Understanding Smallholder Participation in Ecosystem Service Payments: The Case of Costa Rica

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Abstract

This paper uses household survey data to examine the factors associated smallholding households that enroll in Costa Rica's longstanding payments for ecosystem services (PES) program. To date, most evaluations of this sort have focused on larger landowners with relatively few studies that consider smallholders specifically. The study finds that smallholders enrolled in PES tend to be older, wealthier, and have access to non-farm salaried income. These features match enrollment patterns of larger landowners in that enrollees tend to be relatively wealthy and only marginally engaged in agriculture. In addition, smallholders on state agrarian reform lands are significantly less likely to enroll in PES. These results show that targeting PES toward smaller landowners does not necessarily equate to a policy that reaches the rural poor, and suggests that further work is needed to address the access barriers to this program for economically marginal landowners.
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INTRODUCTION

Payments for ecosystem services (PES) is a rapidly proliferating conservation policy mechanism in which farmers are compensated for the ecological services—such as carbon sequestration and hydrological services—their forested land provides. Within much of the already voluminous literature on PES, one strand of scholarly debate is centered on the question of what the end goals of the program can, and should, be (Pagiola 2006; Wunder 2006; Fletcher and Breitling 2012; Milne and Adams 2012; McAfee 2012). One understanding of PES is that it is supposed to be an economically efficient way of protecting forests (Engel et al. 2008). Thus, efficiency requirements mean that payments should mostly go to large landowners and cover more land with the lowest transaction costs. This is a view espoused by some economists at the World Bank (e.g., Pagiola et al. 2005; Pagiola 2006), however, it is contested on a number of fronts. First, some scholars, such as Sven Wunder, point out that if the efficiency criteria alone guided PES implementation, then the program would be less likely to survive politically. Instead, a range of landowners—large ranchers, indigenous peoples, and smaller

farmers—should be included in order to form a more robust political coalition that supports the policy (see Wunder 2007). Other scholars have made normative arguments that the inclusion of social criteria for payments is not only good politics but is also something that should occur if the program involves state funds or institutions (McAfee and Shapiro 2010; Matulis 2012). In practice, this is indeed occurring, and many countries now include considerations of rural poverty as a means for guiding enrollment in and implementation of PES (McElwee 2012; Lansing 2013).

It is not always clear, however, that marginalized landowners will enroll in the program, even if poverty reduction is a goal. PES programs often have heavy state involvement (McElwee 2012), and therefore landowners need to engage with state institutions and regulations in order to access the program. Research on various access regimes to forest resources have shown how a household's ability to use or access resources often involves a process that favors well-connected and wealthy landowners at the expense of smaller, poorer farmers (Ribot and Peluso 2002; Larson and Ribot 2007). A similar idea can be transposed to smallholder engagement with PES. Where the ability to access payment compensation for forested land requires engagement with state agencies, access to this program will be limited to more wealthy households at the expense of more marginalized landowners. A study by Zbinden and Lee (2005) on Costa Rica's PES program has shown this proposition to be the case. Their analysis of PES contracts found that enrollees were mostly limited to larger landowners, and that this was due to the financial burdens and cultural capital required to navigate state requirements for program enrollment.

Engagement with the state, however, is not the only factor that affects enrollment patterns. Other researchers have pointed to land qualities and household microeconomic decision-making as motivations for enrollment. In a survey of farmers, Arriagada et al. (2009) found that a combination of poor environmental conditions for agriculture and the opportunity cost calculus of landowners drives the decision to enroll in Costa Rica's PES program. In addition, Sierra and Russman's (2006) study of participating landowners in Costa Rica's Osa Peninsula shows that enrollment in the program accelerates land abandonment that is already underway, and that participating farmers are likely taking advantage of a program that compensates them for a land use trend that is already occurring.

Both of these studies have focused on large landowners to the exclusion of smallholding landowners. I suggest here that smallholders should be considered specifically in the context of ongoing discussions and policy decisions that are transforming PES into a dual conservation and poverty-alleviation program. For example, the Costa Rican state has made a number of efforts to target more marginalized landowners, such as including a modality that makes payments for agroforestry practices and changing its prioritization guidelines to focus on payments to areas with low social development indicators (Porras 2010). The agroforestry modality was especially targeted toward smaller landowners, who may not be able to dedicate a large block of land to forests (which the other payment types require), but can dedicate the interstitial spaces of their property—such as fence lines, and areas between crops—to tree plantings. A small landowner, however, does not necessarily equate to a marginalized or poor one, and so it is important to understand the relative wealth, livelihood, and land use factors that are associated with smallholders who currently do enroll in PES.

