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Paying for Environmental Services: An Analysis Of Participation in Costa Rica's PSA Program

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Summary. — Costa Rica has long been a leader among developing countries in the design of and experimentation with innovative environmental programs. Since 1997, Costa Rica's "Pagos de Servicios Ambientales" (Payments for Environmental Services) Program has provided payments to more than 4,400 farmers and forest owners for reforestation, forest conservation, and sustainable forest management activities. Econometric analysis of a survey of farmers and forest owners, including both PSA participants and nonparticipants, shows that farm size, human capital and household economic factors, and information variables significantly influence participation in PSA program alternatives. Large farmers and forest owners are disproportionately represented among program participants.

Key words — environmental payments, program participation, forest conservation, conservation programs, Central America, Costa Rica

1. INTRODUCTION

Natural resource depletion and deforestation have become major threats to the environment and economies of many developing countries. In Central America, deforestation rates have been estimated at about 2% annually in recent decades, among the highest in the world (FAO, 1997; Kapp, 1998; Utting, 1997). Throughout the region, deforestation has caused severe problems of soil erosion, soil fertility loss, watershed deterioration, and the destruction of coastal fisheries habitats, all with adverse effects on the livelihoods of much of the region's rural population (De Groot & Ruben, 1997).

In Costa Rica, the subject of this study, rapid forest loss in the 1950–1970s was driven by many factors: rapid road expansion, credits for cattle exports, and land titling laws that rewarded deforestation (Kaimowitz, 1997). By 1986, the country was one of the most deforested in the region, with an estimated remaining forest cover of only 29% (Chomitz, Brenes, & Constantino, 1998). The rate of forest loss decreased considerably in the 1990s, to an estimated 16,000 hectares annually (World Bank, 2000); however, more than half this loss was of remaining primary forests. Large-scale loss of forest cover has many adverse effects. Concerns have been expressed about the sustainability of national timber supplies (Segura, Gottried, Miranda, & Gómez, 1997). Forest

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loss threatens small- and medium-sized timber-related firms and leads to an outflow of foreign exchange. Kishor and Constantino (1993) have estimated that nearly two-thirds of Costa Rica's land deforested since 1966 is not suitable for purposes other than forestry, so if land inappropriate for agricultural production is cleared, soil erosion problems are likely. Deforestation-induced soil erosion and run-off are also of critical importance to hydropower generating plants (Orozco & Ruiz, 2001). Loss of primary forest also jeopardizes biodiversity and the country's scenic beauty, potentially threatening Costa Rica's attractiveness for tourism, which is now the country's largest source of foreign exchange.

Recognizing the growing severity of these environmental problems, Costa Rica has become a pioneer in policy innovation dealing with deforestation (World Bank, 2000). In the past, Costa Rica established a number of forestry programs that employed direct and indirect subsidy-based incentive instruments to promote reforestation (Segura Bonilla, Kaimowitz, & Rodríguez, 1997). In 1996, the country went even further, adopting a new forestry law (No. 7575) that explicitly recognizes the environmental services provided by forests (Chomitz *et al.*, 1998). This law laid the groundwork for the introduction of a new national forest strategy transforming earlier reforestation incentive programs into a new policy framework called "*pagos por servicios ambientales*" (PSA, or "payments for environmental services") (World Bank, 2000). Government programs that reward landowners for conservation behavior are common in industrialized countries. Well-known examples include the Conservation Reserve Program (CRP) and Environmental Quality Incentives Program (EQIP) in the United States, and similar programs in the European Union. But Costa Rica's program is unusual for developing countries, and indeed has recently been termed "probably the most elaborate such system in place in the developing world." (Pagiola, Bishop, & Landell-Mills, 2002, p. 7). The PSA program allows private forest owners to be compensated for the services they provide through activities such as reforestation, sustainable forest management, and forest conservation. The program has multiple objectives, including conservation of remaining natural forests, promotion of forest resources for timber production for industrial purposes, income and rural employment generation, and fostering agroforestry activities among small and medium land holders (Fondo National de Financimiento Forestal (FONAFIFO), 2002).

In their recent review of global market-based programs for forest conservation and development, Pagiola *et al.* (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). All of these elements are relevant to Costa Rica's PSA program. Given the importance of this program and the attention it has received in environmental policy circles, understanding participation in the program is vital for future forest policy decisions in Costa Rica and can inform policy decisions in other countries considering similar policies. This study examines participation in the PSA by identifying the factors that motivate farmers, households and landholders to participate in the three PSA program modalities. The analysis employs a survey-based approach to comparing program participants and nonparticipants. The results provide significant insights into the economic, household, and land-use factors influencing landowners' program participation decisions of relevance not only to Costa Rica but elsewhere.

