THESIS

THE MOTIVATIONS AND BARRIERS OF LANDOWNER PARTICIPATION IN REFORESTATION IN THE BELLBIRD BIOLOGICAL CORRIDOR IN COSTA RICA

Submitted by

Kathryn Powlen

Department of Human Dimensions of Natural Resources

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Summer 2018

Master's Committee:

Advisor: Kelly Jones

Peter Leigh Taylor
Alan Bright

ABSTRACT

THE MOTIVATIONS AND BARRIERS OF LANDOWNER PARTICIPATION IN REFORESTATION IN THE BELLBIRD BIOLOGICAL CORRIDOR IN COSTA RICA

Forest conservation and restoration approaches are implemented to address the decline in global forest cover, yet face institutional and social challenges in reaching end goals. A number of external and internal motivators can influence landowner participation in conservation, but there is still a lack of information on the relative influence of these types of motivators on decision making. This research examines the role of internal and external motivations and barriers on farmer participation in reforestation in the tropics. Eighty-five household surveys and 18 in-depth interviews were conducted with farmers in Costa Rica in 2017. Internal motivations analyzed include farmers' perceptions of environmental, economic and social outcomes of reforestation. External motivations analyzed include perceived support from conservation organizations. Multiple regression models were used to determine the significance of these factors, along with household and biophysical characteristics, on reforestation participation. External support and environmental perceptions were the most consistently significant variables across all regression models. Farm size and the number of years spent on the property also significantly influenced the decision to plant trees. Regression results were triangulated and contextualized with interview data. Results suggest that farmers are primarily concerned about securing regulating ecosystem services, such as water quality and quantity. Respondents showed a preference for in-kind support over cash. Interview data identified a lack of technical knowledge on how to plant trees and appropriate species to plant, unsuccessful past experiences

and a lack of trust in external organizations as barriers to reforestation. Overall, this research suggests that both internal and external motivators influence the decision to participate in reforestation, and that those motivators are moderated by contextual factors. Management implications suggest future extension programs which focus on outreach and environmental education will be important for the success of reforestation projects in the study area. Overcoming the initial cost to plant trees and promoting ecosystem services values from tree planting will be important components of future reforestation project design.

ACKNOWLEDGEMENTS

This thesis was made possible through the continuous support from many individuals at Colorado State University and in the Bellbird Biological Corridor in Costa Rica. A very special thank you to my advisor, Kelly Jones, for your support in designing, executing and analyzing this research. Additionally, I would like to thank my committee members, Alan Bright and Pete Taylor, who reviewed and provided comments for this thesis. Thank you also to Carlos Muñoz-Brenes, Shirley Murillo Ulate and Katy VanDusen, who assisted with the planning, preparation and editing of the survey instrument used. A special thank you to Debra Hamilton and the Monteverde Institute for their space and support while collecting data in the corridor. This research was financially supported by Bosqueterno, S.A. and Colorado State University's International Development Studies Travel Grant. Finally, a special thank you to the key informants and community members from all three of the corridor sectors where this research was conducted. I am truly grateful for all of the support I have received throughout this process.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter One: Introduction

Over the last 8,000 years almost half of the world's forest has been lost-dropping from 62 million square kilometers to 33 million square kilometers; much of this loss has occurred in just the last three decades (Bryant, Nielsen, & Tangley, 1997). Forest loss has consequences on both local and global scales in terms of impacts to ecosystem services and human livelihoods. For example, forest dependent communities in developing countries suffer directly as natural resources necessary for their livelihood grow scarcer (Ellis, 1999; Maruyama & Morioka, 1998; Poore, 1986). Also, the world carbon cycle is threatened as it is losing sequestration abilities and indirectly affecting global citizens through extreme and erratic changes in climate (Adger, 2000; WRI, 2000). Other forest benefits at risk are biodiversity's "genetic library", which contributes to human welfare by providing medicine and crop improvements (Myers, 1997); ecosystem stability through the diversity of plants and animals (Tillman, 1997); and secure habitats for diverse and endemic species (WCMC, 2000; WRI, 2000).

Forest conservation and restoration approaches are being implemented to address this dramatic decline in the world's forest cover (Chazdon, 2008). Approaches to forest conservation include ecotourism, protected areas, community-based conservation and most recently, payment for ecosystem services (Redford, Padoch, & Sunderland, 2013). For areas that have already been deforested, reforestation is critical to regain lost ecosystem services. The Center for International Forestry Research states "the objectives of reforestation projects are to enhance productivity, livelihood and environmental service benefits" (Wunder, 2005). Reforestation projects, like other conservation projects, face many challenges from an institutional and community perspective in reaching end goals. Organizations implementing reforestation projects typically face strict

timelines and limited resources (Kapos et al., 2008; McMichael et al., 2005). At the household level, the delay of the improvements to ecological conditions from reforestation and the costs of implementing these projects can pose a barrier for participation (McMichael et al., 2005).

A number of studies have looked at the factors that influence landowner decision-making and participation in conservation actions including reforestation and agroforestry (Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis, 2015). Agroforestry is a land management practice in which trees are integrated into pastoral farms or agricultural landscapes to diversify or sustain production (FAO, 2015). Common agroforestry practices include plantation intercropping, multipurpose trees, silvopasture, riparian buffers and windbreaks or shelterbelts (Montambault & Alavalapati, 2005). Household characteristics, biophysical characteristics, risk and uncertainty, and motivations, have been identified as factors affecting adoption of agroforestry (Pattanayak, Mercer, Sills, & Yang, 2003). Motivations to plant trees can be external, such as in-kind support or direct payments provided by organizations, or internal, such as perceived benefits or values. In general, external motivators, such as financial incentives, have been assessed more frequently compared to internal motivators of participation. However, the effect of external motivators on adoption is unclear. A study conducted in Costa Rica evaluated the effectiveness of the national payment for ecosystem services (PES) program on increasing forest cover. The author found that while forest cover had increased, the PES program was not the main cause (Allen & Vásquez, 2017). Other research has found PES to positively influence land use changes, even after the payments had ended (Pagiola, Honey-rosés, & Freire-gonzález, 2016). Additionally, in-kind support such as free trees (Ruseva, Evans, & Fischer, 2015) and technical assistance (Garbach, Lubell, & Declerck, 2012) have been found to enhance reforestation adoption.

The few studies that exist on internal motivators have found strong correlation between these motivators and the decision to participate in reforestation (Karppinen, 2005; Mastrangelo, Gavin, Laterra, Linklater, & Milfont, 2014; Meijer et al., 2015; Zubair & Garforth, 2006). Perceived environmental and economic benefits have been identified as strong predicators of tree planting. Specifically, perceived benefits such as erosion control, increased wood for fuel and furniture and increased shade have been found to influence reforestation decision-making (Zubair & Garforth, 2006). Research has also found social norms, identity and interest in building social capital to influence landowner behavior (Mastrangelo et al., 2014; Polomé, 2016). More investigation into internal motivations such as attitudes, values and landowner perceptions of benefits, in conjunction with external motivators, is needed (Meijer et al., 2015).

The overarching goal of this research is to identify how internal and external motivators influence landowner decision-making to participate in reforestation projects. Understanding motivations is key for the sustainability of reforestation projects and for environmental improvements in deforested areas. With a better understanding of motivations, project managers can better tailor projects to align with the interest of landowners, for example, increasing biodiversity or improving farm productivity. Additionally, a better understanding of barriers can improve reforestation project design by addressing landowners' constraints to participate. This research was conducted within the Bellbird Biological Corridor (CBPC) in Costa Rica. There have been several past reforestation projects conducted by local organizations in the corridor that have provided landowners with different forms of support including free trees, fencing material and technical assistance. Landowners in the corridor are also eligible to participate in the national payment for ecosystem service (PES) program, which provides cash in exchange for reforestation and forest conservation on private property. Thus, the CBPC provides a unique

opportunity to examine the role of internal and external motivations, due to the range of support and incentives for reforestation that have been provided to landowners in the past.

The overarching research question is: What are the motivations and barriers that affect landowner participation in reforestation in the Bellbird Biological Corridor? I focus on the following sub-questions to answer this overarching question:

1. How do *internal motivators* influence decision making in reforestation projects?
2. How do *external motivators* – specifically those provided by environmental organizations – influence decision making in reforestation projects?
3. What are the major barriers preventing participation in reforestation?

Chapter Two: Theoretical Foundations

Researchers have identified the need to better understand an individual's motivations and behaviors for increased landowner participation in conservation (de Snoo et al., 2013). Thus, understanding the relationship between cognitions and behavioral intention is key to understanding the decision to plant trees. This research draws on behavioral theories from Social Psychology to assess the role of perceptions as internal motivators for reforestation. Community Based Social Marketing (CBSM) provides a framework to identify the benefits and barriers of a specific behavior. This framework was applied to better understand barriers limiting reforestation participation in the study area and to develop management implications for more effective reforestation programs in the future. Literature on the adoption of agroforestry and reforestation was also reviewed to integrate contextual variables which have been found to influence reforestation, such as biophysical and household characteristics, into the analysis.

Behavior Change

Behavioral Theories. Behavioral theories have been applied in a variety of fields, including conservation, to understand the role of social-psychological factors on behavior. Theories such as the Theory of Planned Behavior (Ajzen, 1991), Theory of Reasoned Action (Ajzen & Fishbein, 1980), Norm Activation Model (Schwartz & Howard, 1981), and Value-belief-norm Theory (Stern, 2000; Stern, Dietz, Abel, Guagnano, & Kalof, 1999) have being applied to understand behavioral intentions. Most recently, Fishbien and Ajzen built upon the Theory of Planned Behavior and Theory of Reasoned Action to develop The Reasoned Action Approach (Fishbein & Ajzen, 2010).

These behavioral theories aim to define the relationship between cognitions (i.e. values, attitudes, beliefs and social norms) and behavioral intention. Cognitions, or mental processes and dispositions, have also been constructed into a hierarchy, ranging from general to specific. The cognitive hierarchy presents values as general desired end states that are formed early in life and resistant to change (Rokeach, 1973; Vaske & Donnelly, 1999). Beliefs are more oriented towards specific objects (i.e. person, action, issue). Beliefs account for much of the variation in attitudes and behaviors and have played a key role in many of the behavioral theories (Ajzen & Fishbein, 1980; Stern et al., 1999). Attitudes, or whether an individual is in favor of a specific behavior or not, has also been integrated into the theoretical frameworks of the Theory of Planned Behavior, The Theory of Reasoned Action and the Reasoned Action Approach. Perceptions have been operationalized similar to other theorized cognitions as a determinant of behavior (Bennett, 2016). An example from the Theory of Planned Behavior is "perceived behavior control" or the extent at which an individual believes they have control over a specific behavior. The Theory of Planned Behavior operationalizes perceived behavioral control to account for barriers influencing behavioral intention (Ajzen, 1991).

Introduction of these theories into behavior prediction began with health studies (Keshavarz & Karami, 2016; Rogers, 1983). More recently, they have been introduced to explain pro-environmental behaviors such as recycling, purchasing "eco-friendly" products and forest conservation (Fishbein & Ajzen, 2010; Karppinen, 2005; Klockner, 2013; Mastrangelo et al., 2014; Stern, 2000). In a study conducted by Mastrangelo et al. (2014), psycho-social factors taken from two theoretical models, Theory of Planned Behavior and the Norm Activation Model, were tested for their ability to predict forest conservation behaviors. Results from this study concluded the Theory of Planned Behavior was the most parsimonious with the greatest

explained variance of 41% (Mastrangelo et al., 2014). Other research testing these theories have found similar results in terms of strength to predict behavior. Karppinen (2005) concluded that the Theory of Planned Behavior was able to predict preferred methods of reforestation among forest owner's when comparing natural reforestation to seeding/planting. Although research has found clear correlations between behavioral theories and actual behavior, it has been highlighted that these theories assume that individuals always make rational decisions, which may not be true (Ajzen, 2012).

Community Based Social Marketing. The CBSM framework has also been used in the conservation social science field to better understand behavior and effectively promote sustainable behavior change (Mckenzie-Mohr, 2011). The CBSM framework builds on social psychology and social marketing to develop a 5-step framework for fostering sustainable behavior. Similar to the Theory of Planned Behavior, the CBSM framework recognizes the influence that barriers can play in behavior intention. The five steps of the CBSM framework include: 1) selecting behavior, 2) identifying barriers and benefits, 3) developing a strategy, 4) conducting a pilot and 5) evaluating broad scale implementation.

CBSM believes that each behavior has its own barriers and barriers for each behavior can vary across population segments (Mckenzie-Mohr, 2011). Population segments may vary by location or household characteristics. Barriers may exist internally (i.e. lack of knowledge) or externally (i.e. affordability) to an individual (Mckenzie-Mohr, Lee, Schultz, & Kotler, 2012). Steps to uncover barriers include reviewing relevant literature, qualitative data collection (i.e. observation and focus groups) and a random sample survey (Mckenzie-Mohr et al., 2012). To develop an effective strategy for behavior change (step three), it is critical to reduce barriers preventing participation.

CBSM has been applied in the health, transportation, and conservation fields (Mckenzie-Mohr et al., 2012; Verissimo et al., 2017; Wright et al., 2015). More specifically, CBSM has been applied to increase sustainability in fisheries in the Philippines and increase landowner participation in forest conservation programs in Mexico. Social marketing was found to influence perceptions and human behavior in multiple campaign sites in the Philippines (Verissimo et al., 2017). A social marketing campaign was found to increase adoption of payments for ecosystem services in Veracruz, Mexico by increasing the knowledge of benefits from tropical forests and potential threats from deforestation. An increase in knowledge, gained through a series of organized meetings, was able to overcome the barrier of technical capacity which had been preventing participation (Green, DeWan, Balcazar Arias, & Hayden, 2013).

Theoretical Framework for Reforestation and Agroforestry Adoption

This research builds upon behavioral theories and past literature on agroforestry and reforestation adoption to develop a conceptual framework for factors influencing the decision to plant trees. Decisions to participate in reforestation are complex and include motivators, as well as other factors that affect the benefits and costs of participation. Five major categories of variables can be identified from the literature as playing an important role in participation in reforestation and agroforestry: internal motivators, external motivators, bio-physical characteristics, household characteristics and barriers (Figure 1). The conceptual framework in Figure 1 summarizes some of the key variables used in the literature under each category; below I explain each of these categories in more detail. Overall, more research has been conducted on the role of external motivators than internal motivators. This may in part be due to the ease in identifying and measuring these motivators quantitatively. However, research has acknowledged the need to assess both internal and external motivators moving forward (Meijer et al., 2015).

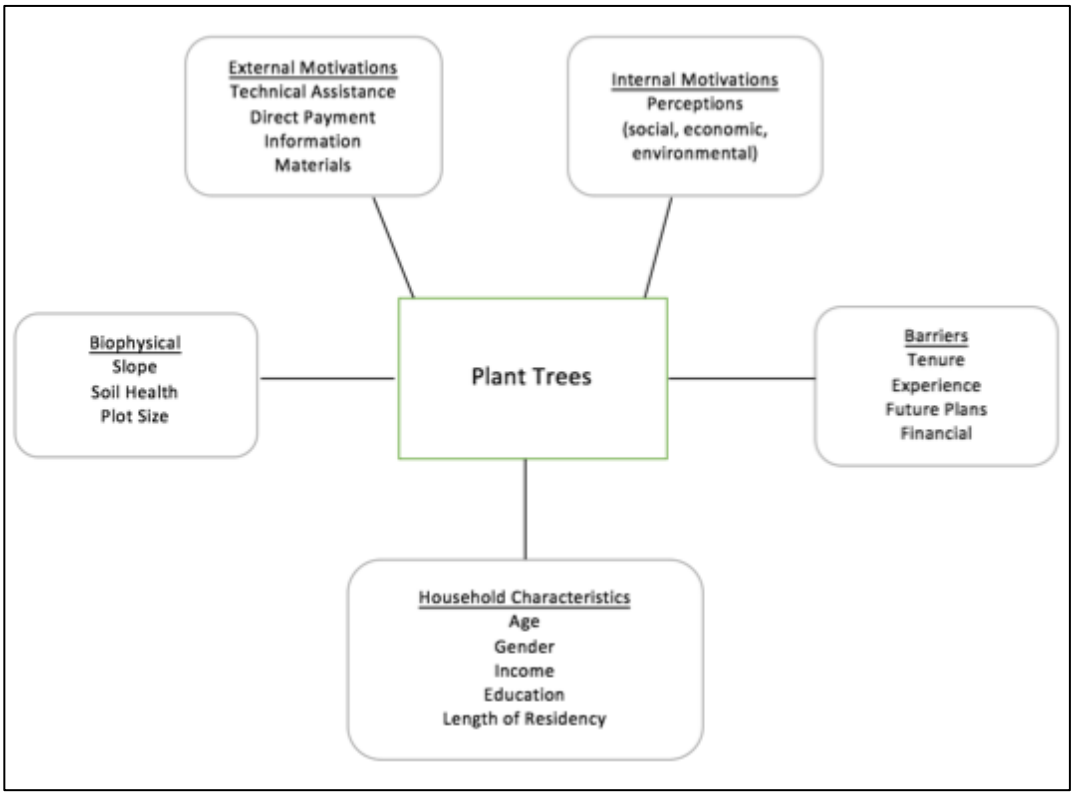


Figure 1: A framework for factors influencing tree planting.

Internal Motivations. Research on conservation motivations has suggested two types of motivators: internal and external. Internal motivators are commonly described as *intrinsic* motivators and draw on cognitions presented in behavioral theories. Internal motivations exist in situations where conservation objectives are seen as being able to improve the quality of life of local populations (Souto, Deichmann, Núñez, & Alonso, 2014). A systematic review of conservation motivation studies conducted by Rode, Gómez-Baggethun, & Krause (2015), distinguishes two categories of intrinsic motivations: pro-social and pro-nature (Rode, Gómez-Baggethun, & Krause, 2015). Pro-social motivations support the sustainable use of resources and public goods for societal benefits, while pro-nature motivations are more focused on the health of natural environments. Pro-social motivations have been noted in the literature by an

individual's desire to guarantee resources for future generations or reinforce social cohesiveness (Ruiz-Mallén, Schunko, Corbera, Rös, & Reyes-Garcia, 2015). An individual's desire to participate because they think protecting the environment is the "right" thing to do is considered a pro-nature intrinsic motivation (Kabii & Horwitz, 2006).

Within agroforestry adoption literature, beliefs about outcomes have been tested to identify the significance of internal motivators. Positive belief outcomes of adoption include an increase in income, increase in available fuel wood and furniture wood, food security, erosion control, pollution control and the increase of shade for humans and animals (Meijer et al., 2015; Zubair & Garforth, 2006). Negative beliefs about outcomes include incurred costs, reduction of agricultural yields due to increased shade and providing harbor to insects, pests and disease (Meijer et al., 2015; Zubair & Garforth, 2006). Other research has identified altruism and place attachment as internal motivations for participation (Polomé, 2016).

External Motivations. External motivations, also referred to as *extrinsic* motivators, have been identified as material benefits provided to individuals in order to encourage participation (Souto et al., 2014). Direct payments, in-kind or material goods, and technical assistance are forms of external motivators. The use of external motivations in conservation is grounded in rational choice theory, which assumes that a landowner will always choose the option with the largest or most immediate benefit (Grillos, 2017; Kabii & Horwitz, 2006). Examples of real-world external motivators include financial incentives for farmers to plant specific crops in South America (Narloch, Pascual, & Drucker, 2012), financial compensations for restrictions of forest use in Mexico (García-Amado, Ruiz Pérez, & Barrasa García, 2013) or fencing materials to protect forests around water sources in Costa Rica (Grillos, 2017). Specific to reforestation, research has found that providing free trees can increase landowner participation

in reforestation (Ruseva et al., 2015). A review of case studies found that cash is the most common incentive used in conservation programs, but it is commonly supplemented by in-kind materials or technical support (Wunder, Engel, & Pagiola, 2008).

While external incentives have increased participation in conservation in some places, there are a number of concerns about the use of economic incentives in settings where internal motivators are strong. These concerns stem from cross-cultural conflicts and questions about the long-term effects of economic incentives on internal motivations (Polomé, 2016; Rode et al., 2015). The term "crowding out", originally introduced in psychology literature, has been used to describe the effects of economic incentives on intrinsic motivations (Deci, 1971; Deci, Ryan, & Koestner, 1999) and has been applied to environmental conservation (Bowles, 2008; Grillos, 2017; Martin, Blowers, & Boersema, 2008; McCauley, 2006). While there is evidence of both a "crowding in" and "crowding out" effect of financial incentives, a recent review suggests that there is greater frequency to "crowd out", or undermine, intrinsic motivations and values (Rode et al., 2015). The use of in-kind materials as external motivators attempts to avoid purely self-interested behavior brought on by direct payment (Kerr, Vardan, & Jindal, 2014).

Biophysical Characteristics. Forest conservation and agroforestry literature have found that bio-physical factors strongly influence reforestation adoption (Agrawal & Chhatre, 2006; Bannister & Nair, 2003; Pattanayak et al., 2003; Sibelet, Chamayou, Newing, & Montes, 2017). Within a meta-analysis conducted by Pattanayak et al. (2003), bio-physical factors such as slope, elevation, soil health and plot size, were significant in agroforestry adoption albeit the significance was inconsistent. For example, Pattanayak et al. (2003) found that poor soil quality can lead to greater probability of adoption, however, in some cases the quality was too low for adoption success. Similarly, research has found farmers to be more willing to plant trees in

steeply sloped areas, along farm boundaries or in riparian areas (Sibelet et al., 2017). Other research has found elevation to be significant in forest conservation due to its relationship with temperature and pressure from humans (Agrawal & Chhatre, 2006). Specifically, pressure from humans for forest use and agriculture was reduced as distance from populations increased, increasing the sustainability of the reforestation efforts.

Household Characteristics. Household characteristics such as age, gender and income have been found to be significant in agroforestry adoption (Chowdhury & Turner II, 2006; Dinh, Nguyen, Hoang, & Wilson, 2017; Le, Smith, & Herbohn, 2014; Meijer et al., 2015; Pattanayak et al., 2003; Sood & Mitchell, 2009; Zubair & Garforth, 2006). The meta-analysis conducted by Pattanayak et al. (2003) categorized household characteristics into "preferences proxies", including education, age, gender and social status, and "resource endowments" which included income, assets, labor livestock and credits. Results of the meta-analysis found that resource endowments had a greater influence in agroforestry adoption than preference proxies. Other research has found mixed results for the influence of on and off-farm income. Dinh et al. (2017) found that landowners who relied more heavily on agriculture were less likely to plant trees, while other research has found landowners with greater off-farm income to be less likely to adopt agroforestry (Chowdhury & Turner II, 2006). Length of residency can also positively influencing tree planting (Chowdhury & Turner II, 2006).

Barriers. Agroforestry research has categorized barriers to adoption as 'risk and uncertainty' (Feder & Umali, 1993; Greiner & Gregg, 2011; Jerneck & Olsson, 2014; Mercer, 2004; Pattanayak et al., 2003). Pattanayak et al. (2003) identified tenure and experience as factors of risk and uncertainty. When tested, both were found to be statistically powerful variables in agroforestry adoption. Mercer (2004) found that tenure had a positive impact on

agroforestry adoption due to the length of time required to receive benefits from planted trees. Other research has classified agroforestry adopters as opportunity seekers and non-adopters as risk evaders (Jerneck & Olsson, 2014). Jerneck and Olsson concluded that risk evaders, or non-adopters, are often low-income households who cannot afford to participate in activities with long-term benefits due to immediate needs. Zubair and Garforth (2006) found uncertainty led landowners to rely on social networks. The authors found that landowners who planted trees had a higher perception of social pressures due to the fact that they were looking to others in their decision making process.

Chapter Three: Study Area

The Bellbird Biological Corridor (CBPC)

Costa Rica is often looked at as a model for sustainable development. After experiencing some of the highest deforestation rates in Latin America through the 60s and 70s, strong environmental awareness backed by new environmental policies began the conservation era in Costa Rica which exists today. The Forestry Laws of 1969 and 1996, which made deforestation illegal and established national parks, has led to a dramatic increase in forest cover, especially since the late 80s (Evans, 1999; Brockett and Gottfried, 2002). In efforts to continue improving and protecting the local ecology, the Sistema Nacional de Áreas de Conservación (SINAC) passed a law in 2006 which officially recognized a network of multi-use biological corridors throughout the country (Oduber et al., 2011).