Current research on smallholder engagement in ecosystem service payments suggests a number of multifaceted logics that might drive a smallholding landowner to enroll in a program of PES. For example, Osbourne's (2010) work on carbon forestry projects in Chiapas found that economic and ecological factors did not drive smallholders to participate in PES, but instead, enrollment was driven by reasons of land security—participation in the program would formalize access to culturally mediated, and communally owned, forms of property in an environment of rapid changes to the property system (see also Mahanty et al. 2013; Whittman and Caron 2009). Daniels et al.'s (2010) review of Costa Rican studies of additionality has also speculated that similar motivations for land security drive enrollment among some landowners in Costa Rica. Such a claim, however, remains theoretical, and has not been empirically evaluated.

This paper's aim, therefore, is to contribute to scholarly debates about including smaller, and more marginalized, landowners by assessing kinds of smallholders that enroll in PES. To do so, I draw on household survey data in order to examine the factors that lead to smallholder (<35 hectares) participation in Costa Rica's PES program. In so doing so, I address two research questions. First, what are the differences between enrolled smallholding households and nonenrolled households? Second, what are the household-level factors that are associated with PES enrollment? The overall goal is to address these questions and determine what kinds of smallholders enroll in PES. In addressing these questions, this paper aims to determine, to the extent that PES reaches smallholders, whether the engagement of smaller landowners with PES can be equated with the policy's goal of reaching the rural poor. I find that smallholders enrolled in PES tend to be older, wealthier, and have access to non-farm salaried income. These features match patterns of larger landowner enrollment in that enrollees tend to be relatively wealthy and only marginally engaged in agriculture. In addition, smallholders on state agrarian reform lands are significantly less likely to enroll. These results suggest that targeting PES toward smaller landowners does not necessarily equate to a policy that reaches the rural poor, and further efforts are needed to address the access barriers to this program for economically marginalized landowners.

STUDY SITE AND METHODS

The present study was conducted in Costa Rica's Atlantic Plain, in Sarapiquí, Siquirres, and Guácimo districts. These areas were chosen because they are the home of two nongovernmental organizations (NGOs) that have been active in enrolling landowners in PES, one of which often targets smallholding landowners, and have had a great deal of success in enrolling smallholding farmers. Seven study sites were chosen. Three are current Agrarian Reform Institute (Spanish Acronym: IDA) settlements, while four are former IDA settlements. In addition, a small number of farmers were surveyed who are not a part of any of these settlements, but are on lands that are located close by. IDA is a state agency established in the 1960s as a response to political pressure over land inequality in the country. IDA operates by purchasing a large tract of land and subdividing it, and installing infrastructure (roads, schools, electricity, etc.). Land is then given to a household, who then pays IDA back for the land at low rates of interest over a period of 15 years. During this time, IDA landowners are not allowed to sell, or rent, their land. After the 15-year period, landowners may sell the land if they wish. Households

that are in a former IDA settlement have no restrictions on the sale or purchase of their land.

To understand the household-level factors that contribute to PES participation, I conducted a livelihoods and land use survey in August 2012. Farmers were queried on household demographics and household assets, as well as sources of on-farm, nonfarm, and off-farm income. The survey was piloted among ten households to test for relevance and clarity of questions. Income from nonfarm and off-farm employment were corroborated through interviews with management at plantations, schools, government agencies, and various other businesses. Following a procedure of rapid rural appraisals developed by Adams et al. (1997; see also Takasaki et al. 2000), in which households were assigned a wealth category by key local informants based on the household's asset and income profile.

Data were coded and analyzed in Stata, and were used to answer the question of who enrolls in PES by carrying out four steps. First, I carried out statistical tests for differences in demographic, land use, and income sources between enrolled households and nonenrolled households. Second, I examined differences in variables associated with household wealth categories to better understand the role of household wealth in shaping PES enrollment. Third, I constructed a logit regression to understand how these variables interact together, and to identify the household-level factors that are the most predictive of PES enrollment. Finally, to better understand livelihood differentiation among households and its relationship to PES enrollment, I conducted a principal factor analysis of variance on key land use, livelihood, and demographic variables to understand the main livelihood types among the sample population. To do this, I chose ten key asset, demographic, land use, and income variables and standardized them prior to running the factor analysis. The resulting significant factors were then transformed into a mean score for each household, and this score was correlated with PES enrollment. The resulting correlations are meant to better gauge which livelihood typologies are most associated with this program.

RESULTS

Differences between enrolled smallholding households and nonenrolled households

A comparison of enrolled and nonenrolled households shows a number of statistically significant differences across demographic, asset, income, and land use variables. The survey found significant differences in PES participation across wealth categories: 15% of "poor" households participate in PES and 16.9% of "medium" households do so, while 31.5% of "wealthy" household participate in the program (ANOVA p-value: .097). In addition, many of the differences between PES and non-PES households can also be seen across household wealth categories, with "wealthy" households mirroring "PES households" in a number of ways. Thus, in this section household-level differences between PES and non-PES households will be discussed in the context of differences seen between households of particular wealth categories as well.