2. THE COSTA RICAN SYSTEM OF PAYMENTS FOR ENVIRONMENTAL SERVICES

Costa Rica's system of payments for environmental services (PSA) is the result of a more than two decades-long evolution of the country's forestry policies. During 1979–92, Costa Rica implemented a series of programs to promote reforestation including income tax deductions and tax offsets, credits, and municipal forestry funding. In the early 1990s, forestry legislation introduced new incentive-based programs to promote sustainable forest management and forest protection and to "democratize" the reforestation incentive program (Segura, 1992). These programs were the direct predecessors of the current PSA programs (Camacho Soto, Segura Bonilla, Reyes Gatjens, & Miranda Quirós, 2002). With a cumulative funding volume of over $100 million, the pre-PSA reforestation incentive programs resulted in about 109,000 hectares of reforested land in the period during 1979–96 (World

Bank, 2000, based on data from FONAFIFO). The programs demonstrated considerable impacts but were plagued by numerous problems in design and execution (Thacher, Lee, & Schelhas, 1997) and posed an increasing burden on the country's budget (World Bank, 2000).

The major recent innovation in the new forestry law (No. 7575) that constitutes the legal and institutional framework for the PSA system is the implementation of "polluter pays" and "beneficiary pays" principles to the financing of the national forest strategy. This represents a shift away from nationally funded subsidies toward market-based financing mechanisms (Camacho Soto *et al.*, 2002; Heindrichs, 1997). The forestry law explicitly recognizes four environmental services provided by natural forests and forest plantations: (a) carbon sequestration, (b) protection of watersheds, (c) biodiversity conservation, and (d) the provision of scenic beauty. Under this framework, private land and forest owners can be compensated for providing these services. The law also defines program financing sources, including a tax on fossil fuels, revenues from selling tradable Carbon Offset Certificates (CTOs), revenues from hydroelectric companies which benefit from watershed services, and state funds for forest conservation.

The incentive modalities for forest- and landowners were adapted from previous programs and consolidated into three major program instruments promoting (i) reforestation, (ii) sustainable forest management, and (iii) forest conservation (Campos, Finegan, & Villalobos, 2001; Rodríguez, 2002). Table 1 presents the basic characteristics and payment schemes of the three modalities. Each program has eligibility requirements well as requirements that must be fulfilled during the contract period. A landowner can participate in the *reforestation program* by assigning a certain part of his land to tree planting. The landowner then has to maintain a threshold survival rate (>85%) in order to receive program payments. *Forest protection* includes a contract in which the forest owner transfers his/her forest use rights to the government for the contract period. The forest owner is not allowed to log timber or otherwise use the forest during this period. In some cases, the government requires a fence around the forested area to prevent cattle from entering. *Sustainable management* emphasizes the selective harvest of timber. First, an inventory of trees is taken and a detailed logging plan is established. Only valuable trees beyond a certain diameter are marked for cutting. Limited access roads are the laid through the forest plot, and timber extraction is done with as little disturbance as possible. After harvesting, the forest is left for 10–15 years for regeneration.

By law, forest engineers (*regentes forestales*) and forestry organizations act as intermediaries between landowners and the government. They establish a management plan for each area proposed for inclusion and also perform control and enforcement tasks during the contract period. Project documents and various forms of proof of legal land status must be submitted to the National System of Conservation Areas (SINAC) for approval (Rodríguez, 2002). The approval information is forwarded to the National Forestry Financing Fund (FONAFIFO) which disburses payments to land and forest owners after project approval. Each year, a decree is issued that sets priority guidelines for approving projects. Most projects are submitted by individual private landholders, but local

Table 1. *Program modalities of the Costa Rican system of payments for environmental services*

Program modality	Name(s) of instrument[a]	Total payment (US$ per ha)[b]	Contract period (years)	Contract area		Disbursement	
				Min. ha	Max. ha	Years	% Distribution pattern per annum of total payment
Reforestation	CAF, CAFa	$623	15	1	–/10[c]	5	50, 20, 15, 10, 5
Sustainable management	CAFma	$384	10	2	300	5	50, 20, 10, 10, 10
Forest protection	CPB, CCB, CAFma-2000	$241	5	2	300	5	20, 20, 20, 20, 20

