area (ha)	125	587 (470)	51	638 (499)	0.519
Head of household born in community	125	0.20 (0.40)	51	0.20 (0.40)	0.670
Time lived in community (yrs)	125	17 (15)	51	15 (11)	0.238
Schooling (yrs)	125	3.5 (2.3)	51	2.2 (1.4)	<0.001
Land tenure					
Protected area	125	0.50 (0.50)	51	1.00 (0.00)	<0.001
Perceived land tenure security (Rank 1-3; 3 most secure)	113	2.27 (0.85)	38	2.26 (0.76)	0.943
Mapped Brazil nut stand	125	0.42 (0.50)	51	0.39 (0.49)	0.772
Access					
Road access	125	0.65 (0.48)	51	0.78 (0.42)	0.078
Distance to market from village center (hrs)	125	9.5 (7.1)	51	2.4 (1.4)	<0.001
Distance to Brazil nut stand from household (min)	124	81 (93)	51	6 (4)	<0.001
Household income 2006-2007					
Total income (USD)	107	5394 (4764)	47	5460 (2759)	0.930
Forest-based income (USD)	107	3423 (3604)	47	2319 (1295)	0.043
Brazil nut income (USD)	107	2304 (1837)	47	765 (973)	<0.001

Table 3-3. Total volume and value of Brazil nuts reported stolen in 2006 and 2007 combined. Values in USD based on mean price/year/paid to collectors by middlemen during the 2006 ($0.46/kg in Pando; $0.40/kg in Acre) and 2007 ($0.50/kg in Pando; $0.44/kg in Acre) harvests.

	Pando, Bolivia			Acre, Brazil		
Variable	N	Mean (SD)	Range	N	Mean (SD)	Range
Amount stolen (kg)	104	1498 (1810)	23-11500	9	216 (158)	58-483
Percent of harvest (%)	104	22 (19)	0.82-100	9	10 (7)	0.5-23
Value (USD)	104	719 (875)	11-5750	9	90 (67)	23-202

Table 3-4. Results of a stepwise logistic regression to identify the most important measured variables that explained incidence of Brazil nut thefts in 2006 and 2007 in Pando and Acre (n=235). No significant interactions between variables were detected.

Variable	Estimate	Wald	P-value	Odds Ratio
Distance to Brazil nut stand from household (min)	0.001	12.371	>0.001	1.001
Distance to market from village center (hrs)	0.023	10.981	0.001	1.023
Income from Brazil nuts (USD)	0.00002	2.274	0.132	1.000
Total landholding area (ha)	0.00006	1.027	0.311	1.000
Mapped Brazil nut stand	0.035	0.406	0.524	-
Road access	-0.48	0.272	0.602	-

Table 3-5. Mean and SE of Brazil nut harvest start date (expressed in Julian days where 1=November 8th), quantity of Brazil nuts collected (kg) and harvest length (days) in three Brazil nut harvest contexts in Bolivia and Brazil in 2006 and 2007.

Variable	1. Bolivia: Thefts	2. Bolivia: No thefts	3. Brazil: No thefts
Harvest start date	60.53 (1.98)	56.37 (2.08)	86.44 (2.48)***
Quantity	163.12 (13.16)	153.53 (13.08)	114.338 (12.06)**
Harvest duration	94.74 (3.66)	91.92 (3.83)	43.25 (4.43)***

Notes: Group 3 differed from Groups 1 and 2 for all variables: ***p <.001; **p<.01. Year x group interactions were not significant.

CHAPTER 4
DOES CERTIFICATION LEAD TO BETTER MANAGEMENT AND IMPROVED INCOMES? A COMPARATIVE ANALYSIS OF THREE CERTIFICATION SCHEMES APPLIED TO BRAZIL NUTS IN WESTERN AMAZONIA

Environmental, Social and Economic Certification of Forest Products

In recent years, a variety of certification and labeling schemes have emerged to address issues of environmental degradation, social injustice, and consumer health. Certification is a market-based tool used to improve the quality, safety, or management of certain products against a set of defined standards through third-party auditing (Bass et al., 2001). The innovation of certification is the use of the market to transform the market (Taylor, 2005a). On one end of the commodity chain, there is a consumer who is willing to pay more for a product that is labeled as environmentally-friendly or socially-just, and on the other, there is a producer who seeks price premiums and better market access from use of superior practices (Bass et al., 2001). Certification has also been conceptualized as a regulatory mechanism that alters the rules of market governance (Taylor, 2005b), a signal mechanism that illuminates organizational characteristics and practices, and a learning mechanism that promotes knowledge transfer and experiential learning (Overdevest and Rickenbach, 2006).

Certification in the forestry sector is considered the most advanced of the environmental certification schemes (Auld et al., 2008). A review of forest certification to date shows that large-sized operations on public or industrial lands, production of high-value goods, exports to Europe and North America, support by producer associations, NGO pressure, and government support positively influence producers' decisions to adopt certification (Auld et al., 2008). While forest certification has traditionally focused on timber, certification of non-timber forest products (NTFPs) is viewed as one way to bolster livelihood benefits of these products for rural communities and promote sustainable harvest over the long-term. According to Walter (2003), there are four main certification systems relevant to NTFPs: (1) Organic certification, which emphasizes agroecosystem health on the production end and consumer safety on the consumption end; (2) Product quality certification, which includes product consistency and safety standards; (3) Social certification, including Fair Trade, which promotes equal benefit sharing among NTFP producers and decent labor conditions; and (4) Forest management certification, which focuses mostly on the ecological aspects of NTFP harvest and management, but also includes social and economic standards;

While the different certification schemes have distinct goals, there is harmony among them. Organic and product quality certifications are best suited for food- and pharmaceutical-based NTFPs, which have the additional criteria of certification for food safety and quality. Fair Trade certification is socially-oriented in seeking to encourage and recognize operations that ensure better work conditions for small producers. Forest management certification for NTFPs promotes better management and forest conservation, and provides greater localized benefits for community-based products (Shanley et al., 2002). Combinations of these certification schemes may help promote environmental, social, and economic sustainability of NTFP management by communities.

This research compares the management and economic benefits of Brazil nut certification systems for communities in neighboring Pando, Bolivia, Acre, Brazil, and Madre de Dios, Peru. We focus on this Brazil nut-rich border region in Western Amazonia (Figure 4-1) because it is the current center of the Brazil nut economy, employing tens of thousands of families during the primary collection season (January–March; Bojanic, 2001). Because of Brazil nut's regional economic importance, Brazilian, Bolivian, and Peruvian legislation prohibit felling the trees. At the producer level, individual Brazil nut trees are considered key livelihood assets by forest dwellers in all three countries.

Our overall research question is: What are the environmental and economic benefits associated with different Brazil nut certification schemes? We address this question through research with certified and non-certified nut harvesters in the tri-national region of Bolivia, Brazil and Peru. In this context, certified participants are mostly organic and Fair Trade producers, with a small group in Peru having also attained FSC certification. Specific objectives of the research are: (1) to identify adherence to Brazil nut "best management practices" by producers in the three countries; (2) to analyze differences in management practices between certified producers and noncertified producers in each country; (3) to quantify the economic benefits associated with supplying or marketing certified nuts; and, (4) to explore producers' perceptions of the benefits and costs of Brazil nut certification. To our knowledge, this is the first study that compares organic, Fair Trade, and FSC certification for a given product using field-based data on the environmental and economic returns of certification.

Brazil Nut Ecology and Best Management Practices

Brazil nuts are collected primarily from mature forests, and the species' combined ecological and economic characteristics give it the potential to promote forest conservation and contribute to the livelihoods of rural communities. Brazil nut trees are long-lived emergents in regional upland forests and attain up to 3 m in diameter. Due to its very large size and dense distribution, this species provides important local and landscape-level ecological structural and functional roles (Zuidema, 2003). The large, woody fruits fall to the ground during the rainy season and hold approximately 25 seeds (here referred to as nuts) inside the hard pericarp. The scatterhoarding agouti (*Dasyprocta spp*.) plays an instrumental role in seed dispersal and burial as one of the few animals that can gnaw through the pericarp. To collect the nuts, people gather the heavy fruits in large piles, use machetes to break them open, and put the nuts in large sacks to carry them out of the forest. Although one study suggest that persistent harvest over decades may result in insufficient juvenile recruitment, populations in Western Amazonia appear to be viable over the medium-term under a range of harvest intensities (Zuidema and Boot, 2002; Wadt et al., 2008). Harvested nuts are a reliable seasonal contribution to local livelihoods, since there is little variability in fruit production at the population level across years (Kainer et al., 2007). The nuts have a relatively high value on local, national, and international markets, particularly since 2003 with increased demand and consequent higher prices.

Government and non-governmental organizations in Western Amazonia have outlined a series of “best management practices” to support Brazil nut production (Table 4-1). These practices are rooted in forestry legislation, certification standards, research on Brazil nut ecology and management, and producers’ practical knowledge. They can be categorized as: (1) pre-harvest practices, such as mapping adult trees and developing a management plan; (2) silvicultural practices, including those that promote regeneration (e.g. enrichment planting) and enhance fruit yield (e.g. vine cutting); and (3) harvest and post-harvest practices, such as nut drying, to improve quality. These practices have been disseminated in the regional extension literature (Wadt et al., 2005; Cardó, 2000) and promoted through Brazil nut cooperatives and at producers' meetings.

Diverse Brazil Nut Certification Systems with Distinct Goals

Brazil nut producers access certified markets largely through affiliation with local cooperatives or producers' associations that promote best management practices. While the primary nut certification option is a combination of organic and Fair Trade certification, FSC standards for Brazil nuts exist for all three countries, and we present one case of FSC certification in Madre de Dios (Table 4-2).

Organic and Product Quality Certification

Organic certification is focused on product quality for export to specialized markets in Europe and the United States. The International Federation of Organic Agriculture Movements (IFOAM) is the umbrella organization for organic certification with more than 750 member organizations throughout the world (IFOAM, 2009). Third-party organic certification began in the 1970s, and standards focus primarily on barring the use of agrochemicals and genetically-modified organisms (GMOs), along with the promotion of additional environmental criteria. Related to organic certification, the FAO/WHO Food Standards Program was created in 1962 to protect consumers from unhealthy foods. It works through the Codex Alimentarius Commission, which developed international codes for product quality (Soldán, 2003). In the case of Brazil nuts, organic certification by communities is achieved through regional adaptations of IFOAM standards. It is important to note that under current management and harvest regimes, all Brazil nuts meet organic standards in that they are collected from natural forests and not cultivated; the focus of organic certification is thus on product quality. The main requirement for organic certification is a clean and dry, aflatoxin-free, product. Aflatoxins are both a toxin and carcinogen, and caused by the fungus *Aspergillus* under hot and humid conditions (Hudler, 1998). They are attributed with causing liver disease in adults and stunted growth and delayed development in children (Abbas, 2005). Based on these health risks, the U.S. Food and Drug Administration set an action level of 20 Ppb for aflatoxins in Brazil nuts, at or above which they will take legal action to remove these products from the market (FDA, 2000). In 1998, the European Union decreased acceptable levels of aflatoxins in Brazil nuts to 4 Ppb (Newing and Harrop, 2000), and in 2003 banned Brazil nut imports from Brazil due to unacceptably high levels of these toxins. While this ban has since been lifted, European Union legislation requires that acceptable aflatoxin levels remain at < 4 Ppb. This legislation is currently under discussion, however, based on a recent study by the European Food Safety Authority (EFSA) that shows little effect on public health if aflatoxin levels were to increase to 10 Ppb (EFSA, 2009).

In Bolivia, the Bolivian Association of Organizations of Ecological Producers (AOPEB), a member organization of the IFOAM, was established in 1991. In 1995, AOPEB founded Bolicert, which is the local organization currently responsible for the inspection and certification of Bolivian Brazil nuts (Soldán, 2003). Of the many large processing plants in Bolivia, only three currently produce organically-certified Brazil nuts. One of these, Tahuamanu, also attained certification for Brazil nut quality (Soldán, 2003). This latter certificate is managed by the Bolivian Quality and Normalization Institute (IBNORCA), which reflects the norms of the FAO Codex Alimentarius. In Brazil, organic certification of Brazil nuts is attained through the Instituto Biodinâmico (IBD), also a member organization of IFOAM. In Peru, the Brazil nut company, Candela

Perú, attained organic certification in 2001 through the international Institute for Marketecology (IMO). By 2005, Fast Trade S.A., another Peruvian nut company, also attained organic status through IMO.

Organic certification is monitored by cooperative norms that require members to perform a set of harvest and post-harvest management practices. During harvest, producers are encouraged to remove the fruit placental tissue (locally known as *ombligo*) and damaged (cut or rotten) nuts, as these can contaminate the rest of the harvest. Immediately after harvest, producers are encouraged to transport nuts from the forest to storage units that meet the following specifications: covered, wooden structures built one meter off the ground where nuts avoid contact with potential contaminants, such as petroleum-based fuels, batteries, and live animals (Figure 4-2). Certified producers empty the nuts from sacks to dry in the storage units, stirring them several times a week to assure thorough drying. In some cases, collectors construct open air drying racks in addition to their storage units, which are also elevated off the ground to promote even faster drying. Local NGOs, government agencies, and the cooperatives themselves have financed construction of these structures for both individuals and groups, since a clean, dry product is the basic requirement of organic certification in the case of Brazil nuts.

Fair Trade Certification

Fair Trade is a socially-focused certification system that aims to promote economic development among disadvantaged producers. Fair Trade certification emerged from the Alternative Trade movement (ATO) in the 1970s, and since 1997, Fair Trade standards have been set by the Fairtrade Labelling Organization (FLO). These standards emphasize terms of sale that favor small producers through price premiums, safe working conditions, strong social organization, and more direct links between producers and markets (FLO, 2009). With Fair Trade, the buyer, and not the producer, pays the costs associated with certification (Taylor, 2005a). While Fair Trade certification mostly focuses on agricultural products, such as coffee, bananas, and cotton, there are examples of Fair Trade certification for NTFPs, including wild-collected honey, Brazil nuts, and cashews.

Fair Trade certification for Brazil nuts requires producers to be organized in cooperatives. The principal certified Brazil nut cooperatives in Pando are COINACAPA and ACERM. COINACAPA (Cooperativa Integral Agroextractivistas Campesinos de Pando) formed in 1998 as an offshoot of the oldest producers' cooperative in northern Bolivia, CAIC, which began in 1979 in the city of Riberalta. As of 2007, COINACAPA had 300 members, and by 2009 had 456 members from more than 40 communities. ACERM (Associación de Campesinos Extrativistas de la Reserva Manuripi) includes only harvesters from the nine communities within the Reserve's bounds. ACERM became accredited in 2005, and as of 2007 maintained its original 56 members. By 2009, this number had grown to more than 200 members. Both cooperatives receive extensive financial support from national and international foundations and non-governmental organizations. As of 2008, a newly-formed cooperative in Pando, ACEBA, had attained both organic and Fair Trade status (A. Chamas, pers. comm.).

In Acre, at the time of field research in 2007, CAPEB (Cooperativa Extrativista e Agropecuária de Produtores de Brasiléia e Epitaciolândia) was the leading Brazil nut cooperative for producers within the Chico Mendes Extractive Reserve with 130 members. From 2001 to 2004, CAPEB received extensive financial and technical support from a group of Brazilian governmental and non-governmental organizations to attain organic, Fair Trade, and FSC Brazil nut certification for its members. In 2005, CAPEB attained Fair Trade certification, but it is questionable whether or not they ever achieved organic certification, although the administrators informed their members that they were selling organically-certified nuts. By 2007, CAPEB was bankrupt apparently due to poor administration. The governmental and non-governmental resources are now being directed toward COOPERACRE, which is located in the capital city of Rio Branco with new hope for production of organically-certified and Fair Trade-certified Brazil nuts.

In Madre de Dios, the first certified Brazil nut cooperative was RONAP (Recolectores Orgánicos de la Nuez Amazónica del Perú), which is aligned with the large Brazil nut company, Candela Perú. RONAP accessed the organic nut market through Candela and attained Fair Trade certification in 2004. In 2007, RONAP had 62 members, which grew to 72 as of 2009. There were also several certified nut producers' associations in Madre de Dios, one of which, ASCART (Associación de Castañeros de la Reserva Tambopata), sold organic nuts through Fast Trade S.A. and attained Fair Trade status in 2005.

A relatively new initiative has emerged to connect certified nut producers in Pando, Acre, and Madre de Dios called the Tri-national Agroextractivist Cooperatives Association. The principal objective of the association is information exchange. Through meetings held 3-4 times per year, this group has had a measure of success in banding together to negotiate minimum prices with the large international buyer, Equal Exchange.

Forest Management Certification

Forest management certification for timber really began in 1993 through the independent, non-profit organization, the Forest Stewardship Council (FSC). While the FSC is still considered the gold standard in forest management certification (Butler and Laurence, 2008), other producer-based competitors have emerged in the United States and Europe (Auld et al., 2008), as well as in Indonesia and Malaysia where national certification schemes have been developed (Dennis et al., 2008).

In 1996, the FSC formed a NTFP working group. Mexican chicle was the first product certified, and by 2008, products such as Brazil nuts (*Betholletia excelsa*), copaiba oil (*Copaifera spp.)*, jarina seeds (*Phytelephas spp.)* and another approximately 50 commercial NTFPs were certified under the FSC label (Shanley et al., 2008). Brazil is a leader in certification for NTFPs, largely due to initiatives by IMAFLORA (Instituto de Manejo e Certificação Florestal e Agrícola), the primary FSC accredited certifying body in Brazil (Azevedo and Freitas, 2002). There are ongoing discussions about whether species-specific guidelines for FSC certification of NTFPs should be created or whether annexes to existing standards are sufficient, especially since the development of species-based standards goes against the spirit of the FSC in certifying forests and not products (Shanley et al., 2008).

While forest management certification for NTFPs has grown in recent years, specialized markets for these products remain small in comparison to certified timber (Shanley et al., 2008). Even in timber certification, where FSC certificate holders have had to adopt more sustainable practices (Newsom et al. 2006), the imbalance toward temperate and boreal producers, difficulties of integrating smallholders, and the limitations of certification in promoting forest conservation remain major challenges

(Auld et al., 2008). NTFPs are considered even more challenging to certify than timber because of the diversity of products included in this broad category and varying certification standards, along with insufficient information on the ecological and social aspects of NTFPs, and, therefore, lack of consumer demand for these products (Pierce and Laird, 2003). A challenge remains to identify specialized markets for NTFPs certified for their promotion of sound forest management.