Statistically significant differences in the age of household head, time since household formation, and the education level of the household head all show that households enrolled in PES were significantly older and more educated than non-PES households. Despite the differences in the household's age, there were not significant

differences in the numbers of adult-age men or women, nor in the number of children in the household. Thus, while PES households tend to be older, they generally have the same level of adult labor available as non-PES households.

In terms of land use differences, PES households have larger farms than non-PES farms (11.8ha vs. 6.8ha; sig. .000). PES households also have significantly more forest (5.6ha vs. 1.3ha; sig. .000) and fallow land (land with <5 years fallow; .77ha vs. .1ha; sig. .000) than non-PES households. Non-PES households, however, have more land in pasture (3.76ha) than PES households (2.29ha; sig. .081). In addition non-PES households have more land in cash crops (1.71ha) than PES households (.71ha), although this is not a statistically significant difference (.107). Thus, PES households have a mix of forest and fallow land, while non-PES households tend to be more engaged in agriculture, have cattle, and more land in pasture and cash crops. This difference in land use can be explained, in part, by differences seen in the physical features of the land. Households enrolled in PES have significantly higher average slope to their land, however, such lands tend to be closer to markets as PES households are less distance to the nearest highway than non-PES households (6.8km vs. 11.6km; sig. .002).

Interestingly, there is an inverse relation between a household's relative wealth and land quality (as measured by slope). The average slope of a household's land increases as it becomes wealthier (sig. .0589). Thus, households with high slope are likely to participate in PES, while households with a high wealth category tend to have a higher slope as well. This latter finding is somewhat counterintuitive, but the poor quality land among wealthier households is perhaps mitigated by the household's location in relation to markets. There is a significant difference between distance to nearest highway and a household's wealth category (p-value: .027): the wealthier a household is, the closer they are to a major highway. Despite these differences in land size, quality, and location, there are no significant differences in forest cover between wealth categories. Instead, the biggest differences in land use between wealth categories are with land in pasture (ANOVA sig. = .000). "Wealthy" households have an average of 7.61ha in pasture, while "poor" households have an average of 1.03ha. Other forms of land use, such as cash crops and early fallow, show no significant differences between wealth categories.

An examination of differences in nonfarm income reveals more key differences between PES- and non-PES households. On average, PES households receive more income from professional salaried work ($1,328USD/month) than non-PES households ($781USD/month; sig. .033). While there are no significant differences in income from plantation wage work, there are significant differences in income from nonfarm, non-plantation wage work ("Non-plantation wage," e.g., security guard), this figure was significantly higher with non-PES households ($65USD/month) than PES households ($18USD/month; sig. .057).

These differences in professional salaried income can be seen across wealth categories as well. Household income from professional salaried work is significantly higher for "wealthy" households($321USD/month) than for "poor" ($57USD/month) and "medium" ($136USD/month) household (ANOVA p-value: .002). In addition, "plantation wage work," is significantly higher among "poor" ($108USD/month) and "medium" ($102USD/month) households than with "wealthy" households ($16USD/month; ANOVA p-value: .029). These differences in nonfarm income appear

to track the differences in nonfarm income and PES participation in one way: households participating in PES tend to have more salaried professional income than nonparticipating households.

Finally, differences in households that are living on IDA settlements show parallels between PES participation and wealth categories. Among households with PES contracts, 6.5% are on current IDA settlements, while 30.5% of non-PES households are on IDA settlements (p-value: .003). This pattern, in which IDA households participate less in PES than non-IDA households, can also be transposed to wealth categories, where "wealthy" households tend not to live on these properties. Among households that are "poor," 31.6% are on IDA properties, and among those that are "medium," 29.5% are on IDA settlements. Among "wealthy" households, the percentage is significantly lower, at 10.5% (ANOVA p-value: .046).

In short, differences between PES and non-PES households track differences across wealth categories in some ways, but not others. Both PES households and "wealthy" households tend to have larger farms with higher slope and garner more income from professional salaries than their non-PES and less wealthy counterparts. PES households tend to have more land in forest, but this is not a distinguishing characteristic for wealth categories. Wealthy households tend to have more cattle and land in pasture, while non-PES households have more pasture and cattle than those enrolled in PES.

Household-level factors associated with PES enrollment

In order to examine how these key household-level features and activities translate into PES enrollment, a logit regression was constructed on the binary independent variable "PES enrollment." Four statistically significant variables were positively associated with PES enrollment (table 3). First, the age of the household head was significantly and positively associated with the probability of enrollment in PES (p-value: .003). A 11.4 year increase in the household head's age translates into a 134.9% increase in the probability the household is enrolled in PES (see figure 1). The presence of early fallow was also significantly and positively associated with the probability of PES enrollment (p-value: .005). A .90 hectare increase in fallow means a household has a 98% increase in the probability of being enrolled in PES. A household's monthly professional salaried income is also significantly and positively associated with PES participation (p-value: .016); an increase in $371USD/month from this income source translates into a 73.7% increase in the probability that a household is enrolled in PES. Finally, average slope is a significant and positive variable in predicting PES enrollment (p-value: .013).

