

THESIS

INFORMING THE DESIGN AND GOVERNANCE OF A PRO-POOR PAYMENT FOR
ECOSYSTEM SERVICES PROGRAM IN WESTERN PANAMA

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ABSTRACT OF THESIS

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Human society depends on healthy ecosystems. Payments for ecosystem services (PES) have emerged as an incentive-based tool to protect and restore ecosystem-service flows, which are being degraded at regional and global scales. Through PES, users of ecosystem services pay landowners who supply these services through land management. This study focuses on PES programs as a possible means to achieve ecosystem-service conservation on private lands, which are playing an increasingly important role in conservation efforts. Specifically, his study examines the potential for PES to address conservation and livelihood issues in the buffer-zone of La Amistad Bi-national World Heritage Site in Western Panama, and provides insights for the equitable architecture of such a program. Although Panama does not currently have a national or regional PES program, there is widely recognized potential for program development.

We conducted a survey of 344 farmers regarding their interest in a hypothetical PES program. While respondents reported a lack of familiarity with the PES concept, after being provided with an explanation, many expressed interest in participating; interest was greatest for the agroforestry and forest conservation scenarios. Using logistic regression analyses we found that farm size, participation in other conservation programs, the number of conservation organizations with which the farmer has worked, and total

income were all significant predictive factors of willingness to participate for at least one of three program scenarios with a positive relationship. Land tenure security and age were significant explanatory factors with a negative relationship for one or more scenario. Several of these factors are related to a household's socioeconomic status.

We also investigated equity and fairness concerns including how potential PES program design factors related to minimum enrolled area, land tenure, and land characteristics (e.g., slope) might affect eligibility of low-income households, an increasingly important target of PES programs, particularly in developing countries. Using eligibility requirements based off of Costa Rica's national program, and also generally in-line with programs elsewhere, we found that respondents who ranked lower on our constructed socioeconomic scale were less likely to be eligible to enroll in a Panamanian PES program despite that many are willing to participate.

PES land enrollment requirements, tenure, and land characteristics (e.g. slope) result in participation trade-offs. For example, higher land enrollment requirements result in a rapid decline in potential participants. Our research contributes to a key piece of the PES design puzzle by proactively exploring ways to ensure that landowners across the socioeconomic spectrum (particularly the poor) are able to participate. Understanding trade-offs is important for guiding PES program architecture to achieve rural development and poverty alleviation goals in tandem with conservation outcomes.

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CHAPTER I
INTRODUCTION AND LITERATURE REVIEW

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INTRODUCTION

In recent years the term “ecosystem services” has proven useful in helping individuals and organizations to understand and value the on-going processes of the natural environment.

Ecosystem services are “the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life” (Daily et al., 1997, p. 3) Provisioning services are products obtained from ecosystems such as food, fiber, fuel, and fresh water. These along with cultural services or non-material benefits obtained from ecosystems, including recreation, scenic beauty, education, inspiration and spiritual value, are directly related to human well-being and are valued by human societies although they may or may not be included in formal markets. However, regulating services such as pollination and climate or erosion regulation make these more tangible goods and services possible and are also crucial for human well-being. The same is true of supporting services (nutrient cycling, provision of habitat, soil formation and retention, the production of atmospheric oxygen, etc.) (Millennium Ecosystem Assessment, 2003, 2005; Secretariat of the Convention on Biological Diversity, 2006). These regulating and supporting services are greatly undervalued by human societies and, as a result, they are rapidly being degraded (Kroeger & Casey, 2007; Millennium Ecosystem Assessment, 2005).

Today society faces unprecedented challenges at the intersection of human well-being and natural resource management, from climate change to biodiversity loss to energy security and beyond. The impacts of unsustainable human use and abuse of ecosystem services are increasingly apparent. In total, 60 % of the world’s ecosystem services have been degraded (Millennium Ecosystem Assessment, 2005). These unprecedented changes are impacting the

services that these ecosystems provide to human societies. Land use change is heavily impacting ecosystem services (Millennium Ecosystem Assessment, 2005). Loss of biodiversity is rapidly taking place on a global scale. These unprecedented changes are impacting ecosystems and the services that these ecosystems provide to human societies. In the face of such complex problems that cut across the socio-ecological interface, decision makers are increasingly interested in transforming how society values ecosystem services.

Simultaneous to the rapid human induced degradation of the world's ecosystems, ecosystems are being revealed by researchers as capital assets, with the potential to generate a stream of vital life-supporting services that merit careful evaluation and investment. The ecosystem services approach recognizes the linked components that form a broader, more holistic view of land management. To better understand the consequences of changes to ecosystems and to evaluate potential future impacts, former UN Secretary General Kofi Annan commissioned, the Millennium Ecosystem Assessment (MA) to examine the relationship between ecosystem services and human well-being. The MA reported that intact ecosystems are essential to numerous aspects of human well-being and by maintaining biological diversity and ecological resilience we are investing in the future of our own species. The MA also concluded that ecosystem services are limited and diminishing, and, as a result, society is forced to evaluate trade-offs between immediate and long-term human needs (Millennium Ecosystem Assessment, 2005).

In order to realize a more sustainable future, we must take a critical look at patterns of change in land use, possible incentives to put new land use practices in place, and how and where we can alter the current trajectory. Transforming these ideas into action is not an easy next step.

Unfortunately, “the dominant national and global institutions—for policy, business,

conservation, agriculture, and research—have been shaped largely by mental models that assume and require segregated approaches” (Galizzi & Herklotz, 2008, p. 64) and change is often slow. Institutions and individual actors must gain the courage to move beyond historical distrust and compartmentalization to recognize that their goals are often ultimately the same. As emphasized in Daily et al. (2009), the time has come for us to “integrate ecosystem services into everyday decision making around the world. This requires turning the valuation of ecosystem services into effective policy and finance mechanisms” (p.21). One increasingly popular approach to integrating ecosystem services into the market is payment for ecosystem services or PES. The adoption of PES approaches to conservation is rapidly increasing globally. A 2002 global assessment found 287 PES and PES-like initiatives that were either in operation or currently being developed (Landell-Mills & Porras, 2002). A few notable examples include a national-scale PES program in Costa Rica that has been operating for over a decade (Pagiola, 2008; Pagiola, Arcenas, & Platais, 2005; Pfaff, Robalino, Boomhower, & Sanchez-Azofeifa, 2007; Sierra & Russman, 2006; Zbinden & Lee, 2005) and a more recently developed national program in Mexico (Alix-Garcia, De Janvry, & Sadoulet, 2004; Corbera, Soberanis, & Brown, 2009; Pagiola et al., 2005), and the municipal drinking water purification services that residents of New York City, USA and Quito, Ecuador pay upland farmers for (Daily & Ellison, 2003; Foley et al., 2005; Grieg-Gran, Porras, & Wunder, 2005; Pagiola et al., 2005).

PURPOSE

The purpose of this study is to determine the potential of payments for ecosystem services (PES) to address conservation and sustainable development goals in the buffer zone area surrounding the La Amistad World Heritage Site – a biodiversity rich agricultural region on the Costa Rica–Panama border. PES are often championed as a tool for supporting conservation and community

livelihoods, yet experience to-date demonstrates that impacts on livelihoods depend directly upon site-specific characteristics and payment design (Engel, Pagiola, & Wunder, 2008; Hope, Porras, & Miranda, 2005; Pagiola et al., 2005; Zilberman, Lipper, & McCarthy, 2008). While neighboring Costa Rica has a well-established national PES program, Panama has not yet implemented a program, though there is recognized potential to do so (Harvey et al., 2008). Both governmental and non-governmental organizations are actively discussing the development of a national and/or local PES programs. This feasibility study is designed to help to define specific goals and metrics of success and then determine the likelihood for program success under alternative PES scenarios. The information gathered through this study could help to inform policy discussions currently underway to propose a law in Panama with the intent of developing PES capacity at the national level. This study builds on the existing literature and attempts to fill gaps in the current knowledge base by uncovering factors that have an important influence on potential participant interest in ecosystem service markets. It looks at characteristics of both likely participants and desirable PES program features. It also assesses farmer and rancher past experience with conservation programs and knowledge of ecosystem services and markets. Our project goals are (1) to assess the potential for a PES approach to achieve conservation and livelihood benefits in the study area, (2) identify community demographics which are likely to correspond with program success, and (3) provide recommendations regarding program design options. We aim both to provide a contribution to the growing discussion of PES as a tool to address conservation and livelihood issues and recommendations for the development of an effective PES approach in the region.

When analyzing PES feasibility one must consider the social, ecologic, and economic landscape and how it will interface with the 3-level provider - intermediary - buyer relationship at the aggregate scale. However, it is also important to understand the options, opportunities, and internal dynamics at each level. This research is focused on the ecosystem service provider level. At the provider or seller level, PES program design, administration, and eligibility requirements determine who can participate, how they participate and the magnitude and quality of social, ecological, and economic outcomes.

PREVIOUS RESEARCH

Drivers of Change in Ecosystem Services: Why focus on Land-use change and agriculture?

Questions of when, where and how to implement and evaluate new policies and programs such as PES that are informed by understanding the value of ecosystem services are pertinent social science questions. Identifying key ecological, social, and political landscapes to focus efforts requires a solid understanding of the relationship between land-use change and ecological change.

Capacity and changes in ecosystems services are determined by many direct and indirect drivers operating at multiple scales. The drivers of ecosystem services are defined in the Millennium Ecosystem Assessment (MA) as human-induced factors that directly or indirectly cause a change in an ecosystem. Direct drivers identified in the MA include land-use change, climate change, and the introduction of invasive species. These direct driving forces are controlled by indirect drivers such as population change, economic development (income), or cultural changes / changes in human behaviors (Millennium Ecosystem Assessment, 2003). Changes in these drivers catalyze changes in the provision of ecosystem goods and services. Direct drivers are

mainly physical, biological, or chemical processes that explicitly influence ecosystem processes, services, and goods. Indirect drivers function more diffusely, often by influencing one or more of the direct drivers.

Land-use change is one of the most important direct drivers of terrestrial ecosystem change and involves changes in the human management of ecosystems (e.g., settlement and cultivation) that alter the cycles, climate, and hydrology of an ecosystem. Land-use change includes land transformation and land degradation, both of which have a negative impact on the ecological complexity of the landscapes and therefore the ecosystem services provided by the land (Millennium Ecosystem Assessment, 2003, 2005; Vitousek, Mooney, Lubchenco, & Melillo, 1997). For example, a full 20 % of irrigated land suffers from secondary salinization and water logging, induced by the buildup of salts in irrigation water. Substantial increases in human exposure to natural disasters is credited by many scientists to climate change which is exacerbated by the intensification of agriculture and other land-use changes (Millennium Ecosystem Assessment, 2005; Sathirathai & Barbier, 2001; UNEP/GRID-Arendal, 2009; Wood, Sebastian, & S. Scherr, 2000). Land-use change also drives biodiversity loss through habitat fragmentation and destruction. Biodiversity and ecosystem services are closely linked. Diversity of flora and fauna is crucial for healthy ecosystems and for healthy human livelihoods. Biodiversity is important for disease resistant crops, resilient animal populations and for creating the unique environments that human populations value for scenic beauty, cultural traditions, and recreation. Biodiversity is also crucial for the many ecosystem processes that are essential to the Earth's life-support systems.

Ecosystem Services and Agriculture

Establishing formal protected areas is one means of conserving ecosystem services, “but socio-economic and political constraints limit the amount of land in such status. Addressing conservation issues on lands outside of formal protected areas is also necessary” (Polasky, Nelson, Lonsdorf, Fackler, & Starfield, 2005, p. 1387). Almost 90% of the world’s total terrestrial land mass lies outside of formal protected areas (WRI, 2003), and agricultural lands now occupy 40% of the total terrestrial land mass and constitute one of the most extensive biomes on earth (Ramankutty & Foley, 1999). This extensive land-use change, from natural ecosystems to landscapes managed for increasingly intensified agricultural production has contributed significantly to fragmentation, habitat and biodiversity loss, unsustainable water use, and to global climate change (Foley et al., 2005). Facilitating the transformation of agricultural production from being one of the greatest threats to global biodiversity and ecosystem services into playing a major role in strengthening ecosystem integrity is a major global challenge (Galizzi & Herklotz, 2008). Around the globe communities, organizations, and governments grapple with this transition. For example, Harvey et al. (2008) argued for “a new approach to biodiversity conservation within human-dominated Mesoamerican landscapes— one that unites a focus on ecologically sustainable agriculture with existing efforts in protected areas to achieve lasting conservation outcomes at local and regional levels... to secure a future for both biodiversity and rural livelihoods in Mesoamerica”(p.13). Some approaches that allow sustainable agriculture and ecosystem conservation to complement and support each other will be further referenced below.

The trade-offs between intensive agricultural production and natural landscapes are significant. Land-use change, especially the increasing intensification of agriculture is one of the strongest and most cited contributors to worldwide biodiversity loss (Sala et al., 2000). The Stern Report indicated that agricultural production is directly responsible for 14 % of global greenhouse gas emissions (GHG), while indirectly responsible for perhaps another 18 % of GHG emissions through deforestation and the burning of biomass, in 2005 (HM Treasury, 2006). Overall, land-use changes are expected to result in average global temperature increases of 1.5° C to 5.5° C over the next 100 years (IPCC, 2001). Forests worldwide contain more than half of all terrestrial carbon and provide approximately 80% of the carbon exchange (Montagnini & Nair, 2004). As these forests are continually converted for agricultural production, we must consider the implications of these land-use changes for biodiversity, climate regulation and other important ecosystem services.

However, there is a middle ground. Although conserved natural ecosystems and ecosystem services are not synonymous, they are closely linked. Biodiversity often differs less between natural habitat and low intensity farming systems than it does between low and high intensity farming (Daily, Ceballos, Pacheco, Suzán, & Sánchez-Azofeifa, 2003; Donald, 2004). Carbon sequestration also differs considerably depending on the type of agricultural system.

Agroforestry also has the potential to yield 50 t C ha⁻¹ in the humid tropics and thus is an increasingly recommended carbon sequestration strategy (Montagnini & Nair, 2004).

Farms that use low intensity methods in areas bordering on forest ecosystems can increase diversity in these buffer zones and decrease the severe transition from forest to farm (Belsky & Siebert, 2003). Agricultural biodiversity provides ecosystem services important to rural

livelihoods. ‘Agricultural Biodiversity’ is defined by the 1992 Convention on Biological Diversity by the United Nations (1992) to include genetic diversity in crops, animals, fish, and trees; diversity of wild species on which agricultural production depends, such as wild pollinators, soil microorganisms, and predators of agricultural pests; and diversity of wild species that use agricultural landscapes as their habitat. Regrettably, agricultural biodiversity, like the other ecosystem services throughout the world critical to poor farmers, is deteriorating (Galizzi & Herklotz, 2008).

Farmers constitute the largest group of ecosystem service providers and natural resource managers on Earth (Wossink & Swinton, 2007). They both depend on and generate a wide array of ecosystem services. Agriculture’s contribution to the provision of ecosystem services depends on the incentives available to farmers. Such incentives currently tend to favor the provision of conventional outputs such as food and fiber over that of other services. In response to massive land use change impacts on biodiversity and other ecosystem services, researchers in conservation biology endorse less intensive agricultural practices like multistrata agroforestry systems that provide income for farmers while protecting biodiversity (Harvest, McNeely, & Scherr, 2002; Finegan & Nasi, 2004). However, global demand for associated agricultural products is projected to rise at least 50% over the next two decades (Sánchez, Hunger, Yuksel, Dobie, & Swaminathan, 2005) and, without a significant change in the system, agricultural production is likely to intensify and agricultural biodiversity, climate stabilization, and water purification/regulation are likely to suffer as a result. What we need to sustain human well-being in the future is “integrated conservation-agriculture landscapes, in which biodiversity conservation is an explicit objective of agriculture, food security, and rural development, and the

latter three are explicitly considered in shaping conservation strategies” (Galizzi & Herklotz, 2008). However, this type of win-win is difficult to achieve without massive changes in our incentive system.

Agroforestry systems provide one tool for realizing a shift especially in areas with sufficient rainfall. These systems can include timber, fruit, and native forest species and contribute to biodiversity conservation by mimicking natural habitats for species and providing landscape connectivity. (Harvey, González, & Sánchez, 2006; Méndez, 2008; Finegan & Nasi, 2004). The fruit, timber and other byproducts of agroforestry systems can provide alternative and supplemental sources of income to households and buffer them from fluctuating prices paid for their crops (Rice & Greenberg, 2009). The shade provided in agroforestry systems conserves soil temperature and “moisture regimes” that improve nutrient cycling and can increase the efficiency of nutrient use of the system (Young, 1997). Heterogeneous agricultural landscapes maintain plentiful tree cover provide landscape connectivity resulting in increased habitat and resources (Harvey et al., 2006; Sekercioglu, Loarie, Brenes, Ehrlich, & Daily, 2007) and they contribute across the larger landscape to the maintenance of important ecosystem services (Daily et al., 1997; Soto-Pinto, Perfecto, & Caballero-Nieto, 2002). Sustainable agriculture practices, including diverse coffee agroforestry (Komar, 2006; Moguel & Toledo, 1999), cacao agroforestry (Connelly & Shapiro, 2006; Harvey et al., 2006), silvopastoral systems (Harvey et al., 2006), and traditional land uses such as organic farming (Finegan & Nasi, 2004) “harbor high levels of both wild and agricultural biodiversity and offer much greater conservation value than the agroindustrial systems that typically replace them” (Harvey et al., 2008, p.9). In Mesoamerica and other key regions of the world a growing number of studies demonstrate that some agricultural landscapes and traditional smallholder practices contribute to biodiversity

conservation (Daily et al., 2003; Estrada & Coates-Estrada, 2002; Mayfield & Daily, 2005) and at the same time can result in long-term sustainability of food production and rural income (Pretty, Morison, & Hine, 2003). However, overcoming short term conversion costs remains a barrier to overcome in many areas and these changes may be impossible in some places, especially those with high potential to produce a lot of food. It is hard to get past the fact that payment for ecosystem services often relies on agriculture that is less intensive and thus produces less food, thus success relies on truly valuing other important services and finding places where the trade-offs are worthwhile.

Reshaping our economic system to value ecosystem services will constitute a fundamental part of catalyzing change. It is important to focus initial efforts on critical landscapes at the socio-ecological interface. This is where our investments will provide the greatest returns in terms of both conservation and human-well being (Harvey et al., 2008).

Key Landscapes: Why is successful protected area and buffer zone management so important to successful conservation and sustainable development?

Ecosystem Services and Protected Areas: Although conservation on private lands is an important new frontier, protected areas remain the primary building blocks of practically all national and international conservation strategies. Protected areas have a high value in terms of the provisioning of ecosystem services including biodiversity, clean water, forest products, etc. They provide habitat to protect the world's threatened species and are increasingly recognized as essential providers of ecosystem services and biological resources. Protected areas are vitally

important to climate change mitigation strategies; and in some cases, they are also vehicles for protecting threatened human communities or sites of cultural and spiritual value.

IUCN, the International Union for Conservation of Nature, recognizes the increasing importance of making the link between protected areas and ecosystem services more explicit. The new IUCN definition of a protected area is: “A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (Dudley, 2008).

Establishing formal protected areas is one of the key means of conserving ecosystem services, but socio-economic and political constraints limit the amount of land in such status. With increasing population growth and development pressure, proponents of conservation are now often expected to justify protection of natural areas by quantifying the direct and indirect benefits realized by local communities and, in many cases, national economies. While difficult and not without critics, this shift does have some positive implications. The ecosystem services framework approach to conservation allows for a more holistic approach to protected area management in which human needs and aspirations are considered as part of an interconnected web with natural systems. By using an ecosystem services approach to land management, the value of conservation to humanity can be made more explicit.

Uninhabited protected area systems are likely near reaching the limit of their ability to expand and improve conservation. If the establishment and management of parks and protected areas constitute the historical foundation of applied conservation, then what future actions will best

build off of this remarkable investment? Among others Wade & Theobald (2010) suggest that the “[c]onservation of ecological processes and biodiversity may require development of a conservation system consisting of protected “cores” surrounded by “buffer zones” that effectively expand and connect the cores”(p151). These buffers zones could consist of conservation agriculture maintained by PES.

Ecosystem Services and Buffer Zones: Buffer zones at the interface between natural and human systems provide an ideal environment for investigation of the impacts of land-use distribution and decisions on biodiversity. (Duffy, Corson, & Grant, 2001). A buffer zone is defined as “Any area, often peripheral to a protected area, inside or outside, in which activities are implemented or the area managed with the aim of enhancing the positive and reducing the negative impacts of conservation on neighbouring communities and neighbouring communities on conservation”(Ebregt & DeGreve, 2000, p.7). Buffer zones are often multiple use areas and they constitute a significant portion of conservation areas in some countries. Effective management of buffer zones can have both significant direct and indirect effects on the ecological integrity of the protected area. With increasing population pressure and food security issues, more communities in the buffer zones of protected areas are encroaching on the parks. The Millennium Assessment reported that more than 45% of 100,000 protected areas analyzed had over 30% of their land area in crop production (Millennium Ecosystem Assessment, 2005). The challenges of reconciling development and conservation goals may be greatest in the buffer zones surrounding biosphere reserves in developing countries (Crihfield, 1994; Oldfield, 1988). Here, both philosophically and physically, the economic and social problems of rural poverty confront the environmental and ecological problem of habitat destruction (Reardon & Vosti, 1995; Stonich, 1989). As the actual spatial location where conservation (in the form of preserved natural areas) and human

development (the communities around the protected area) meet, buffer zones provide critical space for the exploration of sustainable development issues. As crucial areas for both people and nature buffer zone management are best approached using a participatory process (Ebregt & DeGreve, 2000).

Sustainable land-use in the buffer zones around protected areas is a vital contributor to ecosystems services (Daily et al., 1997; Soto-Pinto et al., 2002; Wallace, Barborak, & MacFarland, 2005). Unlike some other kinds of land use, agroforestry systems within the larger agricultural matrix surrounding protected areas contribute to biodiversity conservation (Harvey et al., 2006). Agroforestry systems can serve as a buffer zone and biological corridor between monoculture agriculture and protected areas (Gamez & Ugalde, 1988).

How to Move Forward: What role could Payments for Ecosystem Services play?

The challenge of recognizing the true value of nature has contributed to more systems level thinking about complex environmental problems and transdisciplinary approaches to understanding the natural environment and human development. In order to realize a more sustainable future, decision makers are often drawn to approaches that quantify the value of ecosystem services. As a result, economic value is increasingly associated with many ecosystem services. Economic value, however, is just one representation of the value of ecosystem services to human society. Assigning a price does not magically encapsulate the value of a commodity in a single number and many question how one can put a price on clean water and air for future generations? Often trade-offs are valued differently by different people. It is the role that

valuation plays within the broader framework that helps us to begin to see the big picture of how our decisions, and their resulting actions, affect the planet and human well-being.

The need to balance human development and ecosystem service production activities in protected area buffer zones requires management approaches that are sensitive to the complex ecological, economic, and social conditions at play. The root of the problem with our current system of valuation in regards to ecosystem services is that many of the benefits that we derive from ecosystems are external to the system (externalities) or public goods for which no one pays. In other words “the existence of many forms of market failure means that natural capital depletion is often much greater than would be socially optimal” (Engel et al., 2008). Since a substantial portion of ecosystem benefits are externalities, voluntary approaches are likely to change people’s behaviors or practices if they are rewarded for the provision of the ecosystem services or for land-use practices that are directly related to the improvement of ecosystem services. These approaches are known as *payments for ecosystem services* or PES.

Payments for ecosystem services (PES) are an incentive-based mechanism that resulted from the translation of ecosystems science to economics and ultimately to practical application. In this system the trade-off costs and benefits, and thus the economic value of ecosystem services produced on the land is directly recognized. Areas that provide the highest value of service for the lowest cost are ideally targeted through this system (Engel et al., 2008). The basic concept of PES is for users (beneficiaries) of ecosystem services to pay landowners for the ecosystem services supplied by their land (Pagiola et al., 2005). However, in reality intermediaries make these transactions possible through government programs, non-profit organizations, private brokers or other institutions that link buyers and sellers, help to set prices, and provide information and security to the individuals involved in the transaction.

Often, the term PES is used loosely to describe any kind of market-based mechanism for conservation including eco-certification and other approaches that may not adhere to the strict definition of PES. According to Sven Wunder (2005), a formal definition for PES is as follows:

- a. a **voluntary** transaction where
- b. a **well-defined** environmental service (ES) (or a land-use likely to secure that service)
- c. is being 'bought' by an (minimum one) ES **buyer**
- d. from an (minimum one) ES **provider**
- e. if and only if the ES provider secures ES provision **conditionally**.

Conditionality means that the buyers only pay if actual additional services are provided. This requires oversight and regulation. Through this structured approach PES seeks to internalize what would otherwise be an externality. PES approaches, like environmental taxes, subsidies, and certification, rely heavily on economic incentives. PES programs can also be thought of as an environmental subsidy for the ES providers combined with a user fee charged to the ES users (Engel et al., 2008).