Nonetheless, FSC species-specific standards for certification of Brazil nuts were developed in Bolivia (CFV, 2006), Brazil (CBMF, 2003), and Peru (CP-CFV, 2005). These standards generally follow FSC's 10 Principles, which address environmental, social, and economic aspects, while focusing on additional criteria for NTFPs (SmartWood, 2002). ASCART in Madre de Dios, with 32 members, was the first and only producers' group in the region to achieve FSC certification for Brazil nuts in 2003 through the support of a Peruvian NGO, the Asociación para la Conservación de la Cuenca Amazónica (ACCA). The FSC standards for Brazil nuts in Madre de Dios were created through a cooperative effort between ACCA, the Asociación of Extractivistas de Castaña de Madre de Dios (ASECAMD), and Candela Perú (CP-CFV, 2005). In addition to respect for national forestry laws, FSC certification for Brazil nuts in Peru calls for worker safety precautions during harvest, protection of regeneration, limits on hunting, clean storage areas, and a detailed management plan that includes a tree inventory and documentation of silvicultural practices and annual fruit production (CP-CFV, 2005). To date, no producers in Pando have attempted to certify their products through this particular certification system, largely due to issues of land tenure insecurity (Pacheco and Cronkleton, 2008a; 2008b). In Brazil, the primary cases of FSC certification of Brazil nuts are the cooperative COMARU in the state of Amapá and the Kayapó indigenous group in Pará state (Pinto et al., 2008).

Methods

Communities Sampled

We evaluated Brazil nut management practices and income derived from nuts among certified and noncertified producers in 17 communities in the tri-national region of Pando, Bolivia (n=8), Acre, Brazil (n=5), and Madre de Dios, Peru (n=4) (Figure 4-1). In Pando, communities were chosen to represent differences in market access (river vs. road) and distance to major market centers, and were located both within (n=4) and outside (n=4) the Manuripi National Wildlife Reserve. In Acre, the five communities sampled differed in their access to roads and their distance to central markets. Four were located in the Chico Mendes Extractive Reserve and the fifth in the Chico Mendes Agro-Extractive Settlement Project (commonly known as Cachoeira). In Madre de Dios, three of the four communities sampled were located along the Interoceanic Highway. The fourth was comprised of producers who lived in the town of Puerto Maldonado, but had permission to enter the buffer zone of the nationally-protected Tambopata Reserve to collect Brazil nuts during the harvest season. Most communities represented a mix of certified and noncertified producers, although in several remote communities, no producers sold certified nuts.

From January 2006 to August 2007, we accompanied seasonal Brazil nut harvest and conducted structured interviews with 231 households (125 in Pando, 76 in Acre, and 29 in Madre de Dios). Of the 125 households in Pando, 36 sold certified Brazil nuts (29%). In Acre, 28 of the 76 households sold certified nuts (37%). In Madre de Dios, 15 of the 29 households sampled sold certified nuts (52%). In small communities (<30 families) in Pando and Acre, all available families participated in the study; in larger communities (>30 families), participants were chosen randomly from lists of total households in each community.

Variables Measured

Management variables were based on local best management practices literature (e.g. Wadt et al., 2005; Cardó, 2000; 4-1), and observations made while participating in the 2006 Brazil nut harvest. Economic variables included: (1) price per kilogram of Brazil nuts sold to middlemen versus certified cooperatives; (2) frequency and amount of outstanding debt from the 2005-06 harvest; and, (3) frequency and amount of money advanced for the 2006-07 harvest. We also asked certified nut producers to rank the benefits of certification on a 5-point Likert scale and free-list the perceived benefits and disadvantages of certification.

Data Analysis

Comparative management practices and associations with certification

To understand basic quantitative differences between Brazil nut management in Pando, Acre, and Madre de Dios, we first generated descriptive statistics for management practices. We used a generalized linear model (binary logit) to test differences in practices between countries using a 95% Wald confidence interval. We then searched for relationships between certification and best management practices for each country separately through the use of chi-square tests. Odds ratios were calculated to measure the relations between the presence of certification and performance of management practices.

Comparative economic variables and associations with certification

We compared economic variables related to sale of nuts in Pando, Acre, and Madre de Dios and measured relationships with type of buyer (middleman versus certified cooperative) or certification in general. We first generated descriptive statistics for these variables and then searched for relationships with certification for each country separately through the use of chi-square tests (for discrete variables) and generalized linear models at 95% Wald confidence intervals (for continuous variables). All analyses were performed using the software SPSS Statistics GradPack 17.0 (2008).

Results

Comparative Management Practices

Comparative results between Brazil nut management practices at the pre-harvest stage in Madre de Dios, Acre, and Pando revealed between-country differences (Figure 4-3). In Madre de Dios, a greater percentage of producers ($p<0.001$) had mapped their Brazil nut stands and developed management plans when compared to producers in Pando and Acre. In Madre de Dios, 79% (±8.4 SE) of nut producers mapped their stands, compared with 41% (±4.9 SE) of producers in Pando and 24% (±5.4 SE) in Acre. While these same 79% Peruvian producers developed nut management plans, no producers in Pando or Acre had such plans.

Management for regeneration and to promote fruit production (i.e., silvicultural interventions) showed generally similar patterns between the three countries (Figure 4-3). While more than two-third of producers in the three countries reported that they would not clear and burn agricultural plots in areas where there were Brazil nut seedlings (>1 m high), there was minimal enrichment planting or clearing around seedlings. Relatively few producers in the three countries planted seeds or seedlings

(23% ±3.9 SE in Pando, 21% ±4.9 in Acre, and 38% ±9.5 in Madre de Dios) , and more than half of these had planted less than 10 seedlings each. That said, there were a few cases in which more than 100 seedlings had been planted in agricultural areas and in individual Brazil nut collection outposts in the forest. Also, relatively few producers liberated seedlings through clearing around them; 35% (±4.8 SE) in Pando, 26% (±5.7 SE) in Acre, and 42% (±10.9 SE) in Madre de Dios. Among those who performed this practice, the main reasons given for clearing around seedlings were to enhance growth, to protect them from fire, and to make them easier to find. The most common management practice overall in the three countries was vine cutting to enhance fruit production; almost all producers reported conducting this practice. The only statistically-significant between-country difference among silvicultural practices was found in bleeding trees ($p<0.001$). This practice entails cutting into the inner bark until the red latex is released. While no producers interviewed in Madre de Dios bled adult Brazil nut trees, 32% (±4.8 SE) in Pando and 34% (±6.2 SE) in Acre reported bleeding trees that were either minimally or non-productive to increase fruit yield.

In examining post-harvest management practices, the majority of producers removed the fruit placental tissue and damaged nuts during collection after opening the fruits and before placing them in the collection sacks (Figure 4-3). That said, a lower number of producers removed the placental tissue in Acre when compared with Madre de Dios and Pando ($p<0.001$). Also, a lower percentage of producers in Madre de Dios removed cut and damaged nuts when compared with Pando and Acre ($p=0.046$). Most producers in Pando (85%, ±3.2 SE) transported their nuts from the forest immediately after collection, whereas fewer producers in Madre de Dos (62%, ±9.2 SE) and Acre

(33%, ±5.5 SE) did so ($p<0.001$). Nearly two-thirds of producers in Acre (63%, ±6.5 SE) and Madre de Dios (61%, ±10.8 SE) were careful to keep stored nuts away from potential contaminants. This was higher ($p=0.037$) than the 43% (±5.3 SE) in Pando who performed this practice.

While not articulated as a best management practice in the tri-national literature, the presence of storage units and drying structures allow for post-harvest management. In our sample, more than one-third of producers in Pando (36%, ±4.3 SE), Acre (43%, ±5.7 SE), and Madre de Dios (39%, ±9.4 SE) had their own storage units. Of these producers, 18% (±4.5 SE) in Acre and 38% (±9.2 SE) in Madre de Dios also had access to separate drying facilities, whereas in Pando, nuts were dried in the same structures in which they were stored ($p<0.001$).

Associations Between Brazil Nut Certification and Management

In Madre de Dios alone, all certified producers, regardless of certification type, had mapped their nut stands and developed management plans. They were 1.8 times more likely to have conducted these practices than noncertified Peruvian producers ($p=0.004$; Table 4-3). While no associations were observed between certification and mapped stands in Pando, in Acre certified producers were 8.6 times more likely to have mapped their stand than noncertified Brazilian producers ($p<0.001$).

In all three countries, production of certified Brazil nuts was not associated with most silvicultural practices (Table 4-3). The main exception was that certified producers in Pando were 1.7 times more likely ($p=0.031$) and in Acre were 2.1 times more likely ($p=0.050$) to clear around seedlings when compared to noncertified producers. In Madre de Dios, although non-intuitive, noncertified producers were 2.1 times more likely ($p=0.009$) to protect seedlings in agricultural clearing.

The strongest associations between nut certification and management were observed in post-harvest practices specifically required of organic certification, such as drying nuts and storing them away from potential contaminants. Certified producers in Pando were 4.3 times more likely ($p<0.001$) and in Acre were 15.4 times more likely ($p<0.001$) to dry nuts than their noncertified counterparts. In Pando, certified producers were also 3.4 times more likely ($p<0.001$) to own their own storage unit and 3.8 times more likely ($p<0.001$) to keep nuts away from contaminants. This same pattern of positive associations between certification and these particular post-harvest practices was also evident in Acre where certified producers were 6.4 times more likely ($p<0.001$) to own their own storage unit, 1.6 times more likely to separate nuts from contaminants ($p=0.009$), and infinitely more likely ($p<0.001$) to own their own dryer. No such associations were observed in the case of certified and noncertified producers in Madre de Dios. Additionally, there was a significant association in all three countries between certification and awareness of aflatoxins as contaminants of Brazil nuts. Certified producers were 1.4 times more likely to be aware of aflatoxins in Pando ($p=0.003$), 1.8 times more likely in Acre ($p=0.002$), and 2.0 times more likely in Madre de Dios ($p=0.002$) than non-certified producers. In Madre de Dios, all certified producers were aware of aflatoxins, independent of certification type.

Incidence of hunting was also analyzed, since the FSC Brazil nut standards specifically mention that hunting should be limited in Brazil nut stands (CP-CFV, 2005). Overall, most nut producers reported hunting during the nut harvest: 75% (±3.9 SE) in Pando; 78% (±4.8 SE); in Acre, and 78% (±8.2 SE) in Madre de Dios, and no differences were observed between certified and noncertified producers in each country. Even though the Peruvian sample size was low, we also noted no difference in reported hunting (p=0.609) between producers affiliated with FSC and those not affiliated.

Income Derived From Organically-Certified and Non-Certified Brazil Nuts

In Pando, producers who sold raw, unshelled nuts to certified cooperatives as opposed to middlemen received nearly double the price for their sales (Figure 4-4). Of the 257 sales recorded in Pando, the mean (±SE) price (USD) per kilogram for sale to cooperatives ($0.98, ±0.02) was significantly higher (p<0.001) than the mean price of certified nuts to middlemen ($0.50, ±0.01), a 96% difference. This additional income was generally received in two payments; a portion at the time of the sale, which was comparable to the price paid by middlemen, and a second payment after Brazil nuts were processed, which was received before the start of the subsequent harvest. In Acre, there was no statistical difference (p=0.123) for income gleaned from sale to middlemen when compared with sale of raw, unshelled, certified nuts to cooperatives (Figure 4-4). This can be attributed to administrative failures of CAPEB, which when it went into bankruptcy in 2007 resulted in most producers never receiving their promised second payment after nut processing. In Madre de Dios, the sale of organic shelled nuts to Candela Perú through the Fair Trade-certified cooperative RONAP ($5.55) was significantly higher (p=0.012) than the price gleaned from sale to middlemen ($4.01) – a 38% difference. Overall, the price earned from nuts in Madre de Dios was much higher than in Pando or Acre, because Peruvian producers shelled their own Brazil nuts before sale to middlemen or cooperatives.

In Pando, certified producers were 2.5 times (p=0.037) less likely to have debt or have accepted an advance payment at the beginning of the harvest than non-certified producers, and 1.2 times more likely in Acre (p=0.037; Table 4-4). There were no differences between the amount of money owed as debt or taken out as an advance between certified and noncertified producers, with the exception of debt in Acre (p=0.034) where no certified producers had debt from the previous harvest.

Producers' Perceptions of Brazil Nut Certification

There were differences in perceptions of certification among producers in Pando and Acre who sold certified Brazil nuts. In Pando, most certified producers interviewed perceived certification as moderately to highly beneficial (92%, n=27). The most commonly listed benefit was the better price gained from the sale of certified nuts (68%), followed by the health care benefits that cooperative members received through Fair Trade certification (16%). Some of the negative perceptions included the need to pay transportation costs to the cooperatives (36%) and that certification was too much work and responsibility (36%). Conversely, in Acre, while 49% (n=14) found that certification was moderately to highly beneficial, 22% felt that it had no effect, and 29% reported that their experience was somewhat to extremely negative. The most common complaint was that there was too much work involved in producing certified nuts (33%) and that the promised payment upon nut processing either arrived late or not at all (34%). Poor cooperative administration and lack of support for producers were also listed as negative aspects of nut certification in Acre (15%). That said, in Acre, some perceived benefits of certification were better price (47%), higher quality of nuts produced (35%), better transport (12%) and better management (6%). In Madre de Dios, half of the certified producers interviewed (n=15) felt that organic and Fair Trade certification was neither positive nor negative, and the other half felt that certification was moderately beneficial. The most commonly listed benefit was better price (67%)

followed by higher nut quality (33%). Negative aspects included too much work (50%) and complaints that certified companies cheated producers by not counting the full value of peeled nuts per bag (50%). The main complaint articulated by Peruvian producers specific to FSC certification was the lack of financial benefit given the tremendous amount of extra work required.

Discussion and Conclusion

Our overall objective was to understand if different Brazil nut certification schemes were associated with different management and income generation outcomes for nut producers in Western Amazonia. We explored these relationships through a comparative study focused on best management practices, nut prices, and debt among producers in Pando, Bolivia, Acre, Brazil, and Madre de Dios, Peru. Organic and Fair Trade certification were clearly associated with better post-harvest practices and higher prices, while those producers certified by the FSC in Peru appeared to have adopted more practices related to pre-harvest planning and to a certain extent, individual tree health. While most producers commented on the extra work involved in certification, regardless of certification type, certification was viewed most positively in Pando, where producers were able to glean financial and social benefits, and less positively in Madre de Dios and Acre where financial benefits of certification were lower or non-existent.

Certification and Best Brazil Nut Management

Our data showed a positive association between certification and the pre-harvest practices in Madre de Dios in particular, and to a lesser extent, in Acre. Brazil nut management plans were much more advanced in Madre de Dios than in Pando or Acre. Peruvian law requires producers to inventory their stands and create management plans for legal access to nut concessions, and FSC certification explicitly requires compliance with national forestry laws. Importantly, all certified producers in Madre de Dios had completed their Brazil nut mapping or management plans, and the noncertified producers who had not would eventually be required to do so. In Brazil, while forestry legislation does not require nut management plans, the handful of mapping initiatives that occurred in Acre were undertaken as a first step towards FSC and organic certification, which likely explains the positive association observed between certification and mapped stands. In Pando, we did not observe any association between certification and mapped stands, mostly because mapping is an activity that occurs where community interest and outside technical support exist. Initial mapping projects were primarily used to help communities visualize their traditional forest uses and negotiate resource conflicts (Cronkleton et al., 2008), not necessarily to pursue certification. Although legally required within the Bolivian technical norms for Brazil nut production (Ministério de Desarrollo Sostenible, 2006), of the 159 extractive communities in Pando, to date only seven had nut management plans (W. Suarez, pers. comm.). Elaboration of a management plan is an important component of sustainable Brazil nut management and a basis for FSC certification, but most communities lack the resources or capacity to develop these plans on their own.

While we observed few associations between certification and silvicultural practices, there was a higher incidence of clearing around seedlings by certified producers in Pando and Acre. This may be the result of cooperative messages that promote seedling liberation to enhance growth. That said, enrichment planting is also promoted as a way to increase Brazil nut densities, and there was no association between certification and performance of this practice.

Our results clearly showed that certification influenced harvest and post-harvest practices that are directly related to product quality. This makes sense as guidelines for an aflatoxin-free product are much more strict when compared to pre-harvest and silvicultural practices, which though presented as part of the “best management” package are not requirements for organic and Fair Trade certification – the types of certification that most of our study participants had acquired. Harvest practices, such as removing the placental tissue and rotten and damaged nuts, were not associated with certification in Pando, likely because almost everyone performs these practices during the harvest. While producers in Pando transported their nuts from the forest immediately after collection to avoid the risk of nut theft (Duchelle et al., in review), the positive association between certification and immediate transport in Acre was likely because certified producers have learned that immediate transport is an important way to deter infection by *Aspergillus* (Souza Álvares et al., 2009) even though this practice may be less efficient (See Chapter 3). Certified producers in all three places were much more aware of aflatoxins when compared to noncertified producers, which demonstrates advancement in socializing this concept towards promotion of a healthy product.

Economic Benefits of Certification

The strengthening of producer organizations is considered an important way to facilitate small-scale producers’ participation in forest markets (Sherr et al., 2004) and reduce transaction costs (Mayers and Vermeulen, 2002). Our data showed that organic and Fair Trade certification for Brazil nuts through cooperatives can clearly provide producers with socioeconomic benefits. In addition to the higher price for organic nuts, the Fair Trade price premium received by the cooperatives had important social benefits. Price premiums attained from Fair Trade certification were to be invested back into the cooperative. For instance, in the case of COINACAPA in Pando, the Fair Trade premium was used to provide members with harvest materials (machetes, sacks), health care benefits, and training opportunities. In Peru, the premium covered member costs of producing annual operational plans for harvest in Brazil nut concessions. The economic success of these certification systems, however, was highly dependent on the cooperatives themselves. As we observed in the case of Acre, if a cooperative is not administratively sound, affiliated producers can easily lose the benefits associate with these specialized markets and become disenchanted with the certification process.

There were some downsides to affiliation with even successful certified cooperatives. For instance, COINACAPA has a norm that members were not allowed to manage and harvest commercial timber on their landholdings. While multiple-use forest management is not officially barred under the organic standards of Bolicert, according to COINACAPA, Bolicert expressed concern about potential contamination of nuts through mechanized timber extraction. This creates a dilemma: while producers may want to engage in integrated management of timber and Brazil nuts, if they chose to do so, they risk losing organic and Fair Trade benefits associated with sale of certified nuts.