In addition to these four positive variables, one statistically significant negative variable was found, a binary variable indicating whether a household is on IDA land or not. If a household has land on a current IDA settlement, it has a 54.1% less probability of enrollment in PES. Together, the significant predictors of enrollment paint a picture of a typical enrollee: older households (indicated by "head age"), with more labor dedicated to nonfarm work ("Professional Salary") and less effort toward current agriculture (indicated by the "fallow" variable). Such a household is also likely not to be on a current IDA property.

Livelihood variation and PES enrollment

In order to understand how the relation between livelihood variables and PES enrollment across the study population, a principal components factor analysis was conducted on ten variables that encompass income, land use, asset, and demographic features of households. After a varimax rotation, seven significant factors were identified (see Table 4 and Table 5). After identifying these factors, households were then assigned a mean factor score for each factor. The mean factor score was then correlated with PES enrollment (see Table 6). Household enrollment in PES positively, and significantly, correlated with the following factors.

- *F1, Land extensive households*: slope (.664), forest cover (.918), land size (.843), hectares in fallow (.436) are all significant variables in this factor. This factor has a 47.2% correlation with PES enrollment (p-value: .000).
- *F2, Educated professionals:* household head's education level (.767) and monthly professional salary (.636) are significant loading variables for this factor. This factor has a 24.7% correlation with PES enrollment (p-value: .002).
- *F5, Older tree plantation households* (correlation: .419): Head age (.403) and tree plantings (.829) are significant loading variables. This factor has a 41.9% correlation with PES enrollment (p-value: .000).

The following factors were negatively correlated, or not significantly correlated, with households enrolled in PES.

- *F3, Cattle households*: hectares in pasture (.775) and number of cattle (.826) are high-loading variables in this factor. This factor has a -10.5% correlation with PES enrollment (p-value: .187).
- *F4, Plantation wage households*: motorcycle ownership (.684) and plantation wage income (.827) are significant loading variables. This factor is -2% correlated with PES enrollment (p-value: .802).
- *F6: Farmers and workers*: hectares in cash crops (.768) and off-farm salary (.680) are significant loading variables. This factor has an 11.5% correlation with PES enrollment (p-value: .149).

These correlations reveal that environmental conditions, household demographics, and the form of nonfarm employment are key factors associated with smallholder enrollment in PES, while more intensive engagement with the agricultural economy—either through plantation wage work, cattle, or agriculture—is less associated with household engagement in PES. The results from the logit regression further confirm these trends, as the significant positive predictive variables—slope, age of household head, and professional salaried work, and fallow—closely mirror the livelihood factors that are correlated with PES.

DISCUSSION

Similarities between smaller and larger landowners in PES participation

In this discussion I will situate these findings with respect to previous research on landowner enrollment in PES. Since previous studies have concentrated almost entirely on larger landowners, this discussion will reflect on the comparisons and contrasts between these two types of landowners. The results show that smallholder enrollment in PES mirrors findings with larger landowners in three key ways. First, are the environmental and land factors that are associated with PES enrollment, where households with high slope and land in fallow tend to enroll in PES. This finding

corresponds with studies of PES among larger landowners by both Arriagada et al. (2009) and Sierra and Russman (2006). Both studies found that higher slope was positively associated with a landowner's enrollment in PES.

Second, the presence of land in fallow among smallholders enrolled in PES has parallels with larger landowners. Unlike slope, however, the interpretation of this variable is more ambiguous. Within the existing literature on PES in Costa Rica, there is disagreement over the relation between a household's land in fallow and their enrollment in the program. Sierra and Russman's (2006) study among larger landowners (30ha-300ha) found a significant association of fallow land with PES enrollment as well. They argued that this is evidence that PES is not necessarily producing additional forest cover, but is hastening a process of agricultural abandonment that is already underway. Daniels et al. (2010), however, suggest a different dynamic is at work. They argue that there are many landowners across Costa Rica who do not engage in agriculture on parts of their land, yet they still periodically burn this land for politicized reasons related to land tenure. This is because current Costa Rican law states that land in forest may not be cut, and any use of this land must be approved by an official Forestry Regent. Daniels et al. (2010) theorize that many landowners burn their land to prevent it from becoming forest, and thus prevent their land from falling under these restrictions. They argue that such forms of land use should be prime targets for PES contracts, as such contracts would solidify the land security of these owners and allow for new forest growth to occur.