However, even proponents of PES recognize the many challenges to implementation (Engel et al., 2008; Grieg-Gran et al., 2005; Landell-Mills & Porras, 2002; Pagiola et al., 2005; Wunder, 2006). As a subsidy approach, PES is particularly vulnerable to several potential pitfalls: 1) Lack of Additionality - making payments for land-uses that would have been adopted anyway and thus reducing funds available to induce more sustainable land-use change elsewhere (Pagiola, 2008);

2) Leakage – shifting environmental damage to a different location, but not actually reducing overall impacts (Engel et al., 2008); and 3) Perverse Incentives – increasing environmentally damaging activities in order to be eligible for subsidies at a later date (Engel et al., 2008). In order to avoid these pitfalls, PES should only be used in appropriate situations and with adequate planning and when supported with strong institutional capacity. Although PES could, in principle, merely provide rewards that do not function as incentives for real change, most service buyers are only willing to make additional payments for actual additional services. This “conditionality” is a key redeeming factor of PES, and it requires transaction monitoring and oversight to be credible (Engel et al., 2008). This oversight, once again requires institutional capacity.

PES approaches were originally created as a conservation tool in response to the disparity between actual and recognized values of ecosystem services and mounting concerns about how this discrepancy is contributing to massive and unsustainable global environmental change. PES programs have potential as a conservation tool and many argue that they can also be used as a sustainable development tool that can contribute to poverty reduction (Galizzi & Herklotz, 2008; Grieg-Gran et al., 2005; Hope et al., 2005; Landell-Mills & Porras, 2002; Miranda, Porras, & Moreno, 2003; Pagiola, 2008; Pagiola et al., 2005; Pagiola, Rios, & Arcenas, 2007; Pfaff et al., 2007; Zilberman et al., 2008). PES approaches, however, are not without their critics. Critics fear that the human-centric focus of PES will only favor certain flora, fauna, and ecological processes and that intact natural ecosystems may not be the outcome (Adams et al., 2004; Redford & Adams, 2009). They also point out that the concept may be taking off too quickly and without adequately addressing potential pitfalls such as those mentioned previously (Redford & Adams,

2009). Others have argued that by increasing land value, PES could result in wealthy individuals or politically powerful groups forcing out poorer land users especially when they do not have secure land tenure (Landell-Mills & Porras, 2002). However, Costa Rica's PSA program has been shown to improve tenure security by legitimizing forest management and protecting against squatters rights on “idle” land (Miranda et al., 2003). In many countries, including Costa Rica, tenure has been traditionally secured through making “improvements” to the land and these are generally developments which are not good for conservation such as clearing forest. PES programs can legitimize alternative land management strategies. McCauley argued in “Selling out on Nature”, a commentary in *Nature* magazine, that a PES approach fails to recognize intrinsic value of nature and the moral obligation that we have to protect it (McCauley, 2006). This is yet another frequent concern about PES.

Proponents of PES claim that, when designed and implemented correctly, these programs have the potential to address both conservation and human development goals and could contribute significantly to more sustainable approaches to agriculture. Given that we need to better integrate ecological conservation into working landscapes in order to sustain human well-being in the future, payment for ecosystem services is a promising tool. The question then becomes, how does one design and implement a PES program correctly? This research focuses specifically on the potential for PES to advance conservation and sustainable development goals on agricultural lands and how to develop an appropriate PES program within the context of a specific socio-ecological system.

Potential for PES in Panama

Panama has not yet implemented a PES program, yet multiple avenues for program development seem possible and are being discussed. The carbon market provides one potential avenue for Panama to enter the global PES market. The potential is great for Panama to become a leading supplier of carbon sequestration services at the global market level (Lichtenfeld, 2007). Panama is home to the largest rainforest outside the Amazon Basin in the Western Hemisphere (BBC, 2009). The country contains these extensive areas of primary forest along with increasing areas of deforested and degraded land. Factors contributing to Panama's potential for providing carbon services include substantial humid regions with high tree growth rates, a recent successful program to address land-tenure (rights to land) issues in the country, strong NGO institutional networks, stable government, a growing economy, and a business friendly legal environment (Lichtenfeld, 2007).

Overall, Panama is doing well as far as deforestation rates are concerned. Between 2000 and 2005, Panama lost only 0.1 percent of their forest cover per year compared to the 1.2 percent average yearly deforestation rate across Central America. In total, between 1990 and 2005, Panama lost 1.9% of its forest cover or approximately 82,000 hectares (FRA, 2006). Protected areas in Panama vary substantially in their ability to successfully control deforestation and according to a recent study by Oestreicher et. al. (2009) Parks within the La Amistad Biosphere Reserve have some of the worst records. Estimates of land cover change from 1992 – 2000 derived by ANAM staff from satellite images (ground resolution 30 m) showed that La Amistad suffered the second highest level of loss in mature forest cover out of the ten protected areas included in the study (Oestreicher et al., 2009).

Several industrialized nations, including Canada, Spain, Italy, and Holland, have already signed Memoranda of Understanding with Panama in anticipation of purchasing carbon credits. These MOUs facilitated by Panama's National Environmental Authority (ANAM) provide some guarantee of demand for carbon sequestration services to potential suppliers (Lichtenfeld, 2007).

Biodiversity is another potential avenue for attracting PES investments. In the La Amistad region alone over 300 endemic species of flora and fauna are threatened, including at least 107 that are critically endangered (The Nature Conservancy, 2007). Differences in species composition of tropical forests are greater over distance (beta-diversity) in Panama than even in Amazonia- the epitome of biodiversity (Condit et al., 2002).

In addition to habitat destruction and fragmentation, other land use changes such as globalization of market forces, agricultural industrialization, migration, public policy, and cultural changes are driving the transformation of diverse, traditional, smallholder agroecosystems into agroindustrial systems dependent on chemical inputs and mechanization (Angelsen, Kaimowitz, & Research, 2001; Conroy, Murray, & Rosset, 1996; Perfecto, Armbrecht, Philpott, Soto-Pinto, & Dietsch, 2007; Perfecto, Rice, Greenberg, & Voort, 1996). These changes are also substantial drivers of biodiversity loss in the region. Industrial agriculture leads to intensification and is often accompanied by significant reductions in land cover, habitat diversity, and forest connectivity. These transformations directly threaten species dependent on natural habitat and undermine traditional and more sustainable management practices (Harvey et al., 2008). Most of the agricultural land on earth is grazing land where agroforestry is not possible because of low and

varying rainfall. This is not the case in Panama where precipitation levels are high and many innovative options are viable.

Watershed services offer a third promising opportunity in Panama (Gentry, Newcomer, Anisfeld, & Fotos, 2007). The Panama canal zone has been recognized as a key potential area for project development and “[m]any experts believe that the protection of water and power sources—including water protection payments—may be a practical way to promote forest conservation in the highlands and middle elevations, in indigenous reserves, and buffer-zone lands of the Amistad Park” (Clark, Ashton, & Dixon, 2006, p. 6).

Ultimately, Panama may be well positioned to pursue a bundled service payment program similar to the Costa Rican program. Ecosystems provide several kinds of environmental services at the same time and bundling these services and selling them as a single product can reduce transaction costs while helping to conserve the entire landscape. In Costa Rica’s PSA Program, the National Forestry Fund (FONAFIFO) buys various environmental services as a bundle from local farmers and landowners.

APPROACH

Defining Clear Conservation and Development Objectives

The concepts of human well-being and sustainable rural livelihoods are central to the ongoing debate about environmental management, rural development, and poverty reduction (Scoones, 1998). Researchers working with subsistence and low-income farmers must be aware of the livelihoods issues in their study region. Successfully understanding and incorporating the socioeconomic and cultural landscapes into conservation planning and decision making can be

crucial to the success of many projects. This compromise between conservation and development goals often comprises the main debate around program objectives. Survey information about landowner characteristics aids in targeting efforts (Lynch & Lovell, 2003). This research project examines the potential for farmer participation in PES with insights on how to design such initiatives so that support long term social development and conservation. The collaborative research approach described below was integral to realizing the goals of this project.

A Community-Based Participatory Research Approach

Community-based participatory research (CBPR) is an approach through which research is conducted by both traditionally trained "experts" and community members working in partnership. CBPR is similar in some ways to Participatory Action Research. The development of CBPR grew out of three fields, popular education as advanced by Paulo Freire, international development and the work of Orlando Fals Borda, and the action research of Kurt Lewin (Fals-Borda, 1987; Freire, 2005, 1998, 1995, 1970; Lewin, 1946). CBPR projects start with the community and the community participates fully in all aspects of the research process.

Community can mean many things; various common definitions of community include geographic community, a community of individuals with a common problem, or a community of individuals with a common interest or goal (Schulz et al., 1998). In this project, the community participating in the research includes people already working on sustainable development issues in and around La Amistad. The initial request for this project came from these community partners who approached a contact that they had at Colorado State University (CSU) in order to request assistance with a local ecosystem services research project and were subsequently put in touch with this research team. These partners were involved in the workshop in Cerro Punta,

Panama where researchers from CSU and local practitioners worked together to clearly identify and further define the research problem, need and purpose. CBPR encourages the research “experts” to provide expertise that is seen as useful to the investigation by the community, and be committed to an equitable partnership and producing outcomes that are directly useful to the community. Equitable partnerships require the sharing of power, resources, recognition, results, and knowledge. The success of CBPR projects is dependent upon participants’ capacity to appreciate each other’s knowledge and skills at each stage of the project, including problem definition/issue selection, research design, conducting research, interpreting the results, and determining how the results should be used for action. This collaboration throughout the project often encourages the development of culturally appropriate measurement instruments, thus making projects more effective and efficient (Altman, 1995; Stull & Schensul, 1987). CBPR also establishes a mutual trust that enhances both the quantity and the quality of data collected (Brown, 1995; Cousins & Earl, 1995; Schulz et al., 1998). The insights and perspectives of community participants enhance the knowledge and understanding of researchers about community dynamics and conditions. This research seeks to strengthen the skills of community members in gathering and using data to facilitate change within their own community.

By employing a community-based participatory research process to engage stakeholders from both Costa Rica and Panama, this research team worked together with the community to define the scope of the research, to foster information exchange between stakeholders, and to provide policy-relevant information for PES design. The project launched in May, 2009 when Dr. Josh Goldstein (CSU), Ryan Finchum (CSU), Jorge Pitty (FUNDICCEP), and this writer (Esther Duke, CSU) facilitated a collaborative workshop on ecosystem services in Cerro Punta, Panama.

The workshop involved participation from protected area managers, conservation practitioners, local farmers, and other stakeholders from across the transboundary region. Workshop outcomes included:

- A map developed through a participatory process showing the supply and demand of ecosystem services for communities in the study region (figure 1.1)
- A prioritized list of the most important ecosystem services produced in the region (table 1.1)
- A list of opportunities and challenges for using PES to support farmers and conservation efforts in this region
- Commitments from participants to continue this transboundary partnership.

The information gathered through this workshop was used to develop realistic PES scenarios that might be implemented on agricultural lands in the study region. These scenarios were then presented during interview surveys with local agriculturalists in order to determine the likelihood of success of a PES program given different program design scenarios. The anticipated effect of each program scenario on conservation and local livelihoods was also explored through the survey instrument.

This research team has been particularly interested in involving local stakeholders in the initial planning stages of the research as well as throughout the rest of the process. This collaborative approach is designed to overcome a recognized barrier to using research to support on-the-ground conservation – namely, that input from local stakeholders is too often not obtained at the

beginning of a research project, when this information can be most effective in helping to design research that will inform local management decisions.

CBPR is unique in the way it associates research and practice, so research informs practice and practice informs research synergistically. One of the principal ways in which it is different is that instead of creating knowledge for the advancement of a field or for knowledge's sake, CBPR is an iterative process, incorporating usable research, reflection, and local empowerment (Padgett, 2008). In this study CBPR is used as a framework or approach for conducting research. This study incorporates both qualitative and quantitative methods. What characterizes CBPR is not the methods used, but the principles that guide the research and the relationships between researchers and the community. In this study, the CBPR approach is used in order to develop and implement a mixed-methods study of PES capacity in the buffer zone of La Amistad.

STUDY LOCATION

La Amistad Buffer Zone

This study took place in several communities in the Panama Pacific buffer zone area of La Amistad World Heritage Site and Biosphere Reserve. La Amistad is officially recognized by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as a bi-national Reserve split between Panama and Costa Rica. The area encompasses a conglomerate of different types of protected lands and a buffer zone comprised of several indigenous territories (Cabecar, BriBri, Naso Teribe, and Ngöbe Bugle) Some of the indigenous populations in the area are expanding fairly rapidly, especially the Ngöbe . The mid to high elevation areas in this region are highly regarded for their unique levels of biodiversity (primarily within the Talamanca Montane ecoregion). The Amistad mountain chain includes the highest peaks in both countries:

the Cerro Chirripo in Costa Rica at 3,819 meters, and Volcan Baru in Panama at 3,475 meters (Clark et al., 2006).

Due to its historic isolation and inaccessibility, the area contains large tracts of virgin rainforest, and the watersheds in the highlands provide important freshwater sources for many large communities in the lowland areas of both countries (Clark et al., 2006). The main rivers are the Changuinola, Teribe and Sixaola. The Watershed provides half of Costa Rica's fresh water and the Sixaloa Basin is shared by the province of Bocas del Toro in Panama.

La Amistad is located within the Meso-American Biological Corridor and is recognized worldwide as a biodiversity hotspot. Ten of Panama's 13 life zones, and nine of Costa Rica's twelve life zones are found in the reserve. The highland region of Talamanca also provides a range of habitats and protection for more than 400 species of birds (resplendent quetzal, umbrella bird, harpy eagle and great green macaw), and supports 215 species of mammals including the puma, jaguar, white-lipped peccary, and the countries' largest population of tapir. In fact, the region harbors 70% of the wild animals and an estimated 90% of known flora found in Costa Rica and it is estimated to harbor almost 4% of the varieties of all the Earth's species (Clark et al., 2006; "Parks in Peril," 2009).

Indigenous territories in the highlands along with small locally-owned farms and an increasing number of larger farms make up most of the buffer zone of La Amistad. Isolated rural communities depend on the watershed services, pollination services from wild pollinators in forested areas and many other ecosystem services provided by the protected areas for coffee production and a variety of rural livelihood activities. Intact natural ecosystems provide the

resources needed for rural agricultural communities to maintain material welfare, health and livelihoods (Angelsen & Wunder, 2003; Clark et al., 2006; Dettman, 2006; Landell-Mills & Porras, 2002). In a Park in Peril (PiP) /Nature Conservancy Conservation Area Planning process for La Amistad buffer zone area one of the four key threats identified was “incompatible agricultural activities” (The Nature Conservancy, 2007)and three of the six strategies identified to address the four key threats were: “alternative income generating activities”; “Strengthening of community-based conservation capacity”; and “payment of environmental services initiatives” (p.5). This project is designed to help identify the best next steps to address “incompatible agricultural activities” by implementing these strategies through a PES program. Details about the study site communities are provided in methods sections of Chapter I.

RESEARCH QUESTIONS

The research questions developed in order to accomplish the study objectives are detailed below. For each research question both general results for the region and differences between two communities in the study region were examined.

R1: Which potential PES program modalities are most acceptable to producers?

R2: What factors influence a landowners’ willingness to participate in these hypothetical PES programs?

R3: What is the relationship between household socioeconomic status and likelihood to participate in a PES program?

R4: What is the relationship between household socioeconomic status and eligibility to participate in a PES program?

THESIS ORGANIZATION

This introductory chapter provided an overview of the pertinent literature and the current state of the debate about PES as a tool used to address conservation and livelihood issues on the working landscapes surrounding protected areas. This first chapter also provided a broad overview of the purpose, approach, location, and research questions addressed through this research project in the La Amistad buffer zone of western Panama.

Chapter II focuses on factors which influence participation in PES programs and includes a systematic review of research to date on actual PES program participation and willingness to participate in hypothetical PES programs in Latin America and internationally. This review is followed by results reported from survey research on farmers' willingness to participate in several potential PES programs in western Panama. An overview of the study population and their preferences is presented along with an in-depth analysis of factors influencing willingness to participate in each of the program modalities.

Chapter III provides an overview of pro-poor PES program design considerations based on lessons learned from existing programs along with a socio-economic profile of the study communities in western Panama coupled with analysis and discussion of various PES program eligibility requirement options and trade-offs.

CHAPTER II
PROSPECTS FOR A PAYMENT FOR ECOSYSTEM SERVICES PROGRAM IN LA
AMISTAD BUFFER ZONE, PANAMA

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INTRODUCTION

As human activities increasingly alter ecosystems, there has been an emerging recognition that intact, healthy ecosystems provide many benefits upon which humans depend (Heal, 2000). Agricultural lands cover approximately 40 percent of the Earth's land surface, representing humanity's most extensive type of managed ecosystem (Foley et al., 2005). While these lands are critical to producing food for people, there is broad concern about the detrimental impacts of agricultural production on non-food ecosystem services (e.g., climate regulation, water purification) and biodiversity (Foley et al., 2005). Indeed, facilitating the transformation of agricultural production from being one of the greatest threats to biodiversity and ecosystem services into playing a major role in strengthening ecosystem integrity is a major global challenge (Galizzi & Herklotz, 2008). Protection and restoration of ecosystem services will require a better understanding of how humans benefit from ecosystems and how to modify human behaviors to more sustainably manage ecosystems. Many ecosystem services (e.g., carbon sequestration, water purification) and biodiversity are considered externalities from landowners' perspectives, which has led to their systematic under-provision relative to society's needs (Pagiola, et al., 2007). Given growing pressures on ecosystems, and in an attempt to fix this market failure, payments for ecosystem services (PES) – in which beneficiaries of ecosystem services pay landowners (as sellers) to supply services from their land – have emerged as a major new market-based tool for conservation (Engel et al., 2008; Millennium Ecosystem Assessment, 2005).

Payment for ecosystem services programs are increasingly used to create incentives for agricultural producers to manage their land for biodiversity and ecosystem services outcomes, alongside continued food production (Harvey et al., 2008; Pagiola, Rios, & Arcenas, 2008). Given that agricultural lands are often found in the buffer zone and lands adjacent to protected areas, PES targeting agricultural landowners could be key to improving environmental management of not only the targeted agricultural lands, but also protected areas (Harvey et al., 2006). Accordingly, for a PES program to be successful in achieving its environmental objectives, it must be designed to enable participation by landowners managing ecologically important parcels of land (Kosoy, Corbera, & Brown, 2008). Furthermore, with attention increasingly focused on the potential for PES to support landowners' livelihoods, including contributing to poverty alleviation, it is also necessary to understand how to best design a PES program to allow participation by a broad spectrum of landowners, rather than (even if unintentionally) create a program structure that excludes households with a lower socio-economic status (Pagiola et al., 2008; Wunder, 2008). With investment in PES projected to grow substantially in the coming years, these issues related to effective program design to achieve environmental and social objectives are only growing in importance (Engel et al., 2008; Jack, Kousky, & Sims, 2008).

PURPOSE

When considering the feasibility of a new PES program in a target region, three broad questions should be addressed to inform program design with regards to factors affecting landowner participation and the subsequent potential livelihood impacts of the program. First, do landowners express interest in the PES concept and support the development a new program? Second, assuming a positive response to the first question, what type of program focus (e.g.,

forest conservation, reforestation) would be most attractive to landowners? Finally, how might decisions about specific program design elements (e.g., minimum eligible area, program oversight) affect the ability to participate of individual landowners within the target region? Obtaining responses to these questions from landowners and communities that would be affected by a new program can help to proactively consider ways to expand landowner eligibility and participation, including considering factors that may unintentionally rule out certain groups of landowners. We note at the outset that there is also a set of key questions related to achieving a PES program's environmental objectives, though these are outside this project's focus on potential landowner eligibility and participation. The full economic analysis needed to determine payment amounts is also outside the scope of this project but could build upon insights from this research.

Few studies exist that examine the interactions between ecological, economic, and social factors to make recommendations about appropriate PES program development for a specific region. However, several countries in Mesoamerica have emerged at the forefront of innovative approaches to addressing these issues and research on who is participating in these programs and why can inform program design. Drawing upon what literature does exist and focusing on site specific concerns, this study explores the potential opportunities and obstacles to developing a PES program in the La Amistad buffer zone in western Panama with a particular focus on program accessibility. We provide information that can be used to improve sustainable development opportunities in the buffer zone of La Amistad World Heritage Site (a globally important ecosystem on the Panama – Costa Rica border) by exploring options and opportunities for assessing real world PES feasibility and preferred development strategies. As a result of this

study, local non-profit organizations will have key data about the communities that they work in, and their preferences and thresholds for PES program participation. At the regional and national level, this study will help to identify the types of PES programs that are most likely to be effective in one of Panama's most important rural production and biologically rich areas and provide recommendations for effective implementation.

In this chapter we provide contextual information demonstrating why PES may be the appropriate tool to address conservation and livelihood issues in this region including lessons learned about PES on private lands and individual household factors which influence participation. A systematic literature review of 56 publications contributing to our knowledge of key factors influencing likelihood of landowner participation in PES is presented with a brief overview of each of the key factors. This is followed by an overview of the methods of this empirical study, and results including general characteristics of the study sample for the districts of Renacimiento and Boquete, a discussion of responses to the payment for ecosystem services scenarios, scenario preferences, and a logistic regression analysis to determine factors contributing to stated willingness to participate in the PES scenarios presented in the study. These factors are then discussed within the broader context of the systematic literature review. Overall the findings from this study are supported by the literature but also offer site specific insights that could be used to help decision makers with PES design.

PREVIOUS RESEARCH

PES? Why and How?

PES when used in tandem with other sustainable development incentives has the potential to catalyze a healthy change in ecosystem service production on private land (Goldstein, et. al. 2006). A PES program could help to incentivize large scale adoption of agroforestry, forest conservation, reforestation, and other land management practices to protect and enhance biodiversity and ecosystem services on private lands.

Policy makers, conservation organizations, and human welfare agencies need specific information in order to determine whether, first, a PES approach is appropriate for the region, and second, how a PES program could be designed to best achieve policy targets. Identifying the best PES architecture for a given landscape is a complicated and difficult task. The lessons learned from functioning and failed programs can help guide how to proceed and what information and indicators are relevant, especially if these programs were implemented in similar socio-economic and/or ecological landscapes. There exists a need to understand the conditions, eligibility requirements, incentives, processes, and players that will make a PES program successful in achieving its environmental and, where defined, social objectives. Related to social objectives, there is a growing focus on understanding which landowners are participating in PES programs and how program structure affects participation (Pagiola, Arcenas, & Platais, 2005; Wunder, 2005; Zbinden & Lee, 2005). By understanding the factors that will affect an individual's likelihood of participating in a PES program, one can then determine how a PES program could be most effectively designed to deliver livelihood benefits to participating landowners, while also achieving its environmental objectives.

Lessons Learned About PES on Private Lands

A handful of national, regional and local level PES programs have been operating long enough that researchers have evaluated the outcomes of different legal frameworks and implementation structures when applied in communities across the socio-economic spectrum. In a review of global market-based programs for forest conservation and development, Pagiola & Platais (2002) identify a number of key factors that are critical to the success of incentive-based programs, including: ensuring effective demand, flexibility in program design, ensuring that the poor can participate, and covering transactions costs (p. 286). When analyzing PES feasibility, one must determine how to effectively bring together buyers, sellers, and intermediaries to enable program operation. Equally important, however, is understanding the internal dynamics of each group. For landowners who act as sellers of ecosystem services, PES program design, administration, and eligibility requirements determine who can participate, in what ways they can participate, and the social, ecological, and economic outcomes. Only through investigating these issues and ensuring that incompatibilities are addressed through appropriate program design will a program be successful. In the subsequent section we explore factors which influence participation and discuss the implications of these factors for program participation.

Understanding the Individual Household Factors which Influence Participation: How to make a PES program successful

Land-use and management decisions are normally made at the household level, meaning that these decisions are subject to the constraints facing these households (Chowdhury & Turner, 2006). Economic and environmental outcomes are clearly shaped by how households manage

their productive assets, including different types of material, economic, and cultural capital. In order to promote sustainable land use approaches as a viable livelihood strategy, one must understand the factors that contribute to household land-use decisions and how incentives can be most effectively created to push adoption of more sustainable practices.

With interest in PES program development growing rapidly, researchers have begun to investigate landowners' interest in ecosystem service markets, their preferences, and factors affecting their willingness to participate (Kramer & Jenkins, 2009). This information is important, because these factors determine who is able to benefit from PES and how PES may affect social and economic development as well as environmental resource management (Kosoy, Corbera, & Brown, 2008; Kramer & Jenkins, 2009).

Research on factors influencing participation in existing PES programs or willingness to participate in hypothetical programs is increasingly available as well (Jolejole, Swinton, & Lupi, 2009; Kramer & Jenkins, 2009; Zbinden & Lee, 2005). The hope is that understanding these factors will help PES program designers to tailor programs to be more accessible to a wider spectrum of landowners, and also successful in achieving their environmental and social objectives. The following case studies provide examples of the kinds of lessons that can be learned from 1) existing PES programs (Costa Rica), and 2) research into potential future PES programs using surveys about hypothetical scenarios (North Carolina). Following these case studies, we present a systematic literature review of key factors influencing likelihood of participation in PES.

Costa Rica – PSA Program

In 1996, Costa Rica launched the first PES program in a developing country (Pagiola, 2008). The Costa Rican program is generally referenced as the PSA program, an acronym derived from the Spanish ‘Pagos por Servicios Ambientales.’ The PSA program initially recognized four services: (1) greenhouse gas mitigation; (2) hydrological services; (3) scenic value; and (4) biodiversity. Where feasible, the PSA program developed mechanisms to charge the users of ecosystem services for the benefits they receive, including charging water, biodiversity and carbon sequestration users. The program then used the money raised through these fees along with additional resources from international funders to compensate forest landowners for value created by either reforested or conserved natural forest parcels on their land. Between 1997-2005, Costa Rica’s PSA program had already provided payments to more than 4,400 farmers and forest owners for reforestation, forest conservation, and sustainable forest management activities (Zbinden & Lee, 2005).