Amongst this network of biological corridors is the CBPC (for its Spanish name Corredor Biológico Pájaro Campana). The CBPC was founded in 1992 with the support of six institutions, Monteverde Institute (Instituto Monteverde, IMV), University of Georgia-San Luis (UGA), Reserva Bosque Nuboso Santa Elena, Reserva Biológica Bosque Nuboso Monteverde, Costa Rican Conservation Foundation (Fundación Conservacionista Costarricense, FCC) and Monteverde Conservation League (Asociación Conservacionista Monteverde, ACM). The CBPC "*is a process that articulates actors and promotes integrated actions that lead to the reestablishment and maintenance of biological connectivity, the conservation of natural resources and the wellbeing of local communities*" (CBPC, 2018). The ultimate vision is to maintain an area which holds high ecosystem integrity and prosperous communities due to the sustainable and appropriate use of natural resources (CBPC, 2018).

The boundary of the CBPC reaches from the Gulf of Nicoya to the Pacific slope of the Tilarán mountain range in the Puntarenas province. The initial boundary of the CBPC covered a total of 667 km^2. A recent addition to the CBPC expanded near the southwest corner and increased the area to 880 km^2 (Figure 2). The corridor's boundaries contain four major rivers, Guacimal, Aranjuez, Lagarto and the Canamazo River. The CBPC protects habitat critical for the protection of the Three Wattled Bellbird (*Procnias tricarunculatus)*. In addition to the Three-Wattled Bellbird, 50% of the terrestrial vertebrates in Costa Rica are believed to be represented within the corridor's boundaries (Oduber et al., 2011). An altitudinal gradient of up to 1,800 meters produces a wide range of temperatures and rainfall throughout the corridor, promoting a diverse set of eco-regions (Figure 3). Forest fragments are scattered throughout the corridor due to past deforestation (Figure 2) (Chinchilla, 2015).

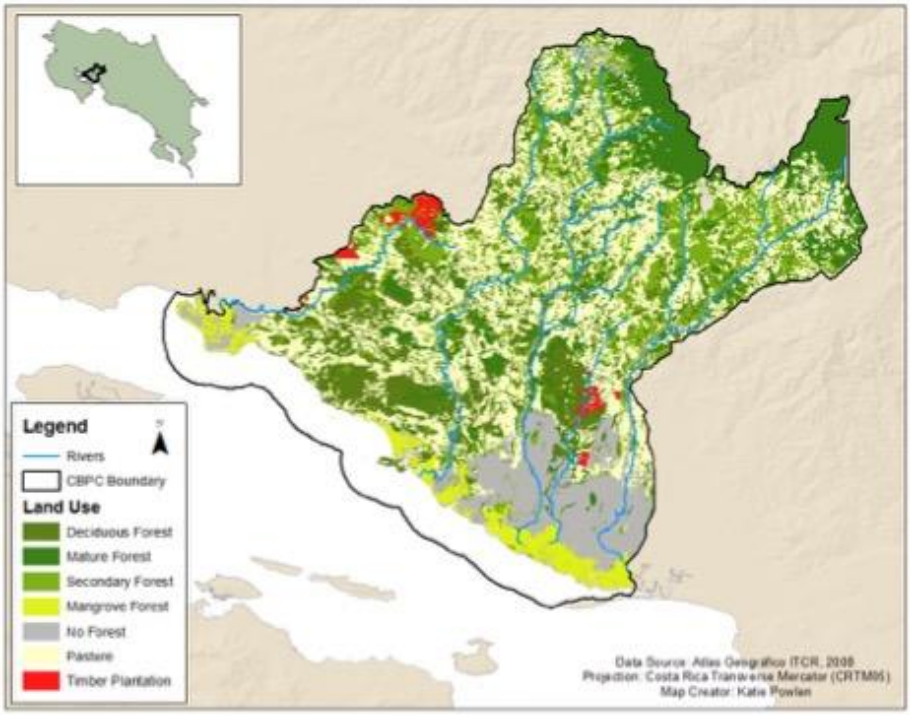


Figure 2: 2008 land use map of the Bellbird Biological Corridor (CBPC); includes boundary expansion.

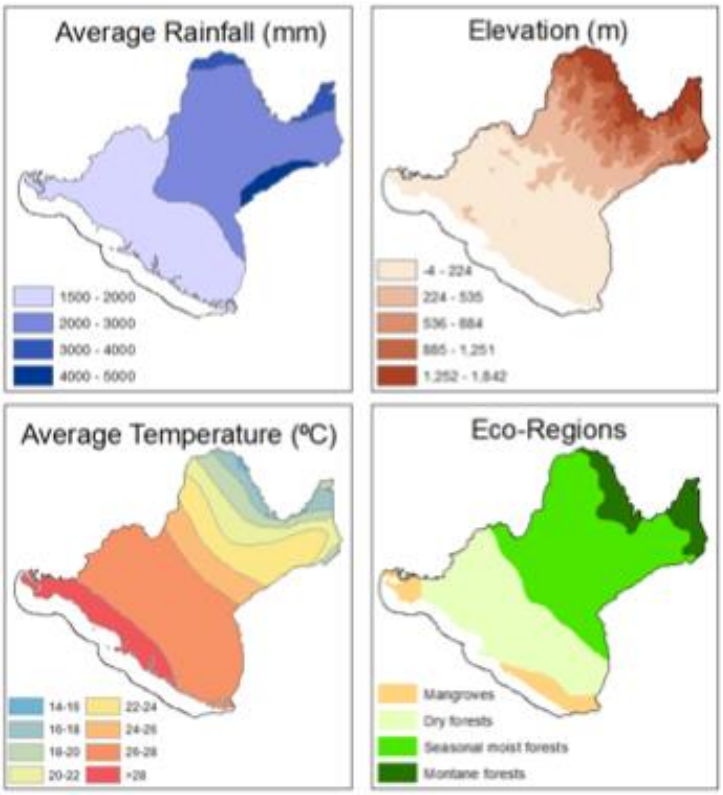


Figure 3: Ecological variation within the CBPC.

For the purpose of this research, the CBPC was divided into three sub-sections: upper, middle and lower. The three corridor sections (Figure 4) were chosen to reflect the social and ecological diversity within the corridor (Figure 3). Each section is located at a different elevation, producing different climate conditions and supporting a variety of flora and fauna. Within each corridor section, multiple communities were selected for sampling based on similar population characteristics (i.e. main livelihoods, population density) and key informant recommendations. District boundaries were also taken into consideration when selecting upper, middle and lower corridor communities. Most of the households sampled in each corridor section are located within the same district, however, a few households are just over the district boundary line.

Six communities were sampled in the upper section of the corridor, which was limited to the Monte Verde district (Table 1). The upper corridor communities include: Monteverde, Santa Elena, Los Llanos, Cañitas, La Cruz and La Lindora. Because of the growing eco-tourism industry and diverse occupational opportunities in the upper section, communities were selected with the assistance of key informants to ensure consistency among households. Four communities were sampled in the middle corridor, which was limited to the district of Guacimal. The middle corridor communities include: Guacimal (Central), San Antonio, Fernandez, and Vera Cruz. Three communities were sampled in the lower section, which followed the Manzanillo district boundary. The communities sampled in the lower corridor include: Manzanillo, Abangaritos and Coyolitos. For the remainder of the thesis, each group of communities will be referred to as upper, middle and lower corridor.

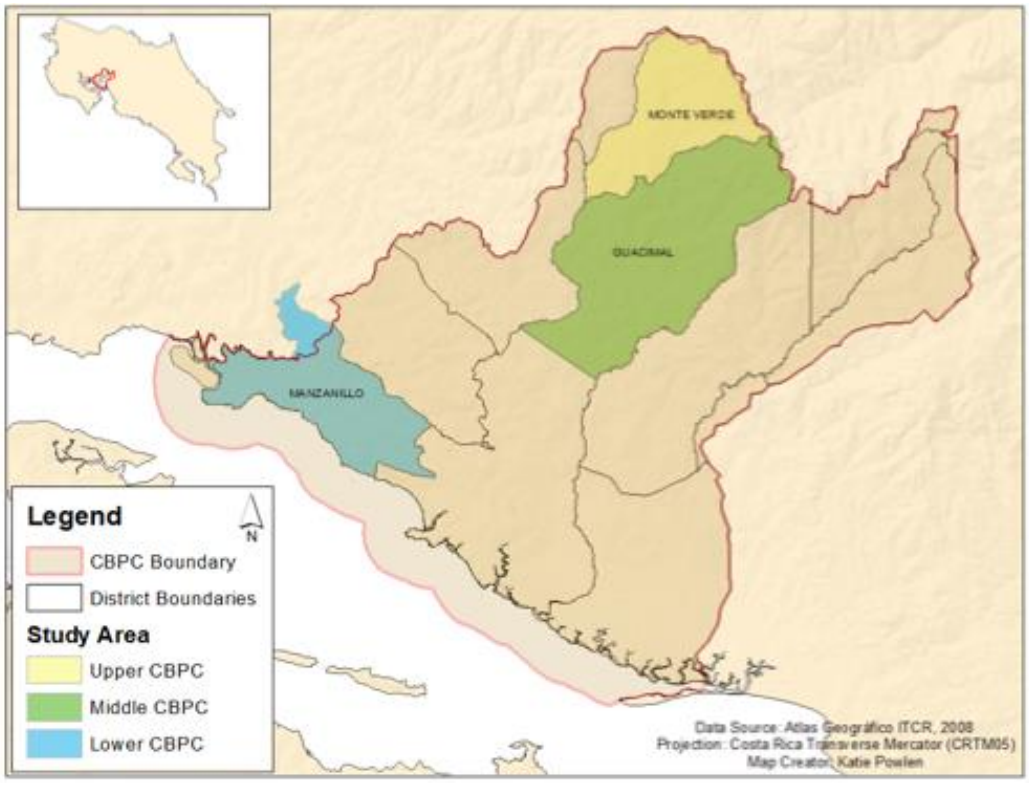


Figure 4: Map of study area

Table 1: Summary of the communities sampled in each part of the CBPC

Corridor Section	District	Total Communities Sampled	Total Households Sampled
Upper	Monte Verde	6	35
Middle	Guacimal	4	24
Lower	Manzanillo	3	26

Upper Corridor Section

The upper section of the corridor contains dense cloud forests and multiple biological reserves. The establishment of Monte Verde has been attributed to the settlement of the Quakers, who immigrated from the United States in the 1950s (Vivanco, 2006). Shortly after settling in Monte Verde, the Quakers constructed the Monteverde cheese factory, which helped establish stable markets for local dairy farming. Today, dairy farming has become less popular as it has become less profitable and new opportunities have emerged. In the late 1980s, this region became a hotspot for tourism and conservationists due to the rich biodiversity. Santa Elena, the center of Monte Verde, contains numerous hotels, restaurants, museums and other attractions for locals and tourists. As tourism has spread from Santa Elena into surrounding communities, many residents have abandoned farming and transitioned into tourism. Others have found ways to integrate tourism into farming (i.e. coffee tours).

The national census, collected in 2011, reported the total population of the Monte Verde district as 4,155 residents and a total of 1,523 households (Table 2). Today, the population is believed to have increased to over 5,000 inhabitants. The reported population density of the district is 78 people per km^2 and over half of the population is considered to be living in 'urban' housing. In 2011, 69% of the population held primary and secondary level education. The

literacy rate was 96% for both males and females. Almost 60% of the population over 15 years of age were reported as active in the labor force. Sixty-eight percent of the labor force were reported as working in the tertiary employment sector, also known as the service industry. This can include hotels, restaurants and other tourism services.

Living conditions within the upper corridor are higher than the middle and lower corridor, due to the higher level of economic development from tourism. Twenty-two percent of the population reported lacking one or more basic need, under 4% reported lacking two or more. The census also reported only 8% of Monte Verde residents as lacking a healthy lifestyle, with 6% lacking access to knowledge and 6% lacking access to other goods or services. Overall, there is a higher living standard in the Monte Verde district. However, the economic development and stability brought by tourism has not been evenly distributed. Communities further from the district center may experience lower living conditions compared to the district statistics.

Table 2: Population Characteristic, Census Data 2011

District		**Manzanillo**	**Guacimal**	**Monte Verde**
Total Population		2,811	923	4,155
Total Individual Houses		971	424	1,523
Population Density (per km^2)		47.8	8.7	78.4
Literate (% Population 10+ years)	Male	1,124 (90%)	366 (87%)	1,206 (96%)
	Female	998 (90%)	356 (92%)	1,168 (96%)
Percent of population with basic education		62.8	65.8	68.5
Percent of population 5-15 yrs of age pursuing basic education		88.3	82.6	86.8
Percent of population 15+ currently in school		13.2	8.7	12.0
Percent population in labor force (15+ yrs)		43.9	48.2	59.9
Percent work force in primary sector (i.e. agriculture, animal husbandry)		74.9	67.4	13.7

Percent labor force in tertiary sector	18.8	25.8	67.8
Percent households lacking at least one basic need	45.4	49.5	22.2
Percent households lacking one basic need	29.6	36.7	18.4
Percent households lacking two or more basic need	15.8	12.8	3.7
Percent of households below 'decent' housing standards	26.5	14.1	5.9
Percent household lacking a healthy lifestyle	12.0	32.5	8.4
Percentage of households lacking access to knowledge	12.6	4.9	6.4
Percent of households lacking access to other goods or services	14.4	12.1	5.6

Middle Corridor Section

Communities sampled in the middle corridor are within the Guacimal district and are located at a lower elevation than the upper corridor. Guacimal began operating as a gold mining town in the early 20th centuries much before the Quakers became established in Monte Verde (Vivanco, 2006). Despite being located next to Monte Verde, few tourism benefits reach this region. As a result, much less infrastructure and service industry opportunities exist in the middle corridor. Alternatively, larger beef and dairy farms have become the primary source of income due to warmer weather and less threat from harsh winds. Fruit trees, such as avocados, mangos, and citrus fruit, and apiculture commonly supplement income in this region.

An important characteristic of the middle corridor is the Veracruz River, which runs through Guacimal and serves a water source for many residents. In recent years, the Veracruz river has been at the center of controversy due to an irrigation project to reroute a portion of the river water for agricultural purposes. The irrigation project proposed to deliver water to nearby cattle farms, a large poultry farm (PIPASA) and pineapple plantations further south in the corridor. Many local residents were concerned over possible household and ecological outcomes

of the irrigation project. Collaborative forces, including community members, a local non-profit, national universities and universities from the U.S., pushed back against the project. In July of 2017 the proposal was officially rejected, cancelling the irrigation project after a 9-year legal battle.

In 2011, the census data reported the total population of the Guacimal district as 923, with a population density of almost 9 people per km^2 (Table 2). Almost 66% of the total population hold both a primary and a secondary level education. Literacy rates for residents over 10 years old were 87% for males and 92% for females. Less than half of the total population 15 years and older are actively engaged in the labor force. The primary sector, which could include agriculture, mining, ranching and beekeeping, accounts for 67.4% of the district labor.

The census recorded a total of 424 homes in the district, all categorized as rural households. Half of the total households reported lacking at least one basic need, 13% of which were lacking two or more. Thirty-three percent of households are also listed as lacking a healthy lifestyle and 12% are lacking access to goods and services. Access to knowledge was the highest in the middle corridor compared to the upper and lower districts. Less than 5% of the Guacimal population reported lacking an access to knowledge.

Lower Corridor Section

The lower corridor is located in the southwest region of the CBPC, along the Gulf of Nicoya (Figure 4). The coastline and mangrove forest support local fishermen, whom are heavily concentrated in Costa del Pájaros. The warm weather and flatter landscape of this region allows for different farming opportunities, such as timber farming and melon cultivation. Teak (*Tectona grandis*) and Melina (*Gmelina arborea*) timber farms are more common in this region and often owned by absentee landowners. Other economic activities include large cattle ranches,

watermelon cultivation and salt extraction. Large landowners control much of the land in this region and employ other community members on the farm or rent small lots to other smallholder agriculturalists. Smaller landowners maintain subsistence plots on their property and rent secondary plots or work part time to supplement income.

The 2011 census reported a total of 2,811 residents in the Manzanillo district with a population density of 48 people per km^2 (Table 2). Almost 63% of the population holds a general education of both primary and secondary schooling. Ninety percent of both male and female residents over 10 years of age are literate. Eighty-seven percent of the total households were categorized as rural and 49% percent of the households are part-time or vacation homes. Forty-five percent of the households were recorded as lacking at least one basic need and 16% were lacking two or more. The lower corridor also has a larger percentage of households lacking access to knowledge (13%) and lacking access to other goods and services (14%). Almost 75% of the labor force works in the primary sector (i.e. farming, fishing, salt extraction) and 20% works in the tertiary sector.

Conservation Organizations

Many conservation organizations, both local and national, work within the corridor to promote reforestation and forest conservation. Many of the local organizations are located in the upper corridor including the Monteverde Conservation League, the Monteverde Institute and the Costa Rican Conservation Foundation. In the late 80s to early 90s, Monteverde Conservation League became widely recognized by agroforestry programs and land purchases, for what is known today as the Children's Eternal Rainforest. Current and former Monteverde Conservation League employees report planting over 1,500,000 trees in early reforestation projects. Trees were planted most often in the form of windbreaks. Many of these formations, now mature corridors,

can be seen throughout the upper corridor. Today, the Monteverde Conservation League's main focus is on managing the Children's Eternal Rainforest. While the Monteverde Conservation League has shifted their focus, other organization such as the Monteverde Institute and the Costa Rican Conservation Foundation continue to develop and promote reforestation projects within the corridor.

The Sustainability Demonstration Center is a local non-profit located in Guacimal focused on environmental protection and social justice. They manage a tree nursey in the middle corridor, which was developed with the help of the Costa Rican Conservation Foundation. Students from the Monteverde Institute have assisted with many of the center's reforestation projects over the past few years. The center has provided landowners with free trees and fencing materials. The height of the Center's reforestation projects was in 2013-2014 when almost 17,000 trees were planted in the middle corridor. The Sustainability Demonstration Center was heavily involved in the resistance efforts of the river irrigation project.

Reforestation in the CBPC has also been supported by national level reforestation projects. An autonomous government body known as Fondo Nacional Financiamiento Forestal (FONAFIFO) runs a national level PES program which began in 1997. In the first 19 years, the PES program had produced over 16,000 contracts to protect existing forests and reforest new land. The contracts covered more than 1,170,000 ha throughout Costa Rica (FONAFIFO, 2017). Landowners in possession of a legal title are eligible to enroll in the PES program and receive payments for conserving existing forest or reforesting private property. The Ministerio de Agricultura y Ganadería (MAG) also offers assistance with agroforestry projects, in addition to managing a variety of agricultural programs. MAG extension offices are located throughout the country to provide support to farmers on best farm management practices.

Chapter Four: Methods

A mixed methods approach was used to answer the research question posed in this thesis. Mixed methods research uses complementary quantitative and qualitative methodologies to arrive at a main study conclusion and can provide a better understanding of complex social-ecological systems (Yin, 2015). The application of quantitative and qualitative methodologies in this research allowed for a broader understanding of conservation motivations and barriers in the three sections of the Bellbird Biological Corridor. A household survey, consisting of open and close-ended questions, was developed for data collection. In addition to the survey, two interview guides were designed to conduct key informant and landowner interviews. Appropriate IRB approval (Appendix A) was gained before beginning the data collection summarized in this section. All surveys and interviews were conducted in Spanish.

Data Collection: Household Survey

The household survey was designed to collect quantitative data on multiple variables in the conceptual model (Figure 1). A total of 85 surveys were conducted with landowners in the three sections of the corridor (Table 1). The length of the household survey ranged from 40 minutes to 90 minutes, with an average time of 50 minutes. A few household surveys also included a tour of the property to visit reforestation plots. The complete survey is included in Appendix B.

Sampling

A randomization sampling strategy was used in the field for the survey data collection. A randomization sampling strategy is an approach used when an appropriate sampling frame is not

available (Scheaffer, Mendenhall III, & Ott, 1996) and can also help reduce the subjectivity to selection errors by researchers. In this sampling approach, the researcher randomly selects the first unit and sets a fixed interval (i.e. every *n*th unit), to systematically sample subsequent units (Morgan & Harmon, 1999; Vaske, 2008). For this research, $n = 3$, meaning that every third household was approached and a decision-maker was asked to participate. If the decision-maker was not available, the sequential household was sampled. A property size minimum of one hectare was selected as a requirement for survey participation. This minimum was selected based on key informant recommendations to ensure each property had enough space for substantial reforestation.

To overcome survey sampling limitations, such as a refusal to participate, additional sampling techniques were used. Survey refusal can lead to misrepresentation of specific groups within the sample population (Perecman & Curran, 2006). A common reason for survey refusal from landowners in this research was time constraint. To overcome this limitation, phone numbers were acquired from community members that could not participate at the time of inquiry, and appointments were made with landowners to conduct the survey at a later date.

Survey Instrument

The survey was developed and translated into Spanish before traveling to Costa Rica for fieldwork. After key informant interviews were conducted, the survey was revisited and updates were made as necessary. The survey instrument was also reviewed by two community members from the upper corridor to ensure cultural relevancy and appropriate use of language (Henderson, 2003).

The survey was piloted with five households in the upper corridor. Minor changes were made to finalize the instrument after the pilot. All surveys were conducted in person with a

decision-maker in the household. The decision-maker was identified through initial conversation before beginning the survey. Participants included adult females and males that were knowledgeable about the reforestation efforts of the household. The presence of additional individuals during data collection has been known to influence responses or limit information sharing (Weiss, 1995). Therefore, when possible, the survey was conducted with only one respondent. If more than one person was present during the survey, both individuals were asked to participate in the survey. The format of questions used in the survey included yes/no, multiple choice, five-point Likert scales, open ended and a ranking exercise.

Dependent Variable

The survey instrument measured household level tree planting for the dependent variable. The two questions used to collect tree planting data asked 1) whether or not the participant had planted trees on their property (binary) and 2) how many trees the individual had planted in their property (continuous). If the participant responded 'yes' to planting trees on their property, additional details of the reforestation project were collected. Project details included: years the trees were planted, species of trees planted, where the trees were planted on the property and whether or not they received assistance from a conservation organization.

Independent Variables Related to Adoption of Reforestation

Internal Motivations. Perceptions about reforestation outcomes were used to measure internal motivations for tree planting. Perceptions have been defined as "the way an individual observes, understands, interprets and evaluates a referent object, action, experience, individual, policy or outcome" and have been recognized for their ability to provide important insight to the social and ecological impacts of conservation (Bennett, 2016). Due to the complexity of

perceptions and other cognitions, multiple statements are recommended for measuring these constructs. Compiling multiple responses for complex concepts can help report more accurate responses (Vaske, 2008). A total of 15 statements (Table 3) were used to develop three perception constructs about reforestation outcomes: environmental perceptions, economic perceptions and social perceptions. Survey participants were asked to rank their level of agreement with each statement on a five-point Likert scale ranging from strongly disagree to strongly agree (Likert, 1932). Statements used to measure environmental perceptions of reforestation outcomes referred to soil health, water quality and biodiversity. Statements used to measure economic perceptions asked participants about reforestation's influence on crop yields and general financial gain from tree planting. Subjective norms were used to measure perceptions of social outcomes. Klockner (2013) defines subjective norms as "the perceived expectation of relevant other people which behavioral alternative should be performed (in other words the social pressure) times the willingness to comply with that expectation" (Klockner, 2013 p.1029). Statements used to measure social perceptions refer to social pressures from family members, friends and neighbors. All 15 statements (Table 3) were original to this research.

Table 3: Statements used to operationalize environmental, social and economic perceptions of reforestation outcomes in the household survey.