The findings of the present study lend some support to both of these theories. The fallow land among PES households in the survey is not protected under a PES contract. This means one of two things: 1) landowners enrolled in PES have already moved toward agricultural abandonment, and existing fallow represents more nonagricultural land beyond the forested land that is under the PES contract or 2) the existing fallow will soon be burned so as to prevent the expansion of forest and to allow for the option of agricultural use in the future. I argue that it is more likely to be the former scenario than the latter. This is because hectares in fallow is significantly and positively correlated with forest cover (29.9%, p-value: .000) as well as PES enrollment (26.3%, p-value: .000). This means that many households with fallow already have land that is, or has become, forest. In addition, they are already enrolled with a state policy (i.e., PES) that restricts use of their forested land. In this context, it seems unlikely that these households will burn their existing fallow land in the future to prevent it from becoming a forest with its attendant state restrictions, when many of these households have already voluntarily placed other parts of their land under the restrictions of PES.

The limitations of the present data mean that this argument is more suggestive than definitive. It is possible that households with both fallow, and PES contracts, would want to maintain their fallow land as potential sites of agriculture, and thus eventually burn off the regrowth on their fallow land. The present study is unable to provide a definitive answer concerning which of these decision pathways are prominent among PES households, but the strong correlation between fallow and PES suggests support for Sierra and Russman's thesis that PES encourages accelerated agricultural abandonment. .

A final pattern in this study mirrors previous work among larger landowners, and that is the association of wealthier households with PES enrollment. Households in the "wealthy" category are enrolled in PES at close to twice the rate of households in the "medium" and "poor" categories. Further, three of the variables in the logit regression—

slope and income from professional salaries—indicate that there is some association between PES enrollment and wealth differentiation among smallholders. Households in higher wealth categories have higher slope and more income from professional salaries than their less wealthy counterparts. In addition, households with high wealth tend not to be located on IDA properties. Similar patterns related to wealth and program participation have been found among studies of larger landowners and PES. Zbinden and Lee (2005), for example, have shown that highly educated, larger, and wealthier households are associated with PES enrollment in Costa Rica. The present study shows how this trend is reproduced among smallholders as well.

Differences between smallholders and larger landowners in PES enrollment

While there are similarities between smallholders and larger landowners in terms of who enrolls in PES, there are also household-level factors associated with PES that appear to be unique among smallholders. Specifically, the role of the household's age, the type of nonfarm activities in which PES households engage, and the role of state agrarian reform are significant factors in shaping the kinds of households that enroll in PES. These factors have not been found in previous studies, and some of them suggest that they are specific to the logics of smallholder agriculture.

The strongest, and most significant, predictive variable for PES enrollment in the logit regression was the age of the household head. This suggests that PES enrollment is congruent with a later-in-life retirement strategy. Quite a large body of research has explored the effects of household lifecycles on patterns of land use, and the role of the household's age (expressed by the headage variable in this study) on land use is quite mixed. For example, Walker et al.'s (2002) review of deforestation studies in the Amazon found only a few studies that showed a relationship between household lifecycle and deforestation, while a number of studies have shown that labor availability is associated with deforestation (Pichón 1991; Rudel and Horowitz 1993). Other empirical work on nonfrontier, or postfrontier, areas (which characterizes this study site) indicates a host of cultural, social, and personal factors that shape the relationship between household lifecycle and its use of the environment. No clear relationship emerges from this literature. Instead, in this context household lifecycles can have quite varied effects on land use change depends on a host of other contextual factors (DeSherbinin et al. 2007). The present study shows persistent differences in the age of the household head between PES and non-PES households, yet similarities in adult labor availability and children between these two groups. This suggests that Chayanovian theories of household lifecycles are inappropriate for understanding the dynamics of forest cover and policy engagement seen here.

Instead, I suggest that the role of head age, along with the significance of professional salary wages in predicting enrollment in PES, indicates a particular kind of smallholder household that tends to enroll in PES. In this case, it is the part-time hobby farmer, or a landowner who is only marginally engaged in agriculture. Follow-up interviews with some farmers did indeed confirm this trend. I interviewed a number of farmers for whom the farm they owned was largely either a weekend reforestation or permaculture project, or a weekend retreat from their job in the city. Not all farmers fit this profile, however, and I interviewed some older farmers who were still engaged in agriculture, but on a reduced scale from before, and they were letting more of their land

revert to forest or switching to less labor-intensive tree crops (for which they receive a PES payment).

A final finding in this study that is not found in existing work among larger landowners has to do with the impact of state agrarian reform policies on smallholder access to this policy. The results of the logit regression show that having land on an IDA settlement is a clear predictor of a household's nonparticipation in the program. This can be for two primary reasons. One is that the economics of land use make conserving one's land in forest economically unviable for IDA farmers. A second alternative is due to the constraints related to the recognition of land tenure that can prevent smaller landowners from enrolling in PES. If a landowner is behind on his or her payments to IDA, for example, he or she may not enroll—this is a common scenario among IDA households. Or, alternatively, if IDA has not yet issued a formal title to the land, the owner would fail to meet one of the requirements to enroll in PES. One final access barrier related to land tenure is that throughout the 15-year history of PES, there has frequently been discord between IDA and FONAFIFO (the agency that administers PES) over whether IDA farmers are allowed to participate in the program (author citation withheld for review). This thumbnail sketch of the problems that IDA farmers confront glosses over a complex history, but it points to how the politics of land recognition can play a key role in deciding whether a smallholder may be able to access PES. It is not impossible for an IDA landholder to access this policy—for example, 6.5% of PES households were on IDA lands, but this was a significantly lower rate of IDA occupancy than non PES households. This difference suggests that IDA households often face extra constraints related to land tenure that others do not, and this is reflected in the lower rates of participation among this group.