One of the main justifications for production of Fair Trade-certified Brazil nuts is helping producers' break the cycle of debt with middlemen. While middlemen are often essential actors in NTFP production chains, especially for remote communities with limited means of transport to markets (Padoch, 1992), financial dependence on these buyers can be problematic. In the Western Amazon, middlemen arrive in communities at the end of the dry season when there are few other income-generating opportunities. Producers who are short on cash will incur debt to stock up on basic food and clothing items, and oftentimes purchase larger items such as motorcycles, which they will then pay back during the nut harvest at a predetermined price/volume set by the buyer. If Brazil nut production is less than expected, producers can easily find themselves with outstanding debt. In one community in Bolivia, a producer complained of a debt owed from the 2000-01 harvest when prices were at an all-time low. In 2007, the producer was still receiving the 2000-01 price for nuts sold to this buyer even though current market prices were much higher. The benefit of affiliation with certified cooperatives was that the second payment from processing nuts from the previous harvest also arrived at the end of the dry season when producers were most vulnerable. While our data from Pando and Acre showed that certification indeed helped some producers avoid debt and money advances, the amount owed was no different between indebted certified and noncertified producers. This finding was largely because certified producers often sold a portion of their Brazil nuts to middlemen, while maintaining the agreed-upon portion for sale to cooperatives. This demonstrates the importance of middlemen in the production chain as producers minimize risk by diversifying their sales.

Partnerships for Certification are Key

Multiple actor partnerships are essential to the success of community-based certification projects. Our study highlights the important role of the different actors involved in supporting community Brazil nut certification in Western Amazonia, including cooperatives, companies, government and non-governmental organizations, and national and international donors. These organizations promoted information sharing and facilitated producers' access to specialized markets through: trainings in best management practices and administrative matters, nut stand inventories and creation of management plans, construction of nut storage units and drying structures, and communication with accredited certifying bodies. In studies of other certified products, such as coffee, the strong NGO base (Raynolds et al., 2007) and technical farmer-to-farmer training (Bray et al., 2002) have been essential to marketing success. Also, the role of producer organizations, NGO involvement and pressure, and governments' promotion of both the supply and demand of certified products are considered essential to producers' uptake of forest certification, highlighting the importance of involvement by a broader scope of actors (Carrera et al., 2004; Auld et al., 2008). That said, different actors will have their own reasons for engagement in product-oriented forestry partnerships; while communities may seek livelihood benefits, companies may wish to profit from niche markets, and NGOs and donors may have specific conservation or development objectives (Ros-Tonen et al., 2008). These interests may clash, especially when certification projects are not successful. In the case of Acre, we can clearly see the negative effect that bankruptcy of the main certified cooperative had on affiliated nut producers. They did not financially benefit from certification as promised, and many lost trust in the broader network of support organizations, which may preclude their future involvement in certification initiatives. Also RONAP, the Peruvian producers' cooperative, is currently seeking independence from Candela Perú, because of perceived economic losses from the way in which Candela determines shelled nut weights. While cooperatives in Pando continue to benefit from extensive donor support, an end to that funding for financial or ideological reasons would certainly have negative implications. Partnerships for certification have enabled Brazil nut producers in Western Amazonia to access these specialized markets; however, their future success will be based on encouraging fairly negotiated objectives and prices, empowering nut producers and promoting ecological sustainability of the resource.

Benefits and Challenges Associated with Three Certification Schemes

There are unique benefits and challenges associated with the three different certification schemes examined in this paper. Organic and Fair Trade certification clearly had some success as market-based mechanisms. Additionally, we can argue that these certification schemes acted as regulatory mechanisms by influencing post-harvest management practices, as signal mechanisms of cooperatives' administrative successes or failures, and as learning mechanisms that enhanced producers' knowledge of product quality. The most important challenges for the future of organic and Fair Trade nut certification are continued supply of a high-quality product, sound cooperative administration, and continued international demand.

Unfortunately, forest management certification is limited as a market-based mechanism by lack of consumer demand, even in the seemingly clear case of Brazil nut where regional species-specific FSC standards have been developed. This absence of monetary reward is the main reason that FSC certification of Brazil nuts has not yet taken off in Pando or Acre, and that the one case of FSC certification in Madre de Dios ended after five years. Such inconsistency between supply and demand of certified products is considered the main limiting factor to the growth of these specialized markets (Overdevest, 2004; Ros-Tonen, 2005; Wilsey, 2008). Of the three certification types, FSC certification is the only one that specifically addresses pre-harvest, silvicultural and post-harvest management practices in its standards, which seemed to be present among certified producers in Peru. Although pre-harvest mapping and management plans are time consuming, these practices allow for compliance with federal regulations, greater collection efficiency in reaching trees once maps are generated and evaluated, and identification of previously overlooked fruit producing trees. Also, almost no Peruvian producers bled their Brazil nut trees. Even though wounding can stimulate fruit production in the short term, this practice can negatively impact tree health over time with wounds serving as invasive routes for pathogens (Kramer and Kozlowski, 1979). Given the benefits associated with FSC certification, as Taylor (2005b) suggests, linking FSC with Fair Trade certification (and we argue also organic) may be a way to promote the FSC label, and its added management benefits, within a certification system that is better established for small producers. FSC, IFOAM, and Fairtrade Labelling Organizations International are already unified under the international umbrella ISEAL (International Social and Environmental Accreditation and Labeling) (Auld et al., 2008), which could facilitate the creation of complementary certification schemes.

Organic, Fair Trade and FSC certification may have benefits for tropical forests and the people who live in them. While our study focused on Brazil nuts, the findings are relevant to products such as cacao, coffee, chicle, and other consumable non-timber forest products. Finding ways to overcome the challenges associated with certification and maximize the management and economic benefits for producers may help promote tropical forest conservation and livelihood development.

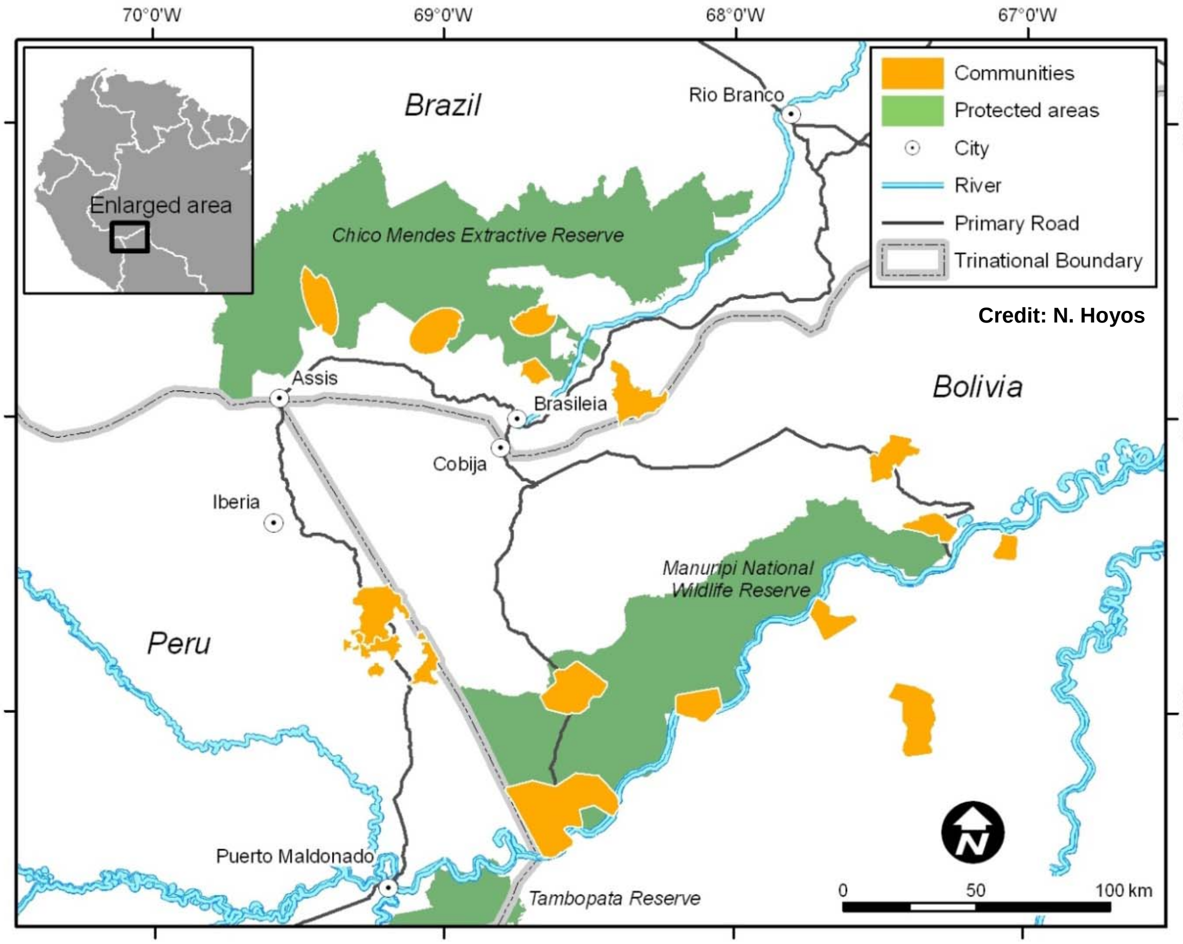


Figure. 4-1 Map of sampled communities.

Figure 4-2. Brazil nut producers at the door of their storage units in Bolivia (top left) and Brazil (bottom left). Separate structures for drying nuts in Peru (top right) and Brazil (bottom right).

Figure 4-3. Percent and SE of Brazil nut producers practicing best management practices in Pando, Acre and Madre de Dios. Significance of between-country comparisons (***p<0.001, **p<0.05); actual p-values given in text.

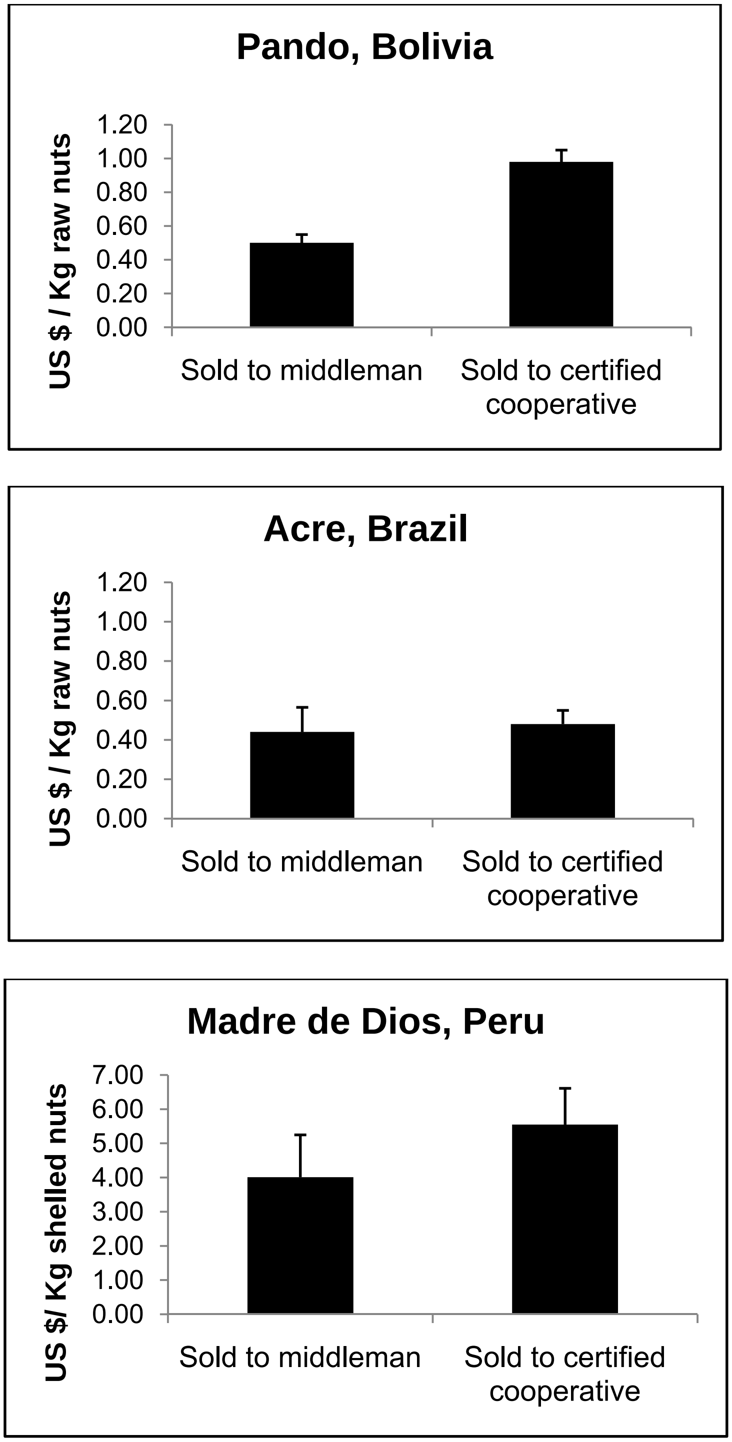


Figure.4-4. Producer prices received when selling Brazil nuts to middlemen versus certified cooperatives in 2007. Prices are based on number of sales recorded (Pando, n=257; Acre, n=98; Madre de Dios, n=37). Cooperative prices were significantly higher than those offered by middlemen in Pando and Madre de Dios, but not in Acre ($p<0.05$). Price per kilogram was higher in Madre de Dios, because weights were for shelled nuts versus raw nuts sold in Pando and Acre.

Table 4-1. Best management practices for Brazil nut as outlined in regional extension literature, along with justifications and supporting research for the performance of each practice.

Best management practice	Justification	Supporting research
Pre-harvest practices		
Map productive trees	Plan harvest, negotiate conflicts	Cronkleton et al., 2008
Develop management plan	Promote sustainable management, monitor annual production, comply with national forestry legislation and certification standards	
Silvicultural practices		
Enrichment plant	Increase density and number of trees	Kainer et al., 1998; Kainer et al., 1999; Zuidema, 2003
Protect seedlings when clearing agric. plots	Maintain regeneration in swidden fallows	Kainer et al., 1998; Cotta et al., 2008
Liberate seedlings through clearing	Enhance seedling growth	
Avoid bleeding trees	Potential tree mortality in long-term	Kramer and Kozlowski, 1978
Cut vines	Increase fruit production	Zuidema, 2003; Kainer et al., 2006, 2007
Harvest and post-harvest practices		
Remove fruit placental tissue	Prevent infection by Aspergillus	Souza Álvares et al. 2009
Remove cut/damaged nuts	Prevent infection by Aspergillus	Souza Álvares et al. 2009
Transport same day as collection	Prevent infection by Aspergillus	Leite 2008, Souza Álvares et al. 2009
Dry nuts	Prevent infection by Aspergillus	Labuza 1980, Souza Álvares et al. 2009
Separate stored nuts from contaminants	Prevent infection by Aspergillus	Souza Álvares et al. 2009

Table 4-2. Brazil nut certification initiatives in the tri-national region of Western Amazonia. Dashes signify that although standards were created, no companies or cooperatives were certified.

Place	Certification	1st Year Attained	Accredited certifier	Certified nut companies	Certified nut cooperatives	Supporting organizations	Status in 2009
Pando, BOLIVIA	Organic	1995	Bolicert, IMO Control LA	El Campesino, Tahuamanu, Manutata	COINACAPA, ACERM (2005)	CARE, Fundacion Puma, Herencia	New cooperative (ACEBA) certified
	Product Quality	2003	IBNORCA	Tahuamanu	---	---	Maintained
	Fairtrade (FLO)	2001	Trans Fair International	El Campesino	COINACAPA, ACERM (2005)	CARE, Fundacion Puma, Herencia	New cooperative (ACEBA) certified
	FSC	2003	SmartWood	---	---	CFV, PROMAB	No advance
Acre, BRAZIL	Organic	2005	IBD	---	CAPEB	WWF, EMBRAPA, Ecoamazon, SEBRAE, SEAPROF, CTA	COOPERACRE (in process)
	Fair Trade (FLO)	2005	FLO	---	CAPEB	WWF, EMBRAPA, Ecoamazon, SEBRAE, SEAPROF, CTA	COOPERACRE (in process)
	FSC	2003	IMAFLORA	---	---	WWF, FASE, IMAZON, among others	No advance
Madre de Dios, PERU	Organic	2001	IMO	Candela Perú, Fast Trade S.A. (2005)	RONAP (via Candela Perú), ASCART (via Fast Trade S.A.)	WWF, ACCA, CAMDE Peru, FONDEBOSQUE	New producers' associations certified
	Fair Trade	2004	FLO	---	RONAP, ASCART (2005)	Candela Perú	Maintained
	FSC	2003	SmartWood	---	ASCART	ACCA, Candela Perú, ASECAMD	Ended in 2008

Table 4-3. Odds ratios (OR) and p-values from Pearson Chi-square tests of association between selling certified nuts and best management practices.

	Pando, Bolivia			Acre, Brazil			Madre de Dios, Peru		
Variable	N	OR	p-value	N	OR	p-value	N	OR	p-value
Pre-harvest practices									
Mapped stand	122	0.863	0.555	76	8.571	<0.001	29	1.75	0.004
Management plan	--	--	--	--	--	--	29	1.75	0.004
Silvicultural practices									
Enrichment plant	122	1.405	0.331	76	1.333	0.519	29	1.633	0.316
Protect seedlings in agric. clearing	66	1.044	0.793	61	1.082	0.634	26	0.468	0.009
Liberate seedlings via clearing	121	1.700	0.031	76	2.095	0.050	26	0.80	0.781
Avoid bleeding trees	106	1.226	0.159	67	1.169	0.395	20	1.000	--
Cut vines	122	1.041	0.491	76	1.067	0.177	29	2.5	0.129
Harvest and post-harvest practices									
Remove placental tissue	123	1.020	0.616	76	1.322	0.011	28	1.300	0.049
Remove damaged nuts	123	1.004	0.929	76	0.985	0.696	27	1.333	0.04
Transport same day	122	1.080	0.311	76	2.571	0.003	29	1.467	0.196
Dry nuts	122	4.330	<0.001	76	15.43	<0.001	29	0.560	0.089
Separate nuts from contaminants	117	3.789	<0.001	76	1.577	0.009	28	0.770	0.390
Other									
Own storage unit	121	3.413	<0.001	76	6.367	<0.001	28	1.040	0.934
Own dryer	--	--	--	76	infinite	<0.001	29	0.778	0.597
Knowledge of aflatoxins	123	1.356	0.003	76	1.792	0.002	29	2.000	0.002

Table 4-4. Odds ratio (OR) and p-value from Pearson Chi-square test of association between nut certification and no debt or payments in advance. Correlations between certification and amount of outstanding debt from the 2005-06 harvest and amount of advanced payments received before the 2006-07 harvest.