Statements	English Translation
1. La reforestación traerá beneficios a mi familia.	1. Reforestation will bring benefits to my household.
2. La reforestación traerá beneficios económicos.	2. Reforestation will bring economic benefits.
3. La reforestación aumentará la biodiversidad.	3. Reforestation will improve biodiversity.
4. La reforestación aumentará la producción de mis cultivos.	4. Reforestation will improve the productivity of my farm.
5. La reforestación beneficiará a las aves mejorando su hábitat.	5. Reforestation will benefit birds by improving their habitats.
6. La reforestación puede mejorar la calidad del suelo.	6. Reforestation will improve soil quality.
7. La reforestación puede disminuir las amenazas de erosión del suelo.	7. Reforestation will reduce the risk of erosion.
8. Mis vecinos esperan que yo plante árboles.	8. My neighbors expect me to plant trees.
9. La reforestación puede reducir las amenazas de las inundaciones.	9. Reforestation will reduce risk of floods.
10. La sombra de los árboles sembrados para reforestación disminuirá los rendimientos de mis cultivos.	10. The shade from reforestation will reduce my cultivation productivity.
11. La reforestación aumentará la cantidad de plagas en mi propiedad.	11. Reforestation will increase the number of threats on my property.
12. Me siento más cerca a mi comunidad cuando siembro árboles.	12. I feel closer to my community when I plant trees.
13. Mis relaciones con mis amigos y familia mejoran si siembro árboles.	13. My relationship with my friends and family improves when I plant trees.
14. Mis amigos y familia tienen la expectativa de que yo siembre árboles.	14. My friends and family expect me to plant trees.
15. La reforestación no mejorará la calidad del agua.	15. Reforestation will not improve the quality of water.

External Motivations. Perceived support from conservation organizations was used to measure external motivations for tree planting. Four statements were used to collect data on the level of support provided by conservation organizations. The statements include: 1) "Conservation organizations have a strong presence in my community." 2) "Conservation organizations offer many courses and/or activities for me and residence in my community." 3) "It is very easy to get in contact with a conservation organization if I want to plant trees." 4)

"Many people in my community work with conservation organizations." Survey participants were asked to respond with their level of agreement using 'agree', 'sometimes', 'disagree' or 'I don't know'. Additional measurements of external support include the forms of support received by each survey participant who planted trees with help from a local organization. Examples of support include materials (i.e. trees, fencing materials, fertilizers, herbicide), in-kind services (i.e. technical trainings, transportation of the trees, labor assistance to plant the trees), and/or direct payments. All data on this variable was self-reported and not verified with conservation organizations due to a lack of documentation.

Biophysical. Biophysical characteristics collected in the survey were self-reported. The total size of the farm was collected in hectares. Participants were asked to estimate how many hectares of their property was currently in agricultural use, pastoral land and forested. Forest owners were asked to report the age of the forest (i.e. primary, secondary, mixed). Soil health and slope were collected using multiple choice questions, each answer choice representing a percentage of the property with poor soil or steep slopes. Answer choices included: 'less than 25%', '25%-50%', 'about 50%', '50%-75%', or 'more than 75%'.

Household Characteristics. The household characteristics collected in the survey included age, gender, years of education and occupation of both the participant and their partner. The total number of individuals living on the property was recorded in three age range groups: 1) younger than five, 2) between five and 10, and 3) older than 10 years old. Participants were asked to estimate the total number of years they had lived in the community and the total number of years they had spent on their farm. Financial status of each household was measured as 1) the percent of total household income coming from on-farm activities and 2) a list of assets owned by each resident, which included car, motorcycle, horse, chainsaw, television, and cell phone.

Barriers. To collect data on participation barriers, the household survey measured ownership of a land title, past reforestation experience and future plans. Ownership of a land title was recorded as "yes/no." Landowners who had not planted trees in the past were asked a series of "yes/no" questions to identify factors that were limiting their ability to plant trees. Examples of the factors referenced in the series of questions include lack of experience, lack of space, financial barriers and time constraints. All landowners were asked if they had family members interested in owning or working on the farm in the future to measure the future plans of the farm.

Additional Questions Related to Reforestation

Reforestation Motivations. For a better understanding of motivations, each survey participant was asked to complete a short activity to rank motivations for reforestation (Table 4). Seven cards were provided to each participant in the activity. Each card represented a benefit from planting trees. Participants were asked to rank the seven cards in order of personal importance. If the survey participant was unable to read the cards, the cards were read to the participant and assistance with the ranking was provided. After the ranking activity, an open ended question allowed participants to list any additional motivations that were not included in the card options.

Table 4: Statements used for ranking motivations for reforestation in the household survey.

Motivation Card Options	**English Translation**
Los árboles producen frutas para consumo humano.	The trees produce fruit for human consumption.
Los árboles producen madera para usar o vender.	The trees produce wood for household or commercial use.
Los árboles protegen las fuentes de agua.	The trees protect water sources.
Los árboles mejoran la calidad del suelo.	The trees protect or improve soil quality.
Los árboles atraen animales y aves a la finca.	The trees bring animals and birds to the farm.
Los árboles mejoran la producción de cultivos.	The trees improve the production of the farm.
Los árboles atraen turismo.	The trees bring tourism.

Preferred Forms of Assistance. In a second ranking activity, survey participants were asked to rank their preferred form of assistance for reforestation projects (Table 5). Six cards were provided for the activity. Each card contained a single form of assistance which had been provided to landowners in the corridor in the past. A procedure similar to the first ranking activity was followed. While participants were strongly encouraged to rank as many cards as possible, protest responses were also accepted from participants who reported having no interest in future reforestation or receiving assistance from an organization. Additional types of assistance were recorded in an open ended question at the end of the ranking activity.

Table 5: Statements used for ranking preferred forms of assistance for future reforestation in the household survey.

Assistance Card Options	**English Translation**
Ofrecen árboles gratis.	Offer free trees.
Ofrecen materiales para cercas.	Offer fencing materials.
Ofrecen capacitación técnica.	Offer technical assistance.
Traen los árboles a mi finca.	Transport the trees to my farm.
Me ayudan a sembrar árboles.	Help me plant the trees.
Ofrecen pagos por plantar árboles.	Offer payments for me to plant the trees.

Open ended survey questions. Open ended survey questions allowed participants to expand on their thoughts about reforestation and forest conservation. Open ended questions included: 1) *For forest owners:* Why did you decide to leave forest on your property? 2) *For tree planters:* What motivated you to plant trees on your property? 3) *For non-tree planters:* Why did you decide not to plant trees on your property? In addition to open-ended questions, personal stories and relevant opinions were recorded through short field notes while conducting the household survey.

Data Analysis: Household Survey

This section presents the steps taken to analyze the data collected in the household survey. After data collection, all survey responses were entered into a Microsoft Excel spreadsheet for data cleaning and preparation for analysis in a statistical software program. Statistical Package for the Social Sciences (SPSS) version 24 for Windows was used in the final quantitative data analysis. Before beginning the data analysis, four outliers were removed from the dataset. An outlier is an observation that does not align with the overall pattern of distribution (Moore & McCabe, 1989). The decision to remove the four landowners was based on the lack of representation of the general population and the decision to not include Costa de Pájaros (community in the lower corridor) in the final analysis. Of the four landowners who were removed, (1& 2) were residents from Costa de Pájaros, (3) owned a Teak plantation and was a full time lawyer in the capital and (4) was a short term renter. Descriptive statistics were run for multiple variables to become familiar with the data and to search for errors in the data input. All missing data was coded as 999 during data input and listed as 'missing data' in SPSS for the final analysis.

Constructing Dependent Variables

Information collected on total trees planted allowed for an additional binary dependent variable to be constructed from the data by selecting a cut-off point above one. Summary statistics on the total trees planted, where the trees were planted, and what type of trees were planted were also taken into consideration. A cut off of '11 or more trees' was chosen due to 10 being the first quartile of the total number of trees planted. Additionally, choosing 10 trees as the cut-off distinguished between small scale reforestation efforts (i.e. fruit trees around the house) and more significant reforestation on the property (Appendix C).

Principle Component Analysis and Reliability Test

Answers to the 15 reforestation perception statements (Table 3) were run in a principle component analysis (PCA) in order to group the statements into the broader environmental, economic and social categories. The PCA was run in SPSS, using a varimax orthogonal rotation to maximize the differences among the constructs (Vaske, 2008). PCA is one of the most common ways to reduce factors in a data set and is often the first step to reduce dimensionality before additional regression analysis (Jolliffe, 2011). The PCA was first run without assigning a component limitation. The initial PCA identified four components, however, the fourth component was inconsistent and contained statements with multiple variable loadings. A component limitation was then set for three variables and the analysis was re-run. The second PCA returned much stronger results, therefore, the statements were combined into three constructs: environmental perceptions, social perceptions and economic perceptions.

Minor changes were made to the PCA results to regroup statements into the final component categories. Decisions to edit the PCA variables were based on an understanding of the statement interpretation gained while conducting the survey in the field. After grouping the statements into three categories, a reliability test was run to examine internal consistency among statements. Cronbach's Alpha and the corrected item correlation were examined for reliability strength. Cronbach's Alpha has been recognized as a valid score of reliability when testing for internal consistency across multiple statements (Cronbach, 1951, 2004). After presenting acceptable values on both the Cronbach's Alpha (α >.65) and the corrected item correlation (>.4) (Table 9), three new variables were constructed by taking the mean of the statements in each group. A total of six statements were used to construct the environmental perceptions variable, three statements were used to construct the economic perceptions variable and four statements

were used to construct the social perceptions variable. Two statements were removed from the analysis due to their low levels of reliability and multiple variable loadings in the PCA results (Vaske, 2008). The new constructed variables, (i.e. environmental perceptions, economic perceptions and social perceptions) were used in the final regression analysis.

A reliability test was also run with the four external support statements to verify internal consistency. After presenting acceptable Cronbach's Alpha (α >.65) and corrected item correlation results (>.4), an external support variable was computed to represent external motivations in the final regression.

Ranking and Open-Ended Survey Questions

Responses to the ranking activity and open-ended survey questions were summarized to understand motivations for forest conservation and reforestation. The ranking exercise identified current motivations for planting trees and preferred types of assistance for reforestation. The top three choices from each participant in the ranking exercises were used in the analysis. Responses were summarized in Excel and presented graphically.

A word count was used to summarize responses to the open-ended survey questions. Participants were allowed to give more than one response. All responses were counted. Past forest conservation motivations were summarized into broader categories (i.e. ecosystem services, conservation, restrictions and limitations and other) and presented graphically (Figure 9). A similar process was used to summarize past motivations for planting trees. The broader categories included ecosystem services, conservation, external support, financial opportunity and other.

Regression Models

A series of tests were run in SPSS to select the final set of independent variables used in the multiple regression models. Independent sample t-tests were used to identify variables with significant differences between (1) landowners who planted trees and those who had not and (2) landowners who planted 11+ trees and those who had not. T-tests have been identified as appropriate tests to determine whether or not two independent samples differ significantly when the independent variable (X) is dichotomous and the dependent variable (Y) is continuous by comparing the means of the dependent variable (Vaske, 2008). Independent variables assessed in the t-tests were selected from each category of the conceptual model (Figure 1).

Pearson's correlation (*r*) was used to describe the strength of the relationship between factors in the conceptual model and the dependent tree planting variables. A point biserial correlation was used when the independent variable was not truly continuous. Pearson's correlation has been identified as one of the most common correlation measurements used in social science (Glass & Hopkins, 1996). Correlation coefficients between independent variables were also examined to reduce the risk of multicollinearity in the final regression model (Vaske, 2008).

Three sets of multiple regression models were run in SPSS to identify the significance of various factors on landowner's decision to plant trees, based on the conceptual model (Figure 1). Two sets of logistic regression models were run using 'planted trees or not' and 'planted 11 or more trees or not' as the dependent variables. Multiple logistic regression models estimate the probability of an event occurring when there is a binary dependent variable and multiple independent variables. Similar to a regression co-efficient in linear regressions, odds ratios (Exp(ß)) are central to the interpretation of logistic regressions. The odd-ratio represents the

change in probability of an event occurring with each one unit change in the independent variable, given that all other independent variables stay constant (Vaske, 2008). Vaske (2008) explains "if an (odds ratio) for an independent variable is greater than 1 (e.g., 1.5), when the independent variable increases by one-unit, the dependent variable increases by a factor of 1.5." (Vaske, 2008 p.457). Odd-ratios and the significance value (*p)* were used to evaluate the relationship between the independent variable and each dependent variable. Nagelkerke R^2 was used to measure the explained variance of each logistic regression model.

A set of linear regression models were run using the log-transformed variable of the total number of trees planted as a continuous dependent variable. The log-transformed variable of the total trees planted created a normal distribution of the variable which was originally skewed to the right (skewness = 2.809) (Appendix D). Linear regression models hold similar event prediction abilities and are used when the dependent variable is continuous and there are multiple independent variables. The regression coefficients and R^2 were used to assess the strength of the model. Linear regression coefficients represent "the amount of change in the dependent variable for one-unit change in the independent variable" (Vaske, 2008 p.453).

Three multiple regression models are presented for each dependent variable. The first model regresses the three internal perception variables and the external support variable on the dependent variable. The second model includes three additional variables selected from the conceptual framework (Figure 1) to control for household and biophysical characteristics. The three variables chosen for the final analysis are 1) total farm size (ha), 2) percent income from on-farm activities and 3) total number of years on the property. These variables were selected for a "best fit" model after many trial regression analyses with other variables from the conceptual model (Appendix E). The third regression model includes all variables from the second model

and a dummy variable representing corridor section (i.e. upper, middle or lower). The dummy variable accounts for differences across the corridor sections that were not controlled for with the existing household-level variables included in the regression model. For example, socioeconomic status varied greatly in each of the three section due to variation in livelihood opportunities.

Data Collection: Interviews

Qualitative data was collected through interviews and observations to record contextual information related to the research question. A total of 18 in-depth interviews were conducted with key informants and landowners. Fifteen of the key informant and landowner interviews were conducted in person and three were conducted over the phone. All were conducted with the assistance of an interview guide. Interview length ranged from 30 minutes to 105 minutes. An extended period of time was spent in each section of the corridor, totaling 10-weeks in the field. Observations from each corridor section were recorded for a better understanding of the biophysical differences across the three regions. Qualitative data also allowed for the triangulation of quantitative data collected in the household survey. Data triangulation, or collecting data on similar events from multiple sources, can confirm balanced and unbiased data (Goldstein, 2002). Complete copies of the interview guides are included in Appendix F.

Sampling

Key Informant Interviews. Key informant interviewing is a data collection method in which the researcher interviews an individual who holds disproportionately more knowledge about a specific topic compared to the general population (Weiss, 1995). Two sets of key informant interviews were conducted in this research, one before the household survey and one after the household survey. A total of six key informant interviews were conducted in the first

set. To select interviewees for the first set, relationships were established with local conservation organizations in November 2016. This allowed access to a list of current and past employees. Three key informant interviewees were selected from these lists. Three more key informants were selected using a convenience sampling technique, snowball sampling (Weiss, 1995). After completion of each interview, referrals for additional influential actors in corridor reforestation were requested. The first set of key informants included current and former members of local conservation organizations such as Monteverde Conservation League and Monteverde Institute.

The second set of key informant interviewees were selected based upon responses in the household surveys and interviews. Conservation organizations identified by landowners, that were not represented in the first set of key informants, were contacted in the second set. This included representatives from national organizations such as NeoTropica, FONAFIFO, two MAG extension offices, and the CBPC coordinador. Contact information was gained through community members and online sources. A total of five key informants were selected in the second set of interviews.

Landowner Interviews. Landowner interviewees were chosen randomly during survey implementation. Two landowners were chosen from each part of the corridor, one who had planted trees on their property and one who had not planted trees on their property. Thus, the decision to conduct an interview was made after asking the household decision-maker about their reforestation experience. A third interview was conducted in the lower corridor to better understand the social dynamics and conservation threats in the area.

Interviews and Observations

Key Informant Interviews. The first set of key informant interviews included a series of questions on the development and involvement of each conservation organization in reforestation

within the corridor. Specific details of each organization's involvement included materials and technical assistance provided, approximate number of trees planted, level of community involvement and perceived factors that led to adoption or barriers to adoption. Key informants were also asked to share their thoughts on current reforestation barriers in each of the three corridor sections. A participatory mapping exercise was conducted with the first set of key informants to define the upper corridor study area. In the mapping exercise, a printed map of the upper corridor communities was provided and key informants were asked to identify contextually similar sites with significant farming populations. These recommendations were taken into consideration when selecting communities for the household survey.

The second set of key informant interviews focused on triangulating data from the household survey. The interviews collected data on reforestation projects of each organization and location of project implementation. For some, details on project enrollment was also recorded. Three of the five interviews were conducted over the phone due to time and resource limitations. The remaining two were conducted in person in the upper corridor.

Landowner Interviews. Landowner interviews focused on the same five factors identified in the conceptual model (Figure 1) to provide more context on how and why these factors matter and to allow for differences across communities to be identified. Landowners were asked about past and present reforestation in the community and about organizations working in their community. Household-level and community-level barriers to reforestation were collected with each interviewee. Landowners were also asked to identify conservation threats experienced in each community.

Interview Recording. The decision to record interviews was made on a case to case basis. After assessing the comfort level of the interviewee, permission to record the interview

was asked. The interviews were recorded using a digital tape recorder after receiving verbal consent from each participant. If interviewees were uncomfortable with the presence of a recorder, interviews were recorded through short field notes (Weiss, 1995). To avoid constrained responses by the interviewee or other concerns that may arise from the interview, confidentiality in the final report was confirmed (Weiss, 1995). A total of 9 interviews were digitally recorded and 9 were recorded using field notes.

Observations. Informal community and household level observations were recorded with photographs and field notes during the stay in each part of the corridor. This allowed for a better understanding of farm activities and biophysical differences in each community. Formal and informal observations of specific settings or organizational units can allow for new understandings of the studied phenomenon (Yin, 1994).

Data Analysis: Interviews

Interviews. The digital recordings of key informant and landowner interviews were downloaded and transcribed verbatim in Spanish. Transcriptions were completed with the assistance of ExpressScribe, a professional audio player and transcription program available online. Transcriptions were translated into English for the data analysis. Verbatim transcriptions were used in data analysis to reflect participant's responses as closely as possible (Weiss, 1994). Field notes of non-recorded interviews were also transferred to electronic documents for coding. Dedoose, a web-based data analysis application, was used to code and analyze the interview transcripts. The first two interview transcripts were coded using open codes. Open coding allows for patterns to emerge from the dialogue (Yin, 2015). After the complete coding of two interview transcripts, the conceptual framework (Figure 1) was used to organize the open codes into a multi-level coding system. Multi-level codes allow for the grouping of specific themes into

broader categories for data analysis (Yin, 2015). Highest level coding themes included motivations, barriers, conservation threats and community specific information. Using the multi-level coding scheme, a second coding analysis was completed and the remaining interviews and field notes were coded. An example of the multi-level coding scheme for '*motivations'* is presented in Figure 5.

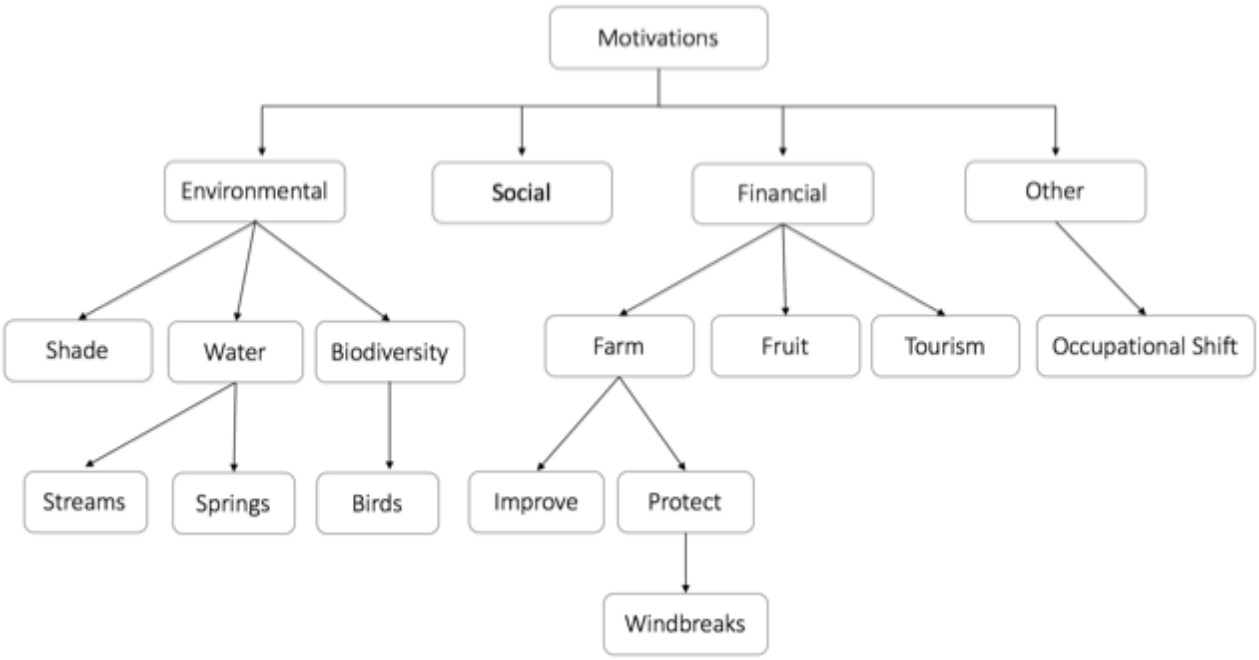


Figure 5: Multi-level Coding Scheme for "motivations".

Research Limitations

Internal and External Validity

Internal validity is the ability of the results to fairly represent the sample population. Internal validity can vary greatly with research design (Campell & Stanley, 1966). Employment of a survey instrument and random systematic sampling, both used in this research, can help ensure internal validity. A comparison of characteristics between the sample population and district level census data also confirms internal validity in this research. A larger sample size, however, could have further strengthened the internal validity.

External validity is the ability to prove the results found in the research are relevant to other settings (Campell & Stanley, 1966). The upper corridor is unique due to the well-established ecotourism industry in Monteverde. It is less likely that the results in the upper section will be generalizable to the rest of the country or Central America. This justifies the decision to stratify the sample population throughout the corridor. The middle and lower corridor contain generalizable populations, strengthening the external validity of the research. Additionally, the results found in this research are similar to other published literature, further suggesting external validity.

Research Bias

Multiple types of biases can occur when conducting research. Researchers may impose biases when sampling or analyzing the data. A systematic random sampling technique was used in this research to reduce sampling bias (Vaske, 2008). Qualitative data analysis could have been strengthened with an inter-rater interview coding check to reduce researcher biases. Using multiple researchers to analyze data can help minimize personal bias in data analysis processes (Yin, 2015). Biases can also occur on the part of the research participants, such as desirability

bias. Desirability bias occurs when research participants provide untruthful responses to please the researcher. Additionally, indicators used in this research, such as perceptions, can be more challenging to measure compared to indicators such as age or ownership of a land title (Grillos, 2017). Therefore, multiple Likert statements were used to increase measurement validity and reduce potential bias.

Survey Instrument Limitation

Survey Relevancy. More time spent in each part of the corridor before data collection could have improved survey design by increasing cultural relevancy. A pilot of the survey was conducted in order to improve the instrument, however, due to time and resource limitations, the survey was only piloted in the upper corridor. Piloting the survey in each part of the corridor could have better defined closed-ended survey question responses. For example, a question in the survey used to measure household assets asked participants to confirm ownership of specific items. Unfortunately, the items did not accurately measure indicators of wealth in each part of the corridor and therefore was not used in the final analysis. Additionally, a better understanding of land ownership in each section of the corridor could have improved the measurement of the land tenure variable. A more accurate measurement of land tenure could have strengthened the regression models by controlling for a potential barrier to reforestation participation.

External Support Variable. Data on external support was limited due to insufficient data collection on material support offered to landowners. The survey instrument only collected data on material support for landowners who reported planting trees in the past and did not measure whether or not landowners who did not plant trees were offered support. Therefore, this indicator could not accurately measure the influence of material support on reforestation participation. Instead, the four statements measuring perceived support from organizations were

used to represent external motivations. Measuring the influence of external support through material benefits received or offered, instead of perceived organizational support, may have resulted in a different finding for external motivations in regression analysis.

Chapter 5: Results

Survey Results

The analysis of the survey data are presented below in the following order: (1) descriptive statistics of household characteristics and past reforestation experience, (2) principle component analysis for perception variables, (3) reliability test and Cronbach's Alpha for all computed variables, (4) ranking exercise results, (5) open ended question results and (6) linear and logistic regression models.