Over the years, the PSA program has evolved considerably. “An agroforestry contract was introduced in 2004, and a natural regeneration contract is being introduced...[Also] the PSA program is moving towards a greater degree of targeting” (Pagiola, 2008). Research revealing the lack of program participation by poorer households, and factors influencing overall participation (Miranda et al., 2003) have influenced additional restructuring of the program in regards to land title requirements, size constraints, and other factors (see Appendix A for detailed discussion). Research on PSA program participation can also provide insights for program development elsewhere. For example, Zbinden and Lee (2005) report outcomes from a logistic regression analysis used to model actual PSA participation dependent on a set of hypothesized

behavioral determinants. The data used in their analysis resulted from a 2002 survey of 246 rural Costa Rican households. This study provides an example of the types of research which we drew upon to inform the focus of this project. Selected results of Zbinden and Lee's research in Costa Rica are presented below along with outcomes from other similar investigations of PES program participation in a *Systematic Literature Review of Key Factors Influencing Likelihood of Landowner Participation in PES*.

North Carolina, USA – Red Wolf Conservation on Private Lands

As part of a larger project to examine economic values generated by red wolf conservation in North Carolina, Kramer and Jenkins (2009) explored ways to use market-based incentives to encourage greater conservation effort by private landowners. They administered a survey to 298 farm operators in the red wolf area about their attitudes toward current conservation programs and their interest in participating in future programs oriented toward the provision of ecosystem services. They found that while there is a lack of familiarity with ecosystem services terminology, many are interested in participating in future PES programs, particularly if the programs emphasize wildlife conservation or water quality. Payment levels are found to be an important factor in decisions to enroll, but so are other program attributes, particularly contract length and the program administration (i.e. government, NGO, private company). Details of these findings are also included in the literature review below.

Kramer and Jenkins designed a series of choice experiments (also known as choice-based conjoint analysis) that would allow the estimation of tradeoffs across contract length, program administrator, and payment level in a PES program. They also designed a contingent valuation

question to estimate willingness to accept payment for providing red wolf habitat on private land. Variables that were shown to have a positive, statistically significant influence (at the 5% level) on respondent non-enrollment were age and household income. They suggested that older respondents may be less willing to change the way they have managed their land, and more affluent ones may not feel the need to consider a change. This research focusing on stated willingness to participate in a hypothetical program provided useful insights for my surveys with farmers exploring hypothetical PES programs in Panama.

SYSTEMATIC LITERATURE REVIEW

Key Factors Influencing Likelihood of Landowner Participation in PES

A compiled review of information from research on existing and hypothetical programs resulted in the following lessons learned about which characteristics are most likely to predict participant response to program opportunities. Although the body of knowledge is gradually increasing, “understanding people’s willingness to participate in PES projects and programs has not been a key analytical concern of the scholarly literature around this new field of environmental policy and practice” (Kosoy et al., 2008). The following section of this chapter is dedicated to compiling what we do know about this important issue. Key factors related to farm/household characteristics, program design, and land attributes are discussed below and summarized in table 2.1 based upon literature relating to PES participation in existing programs and willingness to participate in hypothetical programs.

Farm size is commonly found to be a significant, positively correlated factor influencing participation in PES and other agricultural conservation programs (Lynch & Lovell, 2003). In other words farmers with larger farms are more likely to participate in agricultural land preservation program such as PES. In some cases, this is due to program eligibility requirements. Programs often favor larger farms due to the lower transaction costs per hectare and develop minimum size requirements for enrollment; in other instances, this relationship may be explained by the fact that farmers with sufficient production capacity and incomes from large landholdings typically have greater flexibility to engage in new activities including innovative government programs (Nowak, 1987). This same relationship seems to hold true for PES program participants. For example, in Costa Rica, Zbinden & Lee (2005) found that farm size was positively associated with participation. Also, Jolejole, Swinton, & Lupi (2009) report that the “low cost suppliers of environmental services are the largest farms. Agricultural policies based on payment for environmental services that aim for cost-effective environmental impact will likely achieve most of their impact from larger farms”. Some argue that larger plots submitted for participation in Costa Rica’s PSA (especially, under forest conservation) may be preferred from a forest ecology standpoint in addition to being more economically competitive for a PES contract (Zbinden & Lee, 2005). Although PES programs which target landholders with more land may be more efficient in terms of reducing administrative expenses, they certainly decrease equity in the distribution of payments. Given this, Zbinden and Lee (2005) note that “realizing economic goals (e.g., program efficiency) and environmental goals may conflict with achieving equity goals. Policymakers may ultimately have to choose the optimal balance among these multiple goals.” Some PES programs require a minimum land enrollment size in order to be eligible to enroll. Creative approaches to overcoming this constraint include the establishment of

land collectives in order to bring together several smaller landholders for group enrollment. This approach may help to keep transaction costs lower, though these costs are still problematic (Pagiola et al., 2008; Wunder, 2008). This confirms what various authors have suggested with respect to potential economies of scale associated with PES participation and the need to address these issues early in the discussion about PES program development (Chomitz, Brenes, & Constantino, 1999).

In addition to influencing participation, farm size might play a part in determining the type of PES program that a landowner prefers. Lambert, Sullivan, Claassen, & Foreman (2007) examined characteristics of farmers who were attracted to working lands conservation programs (as opposed to land retirement program) and found that farm size combined with off-farm income were important factor in the decision making process for farmers in the United States. Those with larger farms were generally more interested in working land programs and they suggested that this was because small scale farms in the United States were mostly hobby or retirement farms and not primary income producing activities for their owners. This situation is likely very different in other countries where local livelihoods depend on small farms.

Land and tree tenure has been highlighted as an important factor affecting PES program participation in numerous studies, as it affects landowners' perceptions about the value of undertaking long-term investments and activities (e.g., adoption of agroforestry systems) (Godoy, 1992; Hyman, 1983; Schuck, Njanje, & Yantio, 2002; Zbinden & Lee, 2005). Farmers who own their land and have an official title from the government to certify and recognize their

ownership are generally considered to have secure land tenure. Of course, this is dependent on the legitimacy and stability of the government in their country. In some places land rights are deeply contested and numerous people claim rights to the same land or people have no way to prove that the land that their family has farmed for generations actually belongs to them. Limited tenure rights are often a significant constraint to forest conservation activities in the developing world (Godoy, 1992). Legal land title is often required in order to be eligible to participate in PES programs. For example, all three payments types in Costa Rica's PSA originally required that participants have official title to their land. Even though the PSA program has since relaxed land title requirements, Zbinden & Lee (2005) found that possession of legal land title significantly increases the probability of participation. More generally, Tejada & Peralta (2000) found the lack of efficient, reliable, and workable land registry systems to constitute a significant constraint to rural development across Latin America specifically because this leads to the systematic exclusion of low income rural farmers from some market-based activities. For example, those without secure land title often have no collateral for loans and may not be able to justify long-term investments in their property.

A landowner's *environmental ethic* and other non-financial factors can also play a key role in conservation decisions, because producers may gain direct personal satisfaction from the improved environmental quality (Chouinard, Paterson, Wandschneider, & Ohler, 2008). Some studies have actually found that the environmental attitudes and affiliations, as opposed to economic factors, were the strongest motivation for landowners to participate in PES and other conservation programs on private lands (Jolejole et al., 2009; Kosoy et al., 2008; Lichtenberg & Zimmerman, 1999). Kosoy et al. (2008) concluded that while the PES economic incentive may

attract applicants, it was not the most important motivation for members of the four participating Mexican *ejidos* which he analyzed. In a broad study of the factors that motivate restoration and conservation behavior, Pease, Rankin, Verdon, & Reisz, (1997) also found that environmental values were more important than financial reasons for landowners participating in conservation programs. On a related note, the landowner's perception of environmental improvements or the effectiveness of the conservation action prescribed through the program is another important factor in PES enrollment decisions (Jolejole et al., 2009).

Education, age, and other decision-maker characteristics are another key factor identified as influencing participation decision (Ayuk, 1997; Chambers & Foster, 1983; Jolejole et al., 2009; Nagubadi, McNamara, Hoover, & Mills, 1996; Rahm & Huffman, 1984). Education and age are human capital variables embedded in the decision making process. Education influences one's ability to obtain and process information, as well as one's competence at implementing knowledge-intensive conservation strategies and technologies (De Souza Filho, Young, & Burton, 1999). Based upon a survey of 3,000 Michigan corn and soybean farmers about their willingness to adopt cropping practices that enhance provision of ecosystem services through hypothetical PES programs, (Jolejole et al., 2009) found that those with higher education levels were more likely to say they would participate in the program. In Costa Rica's PSA, Zbinden and Lee (2005) found that participants receiving payments for forest conservation and sustainable management had over twice as many years of formal education as nonparticipants.

The role of age is more ambiguous because age is sometimes used as a proxy for experience with the expectation that older farmers will be more likely to participate; with PES, however, it may be offset by a greater reluctance to try new things, including new technologies or government-sponsored programs. (Zbinden & Lee, 2005). Some researchers, including Jolejole et al., (2009),

have found that younger farmers are more likely to adopt cropping systems that supply more ecosystem services. (Langpap, 2004) found the same when analyzing likelihood of participation in conservation incentives programs for endangered species. However, it is true that previous experience in similar programs tends to increase participation (Jolejole et al., 2009). Data from the Kramer & Jenkins (2009) survey of North Carolina farmers showed that landowners who were already participating in conservation programs were predisposed to be willing to participate in a PES program. “This may be due to their familiarity and satisfaction with programs they are enrolled in. This may also reflect the influence of a stronger conservation ethic that predisposes some individuals to consider enrollment in such programs” (Kramer & Jenkins, 2009). Not surprisingly, landowners are more likely to participate in programs that require them to undertake practices which they already implement and/or are familiar with (Jolejole et al., 2009).

These individual farm and demographic factors often affect a given household’s eligibility or ability to participate in PES. However, demographics (individual household socio-economic factors) are not generally good predictors of attitudes and behaviors and there are other practical household factors such dependence on farm income and available labor which can play a significant role in determining participation decisions for eligible households

Off-farm employment is an important factor highlighted in the literature. Research indicates that landowners with a greater percentage of off-farm income are more likely to enroll or state that they would enroll in a program (Kramer & Jenkins, 2009; Lynch & Lovell, 2003). As Kramer and Jenkins (2009) point out, these landowners are less dependent on farm income, so program participation is less of a gamble of them. However, Zbinden & Lee’s (2005) observations about

positive externalities accruing from the activities that generate off-farm income may also play an important role in this relationship. For example, farmers engaged in off-farm activities often have an increased level of information access (internet, professional networks, etc.) which is hypothesized to be key for participation. Establishing a PES contract can often require considerable knowledge and the ability to manage administrative tasks. This skill set may be stronger for those engaged in off-farm income generating activities. Education level, skills and experience gained from off-farm employment, or the management of larger farm operations all impact human capital and household economics and are thus shown to be significant determinants of program participation. In Costa Rica, less educated (often poorer) farmers are likely to lack the skills needed to take advantage of the government incentive programs (Zbinden & Lee, 2005).

Farm labor availability and source (family or outside) have complex and mixed affects on PES program enrollment decisions. In Costa Rica, the availability of family farm labor was found to be negatively associated with participation perhaps since traditional farming is more labor intensive but can be very profitable those with available farm family members to work on the farm often stick with these those with fewer low cost laborers available are more attracted to the PES program opportunities (Zbinden & Lee, 2005). Other studies have confirmed the significant influence of labor allocation in determining program participation or technology adoption (Ayuk, 1997; Neupane, Sharma, & Thapa, 2002; Scherr, 1992). However it is important to distinguish between different types of PES programs when discussing the affect of labor. For example, reforestation may be an attractive option in the long run when family labor is scarce, because although it is labor-intensive in the short run (planting the trees) and during harvest years, it may

be perceived as a way to decrease labor demand in the long run if household members have the opportunity to take advantage of better off-farm income generating employment.

While previous studies have attempted to identify the characteristics of individuals (demographics and past experiences) that influence participation in conservation programs, less research has been done on the importance of various program design characteristics. The following section begins with an overview of what we do know about program design attributes that make programs more attractive to participants and then delves into research concerning land attributes.

Contract length is a factor that varies considerably in the literature as pertains to landowner participation. In Kramer & Jenkins (2009) study on hypothetical PES programs in North Carolina, landowner respondents showed a preference for shorter contract lengths; as the contract length of a particular program type increased, respondents were less inclined to select that program. This suggests that many respondents may be uncomfortable with the idea of entering into long-term program contracts. Using a series of focus groups, (Schnepf, 1994) found that landowners in his sample were concerned about permanent enrollment terms, and that long-term or permanent enrollment terms may discourage participation. However, Chen, Lupi, He, & Liu (2009) found that participants were more likely to participate in six-year instead of three - year contracts in China's Grain-to-Green Program; they suggest that this may be because longer-term programs provide more stable income and larger cumulative payments, however they also note that longer-term programs "bring more risks and less flexibility by limiting farmers' ability

to adapt to changing conditions in markets of crop products” (Chen et al., 2009, p. 11814). For this reason participation levels remained about the same for six and ten year contracts.

Program administration and oversight are other important factors affecting landowner participation in PES program design (Kramer & Jenkins, 2009). Studies in the United States have shown a preference for or acceptance for working with the government (Jolejole et al., 2009). In fact, (Kramer & Jenkins, 2009) found that respondents were statistically less likely to opt for programs administered by a private company or conservation NGO than a state agency. They speculated that this finding might reveal a distrust of or unfamiliarity with companies or conservation NGOs. This does not necessarily hold true in parts of the world where government corruption and other issues cause landowners to prefer programs administered by NGOs (Hope et al., 2005; Petheram & Campbell, 2010). In Brazil, (De Souza Filho et al., 1999) found that households who had a contract with an NGO were more likely to adopt conservation technologies.

Institutional competence and capacity is key to program success (Kramer & Jenkins, 2009; Lee & Mahanty, 2009). For example, transparency, simple rules, procedural flexibility, information outreach and technical assistance, and effective communication between resource managers, intermediaries and government all encourage participation (Alix-Garcia, Janvry, Sadoulet, & Manuel, 2009; Engel, Wünscher, & Wunder, 2009; Kosoy et al., 2008; Locatelli, Rojas, & Salinas, 2008). Conversely, top-down management and other inappropriate project design or management approaches can negatively affect participation (Fischer & Vasseur, 2002).

Programs with lower ***transaction costs*** are more likely to be successful in attracting participants (Pagiola, Agostini, Gobbi, Haan, & Ibrahim, 2004; Pagiola et al., 2007; 2008; Wunder, 2008).

Transaction costs are generally considered to be one of the biggest barriers limiting participation of poorer households in PES programs (Pagiola et al., 2005; Pagiola et al., 2008; Rios & Pagiola, 2009). NGOs and other organizations often focus on helping to lower transaction costs, thus increasing poor landowner participation (Locatelli et al., 2008).

One of the most obvious program design factors is *compensation amount*. Some empirical studies of conservation-oriented farming practices have found that the most important motives for conservation adoption are “selfish” and financial in nature (Chouinard, Paterson, Wandschneider, & Ohler, 2008). Cary & Wilkinson (1997) found that the best way to increase the use of conservation practices is to make them profitable. There are also a number of PES specific studies showing a positive relationship between the compensation amounts offered and program enrollment or preference (Cooper, 2003; Kramer & Jenkins, 2009). However, most of these studies show that compensation amount is one of multiple significant factors explaining landowner participation decisions in existing or hypothetical programs. For example, (Purvis, Hoehn, Sorenson, & Pierce, 1989) studied farmers’ willingness to participate in a filter strip program using a contingent valuation survey and concluded that farmers’ participation decisions are determined by the yearly payment offered to participants, the related opportunity costs, and farmers' perception of the environmental change. Although compensation amount is the most obvious explanatory factor it is not always the most influential.

Targeting mechanisms such that payments go to lands with higher conservation value, all else equal, can result in a win-win for participants and conservation (Mäntymaa, Juutinen, Mönkkönen, & Svento, 2009). For example, Mexico’s carbon payment program paid more for cloud forest than other types of forest, which proved to be successful in enrolling more land with higher biodiversity value (Kosoy et al., 2008). In China’s Grain-for-Green Program, targeting

resulted in lands with higher environmental benefits participating in the program (Gauvin, Uchida, Rozelle, Xu, & Zhan, 2010). Programs that do not target for conservation value or are unsuccessful in targeting efforts may result in enrolling mostly degraded lands. (Zbinden & Lee, 2005) posited that land quality and slope characteristics may influence the participation decision in all three PSA programs and verified this with findings that the variable measuring perceived degraded area within the farming system was positively related to participation (a 10% increase in degraded area resulted in 51% increase in the probability of participation).

In fact, there are several *land attributes* that are influential. These include soil quality, slope, conservation and ecosystem service value of the land, and the agricultural production value of the land. Land quality and slope characteristics in particular are likely to influence participation decisions about PES programs. Those with highly sloped land are likely to be interested in forest protection or sustainable management because maintaining forest on these lands decreases the threat of landslides and helps to preserve top soil. Also the harvesting costs on sloped land are often high and intensive agriculture may not be financially feasible on lands above a certain grade. It is reasonable to assume that a landowner would first choose to reforest marginal land on his or her parcel (Zbinden & Lee, 2005).

Land opportunity costs play an integral role in PES program participation, as landowners with highly productive land (and therefore greater opportunity costs) are far less likely to participate than landowners with marginal lands (Wunder, 2005). This may not be the case, however, in regions where rich landowners hold secure property rights over large tracks of unproductive lands. For this reason, (Pagiola et al., 2005) suggest that the farming structure (mostly small or

mostly large farms vs. mixed landscape) greatly determines the ability of rural households to participate in PES, jointly with secure land tenure, investment and technical capacities.

A greater the *heterogeneity of land value* results in a greater range of payment levels that are sufficient to encourage landowner participation and thus an increased potential for PES schemes to be cost-effective compared with other approaches (Jack et al., 2008). “By offering a set payment for service provision, individuals who can produce the ecosystem service at or below that price have an incentive to enroll in the program, whereas those providers who have a higher opportunity cost of enrolling do not...Likely sources of individual heterogeneity in the costs of providing ecosystem services include differences in the opportunity costs of land use stemming from biophysical features of the land and its location, as well as individual characteristics of the landholders, such as education, risk aversion, and plot size” (Jack et al., 2008, p. 9467).

There are many types of PES programs and success is largely dependent upon crafting the right PES program for a specific location (Engel et al., 2008; Hope et al., 2005; Pagiola et al., 2005; Pagiola et al., 2008; Zilberman et al., 2008). As illustrated by the information presented above from the systematic literature review on factors influencing the likelihood of landowner participation in PES, there is substantial information (though not always with consistent conclusions) that can be used to guide the design of future PES programs. By building upon what has been learned in similar locations and using the literature and local conditions to guide collection of primary data from the target region, researchers and policy makers are in a position to predict and proactively address issues that are likely to affect landowner participation, thereby increasing the likelihood that a PES program will have intended environmental and social outcomes. Accordingly, this study was motivated by factors identified from this literature review

and extensive discussions with local stakeholders in the focal region in western Panama to explore the design of a future PES program that enables broad landowner participation.

METHODS

We used a community-based participatory research process to engage stakeholders to define the scope of the research, to foster information exchange between stakeholders and organizations, and to develop the survey instrument to provide policy-relevant information for PES design related to landowner participation (Wallerstein & Duran, 2003). Our study uses quantitative and qualitative methods combining mixed-model and mixed method approaches (Johnson & Onwuegbuzie, 2004). The goal of mixing methods in this study is predominately “expansion”, or increasing the breadth and depth of the study (Greene, Caracelli, & Graham, 1989). However, mixed methods also inform the “development” of the study by “using the findings from one method to inform the other” (Johnson & Onwuegbuzie, 2004). In this case, the information collected through the workshop (see Ch. I) informed the development of the research questions and surveys. Corroboration of results is a secondary reason for the mixed methods approach and triangulation of results from different methods of studying the same phenomenon help to make the findings more robust and may help to identify paradoxes and contradictions thus driving further investigation of key issues (Johnson & Onwuegbuzie, 2004).

Study Area

This project focuses on the agricultural buffer zone on the Panamanian Pacific side of the La Amistad Biosphere Reserve and bi-national UNESCO World Heritage Site located in the Talamanca/Chiriquí highlands of Costa Rica and Panama. Located in the northwestern sector of

Panama and the south-central region of Costa Rica, the binational site of La Amistad is one of the region's largest expanses of virgin forest (figure 2.1). In total, La Amistad Biosphere Reserve includes approximately one million hectares (Clark et al., 2006). La Amistad is estimated to harbor almost 4% of the varieties of all the Earth's species (T.Clark et al., 2006). Parque La Amistad (part of the reserve) was designated as a peace park by former president of Costa Rica and Nobel Peace Prize winner Dr. Oscar Arias. By presidential declaration, in both Costa Rica and Panama, the park is dedicated to serving as a working example of peace between neighboring countries and also to fostering sustainable development in buffer zones of the park.

Like most protected areas in Mesoamerica, La Amistad is surrounded by a buffer zone consisting predominately of agricultural landscapes (DeFries, A. J. Hansen, Newton, & M. C. Hansen, 2005; Foley et al., 2005; A. J. Hansen & DeFries, 2007; Harvey et al., 2008). While rich in biodiversity, the area is economically marginalized, and despite the region's remoteness and relatively small human population, many of its biological riches are in jeopardy. This once remote area is now in danger of losing its World Heritage Site designation due to concerns over the degrading impacts of overfishing, unregulated and poorly planned tourism, development, colonization, logging and clearing of land for subsistence farms, unsustainable farming practices (e.g., contamination by agrochemicals), banana plantations, and cattle grazing, and expansion of hydroelectric dams, power plants and roads (The Nature Conservancy, 2007; UNESCO, 2008). In the study region, as with many others, the fate of biodiversity within protected areas is therefore inextricably linked to the broader landscape context, including how the surrounding agricultural matrix is designed and managed (Vandermeer & Perfecto, 2007; Wallace et al., 2005). However, "[t]he region also offers significant opportunities for economic and social

development” (The Nature Conservancy, 2007, p. 22). No PES program are currently in operation in the study region, but PES program development potential has been noted by several researchers and is increasingly discussed by NGOs and government agencies working in the area (Clark et al., 2006; Gentry, Newcomer, Anisfeld, & Fotos, 2007; Oestreicher et al., 2009).

For our interviews with farmers related to landowner participation (described below), we defined our study population as landowners living within the buffer zone of La Amistad in the Panamanian Pacific sector. Although there is no official spatial definition of a buffer zone in Panama, the general agreed upon definition is communities and properties immediately adjacent to the park and where human socio-economic activities are interwoven with the park environment (personal communication Adrian Benedetti- former director of Panamanian national parks, February, 2010). Individuals in the communities involved in this study are both affecting and affected by the protected areas. This project includes the following defined study sites within the general study region: 1) the district of Boquete including the town of Boquete and the surrounding countryside, and 2) the district of Renacimiento including the towns of Cerro Punta, Guadalupe and the surrounding countryside.

The Boquete district, and especially the town of Alto Boquete (referred to commonly as Boquete), until recently was primarily an agricultural region famous for growing flowers and coffee. In recent years, the mild climate, relative accessibility and natural beauty have attracted a large influx of American and Canadian expatriates and retirees. Thus, residential development has increased rapidly with inadequate planning in many cases (The Nature Conservancy, 2007). Land prices in the area have increased with the immigration of foreigners and many

agriculturalists have sold their land to developers (personal communication, Jorge Pitty, Director of FUNDCCEP, May 2009). Farming also continues to be a major economic activity in the region, including an expansion of farming activities in the park due to a recent expansion of the park's boundary.

The Renacimiento district includes the town of Cerro Punta and the small neighboring community of Guadalupe, as well as communities along the road to the Costa Rican border. Farms in this region enjoy the rich volcanic soil under Volcan Baru and produce approximately 80 percent of the vegetables for the entire country of Panama. Despite the region's important position as the breadbasket of Panama, it is economically fragile with fluctuating market prices putting pressure on farmers with already small profit margins (Shah, 2006). Renacimiento primarily relies on industrial agriculture for economic development and "agricultural production is commonly practiced with very intensive agrochemical use, which affects humans and wildlife, as well as water resources" (The Nature Conservancy, 2007, p. 43). The steep slopes in the area have also led to landslides under intensive agricultural production without proper planning. "Analysis suggests that the current agricultural practices are unsustainable and ecologically destructive, due to high dependence on agrochemicals and inefficient irrigation and cultivation on steep slopes." (Shah, 2006, p. 143). The farming techniques used are unsustainable, as a result of the intensification of farming, soils are degraded and nutrients are lost. Without substantial changes, river sedimentation and agrochemical pollution will become major problems (Shah, 2006). In addition to these impacts, encroachment on the park continues as producers claim production land from the Amistad Park. Despite Cerro Punta's position as the main horticultural production center in Panama, the Ministry of Agriculture has very little presence in the area (The

Nature Conservancy, 2007). This district also includes a rural area along the road to Rio Sereno and the Costa Rican border. Many of the farms in this area still produce coffee and are small, locally-owned farms (personal communication, Jorge Pitty, 2009).