	Pando, Bolivia				Acre, Brazil				Madre de Dios, Peru			
Variable	N	Mean (SE)	OR	p-value	N	Mean (SE)	OR	p-value	N	Mean (SE)	OR	p-value
No debt or advance payment												
Non-certified	79	0.10 (0.03)			46	0.46 (0.07)			12	0.50 (0.15)		
Certified	36	0.25 (0.07)	2.469	0.037	17	0.53 (0.13)	1.160	0.037	8	0.25 (0.16)	0.500	0.264
Amount debt (2005-06)												
Non-certified	78	310 (65)	--	0.553	46	239 (58)	--	0.034	12	124 (74)	--	0.414
Certified	35	239 (97)	--		17	0 (96)	--		7	24 (97)	--	
Amount advance (2006-07)												
Non-certified	78	678 (145)	--	0.74	19	399 (102)	--	0.483	6	527 (361)	--	0.22
Certified	36	763 (213)	--		8	267 (158)	--		8	1113 (313)	--	

CHAPTER 5
CONCLUSION

Taken together, the three papers in this dissertation allow for a comparative understanding of the conservation and livelihood benefits associated with community-based forest management in Western Amazonia. The first paper demonstrated extremely high levels of forest income dependency and minimal deforestation in extractive communities along roads in the tri-national frontier region of Madre de Dios, Peru, Acre, Brazil, and Pando, Bolivia. That said, there was a deforestation trend from 1986 to 2005 in these communities, with most deforestation having occurred in Acre, followed by Madre de Dios and Pando. While this general pattern mirrored the findings of a region-wide study for the same time period (Southworth et al., in preparation), there was much less deforestation in the extractive communities in Acre when compared with the surrounding landscape (1986–2005). There was also less deforestation in the final time period (2000–2005) in extractive communities in Madre de Dios when compared with the region-wide study. Fragmentation and close proximity to roads helped explain observed deforestation (via satellite) in all countries in the final time period (2000–2005), and economic variables were the strongest predictors of reported forest clearing at the household level (via surveys) from 2002 to 2007. For instance, income derived from agricultural sources was positively correlated with forest clearing among households in Pando (crops and livestock) and Madre de Dios (livestock), and higher Brazil nut income predicted less forest cleared. In Acre, larger households that had received more government aid reported clearing more forest, with some evidence that higher value livestock assets also predicted forest clearing.

The second paper highlighted the lack of property rights security in Pando, Bolivia when compared to Acre, Brazil, shown by a much greater incidence of reported Brazil nut thefts in Pando than in Acre. The lack of property rights security observed in Pando was partially due to a community titling process that disregarded traditional forest use. Also settlement patterns in Pando, where households were more clustered together, created a situation where people were disconnected from their forested landholdings except during the Brazil nut harvest. This lack of physical connection combined with a product that was in high demand set people up for conflictive situations during the nut harvest. This paper drew attention to participatory mapping as a potentially important tool for communities in dealing with tenure conflict, visualizing traditional forest use systems, and leveraging integration of traditional practices into formal land titling processes and decision-making.

The third and final paper demonstrated that organic, Fair Trade, and FSC Brazil nut certification schemes were associated with different management and income generation outcomes for nut producers in Western Amazonia. Organic and Fair Trade certification was clearly linked to better post-harvest practices and higher prices, while producers certified by the FSC in Peru appeared to have adopted better pre-harvest and silvicultural management practices. While most producers commented on the extra work involved in certification, regardless of certification type, certification was viewed most positively in Pando, where producers were able to glean financial and social benefits, and less positively in Madre de Dios and Acre where financial benefits of certification were lower or non-existent. Importantly, partnerships with cooperatives, government and non-governmental organizations, and donors were essential components of these certification schemes.

Significance : As trends continue to legally designate forests for use by local communities, it is critical to understand their role in tropical forest conservation and address the factors that promote or inhibit forest-based livelihood development. In addition to its broader academic significance, the results of this dissertation can inform regional policy and management of Brazil-nut rich forests in the rapidly-changing tri-national frontier of Western Amazonia.

This dissertation highlights the impressive role of forests, in general, and Brazil nuts, in particular, in local livelihood systems of extractive communities in the MAP region. In Chapter 2, we observed that forest income comprised approximately 40-45% of the total cash and subsistence income in Brazil nut-producing communities along roads in all three countries. In Chapter 3, where both road- and river-accessible communities in Pando were included, this figure exceeded 60%. Preliminary results of the CIFOR PEN study revealed that households in Pando had the highest forest income share among 20 sites in tropical countries worldwide (CIFOR PEN, unpublished data), which was largely based on the contribution Brazil nuts. The finding that greater income derived from Brazil nuts predicted less forest clearing in Pando and Madre de Dios, also underscores the role of this NTFP in promoting tropical forest conservation. Importantly, the governments of Peru, Brazil, and Bolivia have already recognized the value of this NTFP through legislation that prohibits the felling of Brazil nut trees. In the face of massive infrastructural development, however, it is also important to consider how to maintain the forests standing around them.

Given the tremendous contribution of Brazil nuts to rural livelihoods, it is essential to ensure communities' access to this resource. Both the creation of the Chico Mendes Extractive Reserve in Acre and Brazil nut concessions in Madre de Dios were important advances toward securing property rights for Brazil nut producers within the Interoceanic highway corridor. While we did not examine incidence of nut thefts in Madre de Dios, the situation there before implementation of the concessions has been compared to what we observed in Pando. Legal tenure security through creation of the concessions, complemented by Brazil nut mapping and creation of management plans by local NGOs, helped secure the resource rights of Peruvian nut producers (L.M. Velarde, pers. comm.). Although Bolivia has advanced in formalizing property rights for forest-based communities, the climate of insecurity in Pando combined with an extremely high dependence on Brazil nuts, set people up for conflictive situations during the harvest and left them extremely vulnerable to the negative effects of a stolen product.

It is also important to increase the value of Brazil nut-rich forests for communities to promote their conservation. The findings in Chapter 4 demonstrate that organic and Fair Trade certification of Brazil nuts are promising strategies for encouraging better post-harvest management, increasing the income gleaned from Brazil nuts, and alleviating dependence on middlemen. The most important challenges associated with these certification schemes are continued supply of a high-quality product, sound cooperative administration, support from industry partners, and continued international demand. Since adoption of FSC certification is limited by lack of consumer demand, pursuit of FSC certification in conjunction with an organic or Fair Trade label may be a way to maximize the distinct environmental and economic benefits of these schemes.

Although Acre has lagged behind Pando and Madre de Dios in Brazil nut certification, Acre's Forest Government is an important regional model for investment in other aspects of community-based forest management, which has included revitalizing the rubber economy (Kainer et al., 2003), promoting FSC certification for smallholders (Humphries and Kainer, 2006), and experimenting with payments for environmental services (Gomes et al., 2008; Bartels, 2009; SEMA, 2009). Additionally, the Brazilian government recently approved a new federal policy to establish minimum prices for key Amazonian NTFPs, including Brazil nuts (MDA/MMA/MDS, 2009). Despite certain policy barriers and cooperative norms that currently discourage integrated timber and Brazil nut management throughout the region, reduced-impact logging (RIL) can be compatible with conservation goals and management of NTFPs (Putz et al., 2001; García-Fernández et al., 2008; Guariguata et al., 2008). An initial study in Pando showed minimal logging damage to Brazil nut trees in certified concessions, but also recommended including pre-harvest marking of Brazil nut trees in RIL guidelines (Guariguata et al. 2009). In a separate study at the community scale in Pando, observations of increased Brazil nut regeneration along logging roads and in tree fall gaps, likely due to greater light availability, are being tested. Multiple-use forest management is an important strategy for diversifying forest-based livelihoods.

Finally, this dissertation highlights the importance of partnerships with multiple actors in supporting community-based forest management. These actors include cooperatives, industries, government and non-governmental organizations, research organizations, and national and international donors. In Pando, research organizations and NGOs played an important supporting role in smoothing property rights transitions in community-managed forests through participatory mapping of Brazil nut stands. In all three countries, certification would not have been possible without the extensive support of governmental agencies, NGOs and donors, as seen by the varying degrees of success. In conclusion, this dissertation shows that the future of community-based forest management in Western Amazonia will likely depend on secure property rights for extractive communities, access to specialized markets, and partnerships with a diversity of actors to bolster forest-based livelihoods and promote conservation of Brazil nut-rich forests.

APPENDIX A
ANNUAL VILLAGE SURVEY 1 (PORTUGUESE)

Levantamento da vila/comunidade 1 (V1)

Nota: Veja o guia técnico para obter informação apropriada e entrevistados/informantes para as várias questões de levantamento para a comunidade.

Informação de controle

Tarefas	**Data(s)**	**Quem fez?**	**Está OK? Se não, faça comentários**
Encontros com autoridades			
Encontros com grupos de interesse/comunitários			
Outras entrevistas			
Verificar o questionário			
Codificar o questionário			
Digitalização de dados			
Verificação e aprovação da digitalização de dados			

A. Variáveis climáticas e geográficas

1. Qual é o nome da vila/comunidade?	*1.* *(nome)*	*2.* *(comunidade ##)*
2. Quais são as coordenadas de GPS no centro da vila ou comunidade? (formato UTM)		
3. Qual é a latitude da comunidade?		*graus*
1. Qual é a longitude da comunidade?		*graus*
2. Qual é a altitude (metros acima do nível do mar) da comunidade?		*metros*
3. Qual tem sido a precipitação média anual (mm/ano) no distrito durante os últimos 20 anos (ou menos, veja os guias)?		*mês/Ano*
4. Qual é o coeficiente de variação da precipitação nos últimos 20 anos? *(Nota: Preencher se os dados estiverem prontamente disponíveis)*		

B. Demografia

1. Em que ano a vila/comunidade foi criada/estabelecida?	
2. Qual é o tamanho actual da população da vila/comunidade?	*habitantes/pessoas*
3. Quantas famílias vivem actualmente na vila/comunidade?	*famílias*
4. Qual foi o tamanho total da população na vila/comunidade 10 anos atrás?	*habitantes/pessoas*
5. Quantas famílias viveram na vila/comunidade 10 anos atrás?	*famílias*
6. Quantos habitantes (aprox.) vivem na comunidade agora vindos de outras aldeais nos últimos 10 anos (imigração)?	*habitantes/pessoas*
7. Quantas pessoas (aprox.) deixaram a comunidade nos últimos 10 anos (emigração)?	*habitantes/pessoas*
5. Quantos grupos diferentes (grupos étnicos, tribos ou castas) vivem na comunidade?	

C. Infra-estrutura

1. Quantas famílias (aprox.) na vila/comunidade têm acesso a electricidade (de fornecedores públicos ou privados)?	*Famílias*
2. Quantas famílias (aprox.) na vila/comunidade têm acesso a (= utilizam) água canalizada?	*Famílias*
3. Quantas famílias (aprox.) tem acesso ao crédito formal (bancos governamentais ou privados operando na vila/comunidade)?	*Famílias*

<table>
<tr><td colspan="2">4. Há instituições de crédito informal para poupanças (clubes de poupança) e pessoas que emprestarem dinheiro na vila?</td><td colspan="3">(1-0)</td></tr>
<tr><td colspan="2">5. Há algum centro de saúde na vila/comunidade?</td><td colspan="3">(1-0)</td></tr>
<tr><td colspan="2">6. A vila/comunidade possui no mínimo uma estrada que poderá ser utilizada por carros durante todas as estações do ano? Se “sim”, veja pergunta 8.</td><td colspan="3">(1-0)</td></tr>
<tr><td colspan="2">7. Se “Não”: Qual é a distância em quilômetros para a estrada próxima utilizável durante todas as estações (todo o ano)?</td><td colspan="3">km</td></tr>
<tr><td colspan="2">8. Há algum rio dentro dos limites da vila/comunidade navegável durante todas as estações? Se ‘sim’, veja pergunta 10.</td><td colspan="3">(1-0)</td></tr>
<tr><td colspan="2">6. Se ‘não’: qual é a distância ao rio mais próximo navegável durante todas as estações do ano?</td><td colspan="3">km</td></tr>
<tr><td rowspan="5">7. Qual é a distância do centro da vila/comunidade para o próximo … (em km e minutos pelos meios de transporte mais comuns)</td><td></td><td>1. km</td><td>2. min</td><td>3. código – transporte</td></tr>
<tr><td>1. Mercado distrital</td><td></td><td></td><td></td></tr>
<tr><td>2. Maior mercado para bens de consumo</td><td></td><td></td><td></td></tr>
<tr><td>3. Mercado onde os produtos agrícolas são vendidos</td><td></td><td></td><td></td></tr>
<tr><td>1. Mercado onde os produtos florestais são vendidos</td><td></td><td></td><td></td></tr>
</table>

D. cobertura/uso da terra e florestal

1. Categorias de terra na vila/comunidade/comunidade (área aproximada em hectares) (Amazónia: 1ha=4 tarefas; 2ha= 1 alqueire).

Nota: Veja o guia técnico para a definição de categorias de terra e propriedade.

Categoria de terra	**1. Total área (há)**	**Propriedade (ha)**			
		2. Estado	**3. Comunidade**	**4. Privada**	**5. Acesso livre (*de facto*)**
Floresta:					
1. Floresta Natural castanhal)					
Floresta Natural (inundado)					
2. Floresta Manejada					
3. Plantações					
Terra Agrícola:					
4. Áreas de cultivo					
2. Pasto (natural ou plantado)					
3. Sistemas agroflorestais					
4. Silvipastoreio					
5. Pousio/Capoeira					
Outras categorias de terra:					
6. Arbustos/Cerrado/Campina					
7. Capinzal					
8. Áreas Residências, infra-estrutura					
9. Zonas de Pântanos/Gapó/Vargem					
10. Outro, especifique:					
11. Total de terra					

2. Quais são os principais tipos florestais, usuários e produtos na vila/comunidade?
Nota: O objetivo é ligar tipos florestais, usuários e produtos. Veja o guia técnico para detalhes.
Nota: A área total florestal deverá ser igual a indicada na tabela acima.

1. Tipo florestal *(código-floresta)*	**2. Propriedade** *(código-terra)*	**3. Área aprox.** *(ha)*	**Usuários principais[1] (max. 3)**			**Produtos principais (max. 3)** *(código-produto)*		
			4.Ordem1	**5.Ordem2**	**6.Ordem3**	**7.Ordem1**	**8.Ordem2**	**9.Ordem3**

1) Por "usuários principais" são aqueles que têm adquirido o valor mais alto dos produtos florestais (subsistência e dinheiro) a partir de um dado tipo florestal nos últimos 12 meses.
Códigos: Seleccione o mais apropriado entre os seguintes grupos (alguns se sobrepõem):
1 = Comunitários que são membros do GUF;
2 = Comunitários que não são membros do GUF;
3 = Usuários de subsistência nas comunidades;
4 = Usuários comerciais de pequena escala na vila/comunidade;
5 = Usuários comerciais de grande escala na vila/comunidade;
6 = Usuários de subsistência de fora da vila/comunidade;
7 = Usuários comerciais de pequena escala de fora da vila/comunidade;
8 = Usuários comerciais de grande escala de fora da vila/comunidade;
9 = Outros, especifique:

3. A comunidade pratica alguma forma activa ou deliberada de manejo florestal?

Tipo de manejo	**Código[1]**
1. Plantio de árvores	
2. Abate/corte/derrubada de árvores não desejadas (competidoras)	
3. Proteção de determinadas árvores nas florestas (grupos de) para promover a regeneração natural dessas espécies	
4. Proteção de áreas florestais para serviços ambienteis particulares, como bacia hidrográfica	
5. Estabelecer direitos de uso claros para um número limitado de pessoas para produtos específicos (Por exemplo árvores melíferas)	
9. Outras, especifique	

1) Códigos: 0=não, não por completo; 1=Sim, mas somente para certo limite; 2=sim,eles são comuns.

E. Base de recursos Florestais
Nota: As perguntas devem ser feitas num encontro na comunidade em entrevistas de grupo para cada categoria (i.e. coluna por coluna, e não linha por linha).

	1. Lenha ou carvão	**2. Madeira**	**3. Ali-mentos da floresta**	**4. Medica-mentos da floresta**	**5. Pas-tagem flore-stal**	**6. Outros[1]**
1. Qual é o Produto Mais Importante (PMI) para o bem estar das pessoas na vila/comunidade (nesta categoria)? [2] *(nome)*						
2. *(código-produto)*						
3. Como é que a disponibilidade dos produtos mais importantes mudou nos últimos 5 anos? *Código: 1= diminuiu; 2= Constante; 3= aumentou*						

4. Se a disponibilidade de PMI nesta categoria **diminuiu**, quais são as razões? *Por favor ordene os motivos mais importantes, max. 3 (Deixe o resto em branco).*	**Razões**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**
	1. Redução da área florestal devido a abertura de roçados em pequena escala para agricultura						
	2. Redução da área florestal devido a projetos de grande escala (plantações, novos assentamentos, etc.)						
	3. Redução da área florestal devido a compra de terra por pessoas não locais e a restrição de acesso						
	4. Aumento no uso de PMI porque as pessoas locais (comunitários) coletam mais						
	5. Aumento no uso de PMI porque as pessoas de outras comunidades coletam mais						
	6. Restrições de uso pelo governo central ou provincial (p. ex., para conservação florestal)						
	7. Restrições locais de uso (p.ex., regras comunitárias)						
	1. Mudanças climáticas, p.ex., seca e menos precipitação						
	9. Outras, especifique:						
5. Se a disponibilidade de PMI nesta categoria **aumentou**, quais são as razões? *Por favor ordene os motives mais importantes, max. 3.*	**Razões**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**
	1. Menos desmatamento florestal para agricultura (incluindo a criação de animais)						
	2. Menos pessoas locais (comunitários) coletando menos						
	3. Menos pessoas de outras comunidades coletando menos						
	4. Uso reduzido de usuários de grande escala comercial/projetos						
	5. Mudanças no manejo das florestas						
	6. Mudanças climáticas, p. ex.., mais chuva						
	2. Outras, especifique:						
6. Qual será o mais importante aumento de benefícios (uso ou rendimentos) dos PMI? *Por favor ordene as razões mais importantes, max. 3.*	**Acção**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**	**Ordene 1-3**
	1. Melhor acesso a floresta /PMI, i.e., mais direitos para os comunitários						
	2. Melhor proteção das florestas /PMI (evitar uso excessivo)						
	3. Melhores habilidades e conhecimentos sobre como colectar e usar						

	4. Melhor acesso a credito/capital e equipamento/tecnologia						
	5. Melhor acesso aos mercados e reduzido risco de baixa de preço						
	9. Outras, especifique:						

1) Selecione o produto mais importante da vila/comunidade que não cai dentro de qualquer das cinco categorias.
2) "Muito importante" é definido como o mais importante para o bem estar na vila/comunidade, quer seja através do uso doméstico ou através da venda para dinheiro ou ambas.