Descriptive Statistics

Household Characteristics. Of the 81 survey participants, 79% were male and 21% were female (Table 6). Respondents had an average age of 58 and had been living in their community for an average of 47 years. The average years of completed education was six years. Sixty-two individuals (76.5 %) identified as farmers, 20 of which also worked a second job to supplement on-farm income. About 24% of the participants did not list farming as their occupation. The average property size was about 41 hectares; quartiles for plot size are 4.5 ha, 11 ha and 38 ha. The most common type of farm surveyed was pastoral, representing 43% of the sample population. This includes both dairy and beef farms. About 14% of the farms were agricultural and 20% were mixed, agricultural and pastoral.

Table 6: Summary Statistics of Survey Participants

Survey Population Descriptive Statistics (N=81)		
Gender	**Male**- 64 (79%) **Female**- 17 (21%)	
Average Age	57.93 (SD=14.2)	
Average Years of Residency	**Community**	**Property**
	47.6 (SD=20.44)	38.1 (SD=21.26)
Average Years of Education	6.49 (SD=3.17)	
Occupation	**Farmer**- 42 (51.9%) **Farmer and Laborer-** 20 (24.6%) **Laborer**- 19 (23.5%)	
Type of Farm	**Pastoral** - 35 (43.2%) **Agriculture** - 11 (13.6%) **Both** - 16 (19.8%) **Not working farm** - 19 (23.5%)	
Plot Size	**Mean**- 41.18 (SD=115.64)	
	Median- 11.0	
	Quartiles- 4.5, 11, 38	
*SD = Standard deviation		

Reforestation Characteristics. Of the 81 survey participants, 65 landowners (80%) reported planting one or more trees on their property (Table 7). The range of the total number of trees planted was 0 – 7,000, with an average of 760 trees per household. The average number of trees planted was largely skewed by landowners in the upper corridor, which had a much higher average per household than the lower and middle corridor (Figure 6). In early reforestation projects of the Monteverde Conservation League, many landowners planted 1,000+ trees on their property. The median number of trees planted was 100; quartiles for planting trees are 10, 100, and 1000.

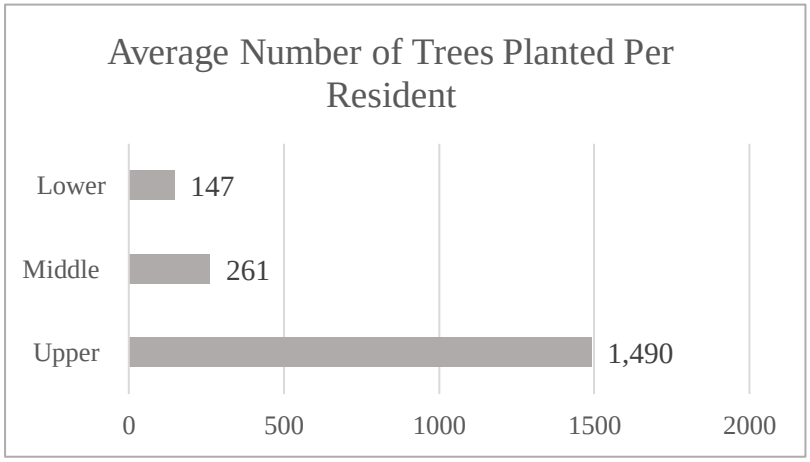


Figure 6: Average number of trees planted per survey participant in the upper, middle and lower corridor

Of the 65 landowners who planted trees on their property, almost 60% received support from a conservation organization (Table 7). Forms of support included free reforestation materials, services and direct payments. Free trees were the most common form of material support provided to landowners. Thirty-three individuals (91% of landowners who received support) claimed they received free trees from an organization. Almost 49% of landowners who received support were provided fencing materials. Other materials that were received include fertilizer (8.1% of landowners who received support) and herbicide (19.3% of landowners who received support). Technical support was the most common service received. Fifty-one percent of landowners who received support received technical assistance for the reforestation project. Twenty-seven percent of the landowners had the trees transported to their property and 8.1% were helped with the labor of planting the trees. Payments for planting trees were the least common form of support. One participant received payments.

Table 7: Summary of Tree Planting Among Survey Participants

Tree Planting Summary	Yes	No
Individuals who planted 1 or more	65 (80%)	16 (20%)
Individuals who planted 11 or more	57 (70.4%)	24 (29.6%)
Number of trees planted	**Mean**	759.85
	Median	100
	Quartiles	10, 100, 1000
External Support	**Yes**	**No**
Number individuals who received support (of the 65 who planted 1 or more)	36	29
Number of Individuals who received each form of support		
Technical Assistance	18	18
Transportation	10	26
Labor	3	33
Trees	33	3
Fencing	18	18
Herbicide	6	30
Fertilizer	3	33
Direct Payments	1	35

Principle Component Analysis & Computed Variable Reliability

The PCA, run in SPSS, converged in five iterations and identified three categories for the perception statements about reforestation outcomes (Table 10); however, results were later modified based on other criteria. The first PCA led to the following results: the first component, labeled as "*economic perceptions",* included the statements: 1) "Reforestation will bring benefits to my family", 2) "Reforestation will bring financial benefits.", 3) "Reforestation will increase biodiversity.", 4) "Reforestation will increase crop yields.", and 5) "Reforestation will benefit birds by improving their habitats." The second component identified was labeled "*environmental perceptions*" and included the statements: 6) "Reforestation can improve soil quality.", 7)

"Reforestation can decrease threats of soil erosion.", 8) "My neighbors expect me to plant trees.", 9) "Reforestation can decrease threats from floods.", 11) "Reforestation will increase the number of pests on my property.", and 15) "Reforestation will not improve the quality of water (reverse-coded)." The third component included the statements: 10) "Shade from reforestation will decrease crop yields.", 12) "I will feel closer to my community if I plant trees.", 13) "My relationship with my family improves when I plant trees." and 14) "My friends and family expect me to plant trees.", and was labeled "*social perceptions"*. Overall, the PCA was able to account for 52% of the variance.

The PCA results were altered for the construction of the economic, environmental and social perceptions variables used in the regression (Table 8). For example, the PCA identified statements 3 (Biodiversity) and 5 (Bird Habitat) as economic. The economic dependence on eco-tourism in the upper corridor can explain these loadings. Biodiversity and healthy bird habitats for rare avian species fuel the eco-tourism industry in this region. Thus, in the upper corridor, biodiversity and bird habitats are linked to the local economy. However, statements 3 and 5 were moved to environmental perceptions due to the reliability test results. Statement 8 (Neighbor Expectation) was moved from environmental perception to social perception. Both statements 10 (Increase Shade) and 11 (Increase Pests) were not included in the perception variables. Removing these statements increased the Cronbach's alpha for the environmental perceptions construct, thus improving internal consistency.

For the final construction of the three perception variables, six statements were included in environmental perceptions, 3 statements were included in economic perceptions and 4 statements were included in social perceptions (Table 9). Cronbach's Alpha for the

Table 8: Principle Component Analysis: Perceptions

Statements	Economic	Environmental	Social
1. Benefits	0.804		
2. Economic Benefits	0.760		
3. Biodiversity*	0.676		
4. Increase productivity	0.668		
5. Bird Habitat*	0.642		
6. Improve Soil Quality		0.716	
7. Reduce Erosion Risk		0.661	
8. Neighbor Expectation*		0.658	
9. Reduce Flood Risk		0.601	
10. Increase Shade**		-0.527	0.468
11. Increase Pests**		-0.496	
12. Community Closeness			0.806
13. Improve Family Relationship			0.779
14. Family Expect			0.438
15. Improve Water		.386	.396

*Moved to another component. **Not included in the computed variable.

environmental perception was 0.637, which is slightly under the recommended score of 0.65 (Vaske, 2008). However, it was not possible to increase the Cronbach's Alpha by removing any of the six statements. Some of the corrected item correlation scores were also slightly lower than recommended (>.40), the lowest statement scored 0.351 (Vaske, 2008). Cronbach's Alpha for economic perception was 0.667, with only one statement scoring below 0.40 on the corrected item correlation (lowest corrected item correlation=0.36). The four statements used for social perceptions had a Cronbach's Alpha of 0.727 with all corrected item correlations above 0.40. The four statements used to construct the external support variable scored above 0.40 on the corrected item correlation, with a Cronbach's Alpha of 0.886 (Table 9).

Table 9: Computed Variables & Cronbach's Alpha

Constructs	Number of Statements	Cronbach's Alpha
Environmental Perceptions	6	0.637
Economic Perceptions	3	0.667
Social Perceptions	4	0.727
External Support	4	0.886

Motivation for Planting Trees and Preferred Assistance

Motivations for planting trees. A short exercise in the survey allowed participants to rank motivations for planting trees. The top three choices of each participant were summarized quantitatively (Figure 7). *Water protection*, a regulating ecosystem service, was listed in the top three choices most often by landowners. A total of 27 landowners listed water protection as their primary motivation for planting trees. Soil protection, also a regulating service, was among the least popular. Fruit production and a source of timber, both provisioning ecosystem services, were selected often as a primary motivation for planting trees. Improving habitats for animals was commonly ranked in the top three choices, however, more landowners ranked this option as second (17 participants) or third (12 participants), compared to the primary motivator (11 participants). Tourism was least important to survey participants. Tourism benefits was never listed as a first choice and only 6 participants ranked tourism as a second or third motivator. Farm production was also among the less popular choices. Motives for selecting this card was not clarified during the exercise.

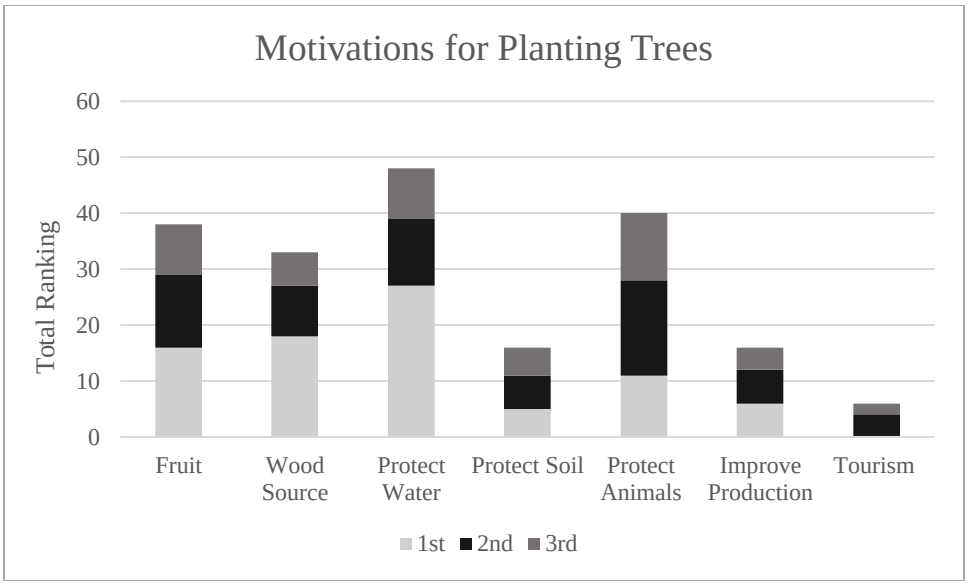


Figure 7: Ranking of reforestation motivations. Top three choices of each landowner represented.

Preferred Assistance. In addition to ranking motivations for planting trees, landowners were asked to rank their preferred form of assistance for reforestation on their property. Free trees were the most preferred form of assistance (Figure 8). Thirty-three participants ranked free trees as their first choice and over half of the participants listed it in their top three. The second most common response was fencing materials. A total of 45 participants ranked free fencing in their top three preferences for reforestation support. Transportation of trees and direct payments were the least common. Sixteen participants placed transportation in their top three choices, a somewhat surprising result because most participants did not own a vehicle. Only 10 participants ranked direct payments in their top three choices. These results show a clear preference for in-kind support over cash. Seven protest responses were given. These seven participants stated they were not interested in reforestation or receiving assistance of any kind.

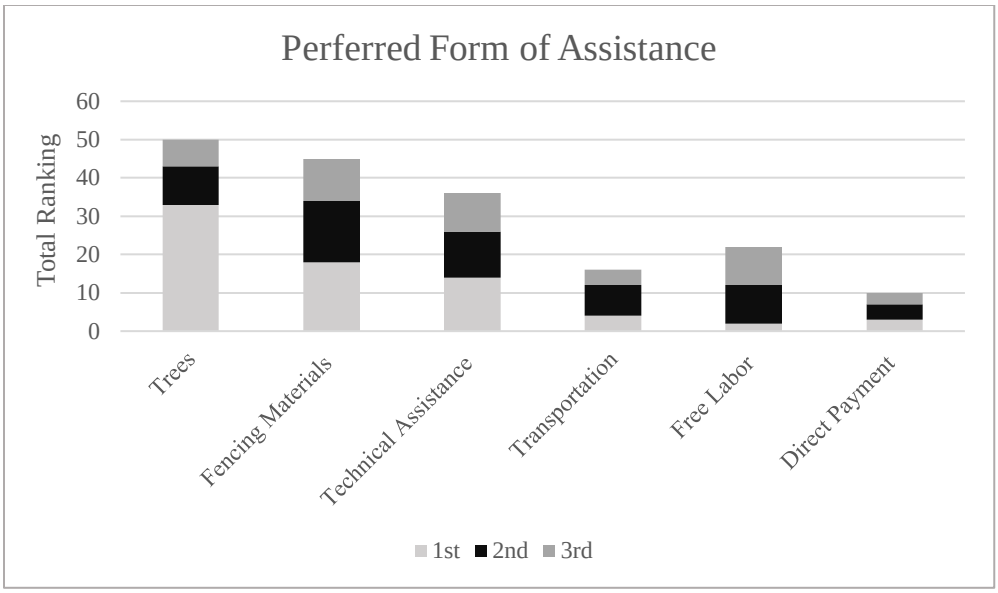


Figure 8: Ranking of preferred form of assistance. Top three choices of each landowner represented.

Open Ended Survey Questions

Two open-ended survey questions asked landowners about their motivations for owning forest on their farm (Figure 9) and for planting trees on their farm (Figure 10). Similar to the results of the ranking activity, regulating services were the most popular motivation for conserving forest. Examples of these responses include: erosion control, protecting water and protecting the farm (Table 10). The second most common category, provisioning services, included providing a source of wood or fruit for the household. Both regulating and provisioning ecosystem services were more common than cultural ecosystem services, which included comments on the aesthetic value of forests or "*I like it"* responses. Generic responses, such as "*to conserve*" or "*conservation*", were also given. While there were many responses reflecting a positive valuation of forests, other participants highlighted barriers to cutting the forest down, such as legal, financial and biophysical restrictions, which led to leaving forest on their property.

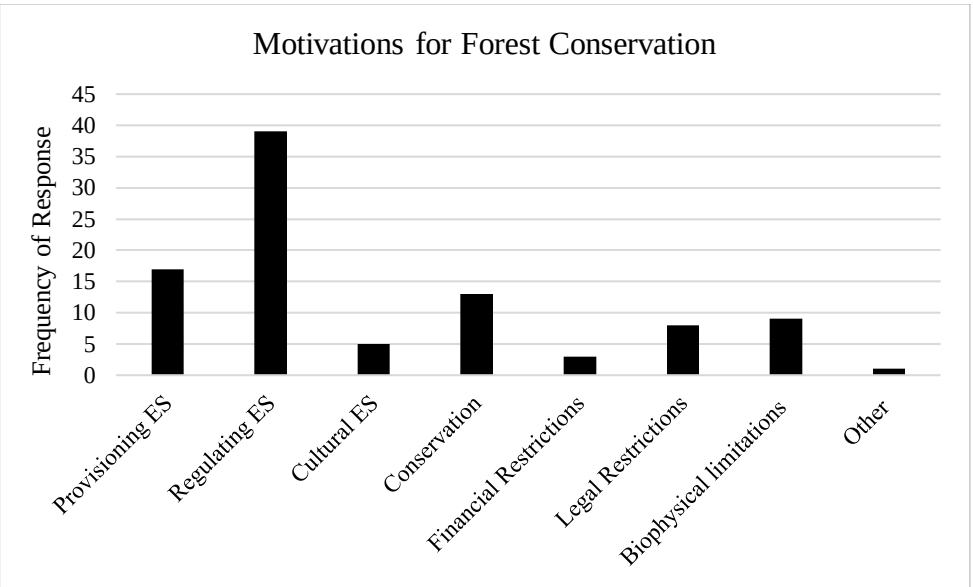


Figure 9: Graph of stated motivations for conserving forest on property. Landowners were allowed to give more than one response. Graph shows the total count of each category.

Table 10: Examples of stated responses to the question, "Why did you leave forest on your property?" (Open-ended survey question)

Motivation Category	**Response Examples**
Provisioning Ecosystem Services	*"to produce posts for the farm", "to provide shade for the cows"*
Regulating Ecosystem Services	*"to protect the stream", "to protect the farm from wind"*
Cultural Ecosystem Services	*"I like it", "Forests are pretty"*
Conservation	*"for conservation", "to conserve"*
Financial Restrictions	*"it is more economical to not cut it", "it is not beneficial to convert it to pasture"*
Legal Restrictions	*"it was already there", "I don't have permission to cut it"*
Biophysical limitations	*"the area is very steep"*
Other	*"to divide my property from the neighbor's property"*

A second open-ended question asked respondents why they planted trees on their property in the past (Figure 10). Similar to the stated forest conservation motivations, provisioning and regulating ecosystem services were the most popular responses (Table 11). External support was the next most common. Examples of external support responses include, *"I*

received free trees" and *"I was planting with Monteverde Conservation League"*. "*For conservation*" or "*to conserve*" responses were also given from survey participants.

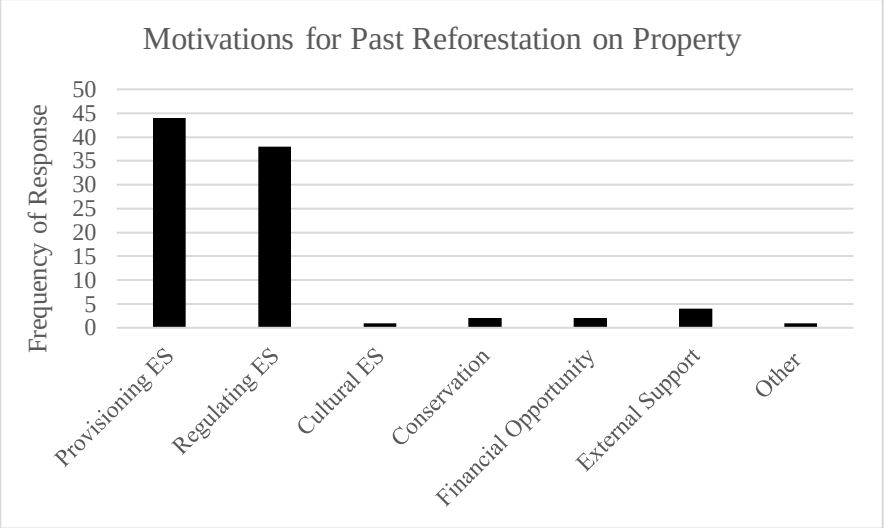


Figure 10: Graph of stated motivations for past reforestation on the property. Landowners could give more than one motivation. Graph shows the total count of each category.

Table 11: Examples of stated responses to the question, "Why did you plant trees on your property?" (Open-ended survey question).

Motivation Categories	**Examples of Stated Responses**
Provisioning Ecosystem Services	*"for a fence", "to produce fruit", "for a future source of wood"*
Regulating Ecosystem Services	*"to protect the spring", "windbreaks", "to protect the farm"*
Cultural Ecosystem Services	*"it is pretty"*
Conservation	*"conservation", "conserve"*
Financial Opportunities	*"to increase farm production"*
External Assistance	*"the League helped me", "I was given free trees", "to receive payments"*
Other	*"I wasn't using that area"*

Regression Results

Overall, survey participants perceived much higher environmental benefits from planting trees (mean=1.35), compared to social benefits (mean=0.79) and economic benefits (mean=1.04), all measured on scale from -2 to 2 (Figure 11 and Table 12). On average, participants did not feel supported, as represented by the negative mean (-0.16) measured on a

scale from -1 to 1. The upper corridor perceived the greatest environmental benefits compared to the middle and lower corridor. The upper corridor also had a positive perceived level of support from conservation organizations. The lower corridor felt the least supported by conservation organizations (mean= -0.8.) and the middle corridor was neutral. The middle corridor perceived greater social benefits from reforestation compared to the upper and lower corridor.

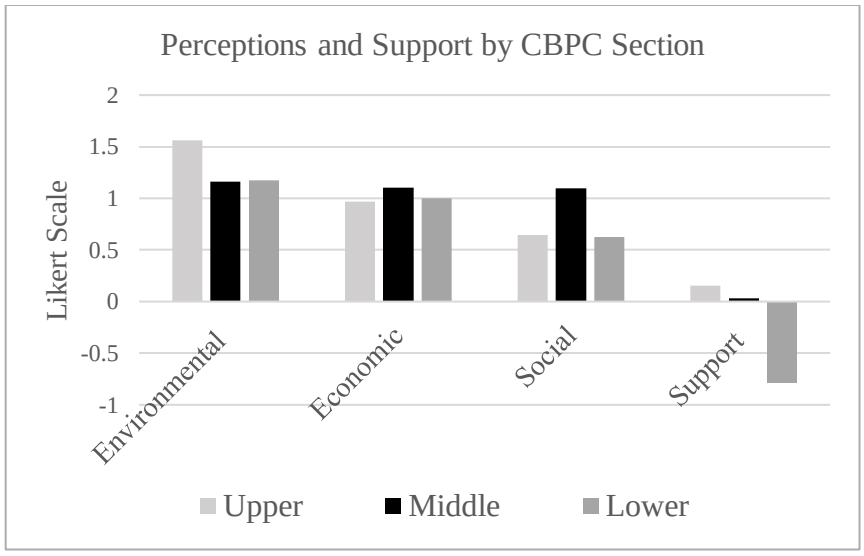


Figure 11: Reforestation perceptions and level of support from conservation organizations in each section of the CBPC. Perceptions measured on a 5-point Likert Scale (-2 to 2). Support measured on a 3-point Likert scale (-1 to 1).

On average, landowners reported between 0-25% of their property as steeply inclined and about 0-25% as having poor quality soil (Table 12). Landowners maintained almost 25% of their property forested. On average, about 50% of their property was pasture and only 15% was being used for agriculture. Eighty percent of respondents had a body of water on their property, which includes rivers, streams and natural springs. Landowners reported selling about 50% of the products they produced on the farm. On-farm activities made up 50% of the average total household income. Just over half of the respondents (mean=0.62) had a family member interested in taking over the farm in the future. Almost all landowners reported owning a land title (mean=0.92).

Table 12: Summary Statistics of Independent Variables

Independent Variables	Mean	Standard deviation
Internal and External Motivation		
External Support (-1 to 1)	-0.16	0.75
Environmental Perceptions (-2 to 2)	1.35	0.63
Economic Perceptions (-2 to 2)	1.04	0.91
Social Perceptions (-2 to 2)	0.79	0.94
Biophysical Characteristics		
% Poor Soil (Scale: 1-5)	1.21	0.59
% Sloped Farm Area (Scale: 1-5)	1.54	0.80
Water Body on the farm (0- No; 1- Yes)	0.79	0.41
% Farm in Primary Forest	20.57	18.98
% Farm in Secondary Forest	9.91	15.27
% Farm in Agriculture	15.07	27.14
% Farm in Pasture	50.18	31.20
Household Characteristics		
% Income from on-farm activities (Scale: 1-5)	2.86	1.77
% Farm products sold (Scale: 1-5)	2.88	1.645
Household Assets (Scale: 1-6)	3.06	1.41
Risk and Uncertainty		
Title (0- No; 1- Yes)	0.96	0.19
Family members to inherit farm (0- No; 1- Yes)	0.62	0.49

A series of t-tests identified variables with significant differences across (1) landowners who had planted trees and those who had not and (2) landowners who had planted 11+ trees and those who had not (Table 13). Results from the second analysis (11+ trees) found more significant differences among the two populations. Age, years of education, household assets, soil health, environmental perceptions and external support were found to be significantly different (Table 13). Landowners who planted 10 trees or less tended to be older, own fewer assets and had completed fewer years of education. Additionally, non-planters reported a greater

percentage of their property with poor soil health. Landowner's who planted 10 or less trees had a lower perception of environmental benefits and felt unsupported by conservation organizations, represented by the negative mean for external support. Property size varied largely across the two groups. The average property size for 10 or less trees was 15 hectares and those who planted 11 or more trees had an average property size 52 hectares. However, this difference was not found to be significant. Similar results were found in the t-test analysis comparing landowners who planted any trees and those who did not. Only years of education and external support were found to be significant using this dependent variable.