Poor agricultural practices throughout Chiriquí province need to be converted to more environmentally sustainable ones, but this transition will “require deliberate policy measures and actions that will make it economically appealing for farmers to adopt sustainable agriculture principles” (Shah, 2006). This study region is an appropriate site to start the process of using sustainable agriculture as a means of supporting conservation in La Amistad buffer zone. For example, “Cerro Punta already has environmentally sensitive civil societies that are prepared to support the message of sustainable agriculture and encourage people to participate and change their farming practices. The prospects for success in the region are high (Shah, 2006, p. 155).

Landowner Surveys

We conducted landowner surveys in the Boquete and Renacimiento districts to gather information about potential participation to inform the design of a PES program targeting lands in the buffer zone of the La Amistad park (Panama). The survey instrument was designed to generate a representative sample of the main farmer and rancher livelihood activities in the study area, which could have external validity for similar rural agricultural landscapes in protected area buffer zones elsewhere. The communities in the Boquete and Renacimiento districts included in this study are directly adjacent to La Amistad with some households even farming within the park’s boundary. The land uses in these communities have important potential to impact the integrity of the park. There is no PES program presently available to these land owners, however

agricultural intensification and other land use changes are underway and are degrading ecosystem services. Furthermore, local leaders have expressed interest in using PES as a new tool to address these concerns. The transboundary dialogue initiated by both Costa Rican and Panamanian community and conservation leaders in the region has the potential to lead to the development of a pilot program in Panama and/or a cross-border regional PES program to operate separately or in tandem with national efforts. Public and nonprofit groups from both sides of the border have made a great deal of progress towards better coordinating management of this region and they are interested in continuing to grow this capacity.

Sampling and Data Collection

We obtained lists of farmers and ranchers in our study region from multiple agencies to obtain as comprehensive a list as possible of the entire population. Surveys of farmers and ranchers are undertaken regularly by Panama's Ministry of Agricultural Development (Ministerio de Desarrollo Agropecuario de Panamá; MIDA). The regional office of MIDA in the city of David provided lists of agriculturalists from which we pulled our most of our sample. The regional office of Chiriquí conducted an *encuesta de café* (coffee survey) in 2005-2006, which focused on coffee planting and harvests for the region and used a similar approach for selecting farmers to survey. The lists available were similar, but not identical for the two districts.

For the Renacimiento district, we were able to access very current lists (a 2007 and 2009 survey) of onion and potato farmers, a list of farms tested for coffee plant disease (2008), and a list of participants in several MIDA farmer assistance programs (2009). Since almost all of the onion and potato farmers also grow coffee and other crops, these lists actually provided a reasonably comprehensive group of farmers. These lists resulted in a total of 910 farmers after removing

duplicates. The total population of Renacimiento is 18,257 (2000 census). In 2009, there were 850 coffee producers in the town of Cerro Punta. They constituted ~12 percent of the total town population of 7,000 people. When this same percentage is used to estimate the total number of coffee farmers for the entire district with a population of ~20,000, then we can estimate that there are approximately 2,400 coffee farmers in the District of Renacimiento. About 38 percent of these farmers were represented in our lists.

For the District of Boquete, we were able to access equally current lists (2007 and 2009) of onion and potato farmers, a survey of coffee producers (2009), and a list of local coffee cooperative members (2009). After removing duplicates, our combined list included 747 farmers. The District of Boquete has a total population of approximately 20,000. Of that population, approximately 5% percent are employed in agriculture, livestock and fisheries. The percent has been on a general downward trajectory over the past decade and is down from 14.6 percent in 1996 with the non-farmer population growing quickly. These numbers include not only farm owners but also day laborers, processors, etc. Our final list of farmers accounted for approximately 75% percent of all those employed in agriculture in the district and most of the farm owners (Plan de Ordenamiento Territorial, 2008).

For both study sites the sample was handled by farm instead of by individual. This means that if a new household had taken over the farm then they were offered the opportunity to contribute to the study. These interviews counted in lieu of the previous resident.

An initial random sample of 250 landowners was selected from the combined list for Renacimiento; of these, 127 participated in the survey, while 29 refused to participate. Ninety-four contacts were not locatable, so a second random sample was taken to replace these missing

individuals and a total of 52 contacts on the second list were not actually living or farming in the region at the time of the survey. This resulted in a final count of 198 landowners contacted with a response rate of 85 percent (169 respondents). An initial sample of 250 farmers was also randomly selected from the combined list for Boquete and of these 74 were not locatable, dead, the farms had been developed, etc. and one refused the survey. Our final count was 176 landowners contacted with a response rate of 99 percent with 175 completed surveys from Boquete.

Out of list of 500 people a total of 374 were successfully located across both regions, we received responses from 344 farmers. Accordingly, the overall response rate for the study was 92 percent. A sample of this size can be used to relatively accurately represent a population of as many as one hundred million people (well above the population of our study area) at a 95 percent confidence level with a +/- 10 percent margin of error or 4,000 people to a 95 percent confidence level with a +/- 5 percent margin of error (Salant & Dillman, 1994). This assumes a conservative 50/50 split approach which is appropriate since little is known about the diversity of opinions that will be represented by this population. The 50/50 split is used to determine the appropriate sample size when a given population is divided half and half on an issue. This the most conservative approach requiring the largest sample size (Salant & Dillman, 1994).

Survey Instrument and Data Collection Procedures

The survey instrument focused primarily on gathering information for an analysis of landowner interest in participating in hypothetical PES scenarios that were representative of major program types currently in operation globally targeting similar types of landscapes (described further below). Supporting information related to demographics, land use, socio-economic status, PES

familiarity, and other pertinent factors was also collected to inform analyses of factors affecting landowners' willingness to participate and potential eligibility conditioned upon hypothetical program design parameters (e.g., minimum area enrollment requirements, program oversight and administration, contract length). The survey instrument is included as Appendix I.

The survey was developed collaboratively by the entire research team, including academic, government, and NGO partners. Extensive input was obtained from the aforementioned May 2009 workshop (see Ch. I), including follow up conversations with key partners. Findings from similar studies in the literature on willingness to participate in hypothetical programs (notably (Kramer & Jenkins, 2009) along with numerous studies on actual PES program participation also helped to inform the development of the survey instrument.

I worked with local research associates to train Panamanian interviewers and to pilot test and modify the survey for maximum success. These local research associates served as “boundary spanning agents” helping to connect the researchers, communities, and policy makers (Reid, et al. 2009). The engagement of local interviewers helped us to avoid issues of potential distrust of external ‘extractive’ research, particularly related to financial issues. Our key local partner in Boquete is the nonprofit Fundación Vida, Salud, Ambiente y Paz (FUNDAVISAP). FUNDAVISAP provides leadership organizing local groups and the local government in order to have an active, participatory, proactive role in the land-use planning process. Fundación para el Desarrollo Integral del Corregimiento de Cerro Punta (FUNDICCEP) also contributed significantly to this effort as the local partner NGO partner in Renacimiento. The organizations

main objective is to promote sustainable development in communities in the buffer zone of La Amistad International Park (PILA). Other project advisors included representatives from:

- Alianza para el Desarrollo Ambiental de las Tierras Altas (ADATA)
- Red Quercus
- Autoridad Nacional del Ambiente (ANAM)
- Sistema Nacional de Áreas de Conservación (SINAC)
- The Nature Conservancy (TNC)

Payment for Ecosystem Services Scenarios

We crafted three PES program scenarios based on workshop discussions and popular program options in neighboring Costa Rica (and also broadly representative of major program options in many other countries). The three scenarios for potential PES payments were (1) forest conservation, (2) reforestation, and (3) agroforestry. Following a general, non-technical description of the PES concept, each of the three PES scenarios was described to the respondent, after which the interviewer asked respondents to answer a series of questions about how much land they would enroll if the program was offered in their community, how they would prefer the program to be structured, and potential eligibility and feasibility barriers. Please refer to the survey instrument in Appendix B for the full text on how each scenario was described to respondents.

Data Analysis

Quantitative data analysis included numerous statistical analyses of both the original quantitative data and the quantitized (originally qualitative) data preformed using PASW-SPSS 18.0

(Predictive Analytics SoftWare - Statistical Package for the Social Sciences). When percentage results are reported from the survey, they are rounded to the nearest whole integer.

Qualitative Data

Qualitative data analysis included coding of the qualitative data. Since the qualitative data collected through this study is highly structured open-end responses from surveys and tightly defined interview questions it was coded without additional segmenting of the content. The codes were applied as a layer on top of the data and the codes can be analyzed quantitatively. The data analysis stage of this project was guided by Onwuegbuzie and Teddlie's (A. J Onwuegbuzie & Teddlie, 2003) seven stage process using exploratory thematic analysis. The seven stages are: 1) data reduction, 2) data display, 3) data transformation, 4) data correlation, 5) data consolidation, 6) data comparison, and 7) data integration. Qualitative data can better provide the researcher with an in-depth understanding of the meaning of the experiences of individuals in a particular setting, while quantitative data suggests trends in a setting.

Differences between Communities

Crosstabulation measuring the linear strength of association between variables was used to analyze relationships between demographic information and along with t-tests was used to identify variations by location and associations between specific populations and location.

Factors Influencing Willingness to Participate

Most studies revealing factors influencing participation in PES programs use some form of regression analysis in order to calculate these explanatory relationships. Many of the 56 studies in the literature review (table 2.1) presented results from regression or logistic regression

analyses. Regression analysis provides information about the predictive potential of the independent variables to explain willingness to participate in various program modalities (Vaske, 2009). Modeling program participation for our dichotomous dependent variables (willingness to participate for the forest conservation, reforestation, and agroforestry scenarios) requires the use of logistic regression, a generalized linear model that extends linear regressions to non-continuous outcomes using logit link functions and a maximum likelihood estimator (Aldrich & Nelson, 1984). Logistic regression analysis of the willingness to participate responses is used to identify demographic, socioeconomic and behavior variables that predict or explain those responses (Champ, Boyle, & Brown, 2003). Zbinden and Lee (2005) used logistic regression to model actual binary participation in Costa Rica's PSA dependent on a set of hypothesized behavioral determinants, as did Kramer and Jenkins (2009) in their investigation of hypothetical PES participation in North Carolina. In this study, a logistic regression model is used to regress respondents' replies to the questions about willingness to enroll for each of the three PES scenarios against a series of explanatory variables to uncover factors, guided by the systematic literature review reported above, that have a significant influence on their willingness to participate. The odds ratio $Ex(B)$ in logistic regression is similar to the unstandardized regression coefficient B in regression, except for instead of explaining the change in the dependent variable for every unit increase the independent variable, $Ex(B)$ is the probability that the outcome occurs to the probability that it does not (Vaske, 2009). For these analyses we used a simultaneous logistic regression model (all variables are included at the same time).

RESULTS

Two sides of the Baru Volcano: General Characteristics of the Study Sample for the Districts of Renacimiento and Boquete

In this section, we present a social and land use overview of the main study region including an examination of key differences in farm and demographic profiles between the two primary study communities.

Summary information on key farm characteristics is reported in table 2.2. Forty-five percent of respondents own small farms with a total of less than 5 hectares. Farm sizes are similar across the two communities. However, we found a significant difference in land tenure responses between the two communities. In Boquete 93% of people have title to their land and Renacimiento 67% of people have title to their land. Approximately one quarter of farmers in Boquete self-reported ownership of steeply sloped agricultural land compared to only 14 percent in Renacimiento. Coffee was reported by most farmers to be their highest income producing land use (54%) and twenty-four percent of the farmers who are planning to change their current land use are planning to increase coffee production on their land. Increasing income was the reason that farmers stated for their land use change decisions in 41 percent of the cases. Still 15 percent did report plans for reforestation and 8 percent were motivated to change their current land use for conservation reasons.

Information about household demographics is summarized in Table 2.3. The majority of respondents (78%) are male and the mean age is 55.62 years (SD = 14.78). Most are second generation farmers in the area with a mean of 49.51 years of local family farming history (SD = 29.46). Ninety-two percent of families have been farming in the area for less than 100 years and

most have a private individual ownership structure for their farm. About 40 percent have at least one household member earning off-farm employment, even so 78 percent still earn the majority or all of their income from farming. The most common income class that was selected by respondents was \$200 – 299 per month; the mean income bracket selected falls almost exactly at the \$500 - \$599 per month range, and the median falls at \$400 - \$499. Incomes in Boquete average slightly higher than in Renacimiento. Almost seven percent (21 respondents) reported incomes of less than \$100 per month, representing a very low-income population in the region.

The most common grade in school completed by respondents was 6th grade; the mean and median fall at the 9th grade mark. On average, farmers in Boquete have obtained a higher level of formal education with ~15 percent more reporting some formal education beyond high school.

A number of questions on the survey related to current and previous participation by landowners in conservation programs (Table 2.4). Sixteen percent reported having land in a private reserve and 11 percent had land enrolled in the Conservation Coffee program (a Conservation International program). When asked about programs which they had participated in the past, but no longer participate in Conservation Coffee was the most common program named. Some respondents also identified themselves as previous participants of the Rainforest Alliance coffee program. The most common reasons they reported for no longer participating were related to issues of insufficient support, high costs, program termination, and program expulsion. Non-participants (64% of respondents) reported lack of access to programs, lack of invitation, and unfamiliarity as the most common reasons for never participating in a program. Respondents in Boquete are 13 percent more likely than in Renacimiento to have enrolled their land in a conservation program.

The number of conservation and agricultural assistance organizations worked with is used in this study as a proxy for the level of the landowner's engagement in conservation. Approximately (42%) of respondents said they had worked with at least one of the farmer/rancher organizations or agencies in the region. Twenty-nine percent reported working with one of the organizations, and only 13 percent reported working with more than one. The most common agency which respondents had worked with was Ministerio de Desarrollo Agropecuario de Panamá - MIDA (32%) followed Autoridad Nacional del Ambiente –ANAM (10%) and the titling organization PRONAT (8.5%).

Payment for Ecosystem Services Scenarios

Respondents were asked to rate their level of knowledge/awareness of the PES concept on a scale of 1-5. The mean response was 1.57, between “no knowledge” and “little knowledge” and only 4 people (or 1.2% reported a high level of familiarity with PES. Of the 34 percent who reported “slightly familiar” or higher largest group (25%) had heard about PES from a friend or acquaintance. Local organizations, Costa Rica program, publications, and television were all reported by over 10 percent of respondents as sources.

Forest Conservation Scenario

Approximately 53 percent of respondents across both communities were willing to participate in the hypothetical forest conservation program if the payment was sufficient and opted for 15 years (SD = 27.13) as the maximum number of years for which they would be willing to sign an initial contract (Table 2.5). Farmers in Boquete were willing to enroll an average of 28.54 hectares (SD = 98.12); this is almost two times as much land as farmers in Renacimiento were willing to

enroll (14.56 hectares, SD = 55.54). These means are reported in the table for consistency, since means are used to measure difference by location in the *t*-test. However, the means are skewed by a few households willing to enroll very large amounts of land. The median amount of land that landowners are willing to enroll overall is 3.00 hectares.

When asked to identify the type of organizations they would prefer to work with as the administrator of the program (charged with helping farmers to register their land, distributing payments to participants, and monitoring the program), the greatest proportion of respondents across both districts (43%) stated having no preference followed closely by non-governmental organizations being preferred by 39 percent of respondents. None of the remaining options were very popular. Private company oversight was preferred by 13 percent and local or federal government oversight was selected by four percent and less than one percent respectively.

Reforestation Scenario

Fewer respondents overall are willing to participate in the hypothetical reforestation program (42%), if the payment is sufficient, and they opted for slightly fewer years for which they would be willing to sign an initial contract (table 2.6). Farmers in Renacimiento are significantly more willing to participate in the reforestation program than those in Boquete, but for fewer years. As seen with the forest conservation scenario, interested farmers in Boquete were willing to enroll more land in the reforestation scenario, with a mean of 26.91 hectares (SD = 108.62); this is three times as much land as farmers in Renacimiento were willing to enroll (mean of 9 hectares, SD = 30.58). Once again, the means are skewed by a few farmers interested in enrolling large land areas especially in Boquete. The median number of hectares respondents across both sectors

were willing to enroll was 2.5 hectares. After “no preference”, non-governmental organizations were again selected as the preferred management option (36%). Votes for private company, and government oversight were low and similar in quantity to those for the forest conservation scenario.

Agroforestry Scenario

The hypothetical agroforestry program was the most popular program option with 78 percent of the overall study population willing to participate if the payment was sufficient (table 2.7). The average preferred contract length approximately was 10 years (SD = 1.50). Consistent with findings for the other two programs, farmers in Boquete were willing to enroll on average more land (26.42 hectares, SD = 100.77) than those in Renacimiento (7 hectares, SD = 9.61). The median reported enrollment was 3.00 hectares across both regions. Non-governmental organizations were selected as the preferred management option (49%). Votes for a private company or government agency were at 12 percent or below.

Program Ranking

After considering each program scenario individually, respondents were asked to compare and rank the programs. The agroforestry program received the most votes for first choice program (57%) followed by forest conservation (42%) and reforestation (10%). This reinforces willingness to participate counts in the same rank order of 78 percent for agroforestry, 53 percent for forest conservation, and 42 percent for reforestation.

Logistic regression analysis to determine factors contributing to stated willingness to participate

Tables 2.8 – 2.17 present the results from a series of logistic regressions with unstandardized logistic coefficients and odds ratios. Logistic regression analysis of the willingness to participate responses is used to identify demographic, socioeconomic and behavior variables that predict or explain those responses. “The goal [of logistic regression] is to identify a set of independent variables (i.e., a model) that predicts or explains group membership on the dependent variable” (Vaske, 2009, p. 457). The dependent variable in our logistic regression models is willingness to participate in the PES scenario. Logistic regression extends linear regression to non-continuous outcomes. Guided by the literature we combined independent continuous variables (income, farm income, age, education, etc.), and added in binary dummy variables - farm size and program participation. This recoding is necessary because categorical variables cannot be included in logistic regression. Therefore, the categorical responses are broken down into sets of dichotomous variables representing the same information (i.e. does the land owner have a small farm or a large farm and does the farmer have a small farm or a medium farm). This allows analysis of the relative importance of these variables in regression models.

When interpreting logistic regression analyses, the odds ratio is represented by $Ex(B)$ in SPSS software. The odds ratio in logistic regression is similar to the unstandardized regression coefficient B in regression analysis. The difference is that in regression analysis B explains the change in the dependent variable for every unit increase in the dependent variable, while in logistic regression $Ex(B)$ is the probability that the outcome occurs to the probability that it does not. A significant odds ratio with a value below one indicates that the independent variable reduces the odds of the respondent being willing to participate, conversely, an odds ratio greater

than one indicates an increase in the odds. Subtracting one from the odds ratio and multiplying the result by 100 gives the percent change in the odds of being willing to participate. For example, the odds ratio for total income (which had a value of 1.11 in the forest conservation model) indicates that every unit increase in this variable (e.g., moving up one income bracket) is associated with an 11% increase in the odds of being willing to enroll in the forest conservation program.

Logistic regression models are used in this study to regress respondents' replies to the questions about willingness to enroll for each of the three PES scenarios against a series of explanatory variables to uncover factors, guided by the systemic literature review reported above, that have a significant influence on their willingness to participate.

Forest conservation scenario

Several variables were found to be statistically significant predictors ($p < 0.05$) of a respondents stated willingness to enroll in a PES program for the forest conservation scenario; these included farm size, participation in other programs, age, and total income (table 2.10). These relationships are described in details below. Other non-significant socio-economic and past behavioral predictors are useful to help identify potential participants, but they only make a small contribution to the prediction. The most influential variable in the forest conservation model (Farm Size difference between Small – Large), represents the impact of the increase from small (less than 5 ha) to large (greater than 30 ha) landholdings on the odds of being willing to enroll in the forest conservation program. Households with large farms are significantly more likely to enroll in the program. In fact, the relationship between participation in the forest conservation

program and the variable Farm Size difference between Small – Large is significant at $p < .001$ with an effect size between typical and substantial ($\phi = .45$). Participation in other programs represents land enrollment in government or NGO agricultural improvement program and these farmers are, not surprisingly more likely to express interest in enrolling in a forest conservation PES program. Participation in other programs is divided into low participation (enrollment of <10 hectares) and high participation (enrollment of >10 hectares) and both serve as significant predictors of willingness to participate in forest conservation PES. An increase in income also increases the likelihood of a household's willingness to participate. The model also found that younger farmers are more likely to be interested in participating in the forest conservation PES program.

The “willingness to participate” question for the forest conservation scenario is influenced by the fact that each landowner must by definition have existing forest on their land in order to be able to participate. As represented in table 2.8, the overall model was predictive for the forest conservation program with a chi-square of 92.05 significant at $p < .001$. This means that the null hypothesis that all the coefficients in the model are zero is rejected because the chi-squared associated with the difference between the – 2LL models (constant /model) is significant. Nagelkerke R^2 approximates the variance which can be predicted as 0.35 The model successfully classifies 75% of participants' willingness to participate in this program with a relatively equal predictive success rate across both participants and non-participants (table 2.9).

Reforestation scenario

As represented in table 2.11 the overall model for the Reforestation scenario has a chi-square of 40.31 significant at $p < .001$. The predictive power (Nagelkerke R^2) is .17. The model correctly

predicts 66 percent of respondents' willingness to participate in this program (see Table 2.12). However, the model is more successful at predicting who will not participate (79%) than it is at predicting who will participate (52%). Farm size, tenure, and amount of land enrolled in other programs are all significant predictors of willingness to participate in the reforestation program at the $p < 0.05$ level or better (see Table 2.13). Those with a medium or a large farm are more likely to be willing to participate in the reforestation PES program than those with small farms. Participation in other agricultural improvement programs significantly predicts participation. Also, those without secure land tenure are significantly more likely to be interested in the program.

Agroforestry scenario

As represented in table 2.14, the overall model for the agroforestry scenario has a chi-square of 16.62 and does not significantly explain variance in willingness to participate in the program ($p = .083$). The predictive power (Nagelkerke R^2) is only .085. Overall, the model correctly predicts 80 percent of participants' willingness to participate in this program (table 2.15). However, the model is only successful at predicting those who will participate (100 %) and did not correctly predict any of the non-participants. The only significant explanatory variable in this model is the number of conservation organizations that the landowner has worked with – those who have worked with more conservation organizations are more likely to be inserted in agroforestry PES (table 2.16).

Combined results from logistic regression analysis

Overall, eight out of the 10 variables were significant predictors of willingness to participate in at least one of the programs. Figure 2.2 provides a summary of the logistic regression analyses for

willingness to participate in the three scenario options. For the forest conservation scenario, farm size explains the most variability, followed by participation in other conservation programs. Willingness to participate in the reforestation scenario is explained predominately by participation in other conservation programs and land tenure, with tenure having a negative relationship with participation as described above. The only significant variable explaining participation in the agroforestry scenario is the number of organizations with which the farmer has worked. The forest conservation scenario model includes six significant variables and the forest conservation scenario model includes five. Age and total income are only significant predicting willingness to participate in forest conservation. Age has a negative effect on willingness to participate, meaning that younger farmers and ranchers were more likely to express willingness to participate. Those with higher income are more likely to express willingness to participate. Tenure is only significant in the reforestation model; those with less secure land tenure expressed a greater willingness to participate.

DISCUSSION

Our survey of agricultural landowners in the districts of Boquete and Renacimiento in western Panama was designed to gather information about potential interest in and preferred design parameters for a PES program that could deliver conservation and livelihood benefits. As noted earlier, no PES program is currently in operation in this region (with the exception of potential participation in international carbon markets), placing this region in a similar position to many across the world where PES is being explored as a new market-based approach to conservation (Daily et al., 2009). How these programs are designed will directly impact the degree to which a broad spectrum of landowners are or are not able to receive PES contracts, and therefore whether they are in a position to benefit from a new program. Appropriate design requires combining

detailed site-specific information with lessons learned from experience to-date with existing PES programs. Within the context of lessons learned we interpret the results of our survey, to provide insights for future development of a successful PES program in western Panama and to inform PES development more broadly.

The first issue that must be addressed, and which could potentially be overlooked, is whether landowners express interest in PES and see such a program, albeit hypothetical at the design stage, as worthwhile to participate in. Landowner response to the PES concept was overwhelmingly positive. Landowner response to the general behavioral intentions to enroll in a given scenario can serve to help predict potential reactions to actual programs. Over half of respondents stated willingness to participate in a forest conservation scenario. This dropped to about 40 percent for the reforestation scenario and swelled to almost 80 percent for the agroforestry scenario. Interest was fairly consistent across both communities surveyed. Interestingly, landowner familiarity with the PES concept was low with an average response of 1.57 on a 5 point likert scale (between “no knowledge” and “little knowledge”). Therefore we surmise that most respondents are basing their interest in the concept on their own sense of its worth and practicality rather than from what they have heard from their neighbors in Costa Rica, read online, or seen on television.

Given that landowners across both communities in our survey expressed interest in developing a PES program, the next key issue is to explore what type of program would be likely to garner the greatest interest. It is logical that agroforestry is ranked as the most preferred scenario, given that it fits in best with respondents current agricultural operations. Probably due to the lack of

upfront costs, forest conservation is the second most popular program. Reforestation requires the greatest change to current operations and a relatively high upfront investment and it is the least preferred program option, but 42 percent of respondents were interested in even this least popular scenario.