F. Instituições florestais

Nota: As perguntas devem ser feitas nos encontros locais ou grupos de interesse para cada categoria (i.e., coluna por coluna, e não linha por linha).
Nota: O Produto Mais Importante (PMI) em cada categoria deverá ser idêntico ao da tabela abaixo.

	1. Lenha ou carvão	**2. Madeira de lei ou outra madeira para uso**	**3. Alimentos da floresta**	**4. Medica-mentos da floresta**	**5. Ração de animais vindo da flore-stas**	**6. Outros[1)]**
1. Qual é o produto mais importante (PMI) para o bem estar das pessoas na comunidade (nesta categoria)? *(nome)*						
2. *(código-produto)*						
3. Em que tipo de mata/floresta você obtém o PMI? *(código-florestal)*						
4. Quem é dono desta mata/floresta? *(código-posse)*						
5. Na comunidade há regras locais/habituais que regulam a utilização de PMI? *Códigos: 0=nenhum/muito pouco; 1=sim,mas vago/não claro; 2=sim, existem regras claras* *Se o código for '0', dirija-se para 7.*						
6. **Se 'sim'**: as regras locais são aplicadas/respeitadas pela população da comunidade?[1)]						
7. Há regras governamentais de regulamentação do uso da floresta ? *Códigos: 0=nenhum/muito pouco; 1=sim, mas vago/não claro; 2=sim, existem regras claras* *Se o código for '0', dirija-se para 9.*						
8. **Se 'sim' (código '1' ou '2' acima):** as regras governamentais são respeitadas pelos membros da comunidade?[1)]						
9. Os comunitários/moradores necessitam de autorização/licença para explorar os PMI? *Códigos: 0=não; 1=sim, Usuários tem de informar as autoridades; 2=sim, necessário permissão por escrito* *se código '0', dirija-se para a próxima secção.*						
10. Se 'sim' (código '1' ou '2' acima): o usuário deverá pagar pela permissão?	*(1-0)*	*(1-0)*	*(1-0)*	*(1-0)*	*(1-0)*	*(1-0)*
11. **Se 'sim'**: quem dá a autorização/licença? *Códigos: 1=chefe da comunidade; 2=GUF; 3=*						

funcionário florestal (departamento florestal); 4=outro funcionário governamental; 9=outro, especificar:						

1) Códigos: 0=não /muito pouco; 1=em certa medida por alguns grupos de comunitários; 2=em certa medida por todos; 3=sim, mas somente por alguns grupos de comunitários; 4=sim, por todos; 9=não existem regras particulares/especificas.

G. Grupos de usuários florestais/grupos de interesse (GUF) ***(grupos de produtores)***
1. Existência de grupos de usuários (grupos de interesse) florestais (GUF).
Nota: Veja guia técnico para definição.

1. Quantos grupos de usuários florestais (GUF) existem na comunidade?	

2. Informação sobre cada GUF (usar uma coluna por GUF).

		1. GUF1	*2. GUF2*	*3. GUF3*
1. Quando é que o grupo se formou? *(ano)*				
2. Como é que o grupo se formou? *Códigos: 1=iniciativa local; 2=initiativa de uma ONG; 3=iniciativa governamental, p. ex., Departamento florestal; 4=outra, especifique:*				
3. O principal objetivo de GUF está relacionado com o manejo de uma área florestal particular ou produto(s) florestal em particular? *Códigos: 1=área; 2=produto(s); 3=ambos*				
4. Se for o produto (código 2 ou 3 acima), Qual é o produto (principal)? *(código-produto)*				
5. Quantos membros fazem parte/participam do grupo?				
6. Quantas vezes por ano o GUF tem encontros?				
1. O grupo possui um plano de manejo escrito?		*(1-0)*	*(1-0)*	*(1-0)*
2. Quais são as principais tarefas do GUF? *Selecione quantas for apropriado: 1-0 código*	1. Estabelecer regras de uso	*(1-0)*	*(1-0)*	*(1-0)*
	2. Monitorar e fiscalizar	*(1-0)*	*(1-0)*	*(1-0)*
	3. Silvicultura & manejo	*(1-0)*	*(1-0)*	*(1-0)*
	4. Exploração de produtos florestais	*(1-0)*	*(1-0)*	*(1-0)*
	5. Venda de produtos florestais	*(1-0)*	*(1-0)*	*(1-0)*
	9. Outras, especificar:	*(1-0)*	*(1-0)*	*(1-0)*
3. Algum projeto de desenvolvimento foi implementado na comunidade nos últimos 5 anos usando os lucros ou retornos dos GUFs?Outra maneira de formular: Houve alguma bemfeitoria comunitária que veio dos lucros/retornos do GUF? (Dificilmente os benefícios serão entendidos como "projeto")		*(1-0)*	*(1-0)*	*(1-0)*
4. Alguém na comunidade terá violado as regras do GUF nos últimos 12 meses? se *não', dirija-se para 14.*		*(1-0)*	*(1-0)*	*(1-0)*
5. **Se 'sim'**: o GUF impôs alguma penalização para quem não cumpriu das regras? Se *não', dirija-se para 14*		*(1-0)*	*(1-0)*	*(1-0)*
6. **Se 'sim'**: Qual foi o tipo de penalização? *Códigos: 1=multa (pronto pagamento); 2=Devolver os produtos coletados; 3=trabalho (trabalho extra); 4=exclusão do grupo; 9=outro, especificar:*				
7. Quais são os grupos de usuários que mais frequentemente violaram as regras nos últimos 5 anos? *Códigos: 1=membros do GUF; 2= não membros do GUF na comunidade; 3=pessoas de outras comunidades; 9=outros, especificar:*				
8. De um modo geral, na escala de 1-5 (1 é altíssimo, 5 é mais baixo) quanto efetivamente poderá dizer que os GUF estão assegurando o uso sustentável e e a divisão justa dos benefícios da floresta?				

Nota: Qualquer GUF na comunidade deverá ser discutido na narrativa da comunidade.

APPENDIX B
ANNUAL VILLAGE SURVEY 2 (PORTUGUESE)

Levantamento da comunidade 2 (V2)

Informação de controle

Tarefas	**Data(s)**	**Quem fez?**	**Está OK? Se não, faça comentários**
Encontros com autoridades			
Encontros com grupos de interesse/comunitários			
Outras entrevistas			
Verificar o questionário			
Codificar o questionário			
Digitalização de dados			
Verificação e aprovação da digitalização de dados			

A. Variáveis climáticas e geográficas

1. Qual é o nome da comunidade?	**(nome)*	*(comunidade ##)*
2. Qual foi a precipitação na comunidade nos últimos 12 meses?		mm/ano
3. Se os dados de precipitação não estiverem disponíveis (pergunta 2): Como foi a precipitação nos últimos 12 meses comparando com um ano normal (= Media dos últimos 20 anos)? *Códigos: 1= Muito abaixo do normal (< 50 %); 2= Abaixo do normal (50-90%); 3= Normal (90-110%); 4= Acima do normal (110-150%); 5= Muito acima do normal (> 150%)*		

B. Risco

1. A comunidade sofreu alguma crise nos últimos 12 meses? *Códigos: 0= Não; 1=sim, crise moderada; 2=sim, crise severa*	1. Enchente/Alagação e/ou excesso de chuva	
	2. Seca	
	2. Incêndios/Queimadas (nas culturas/ florestais/capinzal etc.)	
	3. Ataque de bicho/Peste generalizada na época da colheita/doença e/ou doença animal	
	4. Epidemias humanas (doenças)	
	5. Conflitos políticos /civis	
	6. Crises macro-económicas	
	7. Refugiados ou imigrantes	
	8. Outras, especifique:	

C. Salários e preços

1. Qual foi a diária típica para mão-de-obra agrícola não treinada/casual para um adulto masculino/feminino durante as estações de alta/baixa (escassez) na comunidade nos últimos 12 meses? *(Moeda nacional/dia)*		**Homem**	**Mulher**
	Época de alta	1.	2.
	Época de baixa	3.	4.
2. Qual é a principal alimentação na comunidade? *(código-produto)*			
3. Qual foi o preço por kg do principal alimento durante os últimos 12 meses antes e depois da principal colheita agrícola? *(Moeda nacional/kg)*		**1. Antes da colheita/safra**	**2. Depois da colheita/safra**
1. Qual é o preço de um hectare de terra com boa produção agrícola na comunidade (i.e., não degradada, não muito inclinada, e própria para culturas comuns, e dentro de 1km da estrada principal ou assentamento) *(Lc$/hectare)*			

D. Serviços florestais

<table>
<tr><td rowspan="1">1. A comunidade (como comunidade ou indivíduos na comunidade) recebeu qualquer benefício direto (em numerário (?não sei: talvez – em forma de equipamentos/bemfeitorias) ou em espécie/dinheiro) relativo aos serviços florestais nos últimos 12 meses?
Códigos: 0=não; 1=sim, directamente para as famílias; 2=sim, directamente para a comunidade (p.ex., projectos de desenvolvimento); 3=sim, ambos para família e comunidade</td><td colspan="2"></td></tr>
<tr><td rowspan="6">2. Se a comunidade tem recebido pagamentos (códigos 2 ou 3 abaixo), por favor indique a quantia que a comunidade tem recebido.</td><td>Pagamentos relacionados com:</td><td>Quantia</td></tr>
<tr><td>1. Turismo</td><td></td></tr>
<tr><td>2. Seqüestro de carbono</td><td></td></tr>
<tr><td>3. Bacia hidrográfica</td><td></td></tr>
<tr><td>4. Conservação de biodiversidade</td><td></td></tr>
<tr><td>9. Outros, especifique:</td><td></td></tr>
<tr><td>3. A comunidade tem recebido qualquer apoio florestal externo (assistência técnica, insumos de graça, etc.) a partir do governo, doadores, ONGs) nos últimos 12 meses?</td><td colspan="2">(1-0)</td></tr>
</table>

Nota: Se qualquer destes pagamentos ou assistência tenha sido recebido, deverá ser mais elaborado na narrativa da comunidade.

APPENDIX C
ANNUAL HOUSEHOLD SURVEY 1 (PORTUGUESE)

Levantamento (da unidade) familiar anual 1 (A1) (no Acre: colocação)

Informação de controle

Tarefa	**Data(s)**	**Por quem?**	**Está OK? Se não, faça comentários**
Entrevista			
Verificar o questionário			
Codificar o questionário			
Digitalização de dados			
Verificar e aprovar a digitalização de dados			

A. Identificação

1. Identificação e localização da família.

1. Nome da da unidade familiar e código	**(nome)*	*(FID)*
2. Comunidade	**(nome)*	*(comunidade ##)*
3. Distrito/Município	**(nome)*	*(DID)*
4. Nome e PID (Veja secção B.) entrevistado primário	**(nome)*	*(PID)*
5. Nome e PID (Veja secção B.) entrevistado secundário	**(nome)*	*(PID)*
6. Ponto de referência com base em GPS da família (formato UTM)		
7. Distância da família do centro da comunidade (em minutos andando a pé e em km)	*1.* *min*	*2.* *km*

B. Composição da família

1. Quem são os membros da família?

Nota: Recorde-se da definição de família no guia técnico.

1. Número de identificação pessoal (PID)	*** Nome do agregado familiar**	**2. Parentesco com o chefe da família[1)]**	**3. Ano de nascimento** *(yyyy)*	**4. Sexo** *(0=masculino 1=femenino)*	**5. Educação** *(número de anos que completou)*
1		Chefe da família = código 0			
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

1) Códigos: 1=esposa; 2 filho/filha; 3=enteado/enteada; 4=neto(a); 5=Mae/pai; 6=sogra/sogro; 7=irmão ou irmã; 8=cunhado/cunhada; 9=tio/tia; 10=sobrinho/sobrinha; 11=filho/filha adoptado(a); 12=outra familiar; 13=não parente.
2) Algúem pode perguntar sobre idade e depois calcular o 'ano nascimento' quando entrando os dados.

2. Gostaríamos de fazer perguntas sobre o chefe da família.

1.	Qual é o estado civil do chefe da família? *Códigos: 1=casado ou conjugal; 2=casado mas o marido trabalha longe; 3=viuvo/viuva; 4=divorciado;; 5=nunca foi casado; 9=outros, especifique:*	
2.	A quanto tempo é que a família se formou (veja a definição de família)	*Anos*
3.	O chefe da família nasceu na comunidade? Se *'sim', dirija-se para 5.*	*(1-0)*
4.	**Se 'não':** A quanto tempo o chefe da família vive nesta comunidade?	*Anos*
5.	O chefe da família pertence ao maior grupo étnico/social da comunidade?	*(1-0)*

C. Terra

1. Por favor indique o tamanho de terra/área (em hectares) que possui e tem arrendado ou arrendou.
Nota: Veja as definições de categorias de terra no guia técnico.

Categoria	**1. Área** *(ha)*	**2. Propriedade** *(código-posse)*	**Principais culturas agrícolas plantadas/colhidas nos últimos 12 meses Max 3** *(código-produto)*		
			3. Ordene1	**4. Ordene2**	**5. Ordene3**
Floresta:					
1. Floresta natural					
2. Floresta manejada					
3. Plantações					
Terra agrícola:					
4. Culturas					
5. Pastos (naturais ou plantados)					
6. Sistemas agroflorestais (SAFs, quintal)					
7. Silvipastoreio					
8. Pousio/Capoeira					
9. Outros tipos de vegetação/usos da terra (residencial, floresta, capinzal, pântanos, etc.)					
10. Total da terra possuída (1+2+3+…+9)					
11. Terra alugada/arrendada à alguém (incluída em 1-9)					
12. Terra alugada/arrendada de alguém (não incluída em 1-9)					

D. Bens e poupanças

1. Por favor indique o tipo de casa que possui?

1. Tem casa própria? 1)	
2. Qual é o tipo principal (mais comum) de material das paredes? 2)	
3. Qual é o tipo principal (mais comum) de material no seu telhado/cobertura? 3)	
4. Quantos m^2 aproximadamente tem a casa?	*m^2*

1) Códigos: 0=não; 1=casa própria; 2=casa própria pertencente a mim e outra pessoa(s); 3=aluga a casa sozinho; 4=aluga a casa com outra família(s); 9=outros,e especifique:

2) Códigos: 1=barro/areia; 2=Madeira; 3=peças metálicas; 4=tijolos ou cimento; 5=paxiuba (tronco de palmeira- muito comum na Amazônia) 9=outro, especifique:

3) Códigos: 1=capim; 2=Madeira (tábuas); 3=peças metálicas; 4=telhas; 9=outros, especifique: (Não foi traduzida)

2. Por favor indique o número e valor dos instrumentos e outros grandes itens que a família possui.

	1. No. de unidades possuída	**2. Valor total (valor corrente de venda de todas as unidades, não preço de compra)** *(Lc$. Se o bem não for próprio, coloque '0')*
1. Carro/caminhão		
2. Trator		
3. Moto		
4. Bicicleta		
5. Telefone fixo/ celular		
6. TV		
7. Radio		
8. Fita cassette/CD/ VHS/VCD/DVD/		
9. Fogão (só a gás ou elétrico)		
10. Geladeira/congelador		
11. Barco de pesca e motor de barco		
12. Moto serra		
13. Arado		
14. Carroça / Atrelado para bois		
15. Espingarda/Arma de fogo		
16. Carroça ou carrinho de mão		
17. Movéis		
18. Agua		
19. Panel solar		
99. Outros (preço de compra maior que aprox. 50 USD)		

3. Por favor indique as poupanças e dívidas que a família possui.

1. Quanto é que a família possui de poupanças nos bancos, associações de créditos ou em clubes de poupança?	*Lc$*
2. Quanto é que a família possui em poupanças em bens não produtivos como ouro e jóias?	*Lc$*
3. Quanto é que a família tem em dívidas não pagos?	*Lc$*

E. Base de recursos florestais

1. Qual a distância entre a casa e a margem da mata/floresta natural ou manejada mais próxima a qual tem acesso e pode usar?		1. … medida em termos de distância (linha recta?)	*km*
		2. … medida em termos de tempo (minutos a caminhar)?	*min*
2. A família coleta lenha? Se *'não', dirija-se para 8.*			*(1-0)*
3. **Se 'sim'**: quantas horas por semana os membros da família gasta na coleta de lenha para uso familiar?			*(horas)*
4. Na sua casa, vocês gastam mais ou menos tempo para coletar lenha, comparando com 5 anos atrás? *Códigos: 1=mais; 2=mais ou menos mesmo tempo; 3=menos*			
5. Como é que mudou a disponibilidade de lenha nos últimos 5 anos? *Códigos: 1=diminuiu; 2=mais ou menos a mesma; 3=aumentou se for código '2' ou' 3', dirija-se para 7.*			
6. **Se tiver reduzido** (código '1'da	**Resposta**		**Ordene 1-3**

	pergunta acima), como é que vocês reagiram frente ao declínio da disponibilidade de lenha? *Por favor ordene as respostas mais importantes, máximo 3.*	1. Aumentou o tempo de colheita (ex. o local de colheita é mais distante de casa)	
		2. Plantio de árvores em terra própria/particular	
		3. Aumentou o uso de resíduos da agricultura como combustível	
		4. Compra (mais) lenha e/ou carvão	
		5. Compra (mais) combustíveis comerciais (petróleo, gás ou eletricidade)	
		6. Reduziu a necessidade de uso de combustíveis, p.ex. usando fogões melhorados	
		7. Usa a lenha numa maneira mais conservativa para cozinhar e esquentar a casa	
		8. Reduziu o número de MEALS cozinadas	
		8. Usa melhor tecnólogia	
		9. Aumentou o uso de produtos não madereiros (ej. capim)	
		10. Restrita o acesso/uso de possuir a floresta	
		11. Conserva os arvores para o futuro	
		12. Fazer carvão	
		9. Outro, especifique:	
7.	A família terá plantado árvores na sua colocação/terra nos últimos 5 anos? Se *não', dirija-se para a próxima secção.*		*(1-0)*
8.	**Se sim: qual foi o principal propósito(s)** do plantio destas árvores? Por favor ordene os propósitos mais importantes, *max 3.*	**Propósito**	**Ordene 1-3**
		1. Lenha para uso doméstico	
		2. Lenha para venda	
		3. Forragem para uso próprio	
		4. Forragem para venda	
		5. Madeira/estacas para uso próprio	
		6. Madeira/estacas para venda	
		7. Outros usos domésticos	
		8. Outros produtos para venda	
		9. Seqüestro de carbono	
		10. Outros serviços ambientais	
		11. Demarcação da terra	
		19. Outros, especifique:	

F. Grupos de usuários florestais (GUF)

Nota: O entrevistador deve primeiro explicar o que quer dizer por GUF, cf. o guia técnico. *(Evite o nome GUF na entrevista)*