Table 13: T-test results (mean and SD) of household and biophysical characteristics of landowners who planted trees and did not plant trees and landowners who planted 11+ trees and less than 11 trees

Variable	Didn't Plant	Planted	Plant 10 or less	Planted +11
Age	60.87 (16.361)	57.26 (13.829)	**63.50* (14.900)**	**55.58* (13.477)**
Years of Education	**5.00* (2.512)**	**6.80* (3.221)**	**4.91* (2.695)**	**7.12* (3.146)**
Years on the Property	37.867 (19.478)	38.750 (21.786)	44.958 (22.452)	35.904 (20.351)
Farm Size	20.467 (27.292)	45.889 (127.189)	15.216 (22.852)	52.113 (135.938)
% Farm with Poor Soil	1.47 (1.060)	1.15 (.402)	**1.42* (.929)**	**1.12* (.331)**
% Farm with Steep Slope	1.40 (.632)	1.57 (.829)	1.48 (.730)	1.12 (.331)
% Farm Production Sold	2.67 (1.676)	2.92 (1.648)	2.33 (1.659)	3.11 (1.600)
% Income From On-farm Activities	2.733 (1.751)	2.894 (1.781)	2.458 (1.668)	3.017 (1.771)
Household Assets	2.333 (1.718)	3.227 (1.287)	**2.208* (1.444)**	**3.421* (1.238)**
Environmental Perceptions	1.102 (.632)	1.412 (.616)	**.938* (.697)**	**1.532* (.502)**
Economic Perceptions	1.089 (.840)	1.028 (.931)	.903 (1.123)	1.100 (.804)
Social Perceptions	.594 (.928)	.832 (.944)	.573 (1.002)	.880 (.904)
External Support	**-.816* (.361)**	**-.012* (.737)**	**-.724* (.511)**	**.083* (.707)**

**p <.05*

External support and environmental perceptions were significantly correlated with the number of trees planted (Table 14). Of the biophysical variables, percent of property with primary forest, percent of property in agricultural use and percent of property with steep slopes were significantly correlated with trees planted. Years of education, percent of farm products

Table 14: Pearson's correlation results of independent variables and total number of trees planted (log) dependent variable

Pearson's Correlation: Log Total Tree	Pearson Correlation	Sig.
Internal and External Motivations		
External Support	**.496****	**0.000**
Environmental Perceptions	**.407****	**0.000**
Economic Perceptions	0.070	0.540
Social Perceptions	0.122	0.283
Biophysical Characteristics		
% Poor Soil	**-.229***	**0.040**
% Sloped Farm Area	0.021	0.850
Farm Size (HA)	0.112	0.319
% Farm in Primary Forest	**.298****	**0.007**
% Farm in Secondary Forest	0.080	0.477
% Farm in Agriculture	**-.252***	**0.023**
% Farm in Pasture	0.020	0.857
Household Characteristics		
Age	-0.211	0.059
Years of Education	**.292****	**0.009**
% Income from on-farm activities	0.186	0.096
% Farm products sold	**.228***	**0.041**
Household Assets	**.400****	**0.000**
Years on the property	-0.072	0.525
Years in the community	-0.026	0.818
Risk and Uncertainty		
Title[1]	-0.045	0.694
Family members to inherit farm[1]	0.080	0.508

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level

[1] Point biserial correlation used

sold and household assets were household characteristics significantly correlated with the total number of trees planted.

Correlations were found among some independent variables selected from the conceptual model (Appendix G). For example, the total years of completed education was highly correlated with the age of participants (r = -0.361, p <.01). The relationship was negative, suggesting that younger participants completed more years of schooling. Neither age nor years of education were found to significantly influence decision making when run in a preliminary regression analysis, and were not included in the final multiple regression analysis. The participant's percent income from on-farm activities was strongly correlated with occupation (r = .472, p <.01) and percent of farm products sold (r = .712, p <.01). Therefore, percent income from on-farm activities was selected to represent 'livelihoods' in the final multiple regression analysis.

Multiple variables were tested in initial regression analyses in order to find a "best fit" regression model. In order to have a holistic analysis of reforestation decision making, variables from each category of the conceptual model were tested in the same model. Land tenure was tested to represent "barriers". However, due to the lack of variation among survey participant responses (i.e., Table 12), land tenure was not included in the final analysis. Due to the limited quantitative measurements of barriers in the household survey, barriers were not represented in the final regression analysis. The "best fit" model included household characteristics (i.e. years on the property and percent income from on-farm activities), biophysical characteristics (i.e. farm size), internal motivators and external motivators.

Linear Regression Results. In the first linear regression model using log-transformed number of trees planted as the dependent variable, computed external support (β = .40) and environmental perceptions (β =.385) were found to significantly influence tree planting in a

positive direction, both with a *p*-value of <.01 (Table 15). The four variables used in the first regression model were able to account for 34% of the variance. The second multiple regression model, which included household and biophysical characteristics, accounted for slightly more of the variance (R^2= .391). In the second model, number of years on the property was found to significantly influence tree planting (β = -.170 *p* <.1), in addition to external support (β = .44 *p* <.01) and environmental perceptions (β = .296 *p* <.1). The negative regression coefficient for the number of years on the property suggests that landowners with longer residency on the property were less likely to plant trees. The model was then re-run for a third time with dummy variables representing corridor section (upper section omitted as reference section). Both middle and lower corridors had a strong significance level (middle β = -.311 *p* <.01 and lower β = -.544 *p* <.01) and were negative. This suggests that residents in the middle and lower corridor were less likely to plant trees then those in the upper corridor. Additionally, biophysical characteristics (farm size β = .221 *p* <.05) and household characteristics (years on the property β = -.182 *p* <.05) were found to significantly influence tree planting in this model. External support and environmental perceptions were significant across all models, however their significance dropped to the *p* < .1 level in the third model. The third model was able to account for 56% of the total variance.

Logistic Regression Results. The dependent variable in the first set of logistic regressions was a binary variable of whether the landowner had ever planted trees on their property or not (No = 0; Yes = 1). In the first two models, only external support was found to significantly influence the decision to plant trees (Model 1 Exp(ß)=9.632 *p*<.05 and Model 2 Exp(ß)=10.882 *p*<.05). Of the 8 variables used in the third model, none were significant. The third model was able to account for 42% of the variance (Nagelkerke R^2=.42).

The second set of logistic regression models used the constructed dependent variable of landowners who planted 11 or more trees (10 trees or less = 0; 11 or more = 1). The first model of the set was able to account for 51% of the variance (Nagelkerke R^2=.51) and both environmental perceptions (Exp(ß)=6.942) and external support (Exp(ß)=8.593) were significant with *p*-value of <.01. The second model was able to account for more of the explained variance, explaining almost 71%. In the second model, years on the property (Exp(ß)=.905) and environmental perceptions (Exp(ß)=5.74) were significant with a *p*-value <.05 and external support (Exp(ß)=52.48) was significant with a *p*-value of <.01. In the third model, external support, farm size, and corridor section were all found to be significant with a *p*-value of <.1 and years on the property at the p<.05 level. All relationships were in the positive direction. The third model accounted for 81% of the variance.

Regression Comparison. A cross comparison of the results of each regression set allowed patterns to emerge (Table 15). The most consistently significant variable was external support, suggesting the importance of external motivations in reforestation decision-making. In the first two models of each regression set, external support was significant at the $p < .01$ level. The significance of external support slightly decreased in the third model of each set, however, the variable remained significant at the $p < .1$ level in the linear regression and the 11+ logistic regression. Regression results also found environmental perceptions to have an influence on the decision to plant trees, whereas economic or social perceptions do not. Environmental perceptions were significant at the $p < .01$ level in the first model of the linear and 11+ logistic regression sets, which regresses only internal and external motivators on the dependent variable. Environmental perceptions remained significant in the second model of the 11+ logistic regression ($p < .05$) and in the second and third model of the linear regression set ($p < .01$). This

suggests that farmers who planted trees on their property held a significantly higher perception of environmental benefits from reforestation than those who did not. The lack of significance of social and economic perceptions suggests that they are less important for planting trees. Percent income from on-farm activities was not significant in any model of any set. Farm size was found to significantly influence decision making in third model of the 11+ logistic regression set (Exp(ß)= 1.014, p <.1) and in the linear regression set (β = .221, p <.05), with larger farm size correlated with planting trees. Years on the property was also found to significantly influence tree planting, however, the direction of the relationship on years on property was inconsistent. In the linear regression, years on the property had a negative relationship (Model 2: β = -.170, p <.1; Model 3: β = -.182, p <.05). and in the logistic regression the relationship was positive (Model 2: Exp(ß)= .905, p <.05; Model 3: Exp(ß)= .883, p <.05). The direction of the relationship of the dummy variables was also inconsistent. Overall, the findings suggest that both internal, specifically environmental perceptions, and external motivators significantly influence reforestation participation and that decision-making is also influenced by contextual factors such as biophysical and household characteristic.

Table 15: Results from Regression Model Series

N=81	Plant 1 or More (Logistic)			Plant 11 or More (Logistic)			Log Total Trees (Linear)		
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
External Support	**9.632*** (.852)**	**10.882*** (.890)**	4.065 (.901)	**8.593*** (.661)**	**52.478*** (1.306)**	**28.281* (1.854)**	**.400*** (.103)**	**0.439*** (.104)**	**.208* (.105)**
Environmental Perceptions	2.334 (.693)	1.857 (.748)	1.971 (.867)	**6.942*** (.659)**	**5.740** (.796)**	5.903 (1.183)	**.385*** (.139)**	**.296* (.148)**	**.203* (.139)**
Economic Perceptions	.686 (.549)	.861 (.501)	.742 (.544)	1.000 (.459)	2.889 (.654)	4.246 (.912)	-.053 (.094)	.027 (.097)	.029 (.085)
Social Perceptions	1.004 (.402)	.972 (.431)	.998 (.532)	.751 (.355)	.744 (.418)	1.287 (.666)	-.107 (.087)	-.106 (.088)	-.018 (.081)
% on-farm income		.964 (.224)	.827 (.276)		1.252 (.260)	.958 (.362)		.085 (.045)	.026 (.041)
Farm Size (HA)		1.005 (.007)	1.005 (.006)		1.015 (.016)	**1.014* (.008)**		.148 (.001)	**.221** (.001)**
Years on the Property		.991 (.016)	.998 (.017)		**.905** (.040)**	**.883** (.054)**		**-.170* (.004)**	**-.182** (.003)**
Dummy: Middle			2.948 (1.074)			**16.965* (1.484)**			**-.3110*** (.164)**
Dummy: Lower			3.558 (1.367)			1.807 (1.760)			**-.544*** (181)**
[1]R^2	**0.343**	**0.366**	**0.424**	**0.509**	**0.707**	**0.811**	**0.343**	**0.391**	**0.557**
[1]Standard. R^2	**2.419**	**7.232**	**5.964**	**7.128**	**8.42**	**1.015**	**0.307**	**0.328**	**0.497**
Classification	**84.2**	**82.9**	**84.2**	**76.3**	**82.9**	**92.1**			

*p<.1 **p<.05 ***p<.01

[1]Nagelkerke R^2 and Chi-Square shown for logistic regressions

Logistic: Exp(ß) (Std. Error) **Linear:** ß (Std. Error)

Interview Results

Conservation threats and challenges varied dramatically throughout the three sections of the corridor. Data suggest the lower corridor is challenged by rapid land conversion to monoculture plantations and wildfires. Residents in this region feel unsupported from conservation organizations. The middle corridor is concerned over water scarcity, which they connect to past deforestation. Additionally, a large-scale river irrigation project recently posed a threat to a community water resource. Residents in the middle corridor have experienced unsuccessful reforestation projects in the past. These events have shaped a preference for natural forest regeneration instead of planting trees. Overall, the environmental awareness and strong eco-tourism industry in the upper corridor have reduced traditional conservation threats in this region. However, some residents see new threats developing as the region continues to grow and build new infrastructure. Past reforestation projects in the upper corridor improved many barren landscapes but have created a reliance on support from conservation organizations for reforestation success.

Lower Corridor

Conservation Threats. Two conservation threats identified in the lower corridor are land transition to timber plantations and fires. A warmer climate and flatter geography produces higher pressure for land conversion to monoculture plantations. Types of plantations common in this region include pineapple or timber farms. As a result, Teak and Melina timber farms were more frequently seen compared to the middle and upper corridor (Figure 13A). Owners of timber farms are often absentee owners and have full-time caretakers living on the property. A minority of the local population benefits from these plantations, and some neighbors have been negatively impacted. Research participants shared stories of the damaging effects of these plantations such

as reduced soil quality and reduced biodiversity. One participant from the lower corridor (ID49) reported unusually high mortality rates and lower fruit production on his farm after witnessing two aerial fumigations on the neighboring Teak farm. Landowners were both concerned about the ecological impacts of timber plantations and frustrated about the factors limiting their ability to participate. A required growth period of 15-20 years before harvesting the trees, as well as financial barriers, has limited timber farming to larger and wealthier landowner in this region.

Fires pose a large threat to forest owners in the lower corridor. Dry seasons and high temperatures have made this region prone to wildfires which spread quickly through existing forests. Community members attribute the fires to community conflicts, illegal clearing of land for timber farming, illegal hunting and/or carelessness while burning trash. Representatives from the Ministry of Environment and Energy (MINAE), a national organization actively working on fire control and prevention in the region, reports carelessness (i.e. cigars, cigarettes, etc.), burning trash and illegal hunting as the three main causes of the fires (Jimenez, personal communication). Fires have destroyed large patches of mature forests and created a sense of fear around forested land.

Reforestation Barriers. Significant barriers to reforestation in this region include a lack of knowledge, tenure and land distribution. The lack of knowledge includes both technical skills needed for planting trees and information on how to receive support for conservation projects. A community member from the lower corridor explained:

> *"We are well established and know what we want. What we need is support and capacitation. Right? Because in order to do something, you have to know how to do it. When someone wants to make a tortilla, they have to know how you make a tortilla. Water, a little salt, and you have to kneed the tortilla well. It (reforestation) is exactly the same… I need the tools and to know how to work with the tools. You have to invest a lot; you see? This is what we need."* - *ID92*

Many participants struggled to name one or more conservation organizations working in the region. Residents felt unsupported when it came to land management decisions and conservation. Faced with a lack of knowledge, economic benefits from alternative land uses are more attractive. This has led to much land being cleared for production and limited forest remaining on areas with steep slopes (Figure 13B).

A. B.

Figure 12: Examples of land use in the lower corridor. A. Teak timber farm and B. Cattle ranch with remaining forests on sloped areas

Land tenure and distribution were also identified as barriers to reforestation in the lower corridor. As one interviewee explained, the lower section *"has a lot of land in very few hands"* (ID96). Significant reforestation efforts would require buy-in from larger landowners, who were often more concerned about profits from cattle ranching or renting plots to smaller agricultural farmers. Almost all survey participants reported owning a land title, however, interviews and informal conversations in the community suggest that many residents in this region do not. The ability to verify this fact was limited. If true, this could prevent enrollment in FONAFIFO's PES program or other conservation programs which require proof of land ownership. Additionally, lack of land security could create a disincentive to invest in a long term decision such as reforestation.

Middle Corridor

Conservation Threats. Residents in the middle corridor were very concerned about water scarcity which they often linked to deforestation. Natural springs and rivers have provided residents in the area with clean water for many years. In recent years, natural springs have been experiencing unusually low levels (Figure 14B). Interviewees explained how these events "*woke people up"* and that residents were *"concerned for themselves and their livelihood" (ID91).* Potential threats to water quality and quantity from the proposed irrigation project increased residents' concerns.

The irrigation project divided the community into those in favor of the irrigation and those against. Community members in opposition of the irrigation project argued the quantity to be rerouted would dramatically impact the river and greatly affect the community's water. The project was supported by a number of cattle ranchers in the region. Cattle ranchers in support of the irrigation often owned farms in the outer communities of Guacimal. The proposed irrigation routes would bring water to the farms in this area, while also allowing large amounts of water to flow further south to pineapple plantations and a poultry farm. After a long nine-year legal battle, the irrigation project was officially canceled.

Reforestation Barriers. Qualitative results suggest reforestation was impacted by a conflict of contradicting priorities between residents for and against the river irrigation. The Sustainability Demonstration Center manages the only tree nursery in the middle corridor. They often donate trees to community members through a reforestation project application process. The center took a strong stance against the irrigation proposal. This strong opposition led residents in favor of the irrigation project to feel disconnected from this source of support or

become disinterested in working with the center all together. Therefore, access to reforestation materials became limited for some residents in the middle corridor.

Residents in the middle corridor also reported many unsuccessful reforestation projects in the past. One community member shared a personal story of a reforestation effort to protect a natural spring with the help of a local organization:

> *"In that area, I fenced it off and planted trees. But with the strong flow of water, the posts and fence fell… and the trees, I don't know where they are. They are probably in Chomes (neighboring city) because there is not a single one still there. There is nothing. They must be in Chomes. I hope they took root there because there isn't a single one left up there anymore." - ID87*

This has resulted in a lack of interest in labor and resource investments for reforestation. Causes of the high mortality rates include inconsistent climate conditions, such as unusually wet or dry seasons, and poor quality of tree seedlings. These events have shaped a preference for natural forest regeneration instead of planting trees. In fact, many landowners claimed to allow specific species to grow naturally in their pastures while clearing others (Figure 14A). Species were left based on the services they provided, such as shade or strong timber for posts. This could be seen as a barrier to organizations interested in accelerating forest regrowth by planting trees.

A. B.

Figure 13: A. Example of farm with natural forest regrowth and B. Veracruz River in Guacimal

Upper Corridor

Conservation Threats. The upper corridor is unique because of the eco-tourism industry and environmental awareness that has developed in the region. Eco-tourism has allowed the area to develop with conservation, placing a high value on biodiversity protection. Environmental awareness is well-established despite some residents not working directly in tourism. Thus, few conservation challenges were highlighted in the interviews. One concern was urban encroachment occurring from rapid development in the tourism industry. On the contrary, some landowners who participated in reforestation programs recognized how tourism has allowed for better conservation practices. A resident of the upper corridor explains,

> *"Everything depends on the person… you have to have money to reforest. Why? Because often this person will already be producing coffee. Why? Because it is something that provides (economically). We reforest because we are producing tourism." - ID88*

Reforestation Barriers. The barriers identified in the upper corridor are a result of past reforestation programs. Early reforestation projects in the 80s and 90s provided high levels of support to landowners through material goods and technical support. Some were concerned this created a norm of expectations about donations for conservation participation. When reflecting on past reforestation programs, it was suggested that the level of support offered was erroneous and led to landowners de-valuing the trees. This ultimately led to high mortality rates from lack of sustained maintenance by landowners. An interviewee explained:

> *"We had a meeting in 2000 to talk about the problems with reforestation in Monteverde. Some thought that what had been done had been a mistake. That (the Monteverede Conservation League) went to the farms to offer trees, to give trees that is. Maybe that was not the best move. Why? Because the farmers got used to being given these. So we thought that a small mistake was made in the development of that project, just to bring everything in hand. Right? We thought that the farmers should have done a little more, like come here and solicit the trees. Not simply being brought and given everything. Because later, when the (Monteverde Conservation League) didn't have money to pay extensionists, or cars to bring the trees, then the*

farmers didn't plant trees. They want you to go and bring the trees to their farm for them to plant." – KI4

Another barrier in the upper corridor is a lack of space for reforestation on farms. Past reforestation programs were largely agroforestry based and allowed landowners to reforest and continue farming. Today, many of the trees have grown to maturity and encouraged secondary forest growth (Figure 15 A&B). Additionally, natural regeneration has restored many pastoral and agricultural areas no longer in use. Research participants were concerned that their farms would not be economically sustainable if they were to plant more trees. More specifically, coffee farmers were concerned that more shade would increase threats of fungus on coffee plants.

A. B.

Figure 14: A & B. Examples of mature agroforestry reforestation projects in the Upper Corridor.

Landowners in the upper corridor were most familiar with FONAFIFO's PES program. While discussing reforestation, barriers specific to the PES program were also identified. Many landowners had negative opinions towards the PES program stemming from distrust in the government and frustrations with enrollment processes. Landowners did not have confidence in the cash exchange process. Some felt they would not receive

their entire amount and others were concerned the money would never arrive at all. A large amount of paperwork, proof of identity and property ownership and transportation of documents required in the enrollment process were seen as burdensome. One landowner stated "*it cost more to go through the enrollment process than you will ever gain, if they pay you at all."*- (ID10). Other landowners were concerned about future land use limitations if enrolled in the program.

Key Informant Interviews

Landowner Engagement. Many lessons can be learned by reviewing the reforestation history in the upper corridor and listening to the actors involved in past projects. The success of early reforestation programs is often attributed to the collaboration between extensionists and landowners. A former conservation organization employee reflects on his experience working in reforestation in the upper corridor:

> *"I think that a lot of the success of this program is because the reforestation was to help the farmer and at the same time the environment. When we chose the species with the League, there was an intention to help the environment and help the farmer. The biologists, which were partners of the league, said we should use this species for the windbreaks because the toucans like to eat them, for example. Or they said, this windbreak, if we put it here, it will help the coffee and the pastures, but it's also going to connect two forest patches. It is going to be a mini biological corridor. So, I believe that the main focus should be that the tree serves the farmer. That allowed us to open the door to talk about the rest. – KI3*

Many others emphasized the need to work with farmers to identify their long term goals for more successful reforestation. A key informant suggested that in order to more successfully engage with farmers it is "*necessary to look at the farm as a business and find ways to improve it*" (KI10). For many of the landowners, the farm is *"credit, inheritance and how the family provides for themselves*." (KI10) Therefore, it is key to acknowledge that reforestation requires trade-offs and it is important to find ways to benefit the farmer as well as the environment. For

example, for every natural spring or river protected from cattle, an alternative drinking source should be made available for the livestock.

Barriers. Barriers to reforestation identified by key informants include a lack of environmental education and financial limitations for external support. Key informants were aware of the varying levels of environmental education throughout the corridor. They acknowledged how reforestation is easier to promote in the upper corridor where there is a higher level of environmental awareness. Environmental education was a key component in early reforestation projects and has now become embedded in the culture after many years. As a key informant stated:

> *"There was already a dynamic here in (the upper corridor), to talk about the importance of the forest. That is one thing. Another thing is (the middle corridor) or (the lower corridor). They are other realities. Other histories." KI3*

Another key informant identified the lack of occupational opportunities related to conservation in the lower corridor. In order to better engage landowners in conservation, external organizations should "*teach the lowlands that conservation and reforestation can be a form of income."* (KI11) Providing opportunities to work in conservation, such as tree nurseries or with conservation organizations, could reduce the risk of deforestation for alternative income opportunities. This could also spread environmental awareness to older generations not exposed to environmental education in an academic setting.

The importance of outreach and extension was identified in many interviews, however, key informants also understood the limitations faced by conservation organizations when trying to fill those roles. Extension roles require personnel, time and money for transportation. Current reforestation projects in the corridor face more challenges than past projects due to a reduction in funding and limited grant money. Representatives from national level organizations expressed

similar frustrations. Key informants felt limited in their ability to provide labor and technical assistance as well as help with initial participation costs by providing free materials.

Chapter 6: Discussion and Conclusion

Discussion

This mixed methods research responds to a call for the use of a broader 'menu' of variables and approaches when identifying factors that influence and constrain tree planting (Chowdhury & Turner II, 2006; Pattanayak et al., 2003; Sood & Mitchell, 2009). Specifically, the mixed methods analysis allowed for a better understanding of the factors that influence landowner decision making while recognizing the context specific factors limiting participation. Quantitative data collected in this research measured internal and external motivators, biophysical characteristics, household characteristics, and barriers. By controlling for each of these in the regression analysis, a better understanding of the significance of motivations versus other factors was gained. Interviews added context to the quantitative results and identified the specific conservation threats and barriers faced in each part of the corridor. Below I summarize the key implications for each of the five categories of variables examined in this research.