The basic concept of PES is for users (beneficiaries) of ecosystem services to pay landowners for the ecosystem services supplied by their land (Pagiola et al., 2005). However, in reality, intermediaries often make these transactions possible through government programs, non-profit organizations, private brokers or other institutions that link buyers and sellers, help to set prices, and provide information and security to the individuals involved in the transaction. Across two of the scenarios, “no preference” was the most common response, with the stated preference to work with an NGO a close second or first choice in the case of agroforestry. This is not surprising given the lack of government involvement in the area and the strong positive contributions of several local and some international NGOs (Shah, 2006; The Nature Conservancy, 2007). (Pagiola et al., 2005) emphasize the important role that local organizations community groups or NGOs play in successful pro-poor PES programs.

In addition to choosing a general focus for the PES program, designers are faced with a set of decisions that will directly affect the degree to which individual landowners are eligible, and indeed find it attractive, to participate in the program. Such factors were highlighted earlier in this chapter through the systematic literature review, and how eligibility requirements (e.g., minimum acreage) and other design parameters are set can be a powerful bottleneck affecting landowner involvement (e.g., Pagiola, Rios, & Arcenas, 2007; Wunder, 2008).

The vast majority (82%) of farms in this study region are 30 hectares or smaller, and of these, 45 percent are less than 5 hectares in size. Therefore, if a program were to set a minimum size requirement, and where this number is set, could have a major impact in allowing or making ineligible a substantial fraction of landowners. For example, Costa Rica's PSA effectively set a minimum acreage requirement of 10 hectares, which led to a great deal of criticism of the program (Hope et al., 2005; Miranda et al., 2003). Given that almost half of landowners in our study region own 5 hectares or less, ensuring that PES designers are aware of the number of small farms in the area will be important to evaluating the tradeoffs (ecological, economic, and social) in setting a minimum eligible hectareage.

If PES program developers in Panama decided to use the program to address unsustainable clearing of steep slopes for agriculture, than the number of potentially eligible participants would drop off significantly since only 20 percent report owning steeply-sloped land (however, the definition of "steep" was subjective in this survey).

Our logistic regression analysis showed that those with less secure land tenure are significantly more likely to be willing to participate in a reforestation PES program. The same relationship was evident, but not statistically significant for the other two scenarios. Perhaps this is because the respondents see program enrollment as a possible means for establishing secure tenure. It is important to keep in mind that this study explores potential for enrollment in hypothetical PES scenarios without set eligibility requirements. Studies of actual participation in existing programs typically show that those with secure land title are more likely to participate. Tenure eligibility

requirements are the likely reason for this discrepancy. That said, due to the successful efforts of PRONAT (a land-titling project funded by the Global Environmental Facility and World Bank), land tenure is relatively secure in our study region with 80 percent overall possessing title to their land. In 2003, PRONAT began a project of systematic property registration in five districts (including the two districts where we conducted surveys) in the province of Chiriquí. This is the first step towards registration throughout the country. The project formed part of a World Bank financed program consisting of different components that together were a prerequisite for future land reforms in Panama. Currently, insecure land tenure is considered to be an impediment to PES in most of rest of the country since PRONAT has only addressed this issue in select regions (Connelly & Shapiro, 2006). Property rights in Panama are relatively weak, and this affects farmers' investment decisions (Shah, 2006). The uncertainty in land ownership is a disincentive to investments in sustainable agricultural and other practices delivering longer-term benefits. Participation in the PRONAT project is one of the reasons that this study site was selected.

Farmers interested in PES program enrollment from the district of Renacimeinto would be more impacted by land title PES eligibility requirements since the land tenure variable varies significantly by location with farmers in Renacimineto 26 percent less likely to possess a legal title for their land. They would also potentially benefit less from a program focused on steep slope protection since 12 percent fewer reported steep slope land holdings.

Significant differences between Boquete and Renacimiento exist for all of the socio-economic characteristics reported in table 2.3. Household heads in Boquete were more likely to be female, older, more educated, and have a higher income than those in Renacimiento. Several of these

variables may contribute to differences in willingness to enroll in a PES program and preferences about the way that a program is implemented. Although there are many similarities between these communities they are different enough to offer some insights into program preferences and overall interest across a varied landscape and these differences mean that it is likely that there will be differences in eligibility and participation, and therefore benefits delivered to each community. Understanding the heterogeneity both within and across communities is key to effective PES program design.

This study also revealed an association between location and conservation engagement. Residents of Boquete may have had more access to conservation programs and support organizations over the years due to its less remote location and the large influx of new residents from all over the Panama, the United States, Canada, and elsewhere. Overall, the level of engagement is probably skewed for both communities due to the sampling procedure which selected names from lists of MIDA program participants, member of coffee growing cooperatives, etc. Farmers in Panama are not required to register their farm in any way, so there is no comprehensive list of farmers.

We close this second chapter with an exploration of the role of landowner socio-economic and past behavior characteristics in predicting stated willingness to participate in PES scenarios. The aim of this empirical analysis was to find out the extent to which a set of variables account for the variability in willingness to participate. The same group of 10 predictor variables was used for all three dependent variables (scenarios). It is suggested in the literature that demographics are not the best predictors of attitudes and behaviors (Ajzen & Fishbein, 1980; Dietz, Stern, &

Guagnano, 1998). Therefore, it is not surprising that they were less significant predictors of intention to enroll across the three programs. The best predictors of future behavior are often past behaviors (Eagly & Chaiken, 1993). Past program participation explained the most variation for both the forest conservation and the reforestation scenarios. Other significant explanatory variables such as farm size and tenure would most likely increase in predictive power for actual program participation due to eligibility requirements and payment amounts based on number of hectares enrolled. It is also important to keep in mind that when the sample population is too homogeneous on a factor (i.e. there is not a lot of variability) then not a lot variance can be explained by the factor. This may be true for tenure in this study since 81 percent have title to their land, even though evidence from the literature about existing programs suggests that this is an important factor (Miranda et al., 2003; Zbinden & Lee, 2005).

Overall the analyses of factors influencing stated willingness to participate in the three program modalities provided some useful insights into individual decision making drivers. The logistic regression model for the agroforestry scenario was less successful than the other two models due to a limitation of the model. This model exhibited a lack of variance of the dependent variable due to the very high willingness to participate in the scenario.

CONCLUSION

The information collected through our survey provides information to leaders in our study region of western Panama about the potential feasibility of a PES program from the perspectives of landowners, who would act as sellers of ecosystem services. This information could help to

guide program design decisions. While our specific results are particular to our study region, our approach and the ways in which our results support and contradict existing findings in the literature from PES programs currently in operation contributes to a broader knowledge about the barriers and opportunities presented by PES. Notably this research provides insights regarding the difference between those interested in participating in hypothetical PES program options in Panama and those actually participating in PES programs in other countries. Specifically our results show that farmers with less secure land title are interested in participating. Our results corroborate findings which show that wealthier land owners with more land are more likely to be willing to participate and that conservation engagement and experience with other agriculture programs are significant predictors of interest in PES participation. By proactively investigating these issues, we can help ensure that PES programs are designed to increase the likelihood of broad landowner eligibility and delivering positive livelihood benefits to participating landowners.

CHAPTER III
EVALUATING THE POTENTIAL FOR A PRO-POOR PAYMENT FOR ECOSYSTEM
SERVICES PROGRAM IN LA AMISTAD BUFFER ZONE, PANAMA

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INTRODUCTION

As payment for ecosystem services (PES) programs in developing countries have increased, so have concerns about the impacts on and potential for participation by low income households (Pagiola et al., 2007). An estimated 800 million people do not have access to sufficient food worldwide, of these “half are smallholder farmers, a fifth are rural landless, and a tenth are principally dependent on rangelands, forests, and fisheries” (Galizzi & Herklotz, 2008). Poverty and hunger reduction for these people depends on their ability to sustain and increase production of crops, livestock, and forest goods, and harvest from fisheries. PES programs are increasingly defining social policy objectives, in addition to environmental objectives, that seek to use PES as a tool for poverty alleviation, rural development and livelihood improvement. These approaches, however, are frequently unsuccessful at involving the poorest landowners (Corbera, Katrina Brown, & Adger, 2007; Rosa, Kandel, & Dimas, 2003). This is perhaps not surprising given that the PES approach was created first and foremost as a method to improve natural resource management, and not as an instrument for poverty reduction (Engel et al., 2008; Pagiola et al., 2005). However, some researchers and other advocates maintain that there is a potential for PES to also help alleviate poverty (Landell-Mills & Porras, 2002; Pagiola et al., 2005).

LITERATURE REVIEW

Payment for Ecosystem Services Programs and Poverty

Across a variety of programs and locations there is a positive income gain from PES in Latin America, but there’s a lot of variability around this general trend. The average estimated median income gains for projects in the region range from 1% to 17% (Grieg-Gran et al., 2005). For example, evidence to date has been mixed regarding the impact on the poor for Costa Rica’s PES

program (referred to in Spanish as the *pagos por servicios ambientales*, or PSA), one of the largest and longest operating PES programs. In some situations, PES has been found to contribute significantly to participants' household income (Wunder, 2008). A survey of PSA participants in Costa Rica found that across income levels in one quarter of households the return from PES accounted for over 10% of household income; this can be a significant gain especially for very low-income participants and given the frequent thin margins of profitability for small landowners (Malavasi, Mora, & Carvajal, 2003). At the same time, however, this means that for the remaining three-quarters of households, PES payments accounted for 10% or less of family income. Other studies in Costa Rica have indicated greater returns such as a study in the relatively wealthy Virilla watershed which found that PES payments on average contributed approximately 16% of family income (Miranda et al., 2003). However, several studies (Miranda et al., 2003; Malavasi et al., 2003; Zbinden & Lee, 2005) have found that in mixed income communities, the majority of program benefits go to large land holders and relatively better-off farmers and that overall the middle class benefited the most from PES schemes (Kosoy et al., 2008; Kosoy, Martinez-Tuna, Muradian, & Martinez-Alier, 2007; Locatelli et al., 2008; Pagiola et al., 2007). These results appear to be due in part to high upfront investment costs and program eligibility and selection criteria that create barriers to participation by poorer households (Pagiola et al., 2007).

On the other hand, Munoz (2004) did a study in an impoverished region of the Osa Peninsula in Costa Rica and found that the PSA program plays an important role in the livelihood of low-income land holders. The program lifted half of the participants in this study above the poverty line and became the primary household cash income source in 44 percent of cases (Muñoz,

2004). Other studies in similarly impoverished regions of Ecuador, Bolivia and Costa Rica (Echavarria, Vogel, Alban, & Meneses, 2004; Grieg-Gran et al., 2005; Wunder, 2008) also showed significant income returns for poor land users resulting from PES. The greatest return of 30 percent of household income was documented for a PES project in Pimampiro, Ecuador, where PES compensation was used to cover healthcare, education, and food expenses, thus helping to improve living conditions (Echavarria et al., 2004).

Reasons for concern about the potential adverse effects of market-based conservation mechanisms on rural livelihoods are both moral and practical (Grieg-Gran et al., 2005; Landell-Mills & Porras, 2002; Rosa et al., 2003; Smith & Scherr, 2002). Currently, all major public nationwide PES programs in developing countries (Costa Rica, China, Mexico, South Africa, and Vietnam) have mechanisms in place specifically to target the poor (Wunder, 2008).

According to Pagiola et al. (2005), a pro-poor PES program is one that maximizes its potential positive impact and minimizes its potential negative impact on the poor by 1) keeping transaction costs low, 2) providing targeted assistance to encourage participation, 3) avoiding implementation of programs in areas with conflicts over land tenure, and 4) ensuring the social context is well understood. These factors can have important effects on household participation in PES. If PES programs do not have eligibility guidelines designed with the poorest households in mind, then payments to those who are eligible might actually increase barriers to participation and further exacerbate social inequalities (Rosa, Kandel, & Dimas, 2005).

Many factors have been shown to affect a given household's ability to participate in PES, such as farm characteristics (e.g. amount and type of land), amount of available household labor, payment levels, and land tenure (Pagiola et al., 2007). PES often require landowners to enroll a

minimum number of hectares, have title to their land, and to adopt new land practices (e.g., reforestation) which can prove prohibitively costly to poorer households, thus creating eligibility barriers (Corbera et al., 2007; Pagiola et al., 2007). Property rights have been shown in some case studies to strongly mediate access to PES (Corbera et al., 2007; Rosa et al., 2003). Other PES eligibility barriers are due to poor and less educated households being unable to understand the program guidelines or fill out the required paperwork (Locatelli et al., 2008; Pagiola et al., 2007).

PES Program Design and Poverty: The Costa Rican Example

FONAFIFO, the public agency overseeing Costa Rica's PSA program, recently introduced program modifications designed to increase the potential for positive effects on rural poverty alleviation. Carlos Manuel Rodríguez, the Minister of the Environment who engineered the most recent changes in FONAFIFO, said that "...we need to stop viewing the PSA program as merely a tool for preserving biodiversity and promoting the planting of forests. Instead, we need to see it as a tool for rural development that also includes reforestation and biodiversity conservation." (Hartshorn, Ferraro, & Spergel, 2005). This perspective could be seen as signifying a return to the original project goals, since the 1996 Costa Rican Forestry Law (No.7575) which officially authorized the PSA program specifically identifies income and employment in rural areas as goals of the program and prioritizes support and outreach for small and medium farms (Hope et al., 2005; Miranda et al., 2003).

Recent modifications to make the Costa Rican PSA program more accessible to low-income landowners have included the introduction of agroforestry and silvopastoral activities as a new program option, removing land title as a requirement for landowner participation in the forest

conservation program, and the prioritization of counties having a social development index lower than 40 percent (Wünscher, Engel, & Wunder, 2006, 2008). Including agroforestry and silvopastoral payment schemes can make programs more pro-poor by allowing for diversified income in a continued agricultural land use context, while requiring formal land title in order to participate is probably the most common anti-poor selection bias. It was in response to increasing concern about this tenure bias that Costa Rica recently reformed its program to no longer require land titles for participation (Wunder, 2008). However, applicants must have a cadastral plan that indicates the boundaries and size of their holdings, and many poor farmers lack such plans (Hartshorn et al., 2005).

A remaining issue for the PSA program is that the land area requirement reforms are not entirely transparent. Costa Rica's PSA states that parcels of land from one hectare up to a maximum of 300 ha may qualify for PES payments; however, in practice, FONAFIFO adopts a qualification threshold of 10 hectares, to be consistent with the minimum legal area of a "forest" as defined by the Costa Rican forestry law (Hope et al., 2005). This effectively excludes small farmers, and in the past, FONAFIFO has tended to allocate grants to large and medium landholders (Hayward, 2005; Hope et al., 2005; Solis, 2001). Also, for all of the PSA program options, properties may practically need to be approximately 10 ha or larger to make it financially viable to incur the transaction costs. This is because total payments are calculated on the basis of land area protected, whereas the transaction costs of enrollment are similar for both large and small land parcels (Pagiola et al. 2005). One solution is for small farm transactions to be subsidized. However this is not always a popular option since perceived ecological benefits associated with

conserving large tracts may also increase program administrator bias toward focusing on contracts for more sizable land parcels (Zbinden & Lee 2005).

FONAFIFO has attempted to address some of these issues by allowing *contratos globales* (a system of collective contracting). Using this system, a group of small farmers can join the PSA program collectively rather than individually, thus spreading transaction costs across the group (FONAFIFO, 2000). While a great idea in concept, this approach ran into problems in practice when noncompliance by a single group member resulted in payments being halted to all members. The approach has since been revised to process the applications of such groups together, but then issue individual contracts. This avoids the partial compliance issue, but also results in much smaller savings in transaction costs. FONAFIFO recently increased PSA reforestation payment rates and extended the payment period from 5 to 10 years (FONAFIFO, 2008). Accordingly, these changes may help to attract smaller and more farm-dependent landowners.

In addition to insecure land tenure and small landholdings, landlessness and the poor ecosystem service potential of land owned by the poor can leave out billions of poor people (Wunder, 2008). Furthermore, “[i]f PES promoted land uses reduce demand for labor, those who depend on such employment for their livelihood could be adversely affected (Pagiola et al., 2005).

However, for those low-income households who are able to participate, PES offers a new source of more stable income in frequently cash-poor areas with few opportunities for income (Wunder, 2006).

Other Pro-poor PES Concerns and Opportunities

Wunder (2008) identifies key impacts of PES schemes on poor participants, including important non-income effects. The most commonly recognized non-income benefits resulting from these projects are strengthened tenure security, increased human and social capital, and a healthier and more productive natural environment. Collective action often increases low-income farmers' access to PES programs and many successful pro-poor PES programs have involved cooperative agreements among many small landholders in order to reduce transaction fees. As Wunder (2008) explains, some benefits that the poor enjoy as a result of PES programs are intended, while others are incidental results of addressing other environmental goals. For example, payments to improve water quality for an urban area may also improve the fisheries that local people depend on. Drawing upon observations from three continents, Wunder proposes that often poor service providers can both participate in and benefit from PES schemes. However, he also emphasizes the importance of considering effects on both poor service users and non-participants. Angelsen & Wunder (2003) make the important distinction between poverty reduction - lifting people out of poverty - and poverty prevention - providing safety nets and otherwise keeping people from falling into or deeper into poverty. Wunder (2008) also makes an equally important distinction between conservation and restoration schemes, pointing out that the difference between when "PES is for doing something or for *not* doing something has likely implications for local economic activity, employment, and thus also for poverty."

Even though sustainable livelihoods make a contribution to conservation and ecological integrity, scholars raise caution about considering a PES program primarily as a poverty reduction tool. In fact, "[t]here is no reason to believe that PES could, at the one extreme, risk

becoming a poverty trap nor, at the other, a massive contribution to the poverty-alleviation Millennium Development Goals” (Wunder, 2008). Accordingly, Wunder (2008) argues that the primary criteria for participant selection must be the capacity to provide targeted ecosystem services. A program will only be sustainable if the buyers are satisfied with the quantity and quality of the service that they are paying to receive. Wunder (2008) also argues that “less emphasis be given to direct PES poverty targeting, and more to increasing the scale of well-functioning PES schemes, which likely has more important welfare implications.”

PURPOSE

The review of the literature highlights the multiple factors that must be taken into account when considering how to develop a PES program that has positive impacts on poor households. When designing a PES program, (Pagiola et al., 2005) argue that “...the most important step is to design the payment mechanism so as not to exclude poor land users. This requires keeping the transaction costs as low as possible, and being creative in response to problems such as insecure tenure or lack of titles. This will be easier to do when there are strong local organizations such as community groups or NGOs that can help organize participants and provide a forum for discussing solutions to problems as they arise.” This part of our study investigates the key issue of how to avoid excluding low-income participants at the initial design stage of a PES program.

This chapter focuses on program design factors that are integral to successful pro-poor PES due to their influence on participation. First, we develop a site-specific socioeconomic status index based upon the literature to capture a more nuanced understanding of the socioeconomic landscape. Second, we apply and test the reliability of this index using the survey data from western Panama. Third, we interpret the implications of the results for pro-poor program design

through a structured eligibility analysis considering program design elements that could be important bottlenecks restricting landowner participation (see systematic literature review in Ch. 2). There are certainly other issues that will be necessary to explore in order to determine the feasibility of PES and to identify the best program design for the region, such as ecological targeting, payment amounts, and identifying buyers. Even so, this research contributes to a key piece of the puzzle: how to proactively explore ways to ensure that landowners across the socioeconomic spectrum (including particularly the poor) are able to participate. Understanding trade-offs is important for program success regardless of whether or not a future program has explicit rural development or poverty alleviation goals. However, given the growing prevalence of social policy goals in PES programs in the developing world (Wunder 2008), it is unlikely that a PES program would be offered in Panama without these goals; it is also unlikely that a program could be successful in this region without addressing local livelihood concerns.

PREVIOUS RESEARCH

Factors which influence PES Participation

In a meta-analysis of landowner participation studies for existing and hypothetical PES programs, this author reviewed 56 studies (see Ch. II, table 2.1) and found that program design factors, landscape characteristics, and individual household factors play important roles in determining landowner participation choices across a variety of socioeconomic, political, and ecological landscapes. Based upon a logistic regression analysis from the survey data reported in chapter II for our study region of western Panama, we found that multiple factors had a significant explanatory effect on willingness to enroll in the three hypothetical PES scenarios including farm size, participation in other conservation programs, land tenure, the number of

conservation organizations with which the farmer has worked, age, and total income. Larger farms, higher incomes, and more experience working with conservation organizations and or other agricultural programs are all significant predictors for interest in participating in one or more of the PES scenarios. For the forest conservation scenario age has a negative effect on willingness to participate, meaning that younger farmers and ranchers were more likely to express willingness to participate. Less secure tenure increases willingness to participate significantly for the reforestation model. Several of these factors (farm size, land tenure, total income) are related to a household's socioeconomic status and would likely be related to future PES program eligibility requirements. These are important issues to consider if a program is meant to be accessible to poor households. However, first it is important to clearly define what is meant by socioeconomic status.

Who are we talking about when we talk about 'the poor'? How best to measure socioeconomic status

Particularly in developing countries, traditional one-dimensional measures of socioeconomic well-being (e.g., income, age, profession or education) are generally found to be inadequate for capturing a household's true livelihood or well-being condition (Wagle, 2008). Several studies have responded to this issue of inadequate representation by creating composite indicators of social and economic status or well-being that take other factors into account (Cooke, 2005).

“These indicators attempt to combine several important dimensions of well-being or quality of life into a single measure, which can then be compared between populations and across time” (Cooke, 2005, p. 1). Indicators such as socio-economic status (SES) indices are used to assess current conditions of a system, compare situations, and monitor changes occurring over time (Sayer et al., 2007). These indicators are diverse due to their development and application in a

variety of contexts. Part of the variability of well-being dimensions included in such indices is due to which types of data are available for a particular region and project, as well as their potential comparability (Cooke, 2005). Composite indicators may have anywhere from four to over eighty indicators, which demonstrates the diversity between composite indicators (Cooke, 2005). While no one indicator can comprehensively address all components of well-being or socioeconomic status, combined indicators can demonstrate the validity of the composite index overall, and prove a useful tool for analyzing other factors. Variables used in a variety of SES-oriented composite indices are listed in table 3.1.

Livelihood Issues in Western Panama

Social inequality is pervasive in Panama where privileged families of European descent control most of the wealth and power, and approximately 40 percent of the population lives in poverty (BBC, 2009). The Critical Ecosystem Partnership Fund (CEPF) - a global partnership program that provides strategic assistance to nongovernmental and private sector partners in conserving Earth's biodiversity hotspots - published a review focused on poverty reduction for its Southern Mesoamerica portfolio and reported that "socioeconomic data indicate a low standard of living" in the Osa-Talamanca-Bocas del Toro conservation corridor. In the same report, researchers compared households within the corridor to national averages for the following poverty indicators: cook with charcoal/wood, female-headed household, lack of electricity, lack of access to potable water, and lack of interior plumbing. Households within the corridor in Panama were worse off for all five indicators, with 55 percent cooking with charcoal/wood, 18 percent with female-headed household, 62 percent with lack of electricity, 38 percent with lack of access to potable water, and 35 percent with lack of interior plumbing (CEPF, 2005). This Osa-Talamanca-Bocas del Toro conservation corridor encompasses the Talamanca Highlands of both

Costa Rica and Panama and includes the study area for this research project. However, the highest concentration of poverty occurs within the indigenous territories which are not included in our primary study sites. A small scale explorative study was also conducted by this research team in one indigenous Ngöbe Bugle community in the region but is not included as part of this thesis.

METHODS

See chapter 2 for a full description of the study site, survey instruments, sampling methods, and modes of data collection.

Data Analysis

Quantitative data analysis included statistical analyses of the original quantitative data and the quantitized (originally qualitative) data from the landowner surveys described in chapter 2.

Computer analyses were performed using PASW-SPSS 18.0 (Predictive Analytics SoftWare - Statistical Package for the Social Sciences).

Socioeconomic status (SES) index creation

PES program eligibility criteria determine who of those willing to participate can actually participate. In order to understand potential relationships between eligibility and socioeconomic status in the study region, we created a SES index using indicators selected based upon the literature and the context of the study region (table 3.2). Specifically the measures used by CEPF guided the creation of our survey questions related to SES. The SES index included the following combination of variables: head of household, education level, household monthly income, electricity and plumbing availability in house, and type of cooking fuel.

Standardized Z-scores were computed for each of the variables in order to standardize the variable response scales. These variables were then combined into an additive index to create an SES score for each respondent. The total z-scores that resulted from the index were grouped into three categories based on equal intervals: high SES, medium SES, and low SES. These groups were divided using natural breakpoints closest to thirds within the z-score results (0 – 36.2%, 36.3% - 67.4%, 67.5% - 100%).

Reliability analysis

We used Cronbach's alpha to check the intercorrelation of response patterns and thereby measure the reliability of the scale. We also used an ANOVA analysis to check differences in means across the scale for all of the variables included and for two variables (farm size and tenure) which we hypothesized to be related to the SES index.

SES and Participation Relationship

We use the crosstabs to investigate the relationship between socioeconomic status and willingness to participate. This will help determine if interest in PES enrollment is different based on socio-economic data (i.e. are less-educated and poorer people less interested in program opportunities). If it turns out that those lower on the SES scale are less interested then investigating the reasons why would be important. For instance, are they unable to understand the programs? In this case education and outreach programs might be important components of pro-poor PES design. However, if there is no difference in willingness to participate then eligibility criteria is probably an important place to focus attention in order to make sure that the programs include households across the socioeconomic spectrum.