1.	Você ou outro membro da sua família são membros de um grupo de usuários florestais (GUF)? Se *'não', dirija-se para 11.*	*(1-0)*
2.	Alguém na sua família participa normalmente/regularmente nos encontros dos grupos de usuários florestais (GUF)? Se *'não', dirija-se para 5.*	*(1-0)*
3.	**Se 'sim'**: na sua família, quem normalmente participa nos encontros dos grupos de usuários florestais e participa em outras actividades dos GUF? *Códigos: 1=somente a esposa; 2=ambos, mas principalmente a esposa; 3=ambos participam da mesma maneira; 4=ambos, mas principalmente o marido; 5=somente o marido; 9=outros esquemas não descritos anteriormente.*	
4.	Quantas pessoas dia (= dia completo de trabalho) os membros da família gastaram no total em atividades do GUF (encontros, fiscalização, trabalho conjunto, etc.) nos últimos 12 meses?	*dias*
5.	A família faz pagamentos em dinheiro ou contribuições para o os grupos de usuários	

	florestais (GUF)? *Se 'não', dirija-se para 7.*		*(1-0)*
6.	**Se 'sim':** Quanto é que pagou nos últimos 12 meses? *(Lc$)*		
7.	A família recebeu qualquer pagamento em dinheiro dos grupos usuários da floresta (p. ex., divisão das vendas/receitas) nos últimos 12 meses? Se *'não', dirija-se para 9.*		*(1-0)*
8.	**Se 'sim':** Quanto é que recebeu nos últimos 12 meses? *(Moeda nacional)*		
9.	Quais foram as razões para vocês se juntar ao GUF? *Por favor ordene as razões mais importantes, max 3.*	**Razões**	**Ordene 1-3**
		1. Aumentou o acesso aos produtos florestais	
		2. Melhor manejo florestal e mais benefícios no futuro	
		3. Acesso a outros benefícios, p.ex., apoio governamental, programas de doadores	
		4. É obrigação proteger a floresta para a comunidade e para o futuro	
		5. Para ser respeitado e considerado como pessoa responsável na comunidade	
		6. Aspectos sociais (encontrar-se com outras pessoas, trabalhar em grupo, receio de exclusão, etc.)	
		7. Forçado pelo Governo/líderes/vizinhos	
		8. Preço mais alto para o produto florestal	
		10. Melhor qualidade do produto florestal	
		9. Outros, especifique:	
10.	De um modo geral, o que diria sobre como a existência do GUF tem afetado os benefícios que a famílias obtêm da floresta? *Códigos: 1=efeito grande negativo; 2=pequeno efeito negativo; 3=nenhum efeito; 4=Pequeno efeito positivo; 5=grande efeito positivo.*		
11.	**Se participa em nenhum GUF, Porque**? *Por favor ordene as razões mais importantes, max 3.*	**Razoes**	**Ordene 1-3**
		1. Não há GUF na comunidade	
		2. Sou novo na comunidade	
		3. Os membros dos GUF de um modo geral pertencem a outros grupo(s) (etnia, partido político, religião, etc.) diferentes do meu	
		4. Não possui tempo disponível	
		5. Não possui o recurso/dinheiro requerido para pagar	
		6. Os membros do GUF iriam restringir/empatar o meu uso da floresta, e eu pretendo usar a floresta em função das minhas necessidades	
		7. Não acredito que GUF é efetivo no (ou sabe fazer o) manejo da floresta	
		8. Falta dos produtos florestais	
		10. Não tem interes nas atividades feitas pelos GUFs	
		11. Corrupção no GUF	
		12. Tem interes em afiliar-se mas precisar mais informação	
		13. GUF existe na comunidade mas unidade familar não sabe da presença	
		14. Autoridades florestais	
		9. Outros, especifique:	

APPENDIX D
ANNUAL HOUSEHOLD SURVEY 2 (PORTUGUESE)

Levantamento (da unidade) familiar anual 2 (A2)

Informação de controle

Tarefa	Data(s)	Por quem?	Esta OK? Se não, faça comentários
Entrevista			
Verificar o questionário			
Codificar o questionário			
Digitalização dos dados			
Verificação e aprovação da digitalização dos dados			

A. Identificação

1. Nome da da unidade familiar	*(nome)	*(FID)*
2. Comunidade	*(nome)	*(comunidade ##)*
3. Distrito	*(nome)	*(DID)*
4. Nome e PID do respondente primário	*(nome)	*(PID)*
5. Nome e PID do respondente secundário	*(nome)	*(PID)*

B. Crises e despesas inesperadas

1. A família tem enfrentado qualquer falta de rendimentos financeiros ou despesas grandes inesperadas nos últimos 12 meses?

Evento	**1. Como séria?**$^{1)}$	**Como é que compensou a perda de rendimento ou custos?** *Ordene max. 3*$^{2)}$		
		2. Ordem1	**3. Ordem2**	**4. Ordem3**
1. Séria falha de cultura agrícola/roçado				
2. Doença grave na família (grupo de idade do adulto incapaz de trabalhar por mais de um mês durante os últimos 12 meses devido à doença ou por tomar conta de alguém doente)				
3. Morte de um adulto em idade produtiva				
4. Perda de terra (expropriação, etc.)				
5. Perda grande de gado (roubo, seca, etc.)				
6. Outra perda grande de um bem (fogo, roubo, enchente, etc.)				
7. Perda de salário/emprego				
8. Casamento				
9. Outro, especifique:				

1) Códigos: 0=Não; 1=Sim, crise moderada; 2= Sim, crise séria. Veja o guia técnico para definições.

2) Códigos compensar:

1. *Explora mais produtos florestais*
2. *Explora mais produtos silvestres não florestais*
3. *Planta e colhe mais produtos agrícolas*
4. *Gastou as poupanças de dinheiro*
5. *Venda de bens (terra, gado, etc.)*
6. *Faz trabalho casual/serviço prestado/por diária*
7. *Assistência de amigos ou parentes*

8. *Assistência de uma ONG, organização comunitária, organização religiosa ou similar*
9. *Obteve empréstimo de um emprestador de dinheiro, associação credora, banco etc.*
10. *Tentou reduzir as despesas familiares*
11. *Não fez nada em particular*
19. *Outros, especificar:*

C. Serviços florestais

1. A família recebeu, nos últimos 12 meses, algum dinheiro ou pagamento relacionado com os seguintes serviços florestais?

Principal propósito	**1. Recebeu?** *(1-0)*	**2. Se sim, quantidades (valores) recebidas** *(moeda nacional)* *(Se não tiver nada, coloque '0')*
1. Turismo		
2. Projetos de carbono		
3. Projetos de conservação de água, bacia hidrográfica		
4. Conservação da biodiversidade		
5. Outras, especifique:		

D. Abertura da floresta

1. A família derrubou/cortou qualquer área florestal nos últimos 12 meses? Se *'não', dirija-se para 9.*		*(1-0)*		
Se sim:	2. Qual foi a área derrubada?	*ha*		
	3. Para que fim foi usada a área derrubada? *Códigos: 1=roçado; 2=plantio de arvores; 3=pastoreio; 4=usos não agrícolas (Ordene max 3)*	1.Ordem1	2.Ordem2	3.Ordem3
	4. Se usado para roçado (código '1' na pergunta anterior), Quais foram as principais culturas plantadas? *(código-produto) Ordene max 3*	1.Ordem1	2.Ordem2	3.Ordem3
	5. Qual foi o tipo de floresta que derrubou? *(código-florestal)*			
	6. Se foi floresta secundária, qual foi a idade da floresta?	*anos*		
	7. Quem era o dono da floresta derrubada? *(código posse)*			
	8. A que distância da casa estava a terra derrubada?	*km*		
9. A família nos últimos 5 anos desbravou a floresta? *Se 'não', dirija-se para 11.*		*1-0*		
10. **Se 'sim':** que superfície (aprox.) foi desbravada nos últimos 5 anos?		*ha*		
11. Que quantidade de terra utilizada pela família nos últimos 5 anos foi abandonada (deixada para ser convertida para vegetação natural - capoeira)?		*ha*		

E. Percepção de bem-estar e capital social

1. Considerando todas as coisas, o quanto o senhor esta satisfeito com sua vida durante os últimos 12 meses? *Códigos: 1=muito insatisfeito; 2=insatisfeito; 3=nem insatisfeito nem satisfeito; 4=satisfeito; 5=muito satisfeito*	
2. Têm sido a renda da família e a produção de comida suficiente durante os últimos 12 meses para cobrir as necessidades da família? *Códigos: 1=não; 2=razoável (justo o suficiente); 3=sim*	

3. Em comparação com outras famílias na associação (comunidade), como o senhor considera que sua famílias está? *Códigos: 1=pior; 2=ao redor da media; 3=melhor*		
4. Como esta sua família hoje em comparação com sua situação há **5 anos atrás**? *Códigos: 1=pior agora; 2=quase igual; 3=melhor agora* *Se 1 ou 3, ir a 5. Se 2, ir a 6.*		
5. **Se está pior o melhor**, qual é a principal razão da mudança? *Por favor faça um ordem de prioridade ás respostas mais importantes. Maximo 3.*	**Razão: Mudança em …**	**Range 1-3**
	1. emprego fora da parcela	
	2. extensão da parcela (p.ex., terra vendida/comprada)	
	3. recursos florestais	
	4. preços da produção (florestal, agrícola,…)	
	5. apoio externo (governo, ONG,…)	
	6. remessas	
	7. custo da vida (p.ex.,inflação alta)	
	8. guerra, conflito civil, intranqüilidade	
	9. conflitos na associação (não violentos)	
	10. situação familiar (p. ex., perda de um membro da família que contribuía ao sustento)	
	11. doença	
	12. acceso (p.ex., ramal novo,…)	
	19. outros (especificar):	
6. O senhor considera que sua associação (comunidade) é um bom lugar para viver? *Códigos: 1=não; 2=parcialmente; 3=sim*		
7. O senhor **em geral** confia nas pessoas em sua associação (comunidade)? *Códigos: 1=não; 2=parcialmente, confio em alguns e não em outros; 3=sim*		
8. O senhor consegue obter ajuda das pessoas em sua associação (comunidade) em caso da necessidade, por exemplo se precisar de dinheiro extra por a doença de um membro da família? *Códigos: 1=não; 2= as vezes posso obter a ajuda mas não sempre; 3=sim*		

F. Avaliação da pesquisadora sobre a família

Nota: Esta secão deverá ser completada pelo pesquisador (a) e/ou a contraparte PEN. Se a pesquisadora que fez A2 (e Q4) ***não*** *é quem tem feito os questionários trimestrais prévios, aquelas pesquisadoras que tivessem maior relação com as famílias deverão responder as perguntas 2-5.*

1. Durante a entrevista, o entrevistado sorriu ou gargalhou? *Códigos: 1 = nunca gargalhou nem sorriu (cara feia), 2 = só sorriu, 3 = sorriu e gargalhou, 4 = sim, gargalhou freqüente e abertamente*	
2. Baseado em suas impressões e em o que tem visto (casa, objetos, etc.), você acha que esta família e rica comparada com outras famílias na associação? *Códigos: 1= pobre, 2 = media, 3 = rica*	
3. O quanto é confiável a informação **geralmente** fornecida por esta família? *Códigos: 1=pobre; 2=razoavelmente confiável; 3=muito confiável*	
4. O quanto é confiável a informação sobre **uso/coleta florestal** fornecida por esta família? *Códigos: 1=pobre; 2= razoavelmente confiável; 3= muito confiável*	
5. Se a informação sobre o uso e coleta florestal não é tão confiável (código 1 acima), pensa que a informação fornecida sobreestima ou subestima o uso real da floresta? *Códigos: 1=subestima; 2=sobreestima; 3= não há sobre ou subestimação sistemática; 4=não sei*	

APPENDIX E
QUARTERLY HOUSEHOLD SURVEY (PORTUGUESE)

Levantamento familiar trimestral (Q1-Q4)

Nota: Todos os rendimentos são levantados para o último mês (últimos 30 dias), exceto para a última secção de culturas, gado e outras fontes de rendimentos aonde o período para relembrar é de 3 meses.

Nota: O investigador deverá listar os produtos mais comuns em várias tabelas, com base em RRAs e pré-teste do questionário. Após ter perguntado sobre a pré-lista de produtos, o entrevistador deverá perguntar se há algum outro produto não mencionado que a família explorou/coletou no último mês ou 3 meses.

Informação de controle

Tarefa	**Data(s)**	**Por quem?**	**OK? Se não, faça comentários**
Entrevista			
Verificar o questionário			
Codificar o questionário			
Digitalização dos dados			
Verificação e aprovação da digitalização dos dados			

A. Identificação

1. Número da família		
2. Comunidade	**(nome)*	*(comunidade ##)*
3. Distrito		
4. Nome e BI do respondente primário	**(nome)*	*(BI)*
5. Nome e BI do respondente secundário	**(nome)*	*(BI)*

B. Renda direta da floresta (rendimentos de produtos florestais não processados

1. Quais são as quantidades e valores de produtos florestais brutos (não processados) que os membros da sua família coletaram para uso doméstico e venda **no mês passado**?

Nota: Respostas nas colunas 3 e 4 devem ser consistentes com as categorias de terra reportadas no questionário da comunidade (V1D01) e no questionário anual da família (A1C).

1. Produto Florestal *(código-produto)*	**2. Coletado por quem?[1)]**	**Aonde foi coletado?**		**5. Quantidade coletada (7+8)**	**6. Unidade**	**7. Uso próprio (incl. presente/dado)**	**8. Venda(incl. trocas)**	**9. Preço por unidade**	**10. Tipo de mercado** *(código-mercado)*	**11. Valor bruto (5*9)**	**12. Custos de transporte/venda (total)**	**13. Compra de insumos/materiais & pagamento de mão-de-obra**	**14. Rendimento liquido (11-12-13)**
		3. Tipo de terra *(código-terra)*	**4. Propriedade** *(código-posse)*										
Castanha													
Borracha													
FRUTOS													
Açaí (fruto)													
Patoá (fruto)													
Bacaba													

Buriti													
Ouricuri													
Tucumã (fruto)													
Jatobá (fruto)													
Jutaí (fruto)													
Bacurí													
Jací													
Cacau da mata													
Doce													
Palmito													
CASCAS													
Adubo vegetal													
Castanha													
Copaiba													
Jatobá													
Jutaí													
Pau d'arco roxo													
Catuaba													
Quina quina													
Canelão													
Unha de gato													
Breu													
Cedro													
Cerejeira													
Aguano													
Assacú													
Sucuuba													
Balso													
Garrafada													
OLEOS													
Copaiba													
Andiroba													
Patoá													
Jatobá													
Mel de abelha													
FIBRAS													
Cipó ambé													
Cipó timbó													

Cipó titica													
Arumã													
Envira de toarí													
Envira outros													
Jarina													
Jací													
Uricuri													
SEMENTES													
Jarina													
Tucumã													
Açaí													
Patoá													
Paxiubão													
Paxiubinha													
Murmurú													
MADEIRA													
Amarelão													
Angelim													
Aroeira													
Bálsamo													
Breu vermelho													
Cambará													
Castanheira													
Catuaba													
Cedro													
Cerejeira													
Copaiba													
Cumaru cetim/cumarurana													
Cumaru ferro													
Guariúba													
Imbirindiba amarela													
Intaúba													
Jatobá													
Marupá													
Massaranduba													

Mogno/Auguano													
Mulateiro													
Pau d’arco roxo													
Pau d’arco amarelo													
Paxiubão													
Paxiubinha													
Preciosa / canelão													
Quariquara													
Samaúba branca													
Samaúba preta													
Toari/Tauari													
ANIMAIS													
Porco do mato													
Queixada													
Veado roxo													
Veado capoeiro													
Paca													
Cutia													
Cutiara													
Tatu													
Capelão / guariba													
Macaco prego													
Macaco aranha													
Capivara													
Jabuti													
Anta													
Jacú													
Mutum													
Papagaio													
Nambú													
Jacamí													
Tucano													
Arara													

1) Códigos: 1=Só/principalmente pela esposa e mulheres adultas membros da família; 2=ambos adultos homens e mulheres participando de igual forma; 3=Só/principalmente pelo marido e homem adulto membro da família; 4=Só/principelmente por meninas (<15 anos); 5=Só/principalmente por rapazes (<15 anos); 6=Só/principalmente por crianças (<15 anos), e rapazes e meninas participando de forma igual; 7=todos os membros da família participam de igual forma; 8=Nenhuma das alternativas anteriores

C. Renda derivada da floresta (renda de produtos processados)

1. Quais são as quantidades e valores dos produtos florestais processados que os membros das sua família produziram no **mês passado?**

1. Produto *(código-produto)*	**2. Quem na família faz o trabalho?**[1)]	**3. Quantidade produzida (5+6)**	**4. Unidade**	**5. Uso próprio (incl. presente/dado)**	**6. Venda (incl. trocas)**	**7. Preço por unidade**	**8. Tipo de mercado** *(código-mercado)*	**9. Valor bruto (3*7)**	**10. Compra de insumos/materiais & mão-de-obra assalariada**	**11. Custos de transporte/ venda**	**12. Rendimentos líquidos excl. custos de insumos florestais (9-10-11)**
Vinho											
Vassoura											
Paneiro											
Cesta											
Madeira											

1) Códigos: 1=Só/principalmente pela esposa e mulheres adultas membros da família; 2=ambos adultos homens e mulheres participando de igual forma; 3=Só/principalmente pelo marido e homem adulto membro da família; 4=Só/principalmente por meninas (<15 anos); 5=Só/principalmente por rapazes (<15 anos); 6=Só/principalmente por crianças (<15 anos), e rapazes e meninas participando de forma igual; 7=todos os membros da família participam de igual forma; 8=Nenhuma das alternativas anteriores

2. Quais são as quantidades e valores dos produtos florestais não processados usados como insumos para produzir produtos florestais processados na tabela anterior?
Nota: os produtos na coluna 1 terão de ser exatamente os mesmos que os da coluna 1 na tabela anterior.

1. Produtos processados (final) *(código-produto)*	**2. Produtos florestais não processados usados como insumo** *(código-produto)*	**3. Quantidade usada (5+6)**	**4. Unidade**	**5. Quantidade comprada**	**6. Quantidade coletada pela família**	**Aonde foram coletados?**		**9. Quem na família coleta dos produtos florestais?**[1)]	**10. Preço por unidade**	**11. Valor (3*10)**
						7. Tipo de terra *(código-terra)*	**8. Propriedade** *(código-posse)*			

1) Códigos como na tabela acima.
Nota: Colunas 7,8,9 deverão ser deixadas em branco se a família não colecta. Coluna 10 (preço) devera ser perguntado mesmo se só fazem a colecta, mas se não estiver disponível, veja guia técnico na valorização.
Nota: Resposta nas colunas 7 e 8 devem ser consistentes com as categorias de terra reportadas no questionário das comunidades (V1D01) e no questionário anual das famílias (A1C).