CONCLUSION

What kinds of smallholders enroll in PES? The results presented here show that smallholders enrolled in PES both mirror and diverge from the more typical larger landowners that have dominated PES enrollment thus far. They mirror larger landowners in that the smaller landowners who are inclined to enroll tend to be wealthier smallholders, and actual engagement with agriculture appears to be low for many of the smallholders who enroll in PES. Smallholder enrollees are divergent from larger landowners in the strong associations between older households, the household's non-farm income source, and the household's status as an IDA property are strong predictors of enrollment. The latter variable is specific to smallholders, and points to the importance of understanding state-peasant relations in allowing for program participation. PES often involves heavy state support, and an understanding of how landowners might engage with institutions related to PES is critical. What this finding shows is the important role that state institutions outside of PES can play in setting the conditions of participation as well. IDA has little to do with PES, yet the ways in which its settlements are structured has a large impact on the ability of its farmers to realize gains from PES participation.

These results suggest that targeting PES toward smallholding households alone will not necessarily make it an effective poverty-reduction program. Smallholders who enroll in PES appear to be those who are characterized by extensive land assets, greater wealth and relatively lucrative income sources more generally, and thus, one should be careful about using land size as a proxy for poverty. In addition, the kinds of land tenure

issues that arise with landowners who have IDA land—which are typically more marginalized smallholders whom a program with poverty reduction as a goal would want to target—face a gamut of enrollment barriers related to their status as IDA property holders.

As PES programs proliferate, there is justifiably talk about how to design programs that can also have ancillary benefits for the rural poor. What this research suggests is that using "smallholding" landowners as a proxy for the poor or marginalized is insufficient, and could lead to potentially unexpected results. For example, these results suggest that one class of smallholder who is benefitting from PES payments is the professional salaried hobby farmer. If payments are targeted toward smaller landowners, without other checks to assure they are reaching the marginalized, it might appear as if such payments are going toward the rural poor, when in fact they are going toward a relatively well-off class of landowners. If PES appears to be captured by wealthier, and better positioned, smallholders, future work should further investigate the specific governmental and microeconomic barriers that are preventing more marginalized landowners from engaging in the program.

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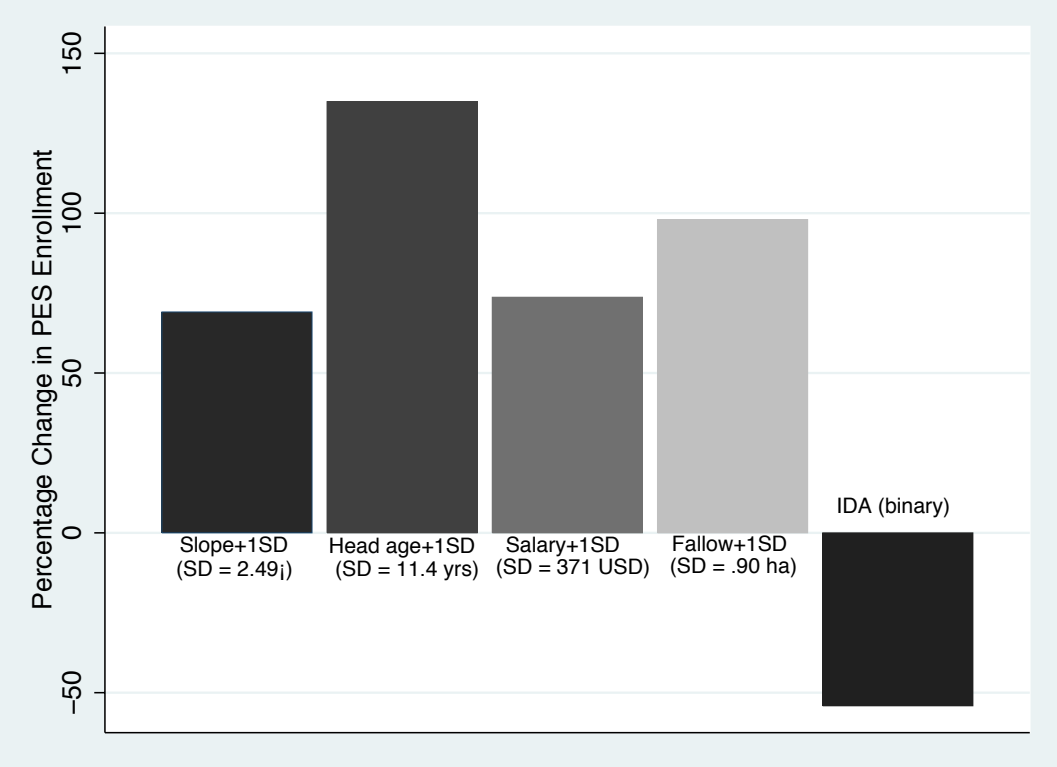