SES and Eligibility Relationship (Eligibility variable creation)

In order to begin to explore the concept of participant eligibility, another variable was created from a combination of pre-existing survey variables. The following variables and their specific criteria were combined: tenure (have title to land), ownership (own land, do not rent land), and farm size (own more than 5 hectares). Those participants that did not answer yes to all three variables were counted as ineligible. This criterion is based on typical PES criteria that require participants to have title to their land, to own their land, and to enroll more than five hectares of land in the program. We used the 5 hectare cut-off because the survey data only collected total farm size data by category (< 5 ha = small farm, 5 – 30 ha = medium farm, and > 30 ha = large farm). Since the Costa Rican PSA program (a representative program for the region and the inspiration for many other programs) basically requires a minimum of 10 ha, we use this to guide our investigation of potential eligibility guidelines in Panama. With this requirement the small category of farms from our survey would be ineligible. Some of the medium farms would be and some would not, meaning that our hypothetical farm size restriction on eligibility errs on the side of being more inclusive for eligibility. Overall, this criterion provides a first approximation measure of eligibility, which serves to determine if a relationship between SES and eligibility exists in the area.

Eligibility and Participation Relationship

We then examine the relationship between eligibility and participation using a crosstabs procedure to see if those who are willing to participate are more likely to be eligible. The statistical significance of this relationship is measured using the Pearson's chi-square test statistic

(comparing the observed against the expected cell counts). Cramer's V is then used to measure the strength of association between the two variables (or effect size).

Potential Eligibility Analysis Curves

The next step of analyses provided a more in-depth investigation of the eligibility relationship, including likely eligibility and pro-poor participation trade-offs. The goal of these analyses is to guide program designers toward a "sweet spot" or potential solution where competing factors produce a favored outcome between extremes. For each PES scenario, we plotted the percent of households against the number of hectares that respondents stated being willing to enroll (line 1). Line 1 represents all respondents who indicated that they are willing to participate in the a given scenario and graphs the number of hectares they reported that they would enroll. Since actual program participation would most likely be bounded by some type of eligibility criteria, we also plotted lines for percent of people willing to enroll a given number of hectares bounded by land ownership and tenure (line 2) , and land ownership, tenure, and slope - defined by farmers self-reporting steep slope (line 3). Line 2 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll. Eligibility as represented in line 2 is based off of affirmative responses to land ownership and possession of land title questions. Line 3 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll when slope requirements are also included in eligibility criteria. Those who are eligible according to the criteria for line 2 and also reported steep slope land on their farm are included in line 3. Prior to this analysis we tested the relationship between eligibility and socio-economic status. If those lower on the SES scale are significantly less likely to be eligible then the difference between line 1 and line 2 has serious implications for the inclusion or exclusion of

poorer potential participants. A steep slope eligibility requirement is likely to dramatically reduce eligibility across all SES levels since only 20 percent of households self-reported steep slope farms across the entire sample population. Reasons for bounding participation by size, ownership, and tenure have already been discussed above; however, the consideration of a slope requirement (or targeting effort) requires explanation. Steeply-sloped lands are more negatively impacted by agricultural intensification, due to increased erosion and loss of top soil. Effects can be especially negative in watersheds (Nelson & Chomitz, 2004). There is some evidence that poorer farmers tend to have more marginal lands including steeply-sloped agricultural lands, so this criteria could actually facilitate pro-poor and conservation targeting (Okwi et al., 2007). Furthermore, slope is a key premise for targeting in China's Grain-for-Green program, one of the largest PES programs in existence (Liu, Li, Ouyang, Tam, & Chen, 2008). This program aims to restore and conserve forest cover and prevent soil erosion on steeply-sloped cropland, as well as to alleviate poverty in some of China's poorest regions (SFA, 2002; Uchida, J. Xu, Z. Xu, & Rozelle, 2007).

RESULTS

SES Index Creation

Measurement reliability (an analysis of the consistency/intercorrelation of response patterns) of our constructed SES index was measured using the internal consistency method and resulted in a Cronbach's alpha reliability coefficient of .61 for the following combination of variables: head of household education level, household monthly income, household electricity and plumbing availability, and type of cooking fuel. The Cronbach's alpha decreased if any items were

removed. Thus, this scale meets the minimum reliability requirements for an adequate scale (Vaske, 2009).

Next we conducted a second test of the index using the ANOVA test statistic (table 3.3). We found that the relationships of all five variables within the SES index (education, income, electricity, plumbing, and fuel) differed significantly across the three SES levels ($p < 0.001$). The effect sizes for these relationships range from typical to substantial ($\eta = 0.367-0.730$). Respondent's average level of education ranged from 6th grade (low SES) to 12th grade (high SES). As expected, household income increased as SES increased. Those with a low SES level had an average monthly income of \$200-299, as compared to the medium SES level with a monthly income of \$500-599 and high SES level with an average monthly income of \$900-999. Respondents in the high SES group were found to all have electricity ($mean = 3.00$), indoor plumbing ($mean = 3.00$) and gas or electric cooking fuel ($mean = 3.00$). The low SES group was slightly less likely to have all three amenities in their households ($mean = 2.31-2.58$).

Variables thought to be related to this index, land tenure and farm size, were tested through mean comparisons; their relationship to the SES index were also found to be significant ($p < .001$), with minimal effect sizes ($\eta > .287$). Those in the low SES group were less likely to have title to their land ($mean = .67$, with 0 = no title and 1 = title), as compared to the high SES group in which nearly all respondents had title to their land ($M = .94$). The household's farm size increased as SES increased; low and medium SES levels had an average farm size between 'less than 5 hectares (1)' and '5 to 30 hectares (2)' (low SES $M = 1.53$, medium SES $M = 1.65$) and those with high SES had an average farm size of '5 to 30 hectares' ($M = 2.03$).

SES and Participation Analysis

The relationship between the participation variable (respondent's willingness to participate in at least one of the proposed programs) and the SES index was analyzed using crosstabs however, it was not found to be statistically significant ($p = 0.483$). As SES decreased, the percentage of people willing to participate remained approximately the same (table 3.4).

SES and Eligibility Analysis

The test statistic of crosstabs was also used for analyzing eligibility and the SES index (table 3.4). The relationship between eligibility and the SES index was found to be significant ($p < .001$), with a typical effect size (Cramer's $V = .314$). The higher a respondent's SES level, the more likely the respondent was to meet the hypothetical eligibility criteria. For example, only 26% of those in the low SES group were eligible, while 64% of those in the high SES group met the eligibility criteria.

The final analysis used eligibility as the independent variable and willingness to participate in one or more of the hypothetical program modalities as the dependent variable in a crosstabs procedure (table 3.5). The relationship between participation and eligibility was statistically significant ($p < .001$), with a minimal effect size (Cramer's $V = 0.172$). Non-participants were less likely to be eligible than those who were willing to participate. For example, only 20% of non-participants were eligible compared with 47 percent of participants.

Potential Eligibility Curves

A total of 182 of the respondents were willing and able (meaning they have forested land) to enroll in the forest conservation scenario at various land enrollment levels ranging from 0.25 to

700 ha. Figure 3.1 shows the percentage of people willing and able to enroll a given number of hectares under various targeting and eligibility criteria up to 40 hectares where the curve levels off considerably; only two percent of respondents are willing to enroll more than 40 ha. for each of the scenarios. In addition, 40 hectares is well above existing minimum eligibility criteria for area seen in existing programs. This same cut-off is used for all three program figures. At the 10 ha cut-off, which has been so controversial in Costa Rica (e.g. Hope et al., 2005; Miranda et al., 2003), 29 percent of people expressed willingness to enroll overall. However, this percentage drops to 22 percent if participants are required to own and possess title to their land, and only 8 percent if a steep slope requirement were added to the program qualifications.

For the reforestation scenario, 144 respondents reported willingness to enroll between 0.1 and 800 ha (figure 3.2). Using the 10 ha point for illustration (as above), a total of 21 percent of those willing to enroll reported that they would enroll a maximum of 10 ha. Adding eligibility restrictions for land tenure and ownership reduces this number to 17 percent, and targeting for steeply-sloped lands further reduces the number to five percent.

Figure 3.3 shows the enrollment intentions for agroforestry, the most popular scenario option presented in the survey, as reported in chapter II (77 percent of respondents, or 265 people, expressed willingness to participate in this scenario). According to our analysis, if a PES program were to require a minimum of 10 ha for enrollment, only 23 percent of potential participants would be likely to enroll. This number decreases slightly to 19 percent with basic ownership and land tenure requirements. Only four percent of interested participants would be eligible to enroll 10 ha if the land also had to have a steep slope.

Interesting differences in the eligibility curves exist between the two districts included in the survey. For the district of Renacimiento, the percentage of potential participants at 10 ha drops off to 1% for both the reforestation and agroforestry scenarios when the slope requirement is included and it is only slightly higher at 4 percent for the forest conservation. For the district of Boquete, enrollment at 10 ha is at 7 percent even when bounded by slope.

DISCUSSION

Socioeconomic Status Index

The results of the SES index analyses support the following conclusions:

- Households across the full socioeconomic spectrum are likely to be interested in participating in a PES program;
- Respondents with a high SES level will be more likely to be eligible for program enrollment than those with a low SES level, given the hypothetical, but representative, eligibility guidelines used in our analysis;
- Households of a higher socioeconomic status are more likely to have more land;
- Households of a higher socioeconomic status are more likely to have title to their land.

The first set of analyses between the SES index and related variables confirmed the validity of the index and the indicators used within it. Education and income increased as SES level increased, and those with higher SES levels were more likely to have household amenities (electricity, plumbing, gas or electric cooking). These results support the creation of the SES index with the selected variables and demonstrate that combining related demographic and household variables into a single index can be effective for measuring SES levels. Land tenure

and farm size were shown to increase as a respondent's SES level increased, demonstrating that those with higher socioeconomic levels were more likely to have title to their land and to own more land. The results of this analysis demonstrate the validity of the SES index that was created, while also demonstrating the significance of the index when compared with farm size and tenure. These findings support prior research and literature that indicates that those with higher SES components (education, income, standard of living) are more likely to have title to their land and own a larger quantity of land (Corbera et al., 2007; Pagiola et al., 2007).

The second set of analyses between SES index and respondent eligibility indicated that those who rank higher on the SES scale due to their income, education, and household amenities were more likely to be eligible for PES programs, which is also supported by previous research (e.g., Corbera et al., 2007; Pagiola et al., 2007; Rosa, Kandel, & Dimas, 2004). This is notable because it highlights the inherent challenges of using PES schemes as a poverty alleviation or livelihood development mechanism. It is also important to note that interest in participating remained constant across socioeconomic status. However, because we did not provide interviewees with hypothetical eligibility requirements or payment levels, we recognize that there is a limitation to our study due to respondents potentially expressing unrealistic participation levels.

There are also practical barriers to participation, which are related to and influence the establishment of some eligibility requirements. It may be for this reason that fewer of the potentially ineligible households expressed willingness to participate. Perhaps they assumed that their farms were too small or that they would not be able to guarantee certain practices under contract without secure land tenure or land ownership.

This analysis of eligibility and participation has implications for the results of participation across SES index levels. One goal of many PES projects is to contribute to improving local livelihoods, even to the point of using PES projects as poverty alleviation tools. If those with a lower SES are less likely to be eligible for PES projects, then there may need to be further consideration for aligning PES goals and eligibility requirements. This issue is demonstrated through the results of this study which show that those with a lower SES are not only less likely to be eligible, but also that land tenure and land size is significantly and positively related to SES levels. Land tenure and size are two of the most common criteria used to establish eligibility (Pagiola et al. 2005;); this demonstrates the need for projects to carefully consider how they craft eligibility guidelines, especially if a major goal of a PES project is to provide poverty alleviation and/or livelihood improvement. This research demonstrates that implementing the standard eligibility guidelines will likely lead to the exclusion of those in the lowest SES bracket. Overall, our findings reinforce past research indicating that those with lower socioeconomic status are less likely to be eligible for PES projects unless the programs are carefully crafted to include them (Grieg-Gran, Porras, & Wunder, 2005; Pagiola et al., 2005; Wunder, 2008). This could have implications for determining appropriate PES eligibility requirements for developing PES projects in this study region with poverty alleviation and economic development goals .

Potential Eligibility Analysis

Our next set of analyses provides some insight into the range of eligibility options and how they expand or diminish program inclusiveness with implications for those with lower socioeconomic status. PES land enrollment requirements, tenure, and land characteristics such as slope are some of the central issues with which any group developing a program must grapple, and these issues

become even more complex when poverty alleviation and ecosystem service production are both explicit goals of the program.

Each successively restrictive curve in figures 3.1 – 3.3 is fully “below” the less restrictive ones. Therefore, these potential eligibility criteria all appear to be important factors to understand. The dependent variable in these analyses is the maximum number of hectares that the respondent is willing to enroll. Most respondents who expressed willingness to enroll in a PES scenario reported a willingness to enroll at least one ha (95 percent or more across all the programs). A big drop-off for these programs can be seen between two and five hectares and between five and 10. In fact, willingness to enroll drops anywhere from 29 – 35 percent (depending on the scenario) between the two and five hectare enrollment levels. Participation continues to drop off steadily 13 – 16 percent between five and 10 hectares. Eligibility requirements impact households on the low land enrollment end of the graph hardest. Therefore, allowing smaller land enrollment levels would have important implications for many potential participants. The diverse agroecological systems that are most favorable to ecosystem service production are typically managed by smallholders and indigenous farmers. Although most environmentally-friendly farming practices are not scale-specific by definition, landscapes that consist of many small farms often demonstrate a high potential for sustaining both biodiversity and rural livelihoods and some studies have found that smaller farms are also more productive per hectare (Rosset, 1999). Policies that favor smallholders, promote diverse farming landscapes, and support dissemination of traditional practices and agroecological knowledge are generally good for the conservation of biodiversity (Castillo & Toledo, 2000). Accordingly, excluding smaller

farms could prove to be problematic for achieving the environmental objectives of PES programs.

Ownership does not contribute much variability to the difference between all willing participants (line one) and only those eligible under basic ownership and title requirements (line two) since 98 percent of respondents reported owning their land. We aimed to only survey those who own land; however, our lists did end up containing a small number of non-land owners (renters involved in agriculture). We included ownership in the eligibility analysis because it is very difficult to design programs that include renters and including squatters may be undesirable (i.e. encouraging squatters to encroach on protected areas) (Wunder, 2005). Renters find themselves in a similar situation to those with insecure tenure, they cannot promise anything about long-term land use without input from the landowner (Wunder, 2005). Thus, accountability is a key concern in working with anyone who does not own the land, although some success has been realized in working with shareholders of communal lands (e.g. Kosoy et. al., 2007).

Tenure contributes most of the variability between all willing participants (line one) and only those eligible under basic eligibility requirements (line two) but most (81%) of respondents do have title to their land. Still the second line falls at most 28 percent below the first line, meaning that requiring land ownership and tenure will make programs inaccessible to these people. We included tenure because almost all PES programs either currently require participants to have title to their land or did have this requirement at the beginning of the program and have since relaxed requirements. This variable may affect program participation significantly more in other parts of the country which have not benefited from the PRONAT titling project (see description in chapter II).

Adding a steep slope requirement to target a program to address soil stabilization for water quality and to prevent landslides reduces participation by as much as 86 percent. Slope was self-reported and only provides a rough estimate of the actual land attribute, but there is substantial slope variability in the region, so it could be a key program feature. Offering higher payments for steeply-sloped land enrollments might be a way to target a program to address the issue without cutting other potential participants out entirely. Other targeting efforts might offer higher payments to land directly bordering protected areas or land within certain watersheds.

Program design factors are integral to successful pro-poor PES due to their influence on participation. Multiple factors must be taken into account when considering how to develop a PES program so as not to exclude poor land users. At the initial design stage of a PES program the socioeconomic landscape and relationships between SES status, land ownership, and land tenure must be carefully considered. Furthermore, the implications of various program design factors, especially eligibility requirements, should be analyzed. Enrollment requirements have important implications for both poverty alleviation and environmental benefits realized through any PES program. In order to realize success on either or both of these fronts it is crucial that program designers clearly define the goals of the program upfront and carefully construct requirements to reinforce these goals.

CONCLUSION

This analysis of empirical data from farming communities in Western Panama provides a nuanced understanding of the regions socioeconomic landscape. By applying a structured eligibility analysis to our site specific data we are able to provide insights regarding the likely

effect of various key program design decisions. Thus, this research identifies program design factors which will likely influence the participation of landowners across the socioeconomic spectrum (including particularly the poor) in this specific location. Using this approach, those interested in developing new PES programs can combine site specific social science data with lessons learned from other programs to build customized approaches which are more likely to succeed. Ultimately, this research offers both practical information which could help inform the development of a pilot PES program in western Panama as well as an example of how social science research can be used to inform PES site appropriate program design and during this era of rapid growth and innovation.

CHAPTER IV
CONCLUSION

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SUMMARY

Human society depends on healthy ecosystems. Our study focused on PES programs as a possible means to achieve ecosystem-service conservation on private lands, which are playing an increasingly important role in conservation efforts. Specifically, our study examined the potential for PES to address conservation and livelihood issues in the buffer-zone of La Amistad Bi-national World Heritage Site in Western Panama, and provides insights for the equitable architecture of such a program.

CONTRIBUTION TO THE LITERATURE

While our specific results are particular to our study region, our approach and the ways in which our results support and contradict existing findings in the literature from PES programs currently in operation contributes to a broader knowledge about the barriers and opportunities presented by PES.

Our study provides support for a growing body of research showing that past behaviors and some socio-demographic information can successfully predict or explain an individual farmer's likelihood to be willing to participate in a payment for ecosystem service program. Specifically, past improved practice or conservation program participation, and farm size are major drivers of PES participation. Using logistic regression analyses we found that farm size, participation in other conservation programs, the number of conservation organizations with which the farmer has worked, and total income were all significant predictive factors of willingness to participate for at least one of three program scenarios with a positive relationship. Farm size is a frequently studied strong driver of actual PES participation (i.e. Zbinden & Lee, 2005, Mullan & Kontoleon,

2009) and our research further supported these findings in context of behavioral intention, or willingness to enroll.

Land tenure security and age were significant explanatory factors with a negative relationship for one or more scenario. This means that as land tenure security and age increase respondents are less likely to be interested in enrolling in a PES program. As discussed in the systematic literature review, studies of existing and hypothetical PES enrollment have resulted in mixed findings regarding the role of age as a driver of participation. This may be because age is a proxy for experience in places where farmers have opportunities to engage in innovative land management programs and partnerships such as PES. We did find that both variables related to past behaviors and prior experience (participation in other conservation programs and the number of conservation organizations) helped to explain willingness to enroll in a PES program. The land tenure results could indicate that respondents hope that a PES program would help them to increase their land tenure security. Perhaps, those with more secure land tenure have more income opportunities competing with the PES option. Land tenure and titling programs may benefit from working in tandem with PES program advocates in Panama.

We also investigated equity and fairness concerns including how potential PES program design and targeting factors related to minimum enrolled area, land tenure, and land characteristics (e.g., slope) might affect eligibility of low-income households, an increasingly important target of PES programs, particularly in developing countries. Using eligibility requirements based off of Costa Rica's national program, and also generally in-line with programs elsewhere, we found that respondents who ranked lower on our constructed socioeconomic scale were less likely to be eligible to enroll in a Panamanian PES program despite that many are willing to participate. Targeting and eligibility criteria must be carefully considered in each site specific socio-

economic landscape were PES might be implemented. PES land enrollment requirements, tenure, and land characteristics (e.g. slope) result in participation trade-offs. For example, higher land enrollment requirements result in a rapid decline in potential participants. Our research contributes to a key piece of the PES design puzzle by proactively exploring ways to ensure that landowners across the socioeconomic spectrum (particularly the poor) are able to participate. Understanding trade-offs is important for guiding PES program architecture to achieve rural development and poverty alleviation goals in tandem with conservation outcomes. Our study provides an example of how survey information can be used to map these eligibility/participation trade-offs to inform the design of pro-poor PES programs. Using these tools decision makers will have a clear indication of the implications that setting specific eligibility or targeting criteria will have on program accessibility in general and particularly for low-income farmers and ranchers.

PRACTICAL IMPLICATIONS

Although Panama does not currently have a national or regional PES program, there is widely recognized potential for program development. Site-specific social science data can help guide PES design. The information collected through our survey provides indicators to leaders in our study region of western Panama regarding the potential feasibility of a PES program from the perspectives of landowners, who would act as sellers of ecosystem services. This information could help to guide program design decisions to be more acceptable, accessible, and pro-poor.

While respondents to our survey reported a lack of familiarity with the PES concept, after being provided with an explanation, many expressed interest in participating. Our research indicates that landowners in the these communities in Chiriquí province are open to trying PES, a new and

innovative market-based conservation strategy, and our study results offer information that can help guide the development of a functional and locally acceptable program.

Program type: We found differences in acceptability across our three program modalities. However, for all three of these scenarios the positive responses may be considered high enough to be worth further investigation as possible future program options. Over half of respondents stated willingness to participate in a forest conservation scenario. This dropped to about 40 percent for the reforestation scenario and swelled to almost 80 percent for the agroforestry scenario.

Program design: Intermediaries often make PES transactions possible through government programs, non-profit organizations, private brokers or other institutions that link buyers and sellers, help to set prices, and provide information and security to the individuals involved in the transaction. When asked what type of PES program oversight or intermediary body respondents preferred, “no preference” was the most common response for two of the scenarios (forest conservation and reforestation), with the stated preference to work with an NGO a close second. However, for agroforestry, the most popular program scenario, NGO oversight was the first choice. This expressed interest by local landowners to work with NGOs through an agroforestry focused PES program provides an incredible opportunity for increasing local institutional capacity and to strengthen local sustainable natural resource governance in the region.

Trade-offs: Notably, our research provides insights regarding the difference between those interested in participating in hypothetical PES program options in Panama and those actually participating in PES programs in other countries. Specifically, our results show that farmers with less secure land title are interested in participating. Our results corroborate findings which show that wealthier land owners with more land are more likely to be willing to participate and that

conservation engagement and experience with other agriculture programs are significant predictors of interest in PES participation. However, landowners across the socioeconomic spectrum expressed interest and given eligibility requirements used in other programs around the globe we are concerned that many of these interested individuals may be excluded if an actual program were to be offered in Panama. In some cases this may be acceptable given gains for conservation and the reduction in overall program costs, but in order to make informed decisions weighing the trade-offs is essential. By proactively investigating these issues, we can help ensure that PES programs are designed to increase the likelihood of broad landowner eligibility and delivering positive livelihood benefits to participating landowners across the socio-economic spectrum.

FUTURE RESEARCH

At the scope of global efforts to inform the development of market-based conservation tools and payment for ecosystem services programs in specific, this research provides both a useful example of how to use site specific data to identify PES program opportunities and potential obstacles prior to pilot program implementation. Our research also provides some useful information on program design preferences from the ecosystem services provider perspective and tools for investigating eligibility/participation trade-offs. These same analyses using data from a different locations could start to provide insights on how trade-offs change with changes to the socio-economic and political landscape. At the aggregate level studies like this one also provide insights regarding PES participant trends.

On the site specific front, the results of this study contribute an important first step in information gathering, consortium building, and collaboration which could ultimately lead to the development of a pilot PES program in the region. Important next steps for research include: 1) identifying key ecosystem service beneficiaries and assessing how they value the services that they use, 2) spatial ecological mapping for targeting purposes, 3) an institutional capacity analysis, and 4) an economic valuation analysis.

If these next steps are carried out by researchers working in close collaboration with the local network of organizations already involved in PES capacity building and build off of the outcomes of this project then concrete and feasible program design opportunities are likely to emerge.

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TABLES AND FIGURES

Figure 1.1 A map with a key of the supply and demand of ecosystem services in and around La Amistad created at our May, 2009 workshop in Cerro Punta, Panama.



Table 1.1 A prioritized list of ecosystem services produced in the La Amistad region. This list was developed by participants at the PES workshop in May, 2009 in Cerro Punta Panama. Each participant was given the opportunity to identify up to 3 top choices.

Ecosystem Service	Number of Votes
Hydrological Power	13
Carbon Fixation	8
Water –consumption/agriculture	7
Forests/ Forest regeneration	5
Protection of biodiversity -ecosystems, species, and genes- for genetic and pharmaceutical improvement	6
Scenic beauty / Tourism (sale of service)	4
Agricultural rangeland soils / Fertile	2
Regulation of regional micro climates	1
Sustainable production/ Good production practices	1

Table 2.1 A systematic review of scientific literature investigating actual and hypothetical PES participation. The relationships between explanatory or influential factors and PES participation are overviewed. For some factors results varied by study location with some showing a positive relationship and others a negative relationship. Some factors were significant predictors of participation in numerous studies but were found to be un-significant in one or two studies. These findings are noted as well. The mixed/other category is used to indicate more complex relationships or situations where different relationships were found for different PES program modalities.