Motivations

Regression results found both internal and external motivations to significantly influence reforestation participation. Of the three internal motivations analyzed in the regression model, only environmental perceptions had a significant influence on participation. Data from interviews, ranking exercises and open-ended survey questions support these findings. Regulating ecosystem services, specifically those related to water, were identified as the primary interest of landowners in planting trees. External motivations significantly influenced participation in the regression results, however, direct payments were not popular among the

sample population. Reforestation materials, such as free trees, and technical support were preferred over direct payments.

External motivations. The results of the regression analysis found external support to be the most consistently significant variable across the three sets of regressions. This significance suggests that support from conservation organizations plays an important role in landowner decision-making. Responses to an open-ended survey question about past motivations for planting trees supported these findings. Responses such as *"I worked with Monteverde Conservation League"* and *"I was offered trees"* highlight the role conservation organizations can play in reforestation. In a study in the highlands of Vietnam, the extent of government support and short-term training sessions were found to influence both participation and intensity of tree planting on private lands (Dinh et al., 2017). Chowdhury and Turner II (2006) also found that access to extension significantly influenced agroforestry adoption in Mexico.

Support for reforestation in the corridor has been provided in various forms (i.e. free trees, free labor, fencing materials or direct payments). Therefore, to more effectively design future reforestation projects, it is important to have a better understanding of landowner's support preferences. The survey ranking exercise found free trees and fencing materials to be the two most preferred forms of support. Direct payment was the least important among landowners. This suggests that landowners hold an intrinsic interest in planting trees but are concerned about initial costs to participate. This could also reflect a concern for the payment program rules which often limit land use opportunities in order to meet contract agreements. Previous research on PES in the CBPC found a similar level of disinterest in the PES program. This research concludes that the majority of participants who were enrolled in the program where already conserving forest on

their land and that the program was not actually influencing behavior changes (Allen & Vásquez, 2017).

Qualitative data on the national PES program suggests that the enrollment process and a lack of trust between landowners and government agencies disincentivize landowners from participating. Previous research has found trust to influence participation in forest management programs (Ford, Williams, Smith, & Bishop, 2014; Jones et al., 2017), as well as moderate landowners beliefs about the outcomes of conservation interventions (Ford et al., 2014). Negative attitudes towards the PES program could be influencing landowner's preferences for external support. If landowners perceive many barriers to receiving direct payments, they may prioritize forms of support which seem more realistic. This could explain the prioritization of free trees and fencing materials over direct payments in the ranking exercise.

Internal Motivations. Of the internal motivations measured in this research, environmental perceptions were significant in two of the three regression sets. Social perceptions and economic perceptions were not significant in any. Similarly, past research has found landowner beliefs about consequences for the environment to more strongly influence forest management and conservation compared to economic beliefs about timber industry impacts (Ford et al., 2014). The lack of significance in social and economic perceptions is somewhat surprising as other studies have found both social (Grillos, 2017; Mastrangelo et al., 2014; Sorice & Donlan, 2015) and economic (Current & Scherr, 1995; Mercer, 2004) factors to influence forest conservation participation.

Results of the ranking and open-ended questions also show a prioritization of environmental benefits over social and economic benefits. Protecting water was the primary motivation for tree planting in the ranking exercise. Tourism was the least chosen option.

Providing an alternative source of fruit and wood for the household were also among the most popular choices. Provisioning ecosystem services, such as fruit or wood, could serve as compensation for the trade-off made when planting trees on the farm. A similar pattern appeared in the open-ended survey questions which asked landowners about their motivations for conserving forests and planting trees in the past. In both questions, regulating and provisioning services were the most common motivation categories. This represents responses such as *"to protect the stream", "to produce posts for the farm",* and *"to provide shade for the cows".* These findings are similar to those from a study which assessed tree planting on small scale farms in Panama. This study found that the most common motivations for planting trees on farms included 1) for a source of wood, 2) to improve water and soil quality and 3) shade for cattle (Garen et al., 2011).

Forest Conservation Motivations. Results from the open-ended question about motivations for leaving forest on the property found two responses categories: financial and non-financial. The non-financial responses include leaving the forest for the services it provides or for conservation in general. The financial responses include leaving the forest because of the financial limitations preventing landowners from cutting it down or because of the lack of financial value if put into production. These two types of motivations, financial and non-financial, relate to a larger body of literature on motivations for forest conservation (Karppinen, 1998; Majumdar, Teeter, & Butler, 2008; Silver, Leahy, Weiskittel, Noblet, & Kittredge, 2015). Similarly, two value orientations, "mutualism" and "domination", have been used to describe landowners who appreciate nature and see nature as valuable for the services it provides (i.e. mutualism) or who see land solely for its production and cultivation value (i.e. domination) (Teel, Manfredo, & Stinchfield, 2007).

Household Characteristics.

Biophysical and household characteristics were used in the final regression analysis to account for contextual factors that have been found to influence decision-making in previous research (Chowdhury & Turner II, 2006; Dinh et al., 2017; Mercer, 2004; Pattanayak et al., 2003; Sood & Mitchell, 2009). In a meta-analysis of agroforestry adoption studies, Pattanayak et al (2003) found income to influence adoption in 50% of the cases. Dinh et al. (2017) found that landowners who relied more heavily on agriculture for income were less likely to plant trees in the highlands of Vietnam, however, Chowdhury and Turner II (2006) found landowners with a greater reliance on off farm wages were less likely to adopt agroforestry practices. Percent of income from on-farm activities was not significant in this research, suggesting that it does not influence tree planting in this study site. However, this lack of significance could also be due to a lack of variation among survey respondents in their on-farm income.

The number of years on the property significantly influenced the decision to plant trees. The direction of the relationship, however, varied across dependent variables. In the logistic regression model, there was a positive relationship and in the linear regression model there was a negative relationship. It was expected that landowners who had spent more years on their property would have planted more trees due to increased opportunities over a longer period of time, especially in the upper corridor as reforestation projects were very common in the late 80s and 90s. The positive relationship between time on property and planting trees has been found in research in Vietnam (Chowdhury & Turner II, 2006). However, the linear regression models and correlation analyses found a negative relationship between years on the property and total trees planted (Appendix H). This suggest that landowners with more years spent on their property are less likely to plant a greater number of trees. Interview data shows evidence of occupational

transitions; as new families move to the upper corridor to look for eco-tourism opportunities or younger generations are inheriting family farms many are retiring agricultural or pastoral land to work in non-agricultural industries. This could explain the negative relationship found in the linear regression model and correlations.

Biophysical Characteristics

The correlation between soil quality, steep slopes and forested areas suggest that forest often exist on poor quality or heavily inclined areas while flatter, healthier plots are used for agricultural production. This relationship is especially visible in the lower corridor. Southworth and Tucker (2001) found this pattern when assessing the distribution of deforestation and agricultural production in Honduras (Southworth & Tucker, 2001). However, research has also found these characteristics to increase the probability of reforestation or agroforestry adoption (Bannister & Nair, 2003; Sibelet et al., 2017). In a reforestation study in the Central Volcanic Talamanca Biological Corridor in Costa Rica, Sibelet et al. (2017) found that farmers were more willing to plant trees in steeply sloped areas, along farm boundaries and riparian areas. Slope did not significantly influence tree planting in the initial regression analyses and therefore was not included in the final regression model. The physical challenge of planting trees on steep inclines or increased risk of mortality could be limiting landowner interest in reforesting these areas. This risk was recognized in an interview when an interviewee shared a personal story of their reforestation efforts washing away in a rain storm.

Farm size was found to influence reforestation participation in the final regression analysis although its significance was weaker than some other variables (11+ Logistic Model 3: $p<.1$ and Linear Model 3: $p<.05$). It is expected that larger farms would have more reforestation due to the greater availability of land (Garen et al., 2011). The positive regression co-efficient

suggests this type of relationship. Qualitative data, however, identified a size threshold for cattle ranching, which suggests that only farms over a certain number of hectares (40-50 ha) can be economically sustainable for ranching. Therefore, as farms are divided for inheritance, they are being taken out of production. Many research participants were transitioning away from farming due to concerns over production and economic stability of the farm. This is a trend that has been found in other areas of Costa Rica (Sibelet et al., 2017) and could be limiting the significance of farm size in the regression models.

Barriers

Each part of the corridor experiences unique barriers to conservation which are embedded in complex social-ecological landscapes. Past literature on agroforestry adoption has identified risk and uncertainty as a barrier to adoption. Risk and uncertainty has been measured as tenure, experience, extension and membership in cooperatives (Feder & Umali, 1993; Greiner, Patterson, & Miller, 2009; Mercer, 2004; Pattanayak et al., 2003). Due to the limited quantitative measurements of barrier variables in this research, they were not included in the final regression analysis. Interview data found a lack of knowledge and lack of space to be preventing reforestation. The lack of knowledge was especially significant in the lower corridor. For example, an interviewee in the lower corridor expressed interest in planting trees but needed more information of how and what species to plant.

Conservation knowledge is influenced by location in the corridor. Many of the conservation organizations are located in the upper corridor thus reforestation materials, assistance and information is more easily accessible in this section. Many interviewees and survey participants in the lower two corridor sections had limited knowledge of conservation organizations or active programs. Residents in the lower corridor found it challenging to name

one or more organization working in conservation. This led to residents feeling unsupported and lacking knowledge of how to contact conservation organizations for assistance with conservation projects.

Reforestation in the middle corridor is limited by unsuccessful reforestation experiences in the past. This has shaped negative attitudes towards planting trees due to loss of investment. Residents in the middle corridor were more willing to allow trees to grow naturally on their property. Past research has found similar preferences among farmers. Siqueira et al. (2017) found that landowners who prefer natural regeneration will permit specific trees to grow back based on the benefits they provide such as shade (Siqueira, Calasans, Furtado, Carneiro, & van den Berg, 2017). Garen et al. (2011) also found food, wood and shade for cattle to be main motivations for maintaining trees on farms in Panama (Garen et al., 2011).

An approach to overcome negative attitudes towards reforestation is by allowing landowners to witness benefits from reforestation on another landowner's property (Mercer, 2004). This can give landowners more confidence before personally investing in reforestation materials and labor. In early reforestation programs, Monteverde Conservation League celebrated the "Día de Reforestador". This was a day where community members would visit a reforested farm to applaud landowners for their conservation efforts. Today, MAG still arranges visits for landowners to see other farms that have adopted specific farming techniques including agroforestry practices.

Management Implications

This research can provide project design and management suggestions for future reforestation programs in the corridor. Results found that both internal and external factors influence landowner decision making. Thus, a strong extension program focused on outreach and

overcoming initial participation costs could encourage participation from landowners. Extension positions should work closely with landowners to align reforestation objectives with the future plans of the landowner. In general, research participants expressed a preference for in-kind goods or technical assistance over cash. Past reforestation in the upper corridor has led to an expectation of high levels of support for reforestation. Examples of external support in past projects include technical support, free trees, fencing materials, fertilizer, herbicide and cash. Conservation literature warns that the use of direct payments can "crowd out" intrinsic motivations. This can create a financial challenge for conservation organizations interested in promoting reforestation in the region. Avoiding direct payments, which could crowd out existing intrinsic motivations, could prevent these future conservation challenges.

Landowners that participated in this research were more concerned about environmental benefits rather than social or economic benefits. Specifically, landowners were interested in the protection of water and material benefits from forests (i.e. fruit or wood). Therefore, a greater emphasis should be placed on ecosystem services security and improvement from reforestation and the benefits that can bring to the household. Having successful reforestation in the corridor will depend on shaping positive attitudes towards conservation and forests.

Each part of the corridor experiences different barriers to conservation and has unique reforestation opportunities. Conservation organizations should find a balance between providing support to overcome initial participation barriers while also requiring a level of investment from landowners to instill responsibility. This level of support may vary in each part of the corridor depending on household socio-economic status and access to resources. Organizations should also focus on building trust with local community members through consistent visits and

activities with landowners, and through implementing participatory approaches. The following are specific recommendations for reforestation projects in each part of the corridor:

1. Lower CBPC: To overcome the low valuation of forest in the lower corridor, extensive outreach and environmental education will be required to change attitudes of landowners. Slowly integrating tree planting onto agricultural properties through agroforestry based programs could begin to shift attitudes and norms in these communities without taking large areas of land out of production.
2. Middle CBPC: Extensive outreach can also help to overcome the trust barrier that exists in the middle corridor and regain the confidence of landowners. Many landowners in this region expressed a preference for natural forest regeneration instead of tree planting. Therefore, conservation organizations could be more successful if they found ways to facilitate natural forest regeneration such as providing fencing materials to protect new forest growth.
3. Upper CBPC: Results from the upper corridor suggest that reforestation motivations have shifted from farm protection to ecotourism. This can have major implications for the reforestation program structure, including the tree species that organizations should be promoting. For example, tree species which attract greater levels of biodiversity, such as Aguacatillo (*Persea caerulea)* which attracts avian species like the Quetzal, could be more successful than species previously used for windbreaks.

Research Needs and Future Directions

This study shows that motivations for reforestation are both internal and external and that there are a number of contextual factors that can influence the decision to plant trees. Continuing this integrated analysis of decision making in future research will allow for a better understanding of these processes. It could also help identify additional factors that can contribute

to the success of reforestation programs. Measurement improvements can be made to better the analysis of internal and external motivators in this research. For example, future analysis of external motivations should differentiate between types of support (i.e. in-kind, cash, perceived support) to compare the significance of each on decision making. Internal motivation measurements could also be improved. This would require the identification of important social networks to more effectively measure social benefits of reforestation. In general, a larger sample size and study area could increase the understanding of the factors analyzed in this research. A larger sample size would increase the probability that the sample population reflects the actual population and increasing the study area would improve the generalizability of the research (Vaske, 2008). Future research should expand this analysis to more areas of the CBPC, Costa Rica and the region of Latin America to test for generalizability of the results.

Future research on reforestation could provide a valuable contribution to conservation literature by using a more evidence based approach. This would require an experimental or quasi-experimental research design to more effectively test the influence of external support on reforestation participation (Ferraro, 2009). Future research designs could implement external support in a way that allows for program monitoring and a rigorous impact evaluation to measure its effect on behavior. This would contribute to a larger body of evidence based conservation and behavior change literature and ultimately improve reforestation program design in the future.

Significance and Conclusion

The CBPC was established to protect and improve critical habitats for the Three-Wattled Bellbird and other rare avian species. Expanding conservation throughout the corridor to restore barren landscapes and connect forest fragments is key for the success of the corridor in reaching these conservation goals. However, for those working in conservation in the corridor, it has

become inherently apparent that there is no ‘one-size fits all’ solution to conservation. Organizations interested in promoting and carrying out conservation projects on a corridor scale must acknowledge the variation of landscapes within the corridor, both social and ecological. Results presented in this research suggest that relying purely on financial incentives will not increase landowner engagement in reforestation. However, other types of external support, such as free trees and technical assistance, are critical for reforestation implementation.

In addition to external support, quantitative and qualitative results from this study reinforce previous literature on agroforestry and reforestation, which argues that conservation behavior is motivated by more than external motivations. Internal motivations, specifically environmental perceptions, were found to play a large role in decision making. This is likely due to perceived vulnerabilities from environmental threats, such as water scarcity. While other types of internal motivators like social norms were not found to be significant in this study, they have been linked to forest conservation decision making in other contexts. In addition to the significance of internal motivations on tree planting, this research demonstrates how these motivations can be moderated by contextual factors such as biophysical characteristics, household characteristics and barriers. In particular, the number of years spent on the property and property size were found to influence the decision to plant trees. Qualitative data found a lack of technical knowledge and a lack of trust exist as barriers to reforestation in the study area.

Overall, the implications for conservation organizations in the CBPC suggest that future extension programs which focus on outreach and environmental education will be important for the success of reforestation projects in the CBPC. Overcoming the initial cost to plant trees and promoting ecosystem services values from tree planting will be important components of reforestation project design. However, a key part of organization success will be building and

strengthening trust between landowners and extensionists by aligning reforestation program design with the future plans of the landowner.

References

Adger, N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, *24*(3), 347–64. http://doi.org/10.1191/030913200701540465

Agrawal, A., & Chhatre, A. (2006). Explaining success on the commons: Community forest governance in the Indian Himalaya. *World Development*, *34*(1), 149–166. http://doi.org/10.1016/j.worlddev.2005.07.013

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. http://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2012). Martin Fishbein's Legacy: The Reasoned Action Approach. *The Annals of the American Academy of Political and Social Science*, *640*(1), 11–27. http://doi.org/10.1177/0002716211423363

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Prentice-Hall.

Allen, K. E., & Vásquez, S. P. (2017). Forest cover, development, and sustainability in Costa Rica : Can one policy fit all? *Land Use Policy*, *67*, 212–221. http://doi.org/10.1016/j.landusepol.2017.05.008

Bannister, M. E., & Nair, P. K. R. (2003). Agroforestry adoption in Haiti: the importance of household and farm characteristics. *Agroforestry Systems*, *57*, 149–158. http://doi.org/https://doi.org/10.1023/A:1023973623247

Bennett, N. J. (2016). Using perceptions as evidence to improve conservation and environmental management. *Conservation Biology*, *30*(3), 582–592. http://doi.org/10.1111/cobi.12681

Bowles, S. (2008). Policies designed for self-interest citizens may undermine "the moral sentiments": Evidence from economic experiments. *Science*, *320*, 1605–1609. http://doi.org/10.1126/science.1152110

Bryant, D., Nielsen, D., & Tangley, L. (1997). *Last Frontier Forests: Ecosystems and Economies on the Edge*. *Frontiers: A Journal of Women Studies*. Retrieved from http://pdf.wri.org/lastfrontierforests.pdf

Campell, D. T., & Stanley, J. C. (1966). Experimental and Quasi-Experimental Designs for Research. Chicago, IL: Rand McNally.

CBPC. (2018). Corredor Biológico Pájaro Campana. Retrieved August 20, 2001, from www.cbpc.org

Chazdon, R. L. (2008). Beyond Deforestation: Restoring Degraded Lands. *Communities*, *320*(5882), 1458–1460. http://doi.org/10.1126/science.1155365

Chowdhury, R. R., & Turner II, B. L. (2006). Reconciling Agency and Structure in Empirical Analysis: Smallholder Land Use in the Southern Yucatan, Mexico. In *Annals of the Association of American Geographers* (Vol. 96, pp. 302–322).

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334.

Cronbach, L. J. (2004). My Current Thoughts on Coefficient Alpha and Successor Procedures. *Educational and Psychological Measurement*, *64*(3), 391–418.

Current, D., & Scherr, S. J. (1995). Farmer costs and benefits from agroforestry and farm forestry projects in Central America and the Caribbean: implications for policy. *Agroforestry Systems*, *30*(1–2), 87–103. http://doi.org/10.1007/BF00708915

de Snoo, G. R., Herzon, I., Staats, H., Burton, R. J. F., Schindler, S., Dijk, J. Van, … Musters, C. J. M. (2013). Toward effective nature conservation on farmland: making farmers matter. *Conservation Letters*, *6*, 66–72. http://doi.org/10.1111/j.1755-263X.2012.00296.x

Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivations. *Journal of Personality and Social Psychology*, *18*(1), 105.

Deci, E. L., Ryan, R. M., & Koestner, R. (1999). A Meta-Analytic Review of Experiments Examining the Effects of Extrinsic Rewards on Intrinsic Motivation. *Psychological Bulletin*, *125*(6), 627–668.

Dinh, H. H., Nguyen, T. T., Hoang, V., & Wilson, C. (2017). Economic incentive and factors affecting tree planting of rural households: Evidence from the Central Highlands of Vietnam. *Journal of Forest Economics*, *29*, 14–24. http://doi.org/10.1016/j.jfe.2017.08.001

Ellis, F. (1999). Rural Livelihood Diversity in Developing Countries : Evidence and Policy Implications. *ODI Natural Resource Perspectives*, *40*, 1–10. Retrieved from http://www.mendeley.com/research/rural-livelihood-diversity-developing-countries-evidence-policy-implications-10/

FAO. (2015). Agroforestry. Retrieved March 13, 2018, from http://www.fao.org/forestry/agroforestry/80338/en/

Feder, G., & Umali, D. L. (1993). The Adoption of Agricultural Innovations A Review. *Technological Forecasting & Social Change*, *43*, 215–239.

Ferraro, P. J. (2009). Counterfactual Thinking and Impact Evaluation in Environmental Policy. *Environmental Program and Policy Evaluation: Addressing Methodological Challenges. New Directions for Evaluation*, *122*, 75–84. http://doi.org/10.1002/ev

Fishbein, M., & Ajzen, I. (2010). *Predicting and Changing Behavior: The reasoned action approach*. New York, NY: Psychology Press.

FONAFIFO. (2017). Datos de Pagos de Servicios Ambientales.