Figure 1: Percentage change in household enrollment in PES. This figure shows the effect of independent variables on the percentage change in the odds ratio that a household will enroll in PES. For continuous variables, each positive bar represents the increase in the odds of a household's enrollment in PES for each increase in the standard deviation of that variable. Standard deviations are listed below the variable in parenthesis. The bar for "IDA" represents the decrease in odds of a household's enrollment if a household is located on current IDA property.

Variable	PES	no PES	t	p-value
Demographics and History				
Head age*** (mean) Standard Deviation (N)[1]	61.26 7.22 (31)	54.45 11.84 (127)	-3.06	0.001
HH formation***	32.68 11.81(31)	25.63 12.53 (122)	-2.83	0.003
Head education**	6.35 4.38 (31)	4.94 3.23 (110)	-1.98	0.025
# working age female	1.5 0.777 (30)	1.41 0.919 (124)	-0.49	0.313
# working age male	1.87 1.2 (30)	1.63 0.879 (124)	-1.23	0.110
# non working age	0.355 0.661(31)	0.551 0.074 (127)	1.22	0.112
Land Qualities and Use				
Land on current IDA property***	6.50% 24.9 (31)	30.50% 46.2 (128)	2.79	0.003
Slope***	5.35 4.04 (31)	3.07 0.148 (128)	-4.92	0.000
Distance to Road (km)***	6.8 6.3 (31)	11.6 8.6(128)	2.92	0.002
Land size (Ha)***	11.8 8.49 (31)	6.83 6.53 (128)	-3.57	0.000
Pasture Ha*	2.29 3.82 (31)	3.76 5.49 (128)	1.40	0.081
# of Cattle	4.8 8.18 (31)	6.8 11.5 (128)	0.89	0.189
Forest Ha***	5.67 8.14 (31)	1.3 2.02 (128)	-5.47	0.000
Fallow (<5 years) Ha***	0.774 1.54 (31)	0.1 0.59 (128)	-3.92	0.000
Cash Crop Ha	0.709 2.25 (31)	1.71 4.31 (128)	1.25	0.107
Non farm income[2]				
Professional Salary (USD)**	1328 2318 (31)	781 1179 (126)	-1.86	0.033
Plantation wage (USD)	66 191 (31)	88 179 (127)	0.60	0.2758
Non-plantation wage (USD)*	18 76 (31)	65 161 (126)	1.59	0.0572

[1]Differences in sample size due to household nonresponse to particular questions.
[2]Income reported in Costa Rican colones. Dollars derived from the monthly average exchange rate for Aug. 2012 (498 colones to 1 dollar).

Table 1: Differences between households enrolled and not enrolled in Costa Rica's PES program.

Variable	Poor	Medium	Wealthy	ANOVA F (p-value)
Demographics and History				
Head age* (mean)	55.1	55.2	57.84	0.445
Standard Deviation (N)[1]	13.3 (59)	10.4 (61)	9.7 (38)	0.063
HH formation	25.62	26.57	30.00	1.400
	14.71 (55)	11.48 (61)	11.03 (37)	0.249
Head education**	4.2	5.52	6.31	4.090
	3.0 (50)	3.79 (56)	3.58 (35)	0.018
# working age female	1.29	1.6	1.37	1.94
	1.04 (56)	.827 (60)	.714 (38)	0.148
# working age male	1.63	1.73	1.66	0.200
	1.07 (56)	.820 (60)	.966 (38)	0.823
# non working age	0.576	0.525	0.40	0.600
	.747 (59)	.906 (61)	.718 (38)	0.552
Land Qualities and Use				
PES enrollment*	15%	16.90%	31.50%	2.37
	36 (60)	37.3 (61)	31.1 (38)	0.097
Current IDA property**	31.60%	29.50%	10.50%	3.14
	46.9 (60)	45.9 (61)	31.1 (38)	0.046
Slope*	2.93	2.5	4.04	2.88
	2.02 (60)	2.68 (61)	2.68 (38)	0.059
Distance to Road (km)***	12.252	10.973	7.624	3.71
	8.482	8.443	7.657	0.027
Land size (Ha)**	6.36	7.45	10.64	4.4
	7 (60)	6.69(61)	7.66 (38)	0.014
Pasture Ha***	1.03	3.29	7.61	23.73
	2.07 (60)	3.86 (61)	7.65 (38)	0.000
# of Cattle***	1.41	5.15	16.55	32.420
	2.61 (60)	5.43 (61)	17.32 (38)	0.000
Forest Ha	1.52	2.48	2.6	1.02
	3.09 (60)	5.17 (61)	4.56 (38)	0.363
Fallow (<5 years) Ha	0.283	0.23	0.158	0.23
	1.11 (60)	0.824 (61)	0.594 (38)	0.797
Cash Crop Ha	1.18	2.08	1.13	0.99
	2.13 (60)	5.65 (61)	2.96 (38)	0.375
Non/Off farm income[2]				
Professional Salary (USD)***	57	136	321	6.57
	183 (58)	317 (61)	549 (38)	0.002
Plantation wage (USD)**	108	102	16	3.63
	189 (59	203 (61)	98 (38)	0.029
Non-plantation wage (USD)	39	85	36	1.91
	115 (58)	181 (61)	136 (38)	0.152