Factor	Study and Relationship (+, -, mixed)
Individual Farm/Household Factors	
<i>Farm size</i>	Positive (ie, larger farms are more likely to participate) (Corbera et al., 2007a; De Souza Filho et al., 1999; Fuwa & Sajise, 2009; Hope et al., 2005; Jolejole et al., 2009; E. Lee & Mahanty, 2009; Lynch & Lovell, 2003b; Mäntymaa et al., 2009; Mullan & Kontoleon, 2009; Stefano Pagiola et al., 2005; Stefano Pagiola et al., 2008; Rios & Stefano Pagiola, 2009; Sven Wunder, 2008; Zbinden & D. Lee, 2005; Zilberman et al., 2008)
<i>Land (and tree) tenure Title</i>	Positive (ie, those with more secure tenure are more likely to participate) (Corbera, Katrina Brown, & Adger, 2007b, 2007c; Corbera, Kosoy, & Martínez Tuna, 2007; Gong, Bull, & Baylis, 2010; H. Rosa et al., 2005; Hope et al., 2005; E. Lee & Mahanty, 2009; Locatelli et al., 2008; Miranda et al., 2003; S. Pagiola et al., 2004; S. Pagiola et al., 2005; Stefano Pagiola, Ramírez, et al., 2007; Pascual & Perrings, 2007; Lisa Petheram & Bruce M. Campbell, 2010; Tejada & Peralta, 2000; Sven Wunder, 2007, 2008; Zbinden & D. Lee, 2005) Not Significant (Stefano Pagiola et al., 2008)
<i>Environmental /Conservation ethic</i>	Positive (ie, those with a stronger conservation ethic are more likely to participate. This effect sometimes has a stronger predictive power than payment amount) (Chouinard et al., 2008a; Corbera et al., 2007c; De Souza Filho et al., 1999; Jolejole et al., 2009; Kosoy et al., 2008b; Kosoy et al., 2007; Kramer & Jenkins, 2009; Lohr & Park, 1995; Mäntymaa et al., 2009; Neupane et al., 2002; Lisa Petheram & Bruce M. Campbell, 2010)
<i>Age</i>	Negative (ie, younger farmers are more likely to participate) (Jolejole et al., 2009; Kramer & Jenkins, 2009; Langpap, 2004a, 2004b; Layton & Siikamäki, 2009; Lynch, Hardie, & D. Parker, 2002; Neupane et al., 2002) Positive (ie, older farmers are more likely to participate) (Xiadong Chen et al., 2009; Nagubadi et al., 1996) Not Significant (Mullan & Kontoleon, 2009; Zbinden & D. Lee, 2005)

<i>Education</i>	<p>Positive (ie, those with a higher level of education are more likely to participate) (Fuwa & Sajise, 2009; Jolejole et al., 2009; Kosoy et al., 2008b; Kramer & Jenkins, 2009; E. Lee & Mahanty, 2009; Lynch et al., 2002; Mäntymaa et al., 2009; Miranda et al., 2003; Nagubadi et al., 1996; Stefano Pagiola et al., 2005; Stefano Pagiola, Ramirez, et al., 2007; Zbinden & D. Lee, 2005)</p> <p>Negative (ie, those with a higher level of education are more likely to participate) (Layton & Siikamäki, 2009)</p> <p>Mixed (Neupane et al., 2002)</p> <p>Not Significant (Mullan & Kontoleon, 2009)</p>
<i>Off-farm income/employment</i>	<p>Positive (ie, those with a higher percentage of off-farm income are more likely to participate) (Xiadong Chen et al., 2009; Kramer & Jenkins, 2009; Lynch et al., 2002; Lynch & Lovell, 2003a; Miranda et al., 2003; S. Pagiola, 2008a; Rios & Stefano Pagiola, 2009; Zbinden & D. Lee, 2005)</p>
<i>Family farm labor</i>	<p>Positive (ie, those with more available family farm labor are more likely to participate) (De Souza Filho et al., 1999; Zbinden & D. Lee, 2005)</p> <p>Mixed (Ayuk, 1997b; Rios & Stefano Pagiola, 2009; Sara J. Scherr, 1992)</p>
<i>Program Design Factors</i>	
<i>Contract length</i>	<p>Positive (ie, households are more likely to enroll in programs with more years required by the contract) (Xiadong Chen et al., 2009)</p> <p>Negative (ie, households are more likely to enroll in programs with fewer years required by the contract) (Hope et al., 2005; Kramer & Jenkins, 2009; Layton & Siikamäki, 2009; Schnepf, 1994)</p>
<i>Program oversight</i>	<p>Prefer non-government (ie, households are more likely to enroll in programs managed by a n NGO) (De Souza Filho et al., 1999; Hope et al., 2005; Lisa Petheram & Bruce M. Campbell, 2010)</p> <p>Prefer government (ie, households are more likely to enroll in programs managed by the government) (Jolejole et al., 2009; Kramer & Jenkins, 2009; Nagubadi et al., 1996)</p> <p>Mixed/Other (Alix-Garcia et al., 2009; Kerr, 2002; E. Lee & Mahanty, 2009; Locatelli</p>

	et al., 2008; Lohr & Park, 1995; Mäntymaa et al., 2009; Neupane et al., 2002; Rosa et al., 2003)
<i>Institutional capacity</i>	Positive (ie, households are more likely to enroll in programs if the institutional capacity of the managing agency is superior) (Alix-Garcia et al., 2009; Kosoy et al., 2008b; Kramer & Jenkins, 2009; E. Lee & Mahanty, 2009)
<i>Transaction costs</i>	Negative (ie, households are more likely to enroll in programs when transaction costs are low) (John Antle & Jetse Stoorvogel, 2009; Locatelli et al., 2008; Nalukenge, J. Antle, & J. Stoorvogel, n.d.; S. Pagiola, 2008b; S. Pagiola et al., 2004; Stefano Pagiola et al., 2005; Stefano Pagiola, Ramirez, et al., 2007; Stefano Pagiola et al., 2008; Rios & Stefano Pagiola, 2009; Tschakert, Coomes, & Potvin, 2007; Sven Wunder, 2008) Mixed/Other (Jolejole et al., 2009)
<i>Compensation amount</i>	Positive (ie, As compensation amounts increase households are more likely to enroll in programs) (John Antle & Jetse Stoorvogel, 2009; Cary & Wilkinson, 1997; Xiadong Chen et al., 2009; Chouinard et al., 2008a; Cooper, 2003; Hope et al., 2005; Jolejole et al., 2009; Kosoy et al., 2008b; Kramer & Jenkins, 2009; Layton & Siikamäki, 2009; Lynch et al., 2002; Máñez Costa & Zeller, 2005; Mäntymaa et al., 2009; S. Pagiola et al., 2005; Lisa Petheram & Bruce M. Campbell, 2010; Purvis et al., 1989; Tschakert et al., 2007) Mixed/Other (S. Pagiola et al., 2004; Stefano Pagiola, Ramirez, et al., 2007; Zbinden & D. Lee, 2005)
<i>Targeting</i>	Positive (ie, targeting results in more land enrolled with higher biodiversity value) (Gauvin et al., 2010; Kosoy et al., 2008b; Mäntymaa et al., 2009)
<i>Land Attributes</i>	
<i>Heterogeneity of land value</i>	Importance of this factor is discussed (Corbera et al., 2007a; De Souza Filho et al., 1999; S. Engel et al., 2009; Kosoy et al., 2007; Mäntymaa et al., 2009; Neupane et al., 2002)
<i>Land attributes/ opportunity costs</i>	Importance of this factor is discussed (S. Engel & Palmer, n.d.; S. Engel et al., 2009; Stefanie Engel et al., 2008; Galizzi & Herklotz, 2008; Hope et al., 2005; Layton & Siikamäki, 2009; E. Lee & Mahanty, 2009; Locatelli et al., 2008; Lohr & Park, 1995; Máñez Costa & Zeller, 2003; Máñez Costa & Zeller, 2005; Mäntymaa et al., 2009; Mullan & Kontoleon, 2009; S. Pagiola et al., 2004; S. Pagiola et al., 2005; Stefano Pagiola et al., 2007; Lisa Petheram & Bruce M. Campbell, 2010; Sierra & Russman, 2006; Sven Wunder, 2005, 2008; Zilberman et al., 2008)

Figure 2.1. Map of La Amistad

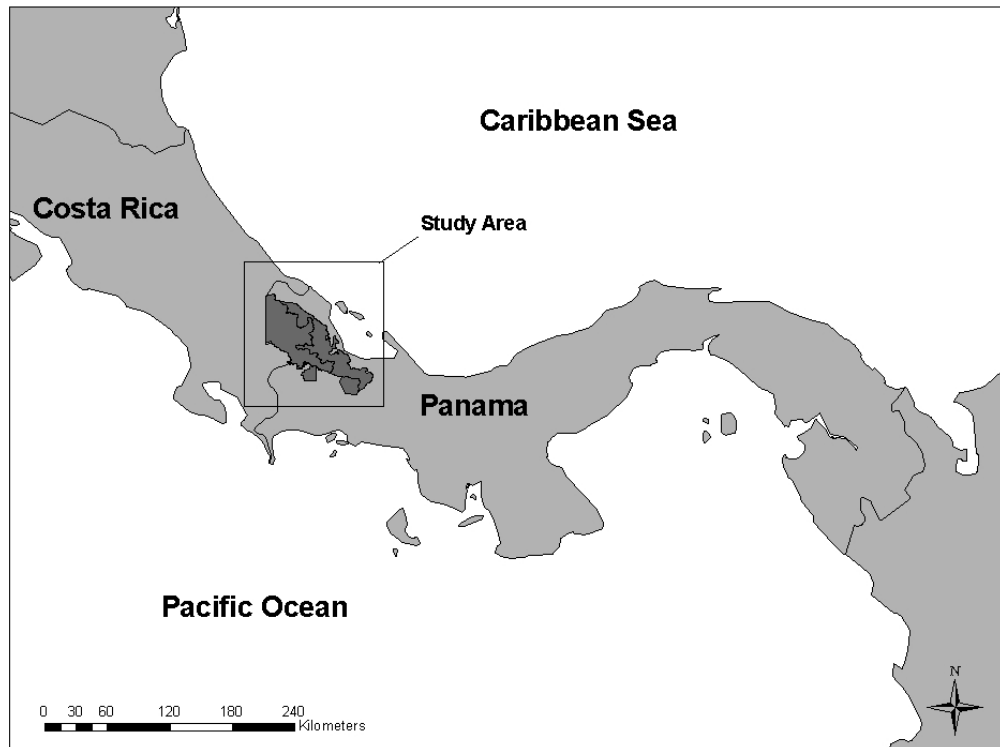


Table 2.2. Key farm characteristics are reported for the entire sample (combined) as well as broken out by district (Boquete and Renacimiento). Respondents selected from three farm size options as detailed below. Those who owned their land also self-reported information about land tenure (official documentation of ownership). Those who reported “Don’t know” may not have any legal claim to their land. Steep slope was also self-reported. Significant differences between the two communities on a given variable are identified by *p* value and the systemic measure offers an indication of the effect size or the strength of the relationship between the variables (minimal, typical, or substantial).

Variable	Combined	Boquete	Renacimiento	Comparing the Two Communities		
				Test Statistic ¹	<i>p</i> value	Systemic Measure ²
Farm Size						
< 5 hectares	45%	47%	43%	2.29	.318	.082
5 – 30 hectares	37%	33%	41%			
> 30 hectares		19%	16%			
Land Tenure						
Title	81%	93%	67%	35.89	< .001	.328
Property rights	17%	5%	28%			
Don’t know	3%	2%	4%			
Slope						
No steep slope	80%	74%	86%	7.11	< .01	-.144***
Steep slope	20%	26%	14%			

¹ The test statistic is chi squared and the systemic measure is Cramer’s V unless indicates as follows: * *t* value, ** eta (minimal ≥ .1 typical ≥ .243, substantial ≥ .371), *** phi. (minimal ≥ .1 typical ≥ .3, substantial ≥ .5).

Table 2.3. Head of household characteristics are reported for the entire sample (combined) as well as broken out by district (Boquete and Renacimiento). Significant differences between the two communities on a given variable are identified by *p* value and the systemic measure offers an indication of the effect size or the strength of the relationship between the variables (minimal, typical, or substantial).

Variable	Combined ¹	Boquete ¹	Renacimiento ¹	Comparing the Two Communities		
				Test Statistic ²	<i>p</i> value	Systemic Measure ²
Age						
	55.62	59.51	51.68	5.04*	< .001	.265**
Gender						
<i>Male</i>	78%	73%	83%	5.36	< .05	-.126***
<i>Female</i>	22%	27%	17%			
Income						
	6.03	6.46	5.56	2.07*	< .05	.113***
Education						
<i>No formal</i>	1%	1%	1%	13.09	< .01	.197
<i>Low</i> (1 st – 5 th)	15%	15%	15%			
<i>Medium</i> (6 th – 12 th)	61%	54%	70%			
<i>High</i> (> 12 th)	23%	30%	15%			

¹percents are listed for all variables except for age and income for which the mean is listed.

² The test statistic is chi squared and the systemic measure is Cramer's V unless indicates as follows: * *t* value, ** eta (minimal ≥ .1 typical ≥ .243, substantial ≥ .371), *** phi. (minimal ≥ .1 typical ≥ .3, substantial ≥ .5).

Table 2.4. A history of conservation engagement is reported for the entire sample (combined) as well as broken out by district (Boquete and Renacimiento). Significant differences between the two communities on a given variable are identified by *p* value and the systemic measure offers an indication of the effect size or the strength of the relationship between the variables (minimal, typical, or substantial).

Variable	Overall ¹	Boquete ¹	Renacimiento ¹	Comparing the Two Communities		
				Test Statistic ²	<i>p</i> value	Systemic Measure ²
Hectares enrolled in Conservation						
<i>None</i>	69%	62%	76%	7.82	< .05	.151
<i>≤ 10 hectares</i>	16%	18%	14%			
<i>> 10 hectares</i>	15%	19%	11%			
Number of Conservation Organizations worked with						
	.6356	.7414	.5266	2.06*	< .05	.111**

¹percents are listed for Hectares enrolled in conservation and means are listed for worked with conservation organization.

² The test statistic is chi squared and the systemic measure is Cramer's V unless indicates as follows: * *t* value, ** eta (minimal ≥ .1 typical ≥ .243, substantial ≥ .371), *** phi. (minimal ≥ .1 typical ≥ .3, substantial ≥ .5).

Table 2.5. Overall interest and preferences related to the forest conservation scenario option are reported for the entire sample (combined) as well as broken out by district (Boquete and Renacimiento). Significant differences between the two communities on a given variable are identified by *p* value and the systemic measure offers an indication of the effect size or the strength of the relationship between the variables (minimal, typical, or substantial).

Variables	Overall ¹	Boquete ¹	Renacimiento ¹	Comparing the Two Communities		
				Test Statistic ²	<i>p</i> value	Systemic Measure ²
Forest Conservation						
Willingness to Participate						
<i>Yes</i>	53%	50%	56%	.98	.322	.053***
<i>No</i>	47%	50%	44%			
Contract Length						
	~15 (3.01)	~15 (3.22)	~ 15 (2.83)	1.34*	.737	.109**
# of Hectares						
	21.59	28.54	14.56	1.14*	<.05	.088**
Program Management						
<i>Federal Gov.</i>	1%	1%	0%	8.44	.077	.217
<i>Local Gov.</i>	4%	1%	7%			
<i>Private Company</i>	13%	11%	15%			
<i>NGO</i>	39%	36%	42%			
<i>No Preference</i>	43%	51%	36%			

¹percents are listed for all variables except for contract length and # of hectares for which the mean is listed.

² The test statistic is chi squared and the systemic measure is Cramer's V unless indicates as follows: * *t* value, ** eta (minimal ≥ .1 typical ≥ .243, substantial ≥ .371), *** phi. (minimal ≥ .1 typical ≥ .3, substantial ≥ .5).

Table 2.6. Overall interest and preferences related to the reforestation scenario option are reported for the entire sample (combined) as well as broken out by district (Boquete and Renacimiento). Significant differences between the two communities on a given variable are identified by *p* value and the systemic measure offers an indication of the effect size or the strength of the relationship between the variables (minimal, typical, or substantial).

Variable	Overall ¹	Boquete ¹	Renacimiento ¹	Comparing the Two Communities		
				Test Statistic ²	<i>p</i> value	Systemic Measure ²
Reforestation						
Willingness to Participate						
<i>Yes</i>	42%	35%	49%	7.45	<.01	.147
<i>No</i>	58%	65%	51%			
Contract Length						
	~15 (2.71)	~15 (3.14)	~10 (2.44)	2.25*	<.05	.195**
# of Hectares						
	16.81	26.91	9.07	1.34*	<.05	.118**
Program Management						
<i>Federal Gov.</i>	1%	0%	1%	4.72	.318	.182
<i>Local Gov.</i>	4%	2%	6%			
<i>Private Company</i>	14%	15%	13%			
<i>NGO</i>	36%	30%	40%			
<i>No Preference</i>	46%	53%	40%			

¹percents are listed for all variables except for contract length and # of hectares for which the mean is listed

²The test statistic is chi squared and the systemic measure is Cramer's V unless indicates as follows: * *t* value, ** eta, *** phi.

Table 2.7. Overall interest and preferences related to the agroforestry scenario option are reported for the entire sample (combined) as well as broken out by district (Boquete and Renacimiento). Significant differences between the two communities on a given variable are identified by *p* value and the systemic measure offers an indication of the effect size or the strength of the relationship between the variables (minimal, typical, or substantial).

Variable	Overall ¹	Boquete ¹	Renacimiento ¹	Comparing the Two Communities		
				Test Statistic ²	<i>p</i> value	Systemic Measure ²
Agroforestry						
Willingness to Participate						
<i>Yes</i>	78%	74%	82%	3.53	.069	.102
<i>No</i>	22%	26%	18%			
Contract Length						
	~10 (2.14)	~10 (2.07)	~10 (2.20)	-.65	.724	<.05
# of Hectares						
	15.22	26.42	6.68	2.23*	<.001	.146**
Program Management						
<i>Federal Gov.</i>	2%	2%	2%	1.97	.741	.086
<i>Local Gov.</i>	3%	2%	4%			
<i>Private Company</i>	12%	10%	14%			
<i>NGO</i>	49%	49%	48%			
<i>No Preference</i>	35%	37%	32%			

¹ percents are listed for all variables except for contract length and # of hectares for which the mean is listed.

² The test statistic is chi squared and the systemic measure is Cramer's V unless indicates as follows: * *t* value, ** eta (minimal ≥ .1 typical ≥ .243, substantial ≥ .371), *** phi. (minimal ≥ .1 typical ≥ .3, substantial ≥ .5).

Table 2.8. This is the model summary of logistic regression analysis for variables predicting willingness to participate in the Forest Conservation PES scenario. The Nagelkerke R^2 approximates the variance which can be predicted by the model (otherwise known as predictive power). -2LL represents -2 times the log likelihood and is a goodness-of-fit test. For a perfect model the -2LL equals 0.

Nagelkerke				
R^2	-2LL	χ^2	df	p-value
.35	325.289	92.05	10	<.001

Table 2.9. This is a classification table^a of our logistic regression analysis for variables predicting willingness to participate in the Forest Conservation PES scenario. Our model successfully classifies 75% of participants' willingness to participate in this program with a relatively equal predictive success rate across both participants and non-participants.

Observed			Predicted		
			Forest Conservation Participant		Percentage Correct
			No	Yes	
Step 1	Forest Conservation Participant	No	100	41	70.9
		Yes	34	127	78.9
Overall Percentage					75.2

a. The cut value is .500

Table 2.10. Logistic regression analysis model of variables predicting willingness to participate in the Forest Conservation PES Program: Regression analysis provides information about the predictive potential of the independent variable to explain willingness to participate in the given program. The two *Farm Size* and *Participation in Other Programs* variables are binary dummy variables. This recoding is necessary because categorical variables cannot be included in logistic regression. B is the unstandardized logistic regression coefficients (i.e., the log odds). The S.E. represents the standard error associated with a given coefficient. A significant odds ratio - $Ex(B)$ - with a value below one indicates that the independent variable reduces the odds of the respondent being willing to participate; conversely, an odds ratio greater than one indicates an increase in the odds. The Wald statistic is used to test the significance of individual logistic regression coefficients for each independent variable (i.e., the Wald statistic tests the null hypothesis that a given regression coefficient is 0). Significant explanatory regression coefficients in the model are indicated by the associated p -value.

Predictor	β	SE	Odds ratio $Ex(B)$	Wald statistic	p -value
Constant	.40	.94	1.49	.19	.661
Farm Size difference between Small – Medium	1.42	.30	4.12	2.85	<.001
Farm Size difference between Small - Large	2.29	.50	9.84	21.31	<.001
Tenure	-.59	.35	.56	2.85	.091
Participation in Other Programs with enrollment of < 10 hectares	1.82	.44	6.16	17.32	<.001
Participation in Other Programs with enrolment of > 10 hectares	.97	.47	2.64	4.32	<.05
Number of Conservation Organizations Worked With	-.12	.16	.90	.45	.501
Level of Education	-.01	.04	.99	.09	.764
Age	-.02	.01	.98	3.96	<.05
Amount of Total Income from Farm	-.09	.12	.91	.58	.448
Total Income	.10	.04	1.11	6.108	<.05

Table 2.11. This is the model summary of logistic regression analysis for variables predicting willingness to participate in the Reforestation PES scenario. The Nagelkerke R^2 approximates the variance which can be predicted by the model (otherwise known as predictive power). -2LL represents -2 times the log likelihood and is a goodness-of-fit test. For a perfect model the -2LL equals 0.

Nagelkerke				
R^2	-2LL	χ^2	df	p-value
.17	371.32	40.31	10	<.001

Table 2.12. This is a classification table^a of our logistic regression analysis for variables predicting willingness to participate in the Reforestation PES scenario. Our model successfully classifies 68% of participants' willingness to participate in this program and predicts better for those who are not willing to participate.

Observed			Predicted		
			Participation in Reforestation program		Percentage Correct
			No	Yes	
Step 1	Participation in Reforestation program	No	138	36	79.3
		Yes	62	66	51.6
Overall Percentage					67.5

a. The cut value is .500

Table 2.13 Logistic regression analysis model of variables predicting willingness to participate in the Reforestation PES Program: Regression analysis provides information about the predictive potential of the independent variable to explain willingness to participate in the given program. The two *Farm Size* and *Participation in Other Programs* variables are binary dummy variables. This recoding is necessary because categorical variables cannot be included in logistic regression. B is the unstandardized logistic regression coefficients (i.e., the log odds). The S.E. represents the standard error associated with a given coefficient. A significant odds ratio - $Ex(B)$ - with a value below one indicates that the independent variable reduces the odds of the respondent being willing to participate; conversely, an odds ratio greater than one indicates an increase in the odds. The Wald statistic is used to test the significance of individual logistic regression coefficients for each independent variable (i.e., the Wald statistic tests the null hypothesis that a given regression coefficient is 0). Significant explanatory regression coefficients in the model are indicated by the associated *p*-value.

Predictor	β	SE	Odds ratio $Ex(B)$	Wald statistic	<i>p</i> -value
Constant	1.26	.84	3.51	2.25	.134
Farm Size difference between Small – Medium	.78	.29	2.18	7.2	< .01
Farm Size difference between Small - Large	.86	.40	2.35	4.60	< .05
Tenure	-1.11	.33	.33	11.53	≤ .001
Participation in Other Programs with enrollment of < 10 hectares	1.18	.37	3.26	10.10	< .01
Participation in Other Programs with enrolment of > 10 hectares	.72	.41	2.06	3.14	< .01
Number of Conservation Organizations Worked With	-.00	.14	.10	.00	.991
Level of Education	-.03	.04	.97	.63	.429
Age	-.02	.01	.98	3.04	.081
Amount of Total Income from Farm	-.13	.11	.88	1.43	.232
Total Income	.03	.04	1.03	.78	.134

Table 2.14. This is the model summary of our logistic regression analysis for variables predicting willingness to participate in the Agroforestry PES scenario. The Nagelkerke R^2 approximates the variance which can be predicted by the model (predictive power). -2LL represents -2 times the log likelihood and is a goodness-of-fit test. For a perfect model the -2LL equals 0.

Nagelkerke				
R^2	-2LL	χ^2	df	p-value
.085	286.37	16.62	10	.083

Table 2.15. This is a classification table^{ab} of our logistic regression analysis for variables predicting willingness to participate in the Agroforestry PES scenario. Our model successfully classifies 80% of participants' willingness to participate in this program. The model only successfully predicts those who are willing to participate. The model predicts no one will be unwilling to participate.

Observed			Predicted		
			Participation in Agroforestry		Percentage Correct
			No	Yes	
Step 0	Participation in Agroforestry	No	0	61	.0
		Yes	0	239	100.0
Overall Percentage					79.7

a. Constant is included in the model.

b. The cut value is .500

Table 2.16. Logistic regression analysis model of variables predicting willingness to participate in the Agroforestry PES scenario: Regression analysis provides information about the predictive potential of the independent variable to explain willingness to participate in the given program. The two *Farm Size* and *Participation in Other Programs* variables are binary dummy variables. This recoding is necessary because categorical variables cannot be included in logistic regression. B is the unstandardized logistic regression coefficients (i.e., the log odds). The S.E. represents the standard error associated with a given coefficient. A significant odds ratio - $Ex(B)$ - with a value below one indicates that the independent variable reduces the odds of the respondent being willing to participate; conversely, an odds ratio greater than one indicates an increase in the odds. The Wald statistic is used to test the significance of individual logistic regression coefficients for each independent variable (i.e., the Wald statistic tests the null hypothesis that a given regression coefficient is 0). Significant explanatory regression coefficients in the model are indicated by the associated *p*-value.