D. Pesca e piscicultura

1. Quanto peixe a sua família pescou **exclusivamente selvagem** (rios, lagos, mar) durante **o mês passado**?

***Tipo de peixe (listar os nomes locais)**	**Onde foi coletado?**		**3. Total pescado (kg) (4+5)**	**4. Uso próprio (incl. presente/dado)**	**5. Venda (incl. trocas)**	**6. Preço por kg**	**7. Valor bruto (3*6)**	**8. Custos (insumos, mão-de-obra assalariada, venda/transporte)**	**9. Rendimento liquido (7-8)**
	2. Tipo de terra *(código-terra)*	**3. Propriedade** *(código-posse)*							
Tucunare									
Tambaqui									
Piranha									
Boado									
Piau									
Curimatã									
Maturixã									
Pirarucu									
Filote									
Surubí dorado									
Piaba									
Manjí									

Nota: as respostas nas colunas 2 e 3 devem ser consistentes com as categorias de terra reportadas no questionário das comunidades (V1D01) e no questionário anual das famílias (A1C).

2. Quanto peixe a sua família pescou **dos açudes (piscicultura) no mês passado**?

*** Tipo de peixe (listar os nomes locais)**	**1. De onde?** [1)]	**2. Total pescado (kg) (3+4)**	**3. Uso próprio (incl. presente/dado)**	**4. Venda (incl. trocas)**	**5. Preço por kg**	**6. Valor bruto (2*5)**	**7. Custos (insumos, mão-de-obra assalariada, venda/transporte)**	**8. Rendimento liquido (6-7)**
Tilapia								

1) Códigos: 1=Tanque propriedade da família; 2=Tanque propriedade de um grupo que a família é membro; 3=Tanque propriedade da comunidade/comunidade; 4=Tanque propriedade de outros e as pessoas podem comprar direitos de pesca (incluindo custos na coluna 7); 9=Outros,especifique:

E. Rendimentos ambientais não florestais

1. Em cima dos produtos florestais e piscatórios incluídos nas tabelas anteriores, quanto de **outros produtos selvagens** (p. ex., de savanas, terras em pousio, etc.) a família colectou **no mês passado**?

1. Tipo de produto *(código-produto)*	**Aonde foi colectado?**		**4. Quantidade colectada (6+7)**	**5. Unidades**	**6. Uso próprio (incl. presente/dado)**	**7. Venda (incl. trocas)**	**8. Preço por unidade**	**9. Valor bruto (4*8)**	**10. Custos (insumos, mão-de-obra assalariada, venda/transporte)**	**11. Rendimento liquido (9-10)**
	2. Tipo de terra *(código-terra)*	**3. Propriedade** *(código-posse)*								

Nota: As respostas nas colunas 2 e 3 deverão ser consistentes com as categorias de terra reportadas no questionário das comunidades (V1D01) e com o questionário anual das famílias (A1C).

F. Rendimentos salariais

1. Algum membro da família foi pago pelo trabalho realizado no **mês passado**?

Nota: Uma pessoa poderá ser indicada mais do que uma vez para diferentes trabalhos.

1. Membro da família (PID)	**2. Tipo de trabalho** *(código-trabalho)*	**3. Dias de trabalho no mês passado**	**4. Pagamento diário**	**5. Rendimento salarial total (3*4)**

G. Rendimento do negócio próprio (não florestal ou agricultura)

1. Está envolvido em algum tipo de negócio, e se sim, qual é o rendimento bruto e os custos relacionados com o negócio no **mês passado?**

Nota: Se a família estiver envolvida em diferentes tipos de negócios, deve preencher cada coluna para cada negócio.

	1. Negócio 1	2. Negócio 2	3. Negócio 3
1. Qual é o tipo de negócio?[1)]			
2. Rendimento bruto (vendas)			
Custos:			
3. Compra de insumos/materiais			
4. Insumos próprios, não incluindo mão-de-obra (valor equivalente de mercado)			
5. Mão-de-obra assalariada			
6. Custos de transporte e venda			
7. Custos de reparação, manutenção, etc.			
8. Outros custos			
9. Rendimento liquido (2 - itens 3-8)			
10. Valor corrente do capital armazenado			

1) Códigos: 1=loja/comércio; 2=processamento agrícola; 3=artesanato; 4=carpintaria; 5=outro baseado em floresta; 6=outro mão- de-obra treinada; 7=transporte (carro, barco,…); 8=acomodação/restaurante; 19=outra, especifique:

H. Rendimento a partir da agricultura – culturas

1. Quais são as quantidades e valores das culturas que a família colheu nos **últimos 3 meses**?

1.Culturas *(código-produto)*	**2. Área de produção** (m^2)	**3. Produção Total (5+6)**	**4. Unidades (para produção)**	**5.Uso próprio (incl. presente/dado)**	**6. Vendas (incl. trocas)**	**7. Preço por unidade**	**8.Valor total (3*7)**
Arroz							
Feijão							
Milho							
Macaxeira*							
*Farinha							
Café							
Abacaxi							
Cupuaçu							
Amendoim							
Cana de azucar							
Banana							
Pimenta (do reinho)							
Maracuja							
Laranja							
Tangarina							
Limão							
Graviola							
Acerola							
Goiaba							
Cajú							
Melancia							
Guaraná							
Mamão							
Manga							
Ingá							
Abacate							
Batata							
Cebolha							
Abobera							
Tabaco							
Pepino							
Tomate							
Pupunha							

2. Quais são as quantidades e valores dos insumos da produção das culturas **nos últimos três meses** (isto refere-se a despesas dinheiro da agricultura)?
Nota: tomar em consideração todas as culturas na tabela anterior.

Insumos/Materiais	1. Quantidade	2. Unidades	3. Preço por unidade	4. Custo total (1*3)
1. Sementes				
2. Fertilizantes				
3. Pesticidas/herbicidas				
4. Estrume/Adubo animal				
5. Tração animal/Animal de trabalho				
6. Mão-de-obra assalariada				
7. Aluguel de maquinário				
8. Transporte/venda				
19. Outros, especifque				
a. foisa				
b. tesado				
c. lima				
d. limatão				
e. corrente				
f. gasolina				
g. oleo				
20. Pagamento pelo aluguel da terra				

I. Rendimentos a partir do gado

1. Qual é o número de animais ADULTOS que a família possui, e quantos vendeu, comprou, matou ou perdeu durante os **últimos 3 meses**?

	1. Número inicial (3 meses atrás)	2. Venda (incl. trocas), vivos ou mortos	3. Abatidos para uso próprio (ou presente dado)	4. Perdidos (roubados, mortos,..)	5. Comprados ou presente/dado recebidas	6. Cuantos tornaram-se adultos?	7. Número agora (1-2-3-4+5+6)	8. Preço por animal adulto	9. Valor total final (7*8)
1. Bovino									
Boi – transporte									
Touro									
Novilho									
Garrote									
Bezerro									
Vaca corte									
Vaca leite									
2. Búfalos									
3. Cabrras									
4. Ovelhas									
5. Porcos									
6. Burros									
7. Patos									
8. Galinhas									
Adultos									

Frangos									
Pintos									
9. Cavalo-Egua									
10. Capote									
11. Outros									

2. Quais são as quantidades e valores de produtos animais e serviços produzidos nos **últimos 3 meses**?

Produto/serviço	**1. Produção (3+4)**	**2. Unidades**	**3. Uso próprio (incl. presente/dado)**	**4. Venda (incl. trocas)**	**5. Preço por unidade**	**6. Valor Total (1*5)**
1. Carne [1)]						
2. Leite						
3. Manteiga						
4. Queijo						
5. Manteiga de búfalo						
6. Ovos						
7. Peles						
8. Lã						
9. Estrume						
10. Tração animal						
11. Rapadura						
12. Outros						

1) Garanta que corresponde com as tabelas anteriores de vendas e consumo familiar de animais.

3. Quais são as quantidades e valores de insumos/materiais utilizados na produção de gado durante **os últimos 3 meses** (despesas em pronto pagamento)?
Nota: O ponto chave é obter os custos totais, em vez de unidades de insumos.

Insumos	**1. Unidade**	**2. Quantidade**	**3. Preço por unidade**	**4. Custo total (2*3)**
1. Alimentação/pasto				
Sal				
Vitaminas				
2. Aluguel da terra para pastagens				
3. Medicamentos, vacinas e outros serviços veterinários				
Vacinas – aftose				
Vacinas – carbuncro (só para bezerros)				
Vacinas - raiva				
4. Custos de manutenção , estábulos, cercas, currais, etc.				
5. Mão-de-obra assalariada				
6. Outra, especifique:				

4. Por favor indique aprox. a divisão de alimentação dos animais, quer para pastos de animais próprios ou trazidos para a casa/estábulo/colocação por membros da família.

Tipo de terra de pastagem ou fonte de forragem		**3. Divisão aproximada** (%)
1. Tipo de terra *(código-terra)*	**2. Propriedade** *(código-posse)*	
Total		100%

J. Outras fontes de rendimento

1. Por favor descreva qualquer outra fonte de rendimento que as famílias vêm recebendo nos **últimos 3 meses**.

Tipo de rendimento	**Quantia total recebida nos últimos 3 meses**
1. Remessas (apoio financeiro por parentes/amigos que moram em outro lugar)	
2. Apoio governamental, ONG, organizações ou similar	
a. FUNRURAL	
b. Soldado da borracha	
c. Salario de maternidade	
d. Auxilio da saude	
e. Auxilio escolar	
f. Bolsa familía	
3. Ofertas/apoio de amigos e parentes	
4. Pensão	
5. Pagamento por serviços florestais	
6. Pagamento pelo aluguel da terra (se for em serviços e bems, indique o equivalente em valores monetários)	
9. Outros, especifique:	

APPENDIX F
HOUSEHOLD ATTRITION SURVEY (PORTUGUESE)

Levantamento de abandono e ausencia temporária

Informação de controle

Tarefa	Data(s)	Por quem?	OK? Se não, faça comentários
Entrevista			
Verificar o questionário			
Codificar o questionário			
Digitalização dos dados			
Verificação e aprovação da digitalização dos dados			

A. Identificação

1. Identificação e local da unidade familiar

1. Nome da unidade familiar e código	**(nome)*	*(NIF)*
2. Comunidade e código	**(nome)*	*(comunidade ###)*
3. Distrito e código	**(nome)*	*(NID)*
4. Quem foi entrevistado?[1)]		
5. A família saiu temporariamente (só um trimestral) ou permanentemente?	*(1=temporário; 2=permanente; 3=ainda não sei)*[2)]	

1) Códigos: 1 = membro da família; 2 = vizinhos; 3 = parentes; 4 = líder ou representante da comunidade; 9=outros, especifique: ____________

2) Código 3 deverá ser usado só temporariamente; usa 1 ou 2 na entrada dos dados finais.

B. Razões para não participar

1. Qual foi a razão para a família não participar neste levantamento trimestral?	**Razão**	**0-1 (quest. 1) ou código**
	1. Mudou/migrou permanentemente	
	2. Temporariamente fora da comunidade (trabalho, visita, …)	
	3. Se divorciu	
	4. Se casou	
	5. Morreu	
	6. Enfermidade	
	7. Nascimento de uma criança	
	8. Não participou porque está ocupado demais	
	9. Não participou porque não quer revelar informação da família	
	10. Não participou porque está cansado de responder as perguntas	
	11. Não localizou a casa	
	19. Outro	
2. Se se mudou/migrou (resposta 1), para onde? *Códigos: 1=dentro da comunidade; 2=comunidade vizinha; 3=outra comunidade mais longe; 4=a vila mais perto; 5=a cidade mais longe; 9=outro:_________*		
3. Se se mudou/migrou (resposta 1), porque foi embora? *Códigos: 1=trabalhar ou procurar trabalho; 2= (governo) serviço, incl. militar; 3=estudar; 4= estar mais perto a um esposo(a)/família; 5=casamento; 6=separação/divorcio; 7= usar herença; 8= procurar tratamento médico; 9=conflitos na comunidade; 19=outro, ___________*		
4. Se entrevistado faleceu (resposta 5), colocar o NIP:		
5. Se o entrevistado faleceu, qual foi a causa da morte? *Códigos: 1=doença; 2=veliçe; 3=acidente; 4=violência; 5=suicidio; 9=outro:_________*		

APPENDIX G
HOUSEHOLD BRAZIL NUT MANAGEMENT SURVEY 2006 (PORTUGUESE)

Comunidade: ____

Família: ____ # _______

Data: ___________________________

Pesquisador(a): ___________

1. Quantas árvores de castanheira têm em sua propriedade?	*árvores*
2. Quantas árvores nunca produzem ouriços?	*árvores*
3. Que data entrou na safra da castanha este ano?	
4. Até que data colectou castanha na safra?	
5. Quando foi a safrinha este ano?	
6. Número(#) de dias que você trabalha na safra por semana	*Dias*
7. Número(#) de dias na safrinha?	*Dias*
8. Descreve suas atividades associadas com a safra: *(1=juntar e quebrar o mesmo dia, 2=juntar uma estrada e depois quebrar, 3=juntar tudo y depois quebrar, 4=quando têm pouco, faz metodo #1, quando têm mais, faz metodo #2, 5=juntar um dia, quebrar o dia seguinte)*	

9. Quem da familia trabalha con Vc. na safra?

Membro da familia (NIP)	**Quantos dias por semana?**	**Paga esta pessoa?** *(1-0)*	**Quanto paga?**

10. Contrata mão de obra em sua propriedade durante a safra? *Si a resposta é não, passa ao número # 13*	*(1-0)*
11. Quantas pessoas pagou esta safra?	*Pessoas*

Nome	**Sexo** *(0=masc, 1=fem)*	**Ano do nascimento** *(aaaa)*	**Relação ao produtor**

12. Como pagou? *(1=dinheiro, 2=parte da safra, 3=troca dos dias, 4=outro)*?	E, quanto?
13. Você é sócio de uma cooperativa? *Se a resposta é não, passa ao número # 15*	*(1-0)*
14. Qual cooperativa?	
15. Quantas latas você coletou no ano passado (2005)?	*Latas*
16. Quantas latas este ano (2006)?	*Latas*

17. A quem você vendeu sua castanha

Nome	Tipo de comerciante *(1=marrateiro, 2=empresa, 3=cooperativa; outro produtor)*	Quantas latas?	Quanto pagou por lata?

18. Qual foi o preço da lata no ano passado (2005)?	
19. Você usa algumas das práticas seguintes no manejo de seu castanhal?	
a. Mapeamento das castanheiras	*(1-0)*
Se sim, qual instituição ajudou com o mapeamento?	
Quanto tempo gastou na prática?	*días*
b. Plano de manejo	*(1-0)*
Se sim, desde quando *(aaaa)*?	
c. Plantio de mudas	*(1-0)*
Se sim, quantas mudas foram plantadas?	*plántulas*
Onde? *(1=roçado; 2=capoeira, 3=mata, 4=jardim na casa, 5=outro)*	
Qual instituição ajudou?	
d. Manutenção das mudas nas capoeiras e roçados *(0=não, 1=só nas roçados, 2=só nas capoeiras , 3=só na mata, 4=em todos os lugais, 5=outro lugar)*	
e. Limpeza ao redor das mudas *(0=não, 1=só nas roçados, 2=só nas capoeiras , 3=só na mata, 4=em todos os lugais, 5=outro lugar)*	
Se sim, porque faz a limpeza? *(1=crescer melhor, 2=previr fogo, 3=ver a muda melhor, 4=outro)*	*Rango 1:* *Rango2:* *Rango 3:*
f. Protege as mudas nascidas contra fogo? *(0=não, 1=só nas roçados, 2=só nas capoeiras , 3=só na mata, 4=em todos os lugais, 5=outro lugar)*	
g. Corte de cipós?	*(1-0)*
Se sim, porque corta? (o *árvore produce mais frutas, 2=cipós matam o árvore, 3=o*	*Rango 1:*

árvore crescerz melhor, 4=as ramas caen com o peso dos cipós, 5=parte das Normas Técnicas, 6=limpar a copa, 7=outro)	*Rango2:* *Rango 3:*
h. Sangrar os árvores *(0=nunca, 1=só aos árvores que nunca producem, 2=a maioria dos árvores)*	*(1-0)*
i. Quebra os ouriços no mesmo dia da coleta	*(1-0)*
Máximo número dos dias que Vc. deixaría a castanha juntada na mata	*dias*
j. Transporte das castanhas a um armazém no mesmo dia da coleta	*(1-0)*
Se sim, porque no mesmo dia? *(1=a castanha fica ruin na mata, 2=os animais comen, 3=a ruin contamina ao resto, 4=eficiencia, 5=previr robos, 6=vende imediatamente, 7=costume, 8=outros)*	*Rango 1:* *Rango2:* *Rango 3:*
Se não, máximo número de dias deixaría a castanha quebrada na mata?	*días*
Metodo de transporte da mata *(1=espalda, 2=moto, 3=animal, 4=trator, 5=bicicleta, 6=outro)*	
k. Secagem das castanhas	*(1-0)*
Tem seu propio armazém? *(0=não, 1=sim, 2=sim, com um grupo)*	
Tem seu propio secador? *(0=não, 1=sim, 2=sim, com um grupo)*	
l. Uso de sacos para transportar la castaña *(0=não, 1=sim, tem que comprar suas bolsas,, 2=sim, os compradores dão as bolsas)*	*(1-0)*
20. Como transporta Vc. as castañas ao mercado? *(1= Seu mesmo, 2=comerciante, 3=cooperativa/empresa (caminão), 4=cooperativa/empresa (barco), 5=amigo/familia, 6=alugar transporte)*	
21. Você sabe que são as aflatoxinas (fungo/veneno)?	*(1-0)*
Se sim, como aprendeu sobre as aflatoxinas?	
22. Você usa algumas das práticas seguintes:	
a. Remover o umbligo	*(1-0)*
b. Remover a castanha cortada	*(1-0)*
c. Secar a castanha bem	*(1-0)*
d. Separar a castanha dos animais y combustivél	*(1-0)*
e. Não deixar os cocos por muito tempo na mata	*(1-0)*
f. Não coletar a castanha do ano anterior	*(1-0)*
23. Vc. caza durante a safra?	*(1-0)*
Se sim, Vc. caza mais ou menos que durante a safra que durante outras épocas do ano? *(1=mas, 2=menos, 3=igual)*	
24. Seu castanhal (está ou está sendo) certificado?	*(1-0)*

Se sim, qual tipo da certificação? *(1=orgánica, 2= FSC, 3=mercado justo)*	
Desde quando? *(aaaa)*	
25. Quais atividades são necessárias para ser certificado? **Rango 1-3**	
a. Remover a castanha ruin	
b. Secar a castanha	
c. Construir un armazém para secar a castanha	
d. Usar bolsa novas	
e. Não contato com animais, combustivél etc.	
f. Mapeamento do castanhal	
g. Empezar a safra cedo	
h. Asistir as reuniões	
i. Outro:	
26. Tem tido conflitos/ pelejas na época da safra?	*(1-0)*
Conflitos de que tipo? *(1=Menhor; sobre os arvores já resolvido, 2= Roubos da castanha (outros comunarios), 3= Roubos por vizinhos (comunarios), 4=Roubos por vizinhos (empresas), 5=Roubos por pessoal da cidade, 6=Roubos por extranjeiros, 7=Roubos da castanha nas bolsas, 8=Empresas enganhando)*	*Rango 1:* *Rango2:* *Rango 3:*
Descreve em detalhe os conflitos, incluido quantas latas eram perdidas y como resolviu o conflito?	
27. Vc. teve problemas con o fogo entrando em seu castanhal no ano passado?	*(1-0)*
Se sim, quantas hetares da mata queimou?	*ha.*
28. Daqui á 10 anos, Vc. pense que a parcela que tem agora vai ser sua? *(1=muito seguro, 2=seguro, 3=inseguro)*	
Porque?	
29. Daqui á 10 anos, Vc. pense que vai a ter *(1=menos, 2=mais, 3=o mesmo* número de) árvores da castaña que tem agora?	
Porque?	
30. O que fez com a renda da safra de castanha este ano?	