[1]Differences in sample size due to household nonresponse to particular questions.
[2]Income reported in Costa Rican colones. Dollars derived from the monthly average exchange rate for Aug. 2012 (498 colones to 1 dollar).

Table 2: Household differences by wealth category

N	157
LR Chi2(5)	46.22
Prob>chi2	0
pseudo R2	0.2963
Log likelihood	-54.89548

Variable	Odds Ratio	Std. Error	Z	p-value
Slope**	1.234546	0.104471	2.49	0.013
Head age***	1.07755	0.0272549	2.95	0.003
Professional Salary**	1.001488	0.006183	2.41	0.016
Fallow***	2.137182	0.5795961	2.8	0.005
IDA**	0.1680975	0.1494487	-2.01	0.045

Dependent binary variable: Enrollment in PES
<.05 *<.01

Table 3: Logistic regression

Factor	Eigenvalue	Proportion	Cumulative
F1: Land extensive households	2.92267	0.1624	0.1624
F2: Educated professionals	1.841	0.1023	0.2647
F3: Cattle households	1.7423	0.0968	0.3615
F4: Plantation laborers	1.44103	0.0801	0.4415
F5: Older tree plantation households	1.23473	0.0686	0.5101
F6: Cash crop households	1.16894	0.0649	0.5751

Chi^2 (153) = 478.32 (p = .000)

Table 4: Livelihood factors

Variable	F1	F2	F3	F4	F5	F6	Uniqueness
Car ownership	-0.1845	0.2518	0.2319	-0.4597	0.053	0.1031	0.3881
Motorcycle ownership	0.1434	0.0816	0.2309	**0.6844**	-0.1424	-0.0331	0.402
Number of cattle	0.0733	-0.0656	**0.8263**	-0.0194	-0.1426	-0.042	0.3267
Head Age	0.1076	-0.4471	0.3072	-0.1354	**0.4032**	-0.1128	0.3559
Head Education	0.0103	**0.7672**	-0.0224	-0.0006	0.1231	-0.1277	0.424
Slope	**0.664**	0.1787	0.0014	0.0051	0.0382	-0.1191	0.381
Land Size	**0.843**	-0.0406	0.2301	-0.0722	0.0097	0.1517	0.2221
Cash Crops	-0.0196	-0.0473	0.0097	0.0913	-0.001	**0.7682**	0.4134
Fallow Ha.	**0.4355**	-0.1578	-0.387	-0.0937	-0.1305	-0.3107	0.4821
Forest Ha.	**0.9183**	0.0662	-0.0041	0.0702	0.0487	0.0663	0.1728
Subsistence Ha.	0.0895	0.0982	0.0134	-0.1192	0.0619	-0.0936	0.2025
Pasture Ha.	0.1069	0.037	**0.7751**	0.0767	-0.0531	-0.0105	0.3958
Tree plantings Ha.	0.0327	0.1734	-0.2003	0.1129	**0.8297**	0.1621	0.3847
Plantation wage	-0.1151	-0.0055	-0.0407	**0.8266**	0.2059	0.0889	0.3032
Professional salary	0.0859	**0.6356**	0.057	-0.0839	0.3658	-0.1919	0.377
Nonprofessional wage	0.1222	0.1173	-0.0866	-0.2309	-0.3992	0.3957	0.5429
Off farm salary	0.2752	-0.1586	-0.0799	-0.0323	0.4166	**0.6804**	0.3456
Pension income	-0.1274	-0.663	-0.0038	-0.0396	0.2122	-0.1228	0.4277

Figures in bold are significant loadings.

Table 5: Livelihood factor loadings

Factor	PES	p-value
Land extensive households*	0.472	0.000
Educated professionals*	0.247	0.002
Cattle households	-0.105	0.187
Plantation laborers	-0.02	0.802
Older tree plantation households*	0.419	0.000
Cash crop households	0.115	0.149

* significant at <.01

Table 6: Household mean factor score correlations with household PES enrollment