Predictor	<i>B</i>	<i>SE</i>	Odds ratio $Ex(B)$	Wald statistic	<i>p</i> -value
Constant	1.32	1.01	3.75	1.72	.190
Farm Size difference between Small – Medium	.03	.34	1.03.62	.01	.938
Farm Size difference between Small - Large	-.47	.46	.75	1.06	.304
Tenure	-.29	.41	1.23	.51	.474
Participation in Other Programs with enrollment of < 10 hectares	.20	.49	1.29	.18	.675
Participation in Other Programs with enrolment of > 10 hectares	.26	.52	1.53	.25	.620
Number of Conservation Organizations Worked With	.43	.21	1.09	3.98	<.05
Level of Education	.09	.05	.99	3.47	.063
Age	-.01	.01	1.11	1.12	.289
Amount of Total Income from Farm	.11	.13	.94	.665	.420
Total Income	-.06	.04		2.07	.150

Figure 2.2. This graph displays the unstandardized logistic regression coefficient B (i.e., the log odds) of variables which predict willingness to participate in the three PES scenarios presented in this study (Forest Conservation, Reforestation, and Agroforestry). A positive B represents that an increase in the given variable results in an increase in the likelihood of their willingness to participate and a negative B represents that an increase in the given variable results in a decrease in the likelihood of their willingness to participate. The Nagelkerke R^2 approximates the variance which can be predicted by the model (predictive power). The starred variables are significant explanatory variables.

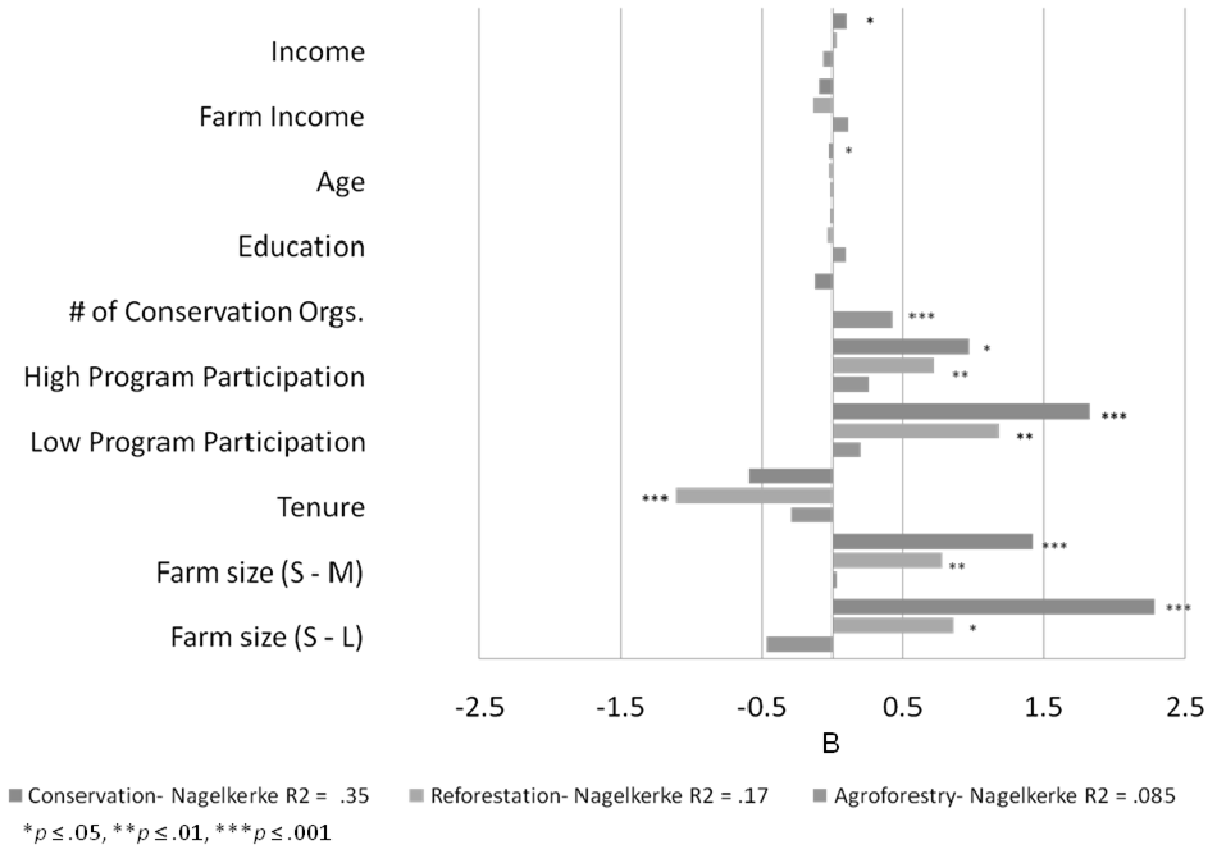


Table 3.1. The table lists literature results for a variety of indicators used in composite measures of socio-economic status.

Source	Indicator									
	Education	Housing Quality/Materials	Income	Ownership of Material Items	Source of Household Water	Toilet/septic system availability	Head of Household Profession	Gas or Electric Stove	Electricity	Number of Household Occupants
Cinner, Daw & McClanhan, 2008	✓	✓		✓		✓	✓			
Cinner, Sutton, & Bond, 2007	✓	✓	✓	✓			✓	✓		✓
Cooke, 2005	✓	✓	✓							
McClanhan, Cinner, Maina, et al., 2008	✓			✓	✓	✓		✓	✓	✓
Rai, Sharma, Misra Sahoo & Malhotra, 2008	✓		✓		✓					
Sahn & Stifel, 2000	✓	✓		✓	✓	✓				
Sayer, Campbell, Petheram, et al., 2007		✓	✓		✓				✓	
Cinner, Daw & McClanhan, 2008	✓			✓		✓	✓			
Cinner, Sutton, & Bond, 2007	✓	✓	✓	✓			✓	✓		✓
Cooke, 2005	✓	✓	✓							
McClanhan, Cinner, Maina, et al., 2008	✓			✓	✓	✓		✓	✓	✓
Rai, Sharma, Misra Sahoo & Malhotra, 2008	✓		✓		✓					
Sahn & Stifel, 2000	✓	✓		✓	✓	✓				
Cinner, Daw & McClanhan, 2008		✓		✓						
Sayer, Campbell, Petheram, et al., 2007		✓	✓		✓				✓	

Table 3.2. Information about the variables selected from the survey to be used in our Socio Economic Status (SES) index¹ is listed in the table.

Variable	Response categories
Income <i>Monthly household income</i>	16 categories from 1 = 'Less than \$100 a month' to 16 = 'More than \$3,500 a month'
Education <i>Head of household highest level of education</i>	15 categories 0 = 'No formal education' Grade levels 1-12 13 = 'Technical school /University' 14 = 'Graduate school'
Electricity <i>Availability of electricity in house</i>	1= 'No', no electricity in house 3= 'Yes', electricity in house
Bath/Plumbing <i>Type of plumbing available in house</i>	1= 'Latrine', no indoor plumbing 3= 'Bathroom', yes indoor plumbing
Cooking Fuel <i>Type of fuel used for cooking in the house</i>	1= 'Wood' 2= 'Kerosene' or 'coal' 3= 'Gas' or 'electric'

1-Response categories are ranked from lowest to highest in terms of contribution to SES status. For education and income, higher response categories correspond to a higher SES score. No electricity and no indoor plumbing score low on the index (scores of 1). Wood, kerosene/coal, electric/gas are listed in ascending order of 'development' level.

Table 3.3. Socioeconomic status index level based on scale attributes and related variables.

Variables in index	SES Index Level ¹			F	<i>p</i> -value	<i>eta</i>
	Low	Medium	High			
Education	5.58	8.02	12.19	174.13	<.001	.730
Income of household	3.03	5.63	10.18	159.00	<.001	.726
Electricity	2.58	2.98	3.00	24.03	<.001	.367
Plumbing	2.31	2.98	3.00	49.18	<.001	.495
Cooking Fuel	2.36	2.96	3.00	41.88	<.001	.462
Related Variables						
Tenure	.67	.83	.94	14.11	<.001	.292
Size of Farm	1.53	1.65	2.03	13.87	<.001	.287

¹ Cell entries are mean scores for respondents.

Table 3.4. Respondent program eligibility across socioeconomic status index.

Variables	SES Index Level ¹			n	χ^2	p-value	Cramer's <i>V</i>
	Low	Medium	High				
Willingness to Participate (Any Program)	85%	87%	90%	271	1.46	.483	.069
Eligibility					30.70	<.001	.314
Yes-eligible	26%	43%	64%	139			

¹ Cell entries are percents of respondents.

Table 3.5. Willingness to participate and program eligibility.

Variable	Eligibility ¹		n	χ^2	p-value	Cramer's <i>V</i>
	ineligible	eligible				
Non-Participant	80%	20%	341	10.103	<.001	.172
Participation_Any	53.5%	46.5%				

¹ Cell entries are percents of respondents.

Figure 3.1. This graph depicts the maximum number of hectares which households are willing to enroll in the forest conservation scenario. Line 1 represents all respondents who indicated that they are willing to participate in the forest conservation scenario and graphs the number of hectares they reported that they would enroll. Line 2 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll. Eligibility as represented in line 2 is based off of affirmative responses to land ownership and possession of land title questions. Line 3 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll when slope requirements are also included in eligibility criteria. Those who are eligible according to the criteria for line 2 and also reported steep slope land on their farm are included in line 3. The dashed line at 10 hectares makes it easier to see how many people would be left out of the program if program requirements included a minimum land enrollment of 10 hectares. We cut off the graph at 40 hectares since the percent of people willing to enroll more than 40 hectares is very low.

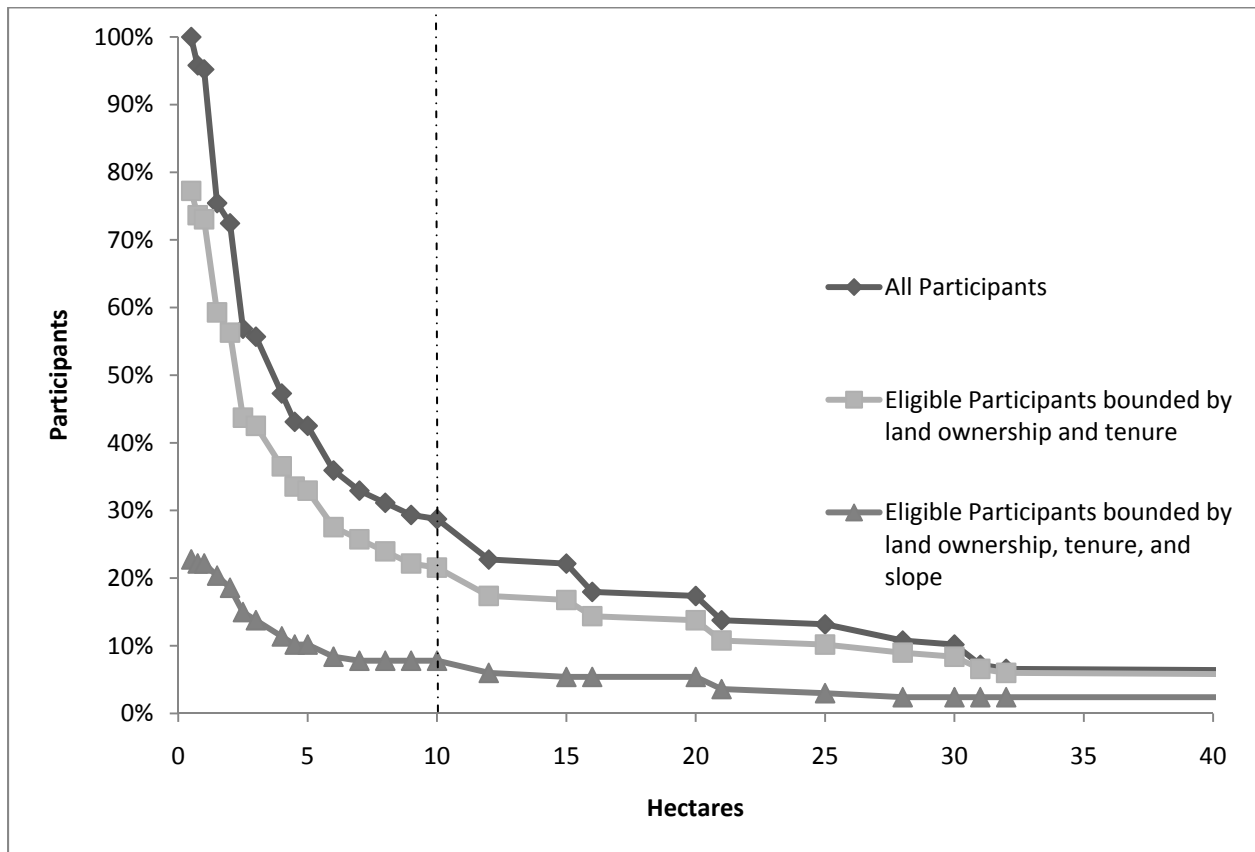


Figure 3.2. This graph depicts the maximum number of hectares which households are willing to enroll in the Reforestation scenario. Line 1 represents all respondents who indicated that they are willing to participate in the Reforestation scenario and graphs the number of hectares they reported that they would enroll. Line 2 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll. Eligibility as represented in line 2 is based off of affirmative responses to land ownership and possession of land title questions. Line 3 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll when slope requirements are also included in eligibility criteria. Those who are eligible according to the criteria for line 2 and also reported steep slope land on their farm are included in line 3. The dashed line at 10 hectares makes it easier to see how many people would be left out of the program if program requirements included a minimum land enrollment of 10 hectares. We cut off the graph at 40 hectares since the percent of people willing to enroll more than 40 hectares is very low.

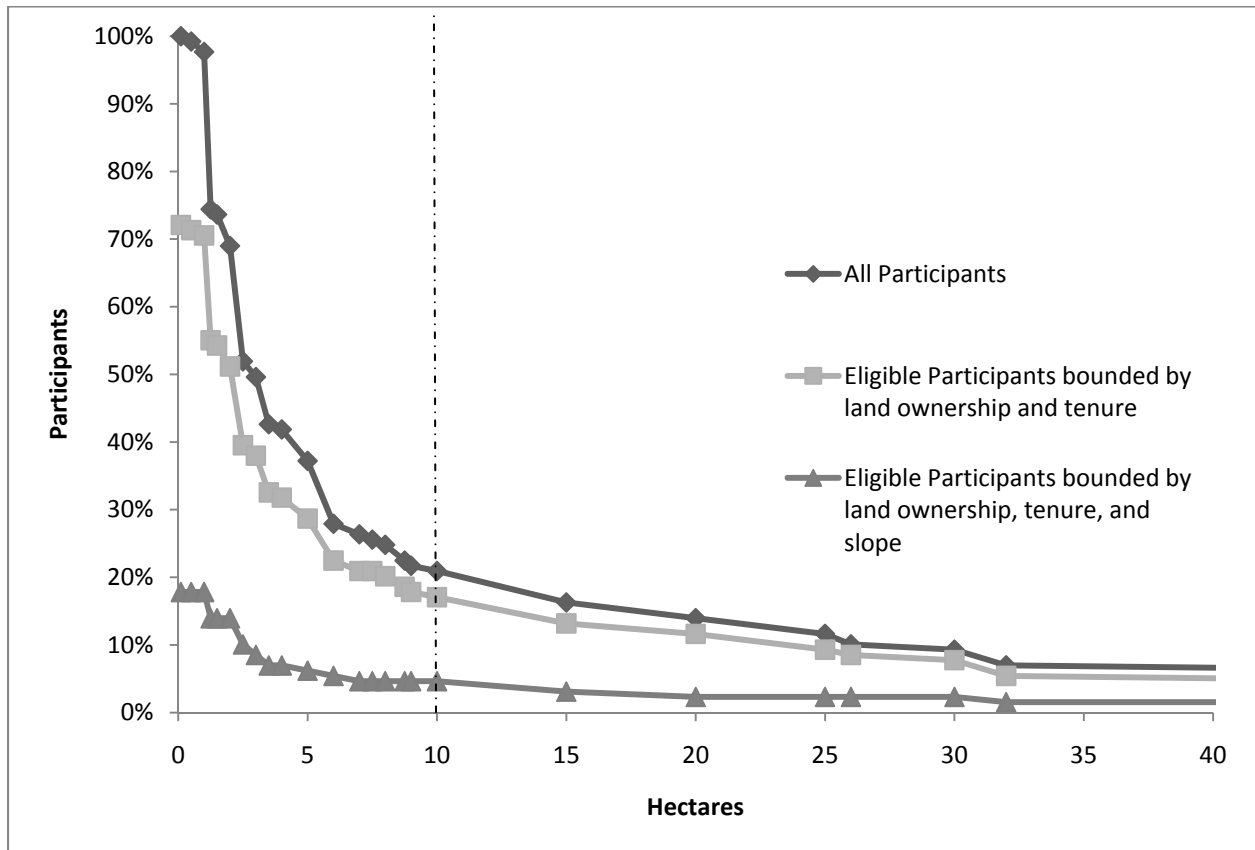
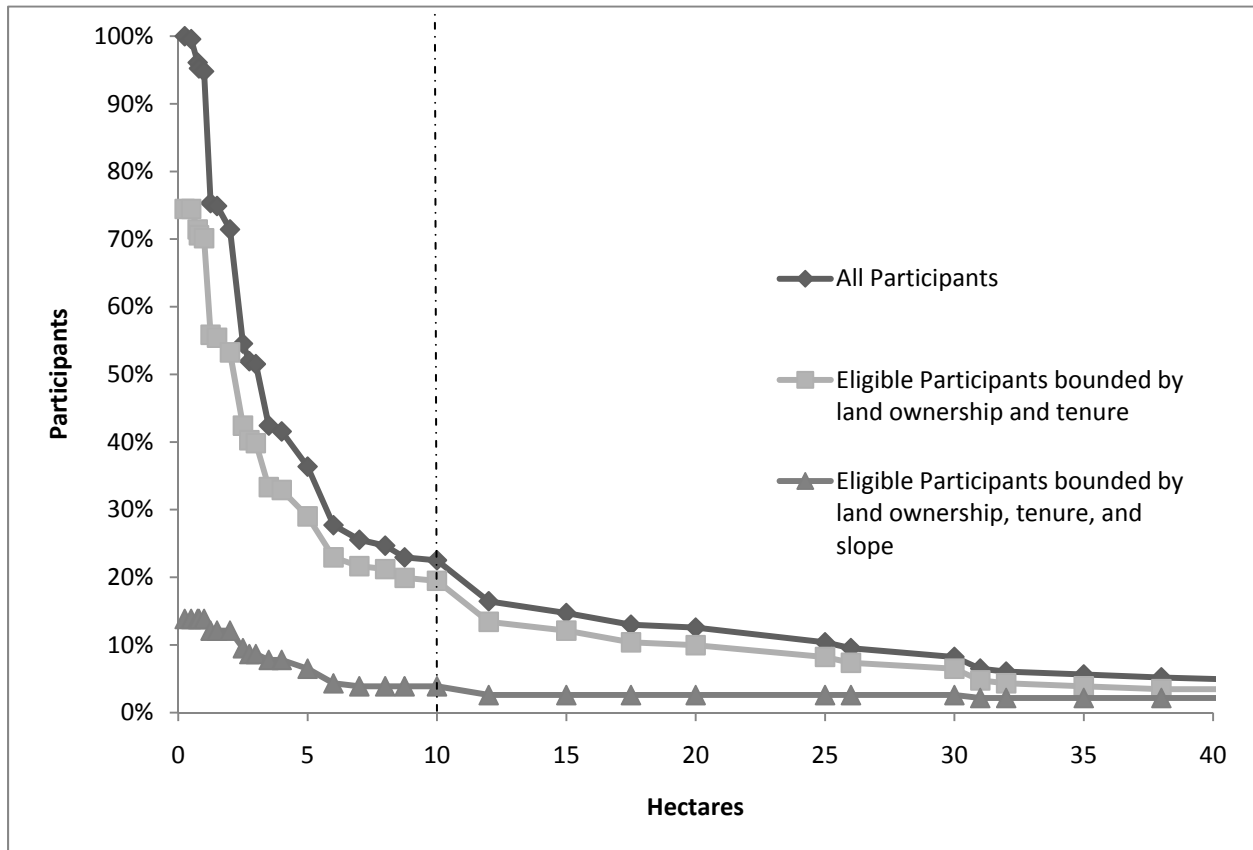


Figure 3.3. This graph depicts the maximum number of hectares which households are willing to enroll in the Agroforestry scenario. Line 1 represents all respondents who indicated that they are willing to participate in the Agroforestry scenario and graphs the number of hectares they reported that they would enroll. Line 2 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll. Eligibility as represented in line 2 is based off of affirmative responses to land ownership and possession of land title questions. Line 3 represents the reported number of hectares that respondents who are likely to be eligible are willing to enroll when slope requirements are also included in eligibility criteria. Those who are eligible according to the criteria for line 2 and also reported steep slope land on their farm are included in line 3. The dashed line at 10 hectares makes it easier to see how many people would be left out of the program if program requirements included a minimum land enrollment of 10 hectares. We cut off the graph at 40 hectares since the percent of people willing to enroll more than 40 hectares is very low.



APPENDIX A

A Case Study: Costa Rica's PSA Program

Costa Rica's national program was one of the earliest large-scale PES programs to be implemented in the developing country context and has been referred to as "probably the most elaborate such system in place in the developing world." (Pagiola, Bishop, & Landell-Mills, 2002, p. 7). This PSA program was initially criticized for not being accessible to low-income populations despite this being a stated goal of the program. Two specific problems that affected the participation of the poor early in the PSA program were lack of land title and delays in payments. Title is often used as proxy for secure land tenure. It is actually secure tenure, and not title that is most important to PES in order to guarantee that the service provider can control the land use. More recently, the law in Costa Rica was changed to facilitate the participation of landowners that lack title (Pagiola, 2008), and the program continues to work on shortening the turnaround time for payments. High transaction costs were another early stumbling block for the PSA program. Applicants had to meet eleven separate requirements (e.g. providing proof of payment of local taxes and that they do not owe anything to the national health system) (Miranda et al., 2003). Many of these requirements had nothing to do with their ability to provide environmental services (Miranda et al., 2003). These requirements have been reduced, by linking FONAFIFO's databases to those of other government agencies (Pagiola, 2008). The 1996 Costa Rican Forestry Law (No.7575) which officially authorized the PSA program specifically identifies income and employment in rural areas as goals of the program and prioritizes support and outreach for small and medium farms (Hope et al., 2005; Miranda et al., 2003). Although the PSA program stated that land parcels anywhere from 1 – 300 hectares would be eligible to apply (Solis, 2001), the National Forestry Finance Fund (FONAFIFO) which directly handles the

payments will only accept parcels of 10 hectares or higher into the program (Hope et al., 2005). The rationale for this revised minimum is that the legal definition of a forest according to the Forestry Law stipulates that it must be at least 10 hectares. Beginning in 2003 the program also required a legal land title deed (Hope et al., 2005).

A brief discussion of how the Costa Rican program has developed and changed over time, offers some useful insights into key issues driving PES program design discussions worldwide.

FONAFIFO, the Costa Rican organization overseeing the PSA program, recently introduced certain modifications to the PSA program in order to increase rural poverty alleviation effects.

The Minister of the Environment, who has engineered the most recent changes in FONAFIFO (Carlos Manuel Rodríguez) said that "...we need to stop viewing the PSA program as merely a tool for preserving biodiversity and promoting the planting of forests. Instead, we need to see it as a tool for rural development that also includes reforestation and biodiversity conservation."

(Hartshorn et al., 2005). Program modifications include the introduction of agroforestry activities as a new PSA program option; the inclusion of land owners without land title to the PSA forest conservation program; and the prioritization of counties having a Social Development Index lower than 35%. Including agroforestry and silvopastoral opportunities in a program can make programs more pro-poor, while requiring formal land title in order to participate is probably the most common anti-poor selection bias. It was in response to increasing concern about this bias that Costa Rica recently reformed their program to no longer require land titles for participation (Wunder, 2008). However, applicants must have a cadastral plan that indicates the boundaries and size of their holdings, and many poor farmers lack such plans (Hartshorn et al., 2005). The land area requirement reforms are also not entirely transparent. The Costa Rican PES

program states that parcels of land from one hectare up to a maximum of 300 ha may qualify for PES payments; however in practice FONAFIFO adopts a qualification threshold of 10 hectares, to be consistent with the minimum legal area of a “forest” as defined by the Costa Rican forestry law. This effectively excludes small farmers so FONAFIFO has historically tended to allocate . Also for all of the program types, properties may need to be over approximately 10 ha to make it worthwhile to incur the transaction costs involved. This is because total payments are calculated on the basis of forest area protected, whereas the transaction costs of enrolment are similar for both large and small forests (Pagiola et al. 2005). Perceived ecological benefits associated with conserving large forest tracts may also increase program administrator bias toward soliciting these contracts (Zbinden & Lee 2005). FONAFIFO has attempted to address some of these issues by allowing *contratos globales* (a system of collective contracting). Using this system, a group of small farmers can join the PSA program collectively rather than individually, thus spreading transaction costs across the group (FONAFIFO, 2000). While a great idea in concept, this approach ran into problems in practice when noncompliance by a single group member resulted in payments being halted to all members. The approach has since been revised to process the applications of such groups together, but then issue individual contracts. This avoids the partial compliance issue, but also results in much smaller savings in transaction costs. Also, they recently increased PSA reforestation payment rates and extended the payment grants to large and medium land holders (Hayward, 2005; Hope et al., 2005; Solis, 2001) period from 5 to 10 years (FONAFIFO 2008). These changes may attract more farm-dependent landowners to the program.

APPENDIX B

Payment for Environmental Services Feasibility Study – Farmer