Ford, R., Walton, S., Stephenson, J., Rees, D., Scott, M., King, G., … Wooliscroft, B. (2017). Technological Forecasting & Social Change Emerging energy transitions : PV uptake beyond subsidies. *Technological Forecasting & Social Change*, *117*, 138–150. http://doi.org/10.1016/j.techfore.2016.12.007

Ford, R., Williams, K. J. H., Smith, E. L., & Bishop, I. D. (2014). Beauty, Belief and Trust: Toward a Model of Psychological Processes in Public Acceptance of Forest Management. *Environment and Behaviour*, *46*(4), 476–506. http://doi.org/https://doi.org/10.1016/j.techfore.2016.12.007

Garbach, K., Lubell, M., & Declerck, F. A. J. (2012). Agriculture, Ecosystems and Environment Payment for Ecosystem Services: The roles of positive incentives and information sharing in stimulating adoption of silvopastoral conservation practices. *Agriculture, Ecosystems and Environment*, *156*, 27–36. http://doi.org/10.1016/j.agee.2012.04.017

García-Amado, L. R., Ruiz Pérez, M., & Barrasa García, S. (2013). Motivation for conservation: Assessing integrated conservation and development projects and payments for environmental services in La Sepultura Biosphere Reserve, Mexico, Chiapas. *Ecological Economics*, *89*, 92–100. http://doi.org/10.1016/j.ecolecon.2013.02.002

Garen, E. J., Saltonstall, K., Ashton, M. S., Slusser, J. L., Mathias, S., & Hall, J. S. (2011). The tree planting and protecting culture of cattle ranchers and small-scale agriculturalists in rural Panama: Opportunities for reforestation and land restoration. *Forest Ecology and Management*, *261*, 1684–1695. http://doi.org/10.1016/j.foreco.2010.10.011

Glass, G. V., & Hopkins, K. D. (1996). *Statistical methods in education and psychology* (3rd

ed.). Boston, MA: Allyn & Bacon.
Goldstein, K. (2002). Getting in the Door: Sampling and Completing Elite Interviews. *PS: Political Science & Politics*, *35*(4), 669–672.
Green, K. M., DeWan, A., Balcazar Arias, A., & Hayden, D. (2013). Driving adoption of payments for ecosystem services through social marketing, Veracruz, Mexico. *Conservation Evidence*, *10*, 48–52.
Greiner, R., & Gregg, D. (2011). Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. *Land Use Policy*, *28*(1), 257–265. http://doi.org/10.1016/j.landusepol.2010.06.006
Greiner, R., Patterson, L., & Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems*, *99*, 86–104. http://doi.org/10.1016/j.agsy.2008.10.003
Grillos, T. (2017). Economic vs non-material incentives for participation in an in-kind payments for ecosystem services program in Bolivia. *Ecological Economics*, *131*, 178–190. http://doi.org/10.1016/j.ecolecon.2016.08.010
Henderson, S. (2003). Building democracy in contemporary Russia: Western support for grassroots organizations. Ithaca: Cornell University Press.
Jerneck, A., & Olsson, L. (2014). Food first! Theorising assets and actors in agroforestry: risk evaders, opportunity seekers and "the food imperative" in sub-Saharan Africa. *International Journal of Agricultural Sustainability*, *12*(1). http://doi.org/10.1080/14735903.2012.751714
Jimenez, A. (2017). SINAC Presentation, June 2017.
Jolliffe, P. (2011). Principle Component Analysis. In *International Encyclopedia of Statistical Science* (pp. 1094–1097). Springer.
Jones, K. W., Holland, M. B., Naughton-Treves, L., Morales, M., Suarez, L., & Keenan, K. (2017). Forest conservation incentives and deforestation in the. *Environmental Conservation*, *44*(1), 56–65. http://doi.org/10.1017/S0376892916000308
Kabii, T., & Horwitz, P. (2006). A review of landholder motivations and determinants for participation in conservation covenanting programmes. *Environmental Conservation*, *33*(1), 11–20. http://doi.org/10.1017/S0376892906002761
Kapos, V., Balmford, A., Aveling, R., Bubb, P., Carey, P., Entwistle, A., … Manica, A. (2008). Calibrating conservation: new tools for measuring success. *Conservation Letters*, *1*(4), 155–164. http://doi.org/10.1111/j.1755-263X.2008.00025.x
Karppinen, H. (1998). Values and Objectives of Non-industrial Private Forest Owners in Finland. *Silva Fennica*, *32*, 43–59.
Karppinen, H. (2005). Forest owners' choice of reforestation method: an application of the theory of planned behavior. *Forest Policy and Economics*, *7*, 393–409. http://doi.org/10.1016/j.forpol.2003.06.001
Kerr, J. M., Vardan, M., & Jindal, R. (2014). Incentives, conditionality and collective action in payment for environmental services. *International Journal of the Commons*, *8*(2), 595–616. http://doi.org/http://doi.org/10.18352/ijc.438
Keshavarz, M., & Karami, E. (2016). Farmers' pro-environmental behavior under drought: Application of protection motivation theory. *Journal of Arid Environments*, *127*, 128–136. http://doi.org/10.1016/j.jaridenv.2015.11.010
Klockner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour — A meta-analysis. *Global Environmental Change*, *23*, 1028–1038.

http://doi.org/10.1016/j.gloenvcha.2013.05.014
Le, H. D., Smith, C., & Herbohn, J. (2014). What drives the success of reforestation projects in tropical developing countries? The case of the Philippines. *Global Environmental Change*, *24*(1), 334–348. http://doi.org/10.1016/j.gloenvcha.2013.09.010
Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, (140), 1–55.
Majumdar, I., Teeter, L., & Butler, B. (2008). Characterizing Family Forest Owners: A Cluster Analysis Approach. *Forest Science*, *54*(2), 176–184.
Martin, A., Blowers, A., & Boersema, J. (2008). Paying for environmental services: can we afford to lose a cultural basis for conservation? *Environmental Sciences*, *5*(1), 1–5. http://doi.org/10.1080/15693430701878240
Maruyama, M., & Morioka, N. (1998). The Impact of Deforestation in Brazilian Amazonia: The indigenous Peoples of Rondonia State. *Japan Society of Forest Planning*, *4*, 71–75.
Mastrangelo, M. E., Gavin, M. C., Laterra, P., Linklater, W. L., & Milfont, T. L. (2014). Psycho-Social Factors Influencing Forest Conservation Intentions on the Agricultural Frontier. *Conservation Letters*, *7*(2), 103–110. http://doi.org/10.1111/conl.12033
McCauley, D. J. (2006). Selling out on nature. *Nature*, *443*, 27–28. http://doi.org/10.1038/443027a
Mckenzie-Mohr, D. (2011). *Fostering sustainable behavior: An introduction to community-based social marketing* (3rd ed.). Gabriola Island, BC: New Society.
Mckenzie-Mohr, D., Lee, N. R., Schultz, W. P., & Kotler, P. (2012). *Social Marketing to Protect the Environment: What Works*. Los Angeles, CA: SAGE Publications, Inc.
McMichael, A., Scholes, R., Hefny, M., Pereira, E., Palm, C., & Foale, S. (2005). Linking Ecosystem Services and Human Well-being. In D. Capistrano, C. Samper K., M. J. Lee, & C. Raudsepp-Hearne (Eds.), *Ecosystems and Human Well-being: multi-scale assessment* (Millenium, pp. 43–60). Washington D.C.: Island Press. Retrieved from http://www.maweb.org/documents/document.341.aspx.pdf
Meijer, S. S., Catacutan, D., Ajayi, O. C., Sileshi, G. W., & Nieuwenhuis, M. (2015). The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. *International Journal of Agricultural Sustainability*, *13*(1), 40–54. http://doi.org/10.1080/14735903.2014.912493
Mercer, D. E. (2004). Adoption of agroforestry innovations in the tropics: A review. *Agroforestry Systems*, *61*(1), 311–328. http://doi.org/10.1023/B:AGFO.0000029007.85754.70
Montambault, J. R., & Alavalapati, J. R. R. (2005). Socioeconomic research in agroforestry: a decade in review. *Agroforestry Systems*, *65*, 151–161. http://doi.org/10.1007/s10457-005-0124-6
Moore, D. S., & McCabe, G. P. (1989). *Introduction to the practice of statistics. Introduction to the practice of statistics.* New York, NY, US: W H Freeman/Times Books/ Henry Holt & Co.
Morgan, G. A., & Harmon, R. J. (1999). Clinicians' Guide To Research Methods and Statistics: Sampling and External Validity. *Journal of the American Academy of Child & Adolescent Psychiatry*, *38*(8), 1051–1053. http://doi.org/10.1097/00004583-199908000-00023
Myers, N. (1997). Biodiversity's genetic library. In *Nature's services: Societal dependence on natural ecosystems* (pp. 255–273). Washington D.C. & Covela, CA: Island Press.
Narloch, U., Pascual, U., & Drucker, A. G. (2012). Collective Action Dynamics under External

Rewards: Experimental Insights from Andean Farming Communities. *World Development*, *40*(10), 2096–2107. http://doi.org/10.1016/j.worlddev.2012.03.014
Pagiola, S., Honey-rosés, J., & Freire-González, J. (2016). Evaluation of the Permanence of Land Use Change Induced by Payments for Environmental Services in Quindío, Colombia. *PLoS One*, *11*(3), 1–19. http://doi.org/10.1371/journal.pone.0147829
Pattanayak, S. K., Mercer, D. E., Sills, E., & Yang, J. (2003). Taking stock of agroforestry adoption studies. *Agroforestry Systems*, *57*(3), 173–186. http://doi.org/https://doi.org/10.1023/A:1024809
Perecman, E., & Curran, S. R. (2006). Focus Groups: Focus Group Interviews. In *A Handbook for Social Science Field Research: Essays & Bibliographic Sources on Research Design and Methods* (pp. 104–117). Thousand Oak, CA: SAGE. http://doi.org/10.4135/9781412973427
Polomé, P. (2016). Private forest owners motivations for adopting biodiversity-related protection programs. *Journal of Environmental Management*, *183*, 212–219. http://doi.org/10.1016/j.jenvman.2016.07.097
Poore, D. (1986). *The vanishing forest: the human consequences of deforestation*. London, UK: Zed Books.
Redford, K. H., Padoch, C., & Sunderland, T. (2013). Fads, Funding, and Forgetting in Three Decades of Conservation. *Conservation Biology*, *27*(3), 437–438. http://doi.org/10.1111/cobi.12071
Rode, J., Gómez-Baggethun, E., & Krause, T. (2015). Motivation crowding by economic incentives in conservation policy: A review of the empirical evidence. *Ecological Economics*, *117*, 270–282. http://doi.org/10.1016/j.ecolecon.2014.11.019
Rogers, R. W. (1983). Cognitive and psychological processes in fear appeals and attitude change: A revised theory of protection motvation. In *Social psychophysiology: A source book* (pp. 153–176).
Rokeach, M. (1973). *The nature of human values*. Free Press.
Ruiz-Mallén, I., Schunko, C., Corbera, E., Rös, M., & Reyes-Garcia, V. (2015). Meanings, drivers, and motivations for community-based conservation in Latin America. *Ecology and Society*, *20*(3). http://doi.org/10.5751/ES-07733-200333
Ruseva, T. B., Evans, T. P., & Fischer, B. C. (2015). Can incentives make a difference? Assessing the effects of policy tools for encouraging tree-planting on private lands. *Journal of Environmental Management*, *155*, 162–170. http://doi.org/10.1016/j.jenvman.2015.03.026
Scheaffer, R. L., Mendenhall III, W., & Ott, L. R. (1996). *Elementary Survey Sampling* (Sixth). Belmont, CA: Duxbury Press.
Schwartz, S. H., & Howard, J. A. (1981). A Normative Decision-Making Model of Altrusim. In J. P. Rushton & R. M. Sorrentino (Eds.), *Altruism and Helping Behavior: Social, Personality and Developmental Perspectives* (pp. 189–211). Hillsdale, NJ: Lawrence Erlbaum.
Sibelet, N., Chamayou, L., Newing, H., & Montes, I. G. (2017). Perceptions of Trees Outside Forests in Cattle Pastures: Land Sharing Within the Central Volcanic Talamanca Biological Corridor, Costa Rica. *Human Ecology*, *45*, 499–511. http://doi.org/10.1007/s10745-017-9924-3
Silver, E. J., Leahy, J. E., Weiskittel, A. R., Noblet, C. L., & Kittredge, D. B. (2015). An Evidence-Based Review of Timber Harvesting Behavior among Private Woodland Owners.

Journal of Forestry, *113*(5), 490–499. http://doi.org/https://doi.org/10.5849/jof.14-089
Siqueira, F. F., Calasans, L. V., Furtado, R. Q., Carneiro, V. M. C., & van den Berg, E. (2017). Agriculture, Ecosystems and Environment How scattered trees matter for biodiversity conservation in active pastures. *Agriculture, Ecosystems and Environment*, *250*, 12–19. http://doi.org/10.1016/j.agee.2017.08.002
Sood, K. K., & Mitchell, C. P. (2009). Identifying important biophysical and social determinants of on-farm tree growing in subsistence-based traditional agroforestry systems. *Agroforestry Systems*, *75*, 175–187. http://doi.org/10.1007/s10457-008-9180-z
Sorice, M. G., & Donlan, C. J. (2015). A human-centered framework for innovation in conservation incentive programs. *AMBIO*, *44*, 788–792. http://doi.org/10.1007/s13280-015-0650-z
Southworth, J., & Tucker, C. (2001). The Influence of Accessibility, Local Institutions, and Socioeconomic Factors on Forest Cover Change in the Mountains of Western Honduras. *Mountain Research and Development*, *21*(3), 276–283. http://doi.org/10.1659/0276-4741(2001)021[0276:TIOALI]2.0.CO;2
Souto, T., Deichmann, J. L., Núñez, C., & Alonso, A. (2014). Classifying conservation targets based on the origin of motivation: Implications over the success of community-based conservation projects. *Biodiversity and Conservation*, *23*, 1331–1337. http://doi.org/10.1007/s10531-014-0659-9
Stern, P. C. (2000). Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, *56*(3), 407–424. http://doi.org/10.1111/0022-4537.00175
Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human Ecology Review*, *6*(2), 81–97. http://doi.org/10.2307/2083693
Teel, T. L., Manfredo, M. J., & Stinchfield, H. M. (2007). The Need and Theoretical Basis for Exploring Wildlife Value Orientations Cross-Culturally. *Human Dimensions of Wildlife*, *12*(5), 297–305. http://doi.org/10.1080/10871200701555857
Tillman, D. (1997). Biodiversity and ecosystem functioning. In *Nature's services: Societal dependence on natural ecosystems* (pp. 92–112). Washington D.C. & Covela, CA: Island Press.
Vaske, J. J. (2008). *Survey Research and Analysis: applications in parks, recreation, and human dimensions* (First). College State, Pennsylvania: Venture Publishing, Inc.
Vaske, J. J., & Donnelly, M. P. (1999). A Value–Attitude–Behavior Model Predicting Wildland Preservation Voting Intentions. *Society & Natural Resources*, *12*, 523–537. http://doi.org/10.1080/089419299279425
Verissimo, D., Bianchessi, A., Arrivillaga, A., Cadiz, F. C., Mancao, R., & Green, K. (2017). Does It Work for Biodiversity? Experiences and Challenges in the Evaluation of Social Marketing Campaigns. *Social Marketing Quarterly*, 1–17. http://doi.org/10.1177/1524500417734806
Vivanco, L. A. (2006). *Green Encounters: Shaping and Contesting Environmentalism in Rural Costa Rica*. (R. Ellen, Ed.). New York, NY: Berghahn Books.
WCMC. (2000). WCMC (World Conservation Monitoring). In B. Groombridge & M. D. Jenkinds (Eds.), *Global biodiversity: Earth's living resources in the 21st century.* Cambridge, UK: World Conservation Press.
Weiss, R. S. (1995). *Learning from strangers: The art and methodology of qualitative interview studies*. New York: Simon and Schuster, Inc.

WRI. (2000). *World resources 2000–2001: People and ecosystems. The fraying web of life.* Washington D.C.

Wright, A. J., Veríssimo, D., Pilfold, K., Parsons, E. C. M., Ventre, K., Cousins, J., … Mckinley, E. (2015). Competitive outreach in the 21st century: Why we need conservation marketing. *Ocean and Coastal Management*, *115*, 41–48. http://doi.org/10.1016/j.ocecoaman.2015.06.029

Wunder, S. (2005). Payments for environmental services : Some nuts and bolts. *CIFOR Occasional Paper*, *42*(42), 24. http://doi.org/10.1111/j.1523-1739.2006.00559.x

Wunder, S., Engel, S., & Pagiola, S. (2008). Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecological Economics*, *65*(4), 834–852. http://doi.org/https://doi.org/10.1016/j.ecolecon.2008.03.010

Yin, R. K. (1994). *Case Study Research: Design and Methods* (2nd ed.). Thousand Oak, CA: SAGE.

Yin, R. K. (2015). *Qualitative research from start to finish*. Guilford Publications.

Zubair, M., & Garforth, C. (2006). Farm level tree planting in Pakistan: The role of farmers' perceptions and attitudes. *Agroforestry Systems*, *66*, 217–229. http://doi.org/10.1007/s10457-005-8846-z

Appendices

Appendix A – IRB Approval

Research Integrity & Compliance Review Office
Office of Vice President for Research
Fort Collins, CO 80523-2011
(970) 491-1553
FAX (970) 491-2293

Date: May 16, 2017

To: Kelly Jones, Ph.D., Human Dimensions of Natural Resources
Katie Powlen, Human Dimensions of Natural Resources

From: IRB Coordinator, Research Integrity & Compliance Review Office (RICRO_IRB@mail.colostate.edu)

Re: An Evaluation of Motivations and Barriers to reforestation in the Bellbird Biological Corridor, Costa Rica

Funding: Unfunded

IRB ID: 093 -18H **Review Date:** May 16, 2017
This project is valid from three years from the review date.

The Institutional Review Board (IRB) Coordinator has reviewed this project and has declared the study exempt from the requirements of the human subject protections regulations with conditions as described above and as described in 45 CFR 46.101(b):

Category 2 - Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

The IRB determination of exemption means that:

- **This project is valid for three years from the initial review.** After the three years, the file will be closed and no further research should be conducted. If the research needs to continue, please let the IRB Coordinator know before the end of the three years. You do not need to submit an application for annual continuing review.
- You must carry out the research as proposed in the Exempt application, including obtaining and documenting (signed) informed consent if stated in your application or if required by the IRB.
- Any modification of this research should be submitted to the IRB through an email to the IRB Coordinator, prior to implementing any changes, to determine if the project still meets the Federal criteria for exemption.
- Please notify the IRB Coordinator (RICRO_IRB@mail.colostate.edu) if any problems or complaints of the research occur.

Please note that you must submit all research involving human participants for review by the IRB. **Only the IRB or designee may make the determination of exemption**, even if you conduct a similar study in the future.

Appendix B – Survey Instrument (English)

Survey: Evaluation of Motivators and Barriers for Reforestation in the Biological Corridor Pájaro Campana, Costa Rica

ID data base: _____
Name: _____

1. Read the entire text of each question when conducting the survey. The text is written with normal and italic letters. The interviewer should read everything in the question to those being interviewed, <u>except</u> the text that is in italics.
2. Each person surveyed has a unique identification number. The number is in the "ID for database" section.
3. Be sure to complete all the questions that apply. DO NOT LEAVE QUESTIONS WITHOUT ANSWERs.
4. At the end of the survey, be sure to collect all the material used in the survey.
5. Note the start and end time of the survey.

****

Good morning / afternoon / evening,
We are carrying out a study with Colorado State University, USA. The goal of this study is to better understand the motivations and barriers that limit landowner participation in reforestation in the Pajaro Campana Biological Corridor. We are interested in knowing if you have planted trees and why, and if you are interested in planting trees in the future. We also want to know about your experiences with conservation organizations that promote reforestation in the corridor. To complete this research, we have selected homes in 3 sections in the Pájaro Campana Biological Corridor to carry out surveys and interviews. We will be talking with people who participated and have not participated in reforestation projects. Your participation in this survey is completely voluntary, however, we would be very grateful if you could answer our questions. There are no risks or direct benefits for you, but this study will help improve forest conservation programs in your region. The survey information will only be used for research purposes; University researchers will not use your name and will be sure to send any information to the University without including your personal information. We can stop the survey at any time if you do not feel comfortable or do not want to answer a question. The survey will take approximately 40 minutes.

If you have any questions about this study, you can contact Co-Principal Investigator Katie Powlen and Kelly Jones, by email or telephone [kapowlen@mail.colostate.edu; 001-508-361-3455; Kelly.jones@colostate.edu; 001-970-491-4175]. If you have any questions about your rights to participate in this study, please contact the CSU IRB at: RICRO_IRB@mail.coloststa.edu; 001-970-491-1553.

(QUESTIONS FOR SELECTING THE PERSON TO BE INTERVIEWED)
1. Are you a member of this household? Yes ( ) No ( )
(If the person is not a household member, DO NOT continue with the survey).

2. Do you make decisions about land use in this household? Yes ( ) No ( )
(If the person making the decisions is not present, DO NOT continue with the survey and make an appointment for a future visit. If that person will not return for a long time, continue to the next house.)

3. Are you willing to participate in this survey? Yes ( ) No ( )

General Information (Complete before starting the interview)

Name of interviewee: _____
Name of the community: _____
Date (month/day): _____/_____/2017
Start time: _____
End time: _____

A. Household Information

Start with questions about the members of the household.

---

1. How many years have you lived in ... (write the number of years for each question):
2. This property? _____
3. The community? _____

---

4. Are your parents from this community? Yes ( ) No ( )

---

5. How many people in this household are ... (write the number of people):
   1. Under the age of five? _____
   2. Between 5 to 10 years old? _____
   3. Over 10 years? _____

---

6. Please answer the following questions about household members. *(For each answer, write the number in each column that corresponds to the person.)*

6.1. Person	6.2. Age *(Years)*	6.3. Sex 1. Female 2. Male *(fill in yourself)*	6.4. How many years of school have you had?	6.5. What is your education level? 1. Incomplete elementary school. 2. Primary school 3. High school 4. Baccalaureate 5. University 6. Technical training 7. Postgraduate 8. Does not know	6.6. What is your main occupation? A. Farmer - Livestock B. Farmer - Agriculture C. Housewife D. Manufacturer E. Construction F. Merchant G. Ecotourism H. Transportation I. Other (Specify)
1. Interviewee					
2. Spouse					

B. Biophysical and Land Use Information

The next questions will be about the farm / property.

---

1. What is the size of the farm / property in hectares?

(Write the number of hectares) _____

---

2. Please indicate the number of hectares you have in each of the following uses. (Enter 0 if they do not have a type of use.)

Use of Land	Hectares
a. Ha. Natural Forest (Primary)*	
b. Ha. Reforestation (Secondary)	
c. Ha. Agriculture	
d. Ha. Pasture	
e. Ha. Otra	

3. Is the 'secondary forest' planted or a naturally regenerated?

1. Planted ( )
2. Natural Regeneration ( )
3. Both / Mix ( )

1.1. **If you have forest on your farm**, why have you left this area forested?

_____

_____

_____

---

4. Which of the following crops or activities are carried out on your property?

Activity	Yes (1)/ No (0)
a. Coffee	
b. Corn/Beans	
c. Vegetables	
d. Pineapple	
e. Sugar Cane	
f. Dairy	
g. Raising chickens	
h. Raising pigs	
i. Extraction of wood for sale	
j. Extraction of wood for the farm/home	
k. Tourism	
l. Other forest products (fruits, nuts, etc.)	
m. Other	

---

5. Approximately what percentage of your day do you spend working on your land?
   a. Less than half (0% - 50%) ( )
   b. Half (50%) ( )
   c. More than a half ( )
   d. Almost all (75% - 100%) ( )

---

6. How far is your farm / property located from a road?
   a. Less than 1km ( )
   b. Between 1km to 5km ( )
   c. Between 5km to 10 km ( )
   d. More than 10 km ( )

   6.1. Is this road paved? Yes ( ) No ( )

---

7. What percentage of the products grown on your property are sold?
   a. Less than a quarter (0% - 25%) ( )
   b. Between a quarter to half (25% - 50%) ( )
   c. About half (50%) ( )
   d. Between half and three quarters (50% - 75%) ( )
   e. Almost all (75% - 100%) ( )

---

8. Approximately what percentage of your total income comes from on-farm activities?
   a. Less than a quarter (0% - 25%) ( )
   b. Between a quarter to half (25% - 50%) ( )
   c. About half (50%) ( )
   d. Between half and three quarters (50% - 75%) ( )
   e. Almost all (75% - 100%) ( )

---

9. What percentage of your land has low quality / poor soils that cannot be used?
   a. Less than a quarter (0% - 25%) ( )
   b. Between a quarter to half (25% - 50%) ( )
   c. About half (50%) ( )
   d. Between half and three quarters (50% - 75%) ( )
   e. Almost all (75% - 100%) ( )

---

10. What percentage of your land has steep slopes?
   a. Less than a quarter (0% - 25%) ( )
   b. Between a quarter to half (25% - 50%) ( )
   c. About half (50%) ( )
   d. Between half and three quarters (50% - 75%) ( )
   e. Almost all (75% - 100%) ( )

---

11. Are there natural water sources on your property?
   Yes ( ) No ( )

   11.1. **If the answer "Yes",** what type?
   a. spring/well ( )
   b. stream ( )
   c. Lake or lagoon ( )
   d. Waterfall ( )
   e. Other ( ) Specify _____

   11.2. Is the water from this sources clean enough to drink?
   Yes ( ) No ( ) I do not know ( )

C. Experience in Conservation and Reforestation - (DEPENDENT VARIABLE)

Now we will ask you a series of questions about local conservation organizations and your experience with reforestation.