APPENDIX H

HOUSEHOLD BRAZIL NUT MANAGEMENT SURVEY 2007 (PORTUGUESE)

Comunidade: ____

Família: ____ # _______

Data: ____________________________

Pesquisador(a): ___________

31. Que data comencou a safra da castanha este ano?	
Até quando o senhor pretende coletar a castanha?	
32. Quantas latas colectou este ano (2007)?	*latas*
Quantas mais latas o senhor pretende coletar?	*latas*
33. Pagou trabalhadores para ajudar com a safra este ano (2007)?	*(1-0)*
Quantas pessoas?	
Como lhes pagou?	
Quantas latas do total tiraram?	
34. A quem o senhor vendeu sua castanha este ano?	

Nome	**Tipo de comercante** *(1=marreteiro, 2=empresa direita, 3=comunario, 4=cooperativa)*	**Quantas latas?**	**Quanto lhe pagou por lata?**

35. O senhor entrou nesta safra com uma dívida da safra de 2005-06?	*(1-0)*
Quanto?	
A quem?	
36. O senhor tirou um adiante do dinheiro antes desta safra (2006-07) da castanha?	*(1-0)*
Quanto?	
A quem?	
37. O que comprou com o adiante e/o a renda desta safra? *(p. ex. comida, remedio, moto, gado…)*	
38. O senhor é sócio da CAPEB/CAEX? Desde quando?	

	(1-0)
39. O senhor vende castanha orgánica?	*(1-0)*
a. Como diría o senhor que vender a castanha orgánica tem afeitado os beneficios que a família obtene da floresta? *(1=efeito negativo grande; 2=efeito negativo pequeno; 3=nenhum efeito; 4=efeito positivo pequeno; 5=efeito positivo grande)*	
b. Quais são os beneficios de produzir castanha certificada *(1=melhor preço, 2=outro)*	*Rango 1:* *Rango2:* *Rango 3:*
c. Quais são os aspetos negativos de ser certificado? *(1=muito trabalho, 2=outro)*	*Rango 1:* *Rango2:* *Rango 3:*
40. O senhor participou num mapeamento de seu castanhal?	*(1-0)*
a. Como diría que o mapeo dos castanhais tem afeitado sua familia? *(1=efeito negativo grande; 2=efeito negativo pequeno; 3=nenhum efeito; 4=efeito positivo pequeno; 5=efeito positivo grande)*	
b Quais são os beneficios do mapeo *(1=reduzir conflitos dentro da comunidade, 2=reduzir conflitos com os vizinhos, 3=fazer a safra mais eficente, 4=melhor manejo, 5=seguir as Normas Técnicas, 6=aprender novas técnicas, 7=outro)*	*Rango 1:* *Rango2:* *Rango 3:*
c. Quais são os aspetos negativos? *(1=muito trabalho, 2=nada mudou, 3=mais roubos depois do mapeo, 4=outro)*	*Rango 1:* *Rango2:* *Rango 3:*
41. Em sua opinião, seus direitos a sua colocação são *(1=muito inseguros, 2=inseguros, 3=não seguro,não inseguro, 4=seguros, 5=muito seguros)*	
42. Têm tido conflitos/roubos este ano na época da safra da castanha (2006-07)?	*(1-0)*
Se sim, conflictos de qual tipo? *(1=Menhor sobre os arvóres já resolvido, 2= Roubos por comunarios, 3= Roubos por vizinhos (comunarios), 4=Roubos por vizinhos (empresas), 5=Roubos por gente da ciudade, 6=Roubos por extranjeiros, 7=Roubos da castanha em sacos, 8=Empresas enganando, 9=outro)*	*Rango 1:* *Rango2:* *Rango 3:*
Descreve en detalhe os conflitos, incluindo quantas latas eram perdidas y como resolviu o conflito?	
43. O senhor quemou sua terra no ano passado (2006)?	*(1-0)*
a. Em que mes?	
b. Que tipo da terra foi quemado? *(1=mata bruta, 2=capoeira (>15 años), 3=capoeira (<15 años), 4=outro)*	
c. Quantas hectáres eram queimadas?	*ha.*
d. Porque o senhor quemou? (*(1=fazer roçado, 2=queimar pasto, 3=otro)*	

44. O senhor teve problemas con o fogo entrando en seu castanhal por accidente no ano passado (2006)?	*(1-0)*
Se sím, quantas hectáres da floresta quemaram?	*ha.*
45. O qué era/é o enfoque do uso da tierra por sua família? *(1=castanhaa, 2=madeira, 3=borracha, 4=agricultura, 5=animais pequenos, 6=pecuaria, 7=mineiria, 8=outro)*	
a. Faz 10 anos (1997)	*Rango 1:* *Rango2:* *Rango 3:*
b. Agora (2007)	*Rango 1:* *Rango2:* *Rango 3:*
c. Daqui 10 años (2017)	*Rango 1:* *Rango2:* *Rango 3:*
46. Como o senhor acha que asfaltar o ramal aquí afectaría a vida da pessoal? *(1=efeito negativo grande; 2=efeito negativo pequeno; 3=nenhum efeito; 4=efeito positivo pequeno; 5=efeito positivo grande)*	
Porque?	
47. O que sería a melhor maneira em apoiar para a produção da castanha no futuro? ¿Y quem pode apoiar?	

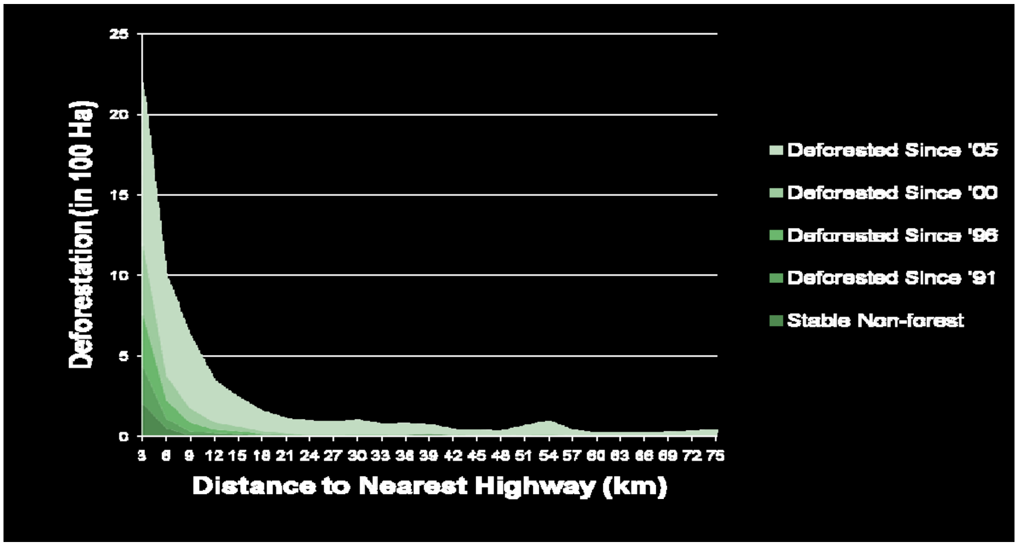
APPENDIX I

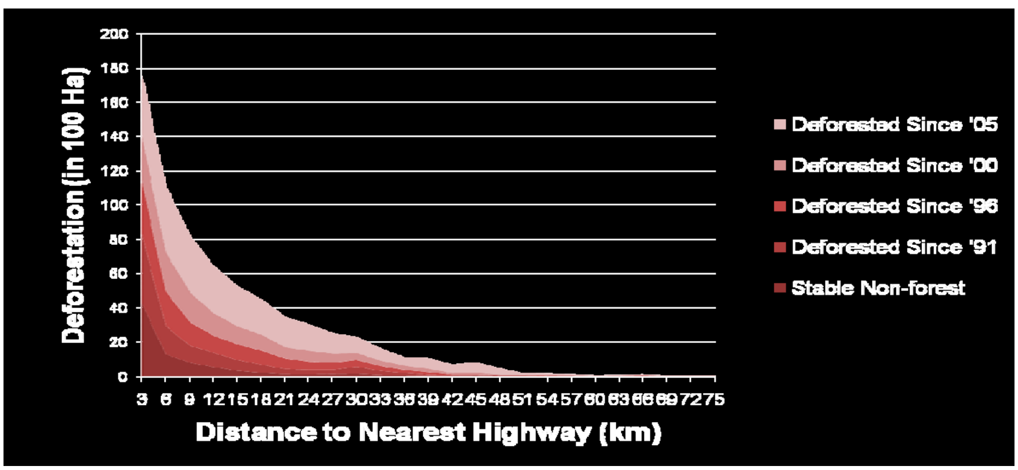
LANDSAT SCENES USED FOR LAND USE LAND COVER CHANGE ANALYSIS IN BRAZIL NUT-PRODUCING COMMUNITIES IN THE MAP REGION

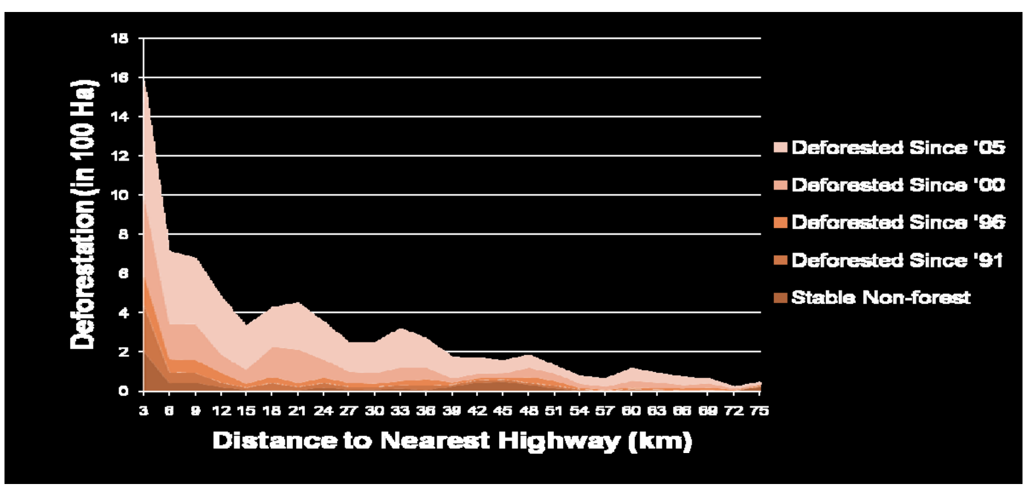
Platform	Path	Row	Year	Month	Day
TM	2	67	1986	8	6
TM	2	68	1986	8	6
TM	2	69	1986	9	7
TM	3	67	1986	7	28
TM	3	68	1986	7	12
TM	3	69	1986	7	12
TM	2	67	1991	7	27
TM	2	68	1991	7	27
TM	2	69	1991	7	27
TM	3	68	1991	10	14
TM	3	69	1991	10	14
TM	3	67	1992	6	18
TM	2	67	1996	8	1
TM	2	68	1996	7	16
TM	2	69	1996	8	17
TM	3	67	1996	7	23
TM	3	68	1996	7	23
TM	3	69	1996	7	23
ETM+	2	67	1999	8	2
TM	2	67	2000	7	27
ETM+	2	68	2000	11	24
TM	2	69	2000	7	27
ETM+	3	67	2000	5	23
ETM+	3	68	2000	7	26
ETM+	3	69	2000	5	23
TM	2	67	2005	8	10
TM	2	68	2005	6	7
TM	2	69	2005	8	10
TM	3	67	2005	6	30
TM	3	68	2005	9	18
TM	3	69	2005	9	18

APPENDIX J

DISTANCE FROM ROAD AND DEFORESTATION RATES FOR MADRE DE DIOS, PERU (GREEN), ACRE, BRAZIL (PINK) AND PANDO, BOLIVIA (ORANGE).







Courtesy of Southworth et al., in preparation.

APPENDIX K

RESULTS OF UNIVARIATE REGRESSIONS FOR POTENTIAL EXPLANATORY VARIABLES ON LOG FOREST CLEARED FOR COMMUNITIES IN EACH COUNTRY IN THE TIME PERIOD 2002-2007.

	Madre de Dios, Peru		Acre, Brazil		Pando, Bolivia		
Variable	Coeff.	*t*-Statistic	Coeff.	*t*-Statistic	Coeff.	*t*-Statistic	F-Stat
Household characteristics							
Size	0.0592	0.90	0.0385	1.09	0.0632	1.77+	0.167
Distance to village center (min)	0.0220	1.47	-0.00044	-0.23	0.00716	2.84**	0.019
Distance to city	-0.00013	-0.01	-0.000260	-0.35	-0.00372	-3.04**	0.028
Education (sum yrs)	0.00710	0.84	0.0061	0.46	0.00955	1.52	0.362
Age of household head (yrs)	0.01430	1.60	0.00002	0.00	0.01384	2.23**	0.062
Number adults (age 15-65)	0.0406	0.55	0.0746	1.17	0.1373	2.02*	0.130
Number children (age <15)	0.007	0.06	0.0360	0.67	0.0401	0.78	0.788
Number elders (age >66)	0.298	0.231	0.013	0.02	0.164	0.87	0.492
Length of residency (yrs)	0.01081	1.23	-0.00099	-0.15	0.00190	0.26	0.662
Household income (USD per capita)							
Forest income (w/out Brazil nuts)	0.000458	0.91	-0.000083	-0.22	0.000524	1.16	0.531
Brazil nut income	-0.000899	-3.61***	0.000123	0.26	-0.000953	-4.57***	<0.001
Aquaculture income	0	---	0.00129	0.719	0.0359	2.43*	0.104
Wage income	0.000444	0.94	-0.000093	-0.38	-0.000148	-0.44	0.748
Business income	-0.001127	-2.27*	-0.00034	-0.22	-0.000437	-1.64	0.205
Crop income	0.001889	2.89**	-0.000267	-1.36	0.001041	4.63***	<0.001
Livestock income	-0.00060	-0.57	-0.000376	-0.89	0.000533	1.84+	0.217
Other income	-0.00156	-0.44	0.000102	0.35	-0.00369	-1.97**	0.246
Total income	-0.000328	-1.75+	-0.000099	-0.91	-0.000002	-0.02	0.278
Assets							
Total land (ha)	-0.000604	-1.56	0.000166	0.80	0.000061	0.22	0.378
Material assets (USD per capita)	-0.000109	-0.14	0.000028	0.12	-0.000055	-0.45	0.971
Livestock assets (USD per capita)	0.000277	0.45	0.0000715	0.94	0.0002111	2.82**	0.033

Notes: All variables were measured using country as a fixed effect. Households were the unit of observation (n=125).

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BIOGRAPHICAL SKETCH

Amy Duchelle has experience in a broad range of tropical forest management issues. She received a Bachelor of Arts in Biology from Colorado College, a Master of Science in Conservation Biology and Sustainable Development from the University of Wisconsin, Madison, and completed her Doctor of Philosophy in the School of Forest Resources and Conservation at the University of Florida. Amy's first engagement with tropical forest ecology was through participation in Boston University's yearlong study abroad program in Ecuador, which included intensive field study in the Ecuadorian Amazon. After her undergraduate experience, she was employed as Education Coordinator at Olbrich Botanical Gardens in Madison, Wisconsin, where she was able to facilitate connections between people and plants through educational programming and exhibits. For her master's thesis research in Ecuador, she assessed how members of one remote Shuar community in the Amazonian Cordillera del Cóndor were managing woody plants in mature and secondary forest, and evaluated a capacity-building program in conservation biology for Shuar and Awá indigenous groups.

Amy strongly believes in collaborative research. During her doctoral work in Western Amazonia, she worked closely with regional partners in the development and implementation of her dissertation, including EMBRAPA-Acre in Brazil, CIFOR and Herencia in Bolivia, and the Asociación para la Conservación de la Cuenca Amazónica (ACCA) in Peru. She was also a research partner in the Center for International Forestry Research Poverty and Environment Network (CIFOR PEN), and her fieldwork contributed to a global database on the role of forests in community livelihood systems. Amy's field team included undergraduate students affiliated with regional universities, and she mentored two students in the development of their thesis projects within her larger research umbrella. She made a commitment to retuning preliminary research results to the communities with whom she worked and led trainings for undergraduate biology students (research design) and for communities (spatial data collection through participatory mapping). Amy also had the opportunity to participate on a scientific advisory team with regional partners toward reforming national policy for Brazil nut management in Bolivia. During her Ph.D., she also worked as a Consultant with CIFOR and as an Environmental Auditor for SmartWood.

Amy currently serves as a post-doctoral researcher with the University of Florida's Amazon Conservation Leadership Initiative, based at the Federal University of Acre, Brazil (UFAC). She works to enhance institutional scientific capacity through training and mentoring UFAC master's students in the *Ecologia e Manejo dos Recursos Naturais* and *Desenvolvimento Regional* programs in multi-disciplinary research that is problem-inspired and engages stakeholders on multiple scales. This research focuses on multiple-use forest management and assessment of Amazonian REDD pilot projects, through collaboration with CIFOR, and socio-ecological forest monitoring with WWF Brazil. Amy is pleased to be on a career path that is filled with interesting people and places and allows her to contribute to tropical forest management and policy decisions through research and outreach.