---

1. Have you or your spouse participated in any community group in the last 5 years?
   Yes ( ) No ( ) Do not know ( )
   If the answer is 'Yes', specify:
   a. Health Board ( )
   b. School Board ( )

c. Community Board ( )
d. Producers Association ( )
e. ASADA ( )
f. Other: _____ ( )

---

2. Have you participated in FONAFIFO's PES program or any other PES programs in the last 5 years?
Yes ( ) No ( ) Do not know ( )
If the answer is 'Yes', specify the years: _____

---

3. Which of the following local organizations do you know or have you heard about? (*Mark all that apply*)

Organizations	Yes	No
a. Monteverde Institute	( )	( )
b. The League or the ACM	( )	( )
c. Bosqueterno, SA	( )	( )
d. Costa Rican Conservation Foundation	( )	( )
e. University of Georgia or UGA	( )	( )
f. FONAFIFO	( )	( )
g. Tropical Science Center	( )	( )
h. Other (specify: _____		

---

4. Please indicate your opinion (how much you agree or disagree) with each of the following statements about the presence of conservation organizations in your community

	Disagree	Neither agree nor disagree	Agree		Does not answer or does not know
a. Conservation organizations have a strong presence in my community.	1	2	3		999
b. Conservation organizations offer many courses or activities for members of my community.	1	2	3		999
c. It is very easy to contact a conservation organization to get help with the projects.	1	2	3		999
d. Many people in my community work with conservation organizations	1	2	3		999

---

5. Have you planted trees on your property?
Yes ( ) No ( ) ***(If the answer is 'NO', skip to question 11 on page 7)***

5.1. If you answer 'yes', why?

_____
_____
_____

---

6. How many trees have you planted, in what year and what species? (Write an approximate number of trees)

# of trees: _____ Species: _____ Year: _____ Location: _____

# of trees: _____ Species: _____ Year: _____ Location: _____

# of trees: _____ Species: _____ Year: _____ Location: _____

---

7. Did you received help from any local organization with the reforestation project?

Yes ( ) No ( ) ***(If you answer 'NO', skip to question 10 on page 8)***

7.1. **If you answer 'Yes'**, what organization and in what year(s) was the project completed in? (Please write the name of the organization and the years you participated (i.e. 2004 or 2005-2007).

a. Organization: _____ Year: _____
b. Organization: _____ Year: _____
c. Organization: _____ Year: _____

7.2. Please check the forms of support that were part of the reforestation project.

a. Trees	( )
b. Technical assistance	( )
c. Materials for a fence	( )
d. Workforce	( )
e. Herbicides	( )
f. Transport through the trees	( )
g. Payments to plant trees	( ) (***If you answer 'Yes',*** write the total: _____)
h. Other	( ) (Specify: _____)
i. Not applicable	( ) (They were planted without help)

7.3. Are you satisfied with the support you have received?

Yes ( ) No ( )

---

8. About how many of the trees are still alive?

a. Less than a quarter (0% - 25%)	( )
b. Between a quarter to half (25% - 50%)	( )
c. About half (50%)	( )
d. Between half and three quarters (50% - 75%)	( )
e. Almost all (75% - 100%)	( )

8.1. Have you cut some trees or branches for use on the farm or around the house?

Yes ( ) No ( )

---

9. What are the benefits you have received from trees planted with reforestation projects?
*Note: **Do not read,** check all the types of benefits mentioned.*

Types	**Examples**	*(Mark: X)*
No Benefits	(There are none)	
Environmental benefits	Better soil quality	
	Better water quality	
	Shade	
	Wind protection	
	More biodiversity	
Economic Benefits	Better production of crops and other forest products	
	Extra wood source	
	Direct payment	
Social Benefits	Closer to community members	
	Social recognition	
Other	***(Write your answer)***	

QUESTION 10: Only for owners who have NEVER planted trees *(If owners have planted trees, skip to question 11 on page 9.)*

10. If you have never planted trees on your property, please indicate if the following reasons were limitations.

You have never planted trees because…	**Yes**	**No**	**Does not know**		**Most important** *(X)*
a. You do not have enough space on your property	1	0	999		
b. It will decrease the options to use your property	1	0	999		
c. Need the space for crops or animals	1	0	999		
d. The compensation is not enough	1	0	999		
e. The costs of planting trees are too high	1	0	999		
f. It is too labor intensive	1	0	999		
g. It has no transport for the trees	1	0	999		
h. There is not enough time	1	0	999		
i. The soil is very poor	1	0	999		

j. You do not know how to plant trees	1	0	999	
k. The trees will bring pests	1	0	999	
l. The trees will be quickly destroyed by human or animals	1	0	999	
m. You are dissatisfied with conservation organizations	1	0	999	
n. You do not need more trees on your property	1	0	999	

10.1. *Read everything that has 'yes' as an answer*. From this list, which is the most important? *(Mark the most important with an 'X' in the table above.)*

10.2. Was there anything else that was not mentioned that prevented you from planting trees?
Yes ( )No ( )

Specify: _____

11, 12 & 13 - For ALL: (Use the cards)

11. *Provide cards with options of reforestation support.* Please rank each option's importance and how would it affect your decision to plant trees on your property in the future? (order from most important (1) to least important (6))

Type of help	**Order**	**Notes**
They offer free trees.		
They offer materials for fences.		
They offer technical training.		
They bring the trees to my house.		
They will help me with labor.		
They offer payments for planting trees.		

11.1. Is there anything else that would motivate you to plant trees? In what order would you put it in the list (How important is it to you)?

_____

_____

11.2. Are you interested in planting trees in the next 5-10 years?

a. Yes ( )
b. Only if someone helps me ( )
c. Do not ( )

---

12. I will read a series of potential reforestation benefits. Please list each one in importance if you plant trees in the future. (order from most important (1) to least important (6))

Benefits	**Order**	**Notes**
Trees produce fruit to eat or sell.		
Trees produce wood to use or sell.		
The trees protect the water sources.		
The trees improve the quality of the soil on the farm.		
The trees attract animals and birds to the farm.		
Trees improve crop production.		
The trees attract tourism.		

12.1. Is there anything else that would motivate you to plant trees? In what order would you put it in the list (How important is it to you)?

_____

_____

---

13. Who of the following have participated in reforestation projects? (*Check all that apply*)

a. Friends ( )
b. Family members ( )
c. Neighbors ( )
d. Other ( ) specify: _____
e. No one I know ( )
f. I dont know ( )

D. Perceived Benefits

Now I am going to talk about the perceived benefits of reforestation.

1.Please indicate if you agree or disagree with the following phrases about tree planting.

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree		Does not answer or does not know
a. Reforestation will bring benefits to my household.	1	2	3	4	5		999
b. Reforestation will bring economic benefits.	1	2	3	4	5		999
c. Reforestation will improve biodiversity.	1	2	3	4	5		999
d. Reforestation will improve the productivity of my farm.	1	2	3	4	5		999
e. Reforestation will benefit birds by improving their habitats.	1	2	3	4	5		999
f. Reforestation will improve soil quality.	1	2	3	4	5		999
g. Reforestation will reduce the risk of erosion.	1	2	3	4	5		999
h. My neighbors expect me to plant trees.	1	2	3	4	5		999
i. Reforestation will reduce risk of floods.	1	2	3	4	5		999
j. The shade from reforestation will reduce my cultivation productivity.	1	2	3	4	5		999

k. Reforestation will increase the number of threats on my property.	1	2	3	4	5	999
l. I feel closer to my community when I plant trees.	1	2	3	4	5	999
m. My relationship with my friends and family improves when I plant trees.	1	2	3	4	5	999
n. My friends and family expect me to plant trees.	1	2	3	4	5	999
o. Reforestation will not improve the quality of water.	1	2	3	4	5	999

E. Additional questions about household characteristics

1. How did you get this property?
   a. Inheritance ( )
   b. Purchased from someone in the family. ( )
   c. Purchased from someone not in the family. ( )
   d. Other ( )

2. Do you own a land title? Yes ( ) No ( )

3. Do you have children or other family members who will inherit the farm? Yes ( ) No ( )

4. Do you receive money or regular income from family members who live outside the community? Yes ( ) No ( )

5. What material is your house made of? (i.e. brick, wood, other.)

Part of the house	Type of material
Walls	
Floor	

6. Please answer if you have or do not have the following things:

Things	Answer	
	YES	NO
a. Car	1	0
b. Motorcycle	1	0
c. Bicycle	1	0
d. Horse	1	0

Things	Answer	
	YES	**NO**
e. Cow	1	0
f. Chainsaw	1	0
g. Cellphone	1	0
h. Television	1	0
i. Kitchen or gas stove	1	0

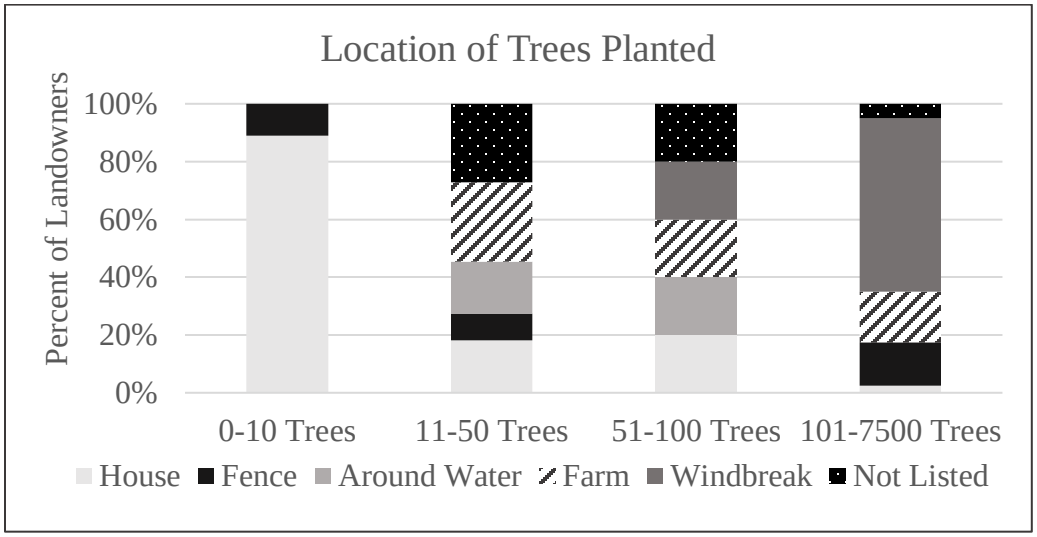
We have reached the end of the survey. I want to thank you for your time and the information you shared during the survey.
Do you have questions about what we have been talking about?

(If they have relevant questions about the survey, write them down. If you cannot answer the question, tell them that you will verify with the research team conducting the study and that you will see how to get the information.)

Make sure you have collected all the materials and noted the completion time of the survey.

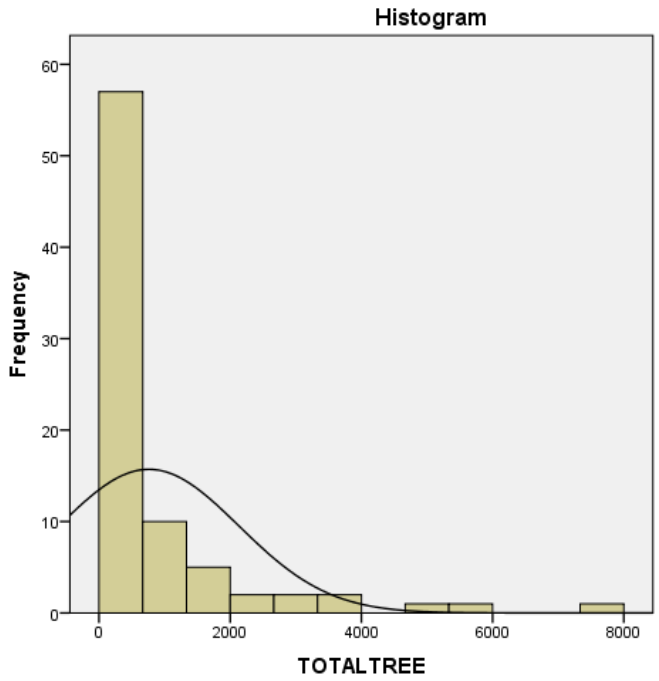
End time: _____

Appendix C – Location of Tree Planting on Property



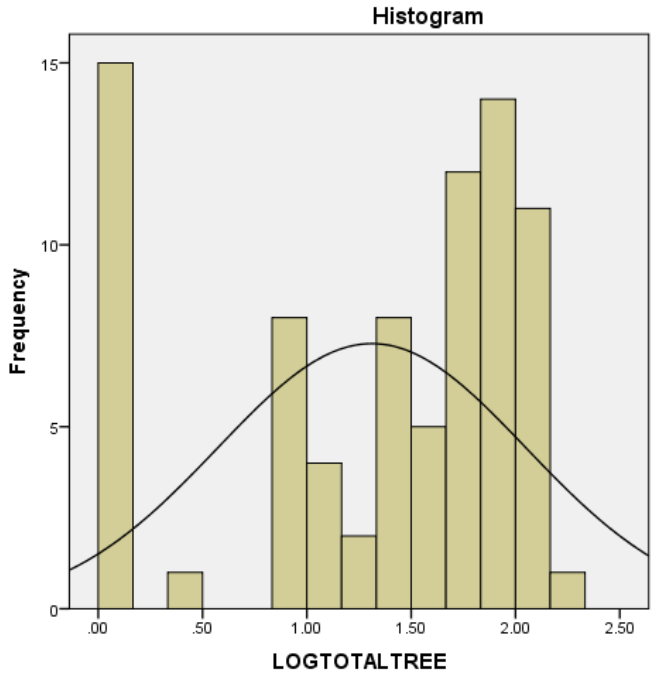
	Tree Planting Groups			
Location	**0-10 Trees**	**11-50 Trees**	**51-100 Trees**	**101-7500 Trees**
House	8	2	1	1
Fence	1	1	1	6
Around Water	15	2	1	0
Farm	0	3	1	7
Windbreak	0	3	1	24
Not Listed	0	0	0	2
Total	**24**	**11**	**5**	**40**

Appendix D - Histograms of Total Trees Planted



Mean	759.85
Median	100.00
Skewness	2.809
Std. Error of Skewness	0.267

Figure 15: Histogram of total trees planted before log distribution



Mean	1.311
Median	1.529
Skewness	-.793
Std. Error of Skewness	0.267

Figure 16: Histogram of total trees planted after log distribution

Appendix E –Multiple Regression Models 1

Multiple Linear Regression – Dependent Variable: Log Total Trees									
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
Support (Computed)	**.400*** **(.103)**	**.348**** **(.097)**	**.371**** **(.101)**	**.343**** **(.107)**	**.381**** **(.102)**	**.364**** **(.103)**	**.399**** **(.104)**	**.392**** **(.103)**	**.322*** **(.110)**
Environmental Perceptions	**.451**** **(.139)**	**.346**** **(.136)**	**.465**** **(.135)**	**.421**** **(.139)**	**.396**** **(.142)**	**.463**** **(.137)**	**.465**** **(.143)**	**.413**** **(.148)**	**.423**** **(.140)**
Economic Perceptions	-.044 .094	-.083 (.089)	-.036 (.091)	-.077 (.095)	-.040 (.093)	-.049 (.092)	-.041 (.095)	-.042 .094	-.078 (.096)
Social Perceptions	-.083 (.087)	-.040 (.082)	-.085 (.084)	-.072 (.087)	-.054 (.088)	-.076 (.086)	-.083 (.088)	-.068 (.089)	-.051 (.088)
Age		-.008 (.005)	**-.011*** **(.005)**						
Sex		**.504**** **(.185)**							
Years of Education				.037 (.025)					
Percent of Farm Products Sold					.069 (.046)				
Soil Quality						-.209 (.119)			
Slope							-.044 (.093)		
Percent Income from On-farm Activities								.033 (.044)	
Percent of Property Forested									.006 (.005)
R	**0.586**	**0.668**	**0.622**	**0.586**	**0.603**	**0.609**	**0.585**	**0.591**	**0.617**
R sq.	**0.343**	**0.447**	**0.387**	**0.343**	**0.364**	**0.371**	**0.343**	**0.349**	**0.381**
Adjusted R Sq.	**0.307**	**0.399**	**0.343**	**0.296**	**0.318**	**0.326**	**0.295**	**0.302**	**0.317**
Std. Error	**0.617**	**0.575**	**0.6**	**0.563**	**0.612**	**0.608**	**0.625**	**0.619**	**0.612**
Sums of Sq.	**14.14****	**18.392****	**15.939****	**13.533****	**14.982****	**15.287****	**14.040****	**14.362****	**15.694****

$p < .01$** $p < .05$*

Appendix E –Multiple Regression Models 2

Plant 11+ Logistic Regression Models									
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
External Support	2.602 (.726)	3.581 (.855)	3.581 (.855)	38.877 (1.933)	39.331 (1.913)	35.510 (1.882)	3.831 (.823)	3.071 (.758)	2.771 (.781)
Environmental Perceptions	**7.402** **(.742)**	**7.947*** **(.944)**	**7.947*** **(9.44)**	5.945 (1.108)	5.949 (1.111)	6.306 (1.120)	**6.467*** **(.875)**	**4.723*** **(.776)**	**5.802*** **(.842)**
Economic Perceptions	.764 (.548)	1.308 (.669)	1.308 (.669)	5.113 (.966)	5.108 (.964)	4.761 (.934)	1.253 (.653)	1.250 (.637)	1.309 (.649)
Social Perceptions	.838 (.464)	.933 (.562)	.933 (.562)	1.747 (.740)	1.747 (.737)	1.764 (.750)	.943 (.531)	.919 (.480)	.857 (.524)
CBPC Sector (Dummy Variable)	**.229*** **(.679)**	**.130*** **(.895)**	**.130*** **(.895)**	**.026*** **(1.597)**	**.026*** **(1.524)**	**.028*** **(1.525)**	**.170*** **(.764)**	**.195*** **(.662)**	**.154*** **(.763)**
Household Assets	1.489 (.288)	.926 (394)	.926 (.394)	.483 (.702)	.483 (.701)	.457 (.679)	.925 (.390)	1.250 (.314)	1.261 (.330)
% income from on-farm activities		.780 (.290)	.780 (.290)	.986 (.376)					.780 (.273)
Farm Size (HA)		1.010 (.010)	1.010 (.010)	1.026 (.032)	1.027 (.032)	1.026 (.031)	1.009 (.012)	1.01 (.009)	
Age			.937 (.035)	.853 (.070)	1.019 (.059)		.937 (.034)		
Years on the Property				**.853*** **(.070)**	**.853*** **(.068)**	**.861*** **(.060)**			
-2 Log likelihood	**46.038**	**37.893**	**37.893**	**26.823**	**26.825**	**26.932**	**38.667**	**42.724**	**41.839**
Nagelkerke R^2	**0.654**	**0.732**	**0.732**	**0.824**	**0.824**	**0.823**	**0.725**	**0.687**	**0.695**
Chi-square	**5.415**	**6.831**	**6.831**	**0.823**	**0.811**	**0.879**	**6.098**	**7.978**	**6**
Classification	**88.2**	**92.1**	**92.1**	**92.1**	**92.1**	**92.1**	**89.5**	**89.5**	**89.5**

*p<.05 **p<.01

Appendix F – Interview Guides (English)

An Evaluation of Motivations and Barriers to Reforestation in the Bellbird Biological Corridor, Cost Rica

***ID for Data:* _____**

Good morning/day/evening,

We are conducting a study from Colorado State University in the United States. The purpose of this study is to better understand what motivates and prevents landowners from participating in reforestation within the Bellbird Biological Corridor. We are interested in both internal and external motivators and understanding how additional factors such as household characteristics, biophysical characteristics and risk and uncertainty might affect these decisions. To complete this evaluation, we have randomly selected households from five communities in the Bellbird Biological Corridor to conduct surveys and interviews. We will be speaking with households that have and have not participated in reforestation projects. We would really like to interview you for this research. Your participation in this interview is completely voluntary, however, we would be much appreciative if you could answer these questions. There are no risks or direct benefits to you, but this study will help improve forest conservation programs in your region. The information from the survey will only be used for research purposes; the university researchers will not use your name and will be sure to submit information to the university with all personal details omitted. The interview will take approximately 40 minutes.

If you have any questions about this project at any time, you can contact the Co-Principal Investigator at: <kapowlen@mail.colostate.edu; 001-508-361-3455> or PI at: kelly.jones@colostate.edu; 001-970-491-4175. If you have any questions about your rights as a volunteer in this research, contact <the CSU IRB at: RICRO_IRB@mail.colostate.edu; 001-970-491-1553.

(QUESTIONS FOR THE SELECTION OF THE PERSON TO BE INTERVIEWED)

Are you a member of this household? Yes ( ) No ( )

1. Are you the decision-maker for this household? Yes ( ) No ( )

2. Are you willing to participate in this interview? Yes ( ) No ( )

General Information (Complete before beginning the interview)

Name of interviewer: _____

Name of community: _____

Date (month/day): _____/_____/2017

Start time: _____

Finish time: _____

Key Informant Interview Guide

Before starting, please indicate your name, your affiliation with (*name of the organization*) and the years you were part of this organization.

1. What was / is your role with (*Name of organization*)?
2. *If you did not talk about reforestation in question:* What was your work in their reforestation programs?
3. Using the map, can you show me where the reforestation programs were carried out and during what years?
4. Can you explain why these areas were selected for reforestation projects?
    a. Did the organization choose them? Were they chosen by the members of the community?
    b. How did you decide which homes to work with?
    c. Who lives in these areas? (type of work, population size, etc.)
    d. What were the original land in these areas?
5. Can you tell me more about how the reforestation projects were implemented? (Example: with technical assistance, free materials, labor, etc.)
6. What do you think motivated the landowners to plant trees?
7. What were some of the reasons or barriers the other households did not participate?
8. Were there households that rejected offers for free trees or reforestation assistance?
    a. Do you know why?
9. What do you think are the greatest challenges for reforestation in these areas?
10. Are there some regions of the corridor that have been more successful with reforestation than others?
    a. Why do you think it is?

We have reached the end of the interview. Thank you for your time and the information you have shared. Do you have questions about what we discussed today?

Landowner Interview Guide

1. Tell me a little about your family and your property.
    a. Are you married, have children, have grandchildren?
    b. Occupation- primary, secondary? (*Note: Ask the following if it is not indicated: What do they grow/ what kind of livestock do they have?)*
    c. Where is your property located?
    d. Size of land?

2. Have you planted trees on your property (the home and/or farm)? ***(If NO, skip to the questions of the "non-participants" - # 9-12)***
    a. In what year did you plant trees?
    b. How many trees did you plant? Species?
    c. Where did you plant the trees (*for example: around the house, windbreaks in the field, etc.*)
    d. What were the original land uses of these plots? (*Note: Ask question for each place that was reforested.*)
    e. Did you work with or receive help from a local organization? ***(If NO, skip to question # 4)***

3. Tell me about your experience working with (*name of organization*)?
    a. How did it go?
    b. How did you get involved with them? (*for example: who contacted whom*)
    c. What kind of support did they provide?
4. Why did you decide to plant the trees? *(for example: financial gain, environmental protection)*
5. Do you know other friends, family or neighbors who planted trees?
    a. Did they plant before or after you?
6. Do you think you will plant more trees in the next 10 years?
    a. Why or why not?
7. Why do you think some people do not plant trees?

Reforestation Questions- Non-participants

8. Have you even been interested in planting trees on your property? ***(If NO, skip to question 7)***
    a. Why or why not?
9. What has prevented you from planting trees in the past?
    a. Knowledge, work, materials, space?
10. What would make it easier for you to plant trees in the future?
    a. Materials, money, knowledge, other types of help?
11. Have your neighbors, friends or family members planted trees?
    a. Who?
    b. Why do you think they planted trees?

We have reached the end of the interview. Thank you for your time and the information you have shared. Do you have any questions about what we discussed today?

Appendix G – Independent Variable Correlations

Independent Variable Correlations															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Poor Soil															
2. Slope	**.348****														
3. Farm Size	-0.08	0.02													
4. Primary Forest	-0.01	**.318****	0.06												
5. Secondary Forest	0.00	0.07	-0.10	-0.20											
6. Agricultural	0.00	-0.14	-0.17	**-.263***	-0.13										
7. Pastoral	0.09	-0.03	0.21	**-.219***	**-.260***	**-0.57**									
8. Age	0.04	0.00	0.05	0.00	-0.17	0.15	-0.09								
9. Yrs of Edu	-0.15	0.03	-0.07	0.14	**.472****	-0.17	**-.245***	**-.361****							
10. Farmer or Not Farmer	-0.20	-0.09	0.14	-0.13	-0.20	0.03	.279*	0.02	-0.18						
11. On-farm Income	-0.13	-0.09	0.20	0.04	-0.11	-0.08	0.18	-0.07	-0.08	**.472****					
12. Farm Products Sold	**-.219***	-0.12	**.235***	-0.12	-0.11	0.10	0.21	-0.10	-0.07	**.510****	**.712****				
13. HH Assets	-0.08	-0.19	0.19	-0.05	0.12	**-.361****	**.358****	**-.366****	0.21	0.17	0.16	0.21			
14. Yrs on Property	-0.01	-0.13	0.05	0.00	-0.22	0.09	-0.02	**.550****	**-.329****	0.01	0.13	0.02	**-.274***		
15. Yrs on Community	-0.03	-0.17	-0.02	-0.02	**-.249***	0.08	0.07	**.665****	**-.373****	0.03	0.22	0.14	**-.241***	**.753****	
16. Future Work	0.19	0.16	0.14	-0.07	0.14	0.00	0.04	0.00	**-.245***	-0.06	**.266***	0.12	0.11	**.264***	-0.02

Appendix H – Length of Residency and Tree Planting Correlations

Years on the Property and Dummy Variable Correlations				
	Years on Property	**Upper**	**Middle**	**Lower**
Plant 1+ Tree	0.016	**.228****	0.089	**-.405****
Plant 11+ Trees	-0.196	**.457****	0.049	**-.551****
Plant 30+ Trees	-0.135	**.477****	-0.06	**-.463****
Log Total Tree	-0.072	**.506****	-0.048	**-.508****