Source: Adapted from Chomitz *et al.* (1998).
[a] Also referred to as PSA-Reforestation, PSA-Management, and PSA-Protection.
[b] Average total payment in nominal US$ during 1997–2001 (Rodríguez, 2002).
[c] CAFa, created for small and medium landholders has a maximum area of 10 hectares; CAF is unlimited.

forest organizations can "bundle" a number of smallholder projects and submit them as "global projects" (*projectos globales*). The rationale for such global projects is that local forest organizations serve as intermediaries between the government and landholders, reducing transaction costs by "wholesaling" collections of individual projects and thus making participation more attractive for small and medium-sized landholders (Chomitz *et al*., 1998).

During 1997–2001, the PSA program had a significant impact in terms of area submitted by land and forest owners. By 2001, the total area submitted to the PSA amounted to more than 284,000 hectares, corresponding to roughly 5.5% of Costa Rica's entire national territory (Table 2). Over 4,400 farmers and forest owners benefited from the program. Table 2 also illustrates that the large majority of the area receiving PSA payments was under the forest protection modality (84.2%). This contrasts with the distribution pattern in the pre-PSA period, in which reforestation was the major forest activity supported (Camacho Soto *et al*., 2002). The program consistently has experienced a significant excess demand for contracts. During the field research reported here (conducted during mid-2002), the government of Costa Rica cancelled the sustainable forest management option. Despite this fact, this study included this program option given that it was in operation during the prior study year, 2001.

3. FACTORS INFLUENCING FORESTRY PROGRAM PARTICIPATION

The literature on forestry and agroforestry, program participation, and agricultural technology adoption provides insights that are relevant to landowners' decisions regarding participation in the PSA program. Many economic, household, and farm-related variables have been commonly identified as determinants of adoption or participation. Farm size or area managed by the decision-maker, for example, is typically hypothesized to be positively associated with program participation in many studies (Ayuk, 1997; Caveness & Kurtz, 1993; Chambers & Foster, 1983; Nagubadi, McNamara, Hoover, & Mills, 1996; Thacher *et al*., 1997). Because of sufficient production capacity and incomes, farmers having large landholdings typically have greater flexibility to engage in new activities including innovative government programs (Nowak, 1987).

Many studies have highlighted the importance of land and tree tenure for promoting long-term investments and activities such as adoption of agroforestry systems and program participation (Godoy, 1992; Hyman, 1983; Schuck, Nganje, & Yantio, 2002). Limited tenure rights are often a significant constraint in forest activities in the developing world (Godoy, 1992). Since legal land title is required in all three PSA program modalities, the issue is directly relevant to this study.

Other studies have examined the relationship between land and soil quality and program participation, revealing mixed results (Adesina & Chianu, 2002; De Souza Filho, 1997; Mortensen, Leistritz, Leitch, & Ekstrom, 1988). Land quality and slope characteristics may influence the participation decision in all three PSA programs. Slope may influence farmers' decisions whether to participate in forest protection or sustainable management by generating higher harvesting costs in the case of forests located on sloped land. It is also plausible to assume that a farmer would choose to reforest marginal land within his or her farm system.

Labor demand, availability and allocation are often found to be central in determining

Table 2. *Areas submitted to payments for environmental services and beneficiaries during 1997–2001*

Program modality	Area (ha)					
	1997	1998	1999	2000	2001	Total
Forest protection	88,829	47,803	55,776	26,583	20,629	239,620
Reforestation	4,629	4,4911	3,8802	2,456	3,281	18,737
Sustainable Mgmt.	9,324	7,620	5,124	–	3,997	26,065
Total	102,783	59,915	64,780	29,040	27,907	284,422
No. of beneficiaries	1,531	1,021	925	501	483	4,461

Source: MINAE (2002).

technology adoption and program participation decisions. De Graaff (1993), for example, states that a household optimizes its consumption and saving opportunities in part through the allocation of family labor. A number of studies have confirmed the significant influence of labor allocation in determining program participation or technology adoption (Ayuk, 1997; Neupane, Sharma, & Thapa, 2002; Scherr, 1992). For example, agroforestry may be an attractive option in the long run when family labor is scarce. Reforestation and sustainable management are labor-intensive in the short run, but may be perceived as a way to decrease labor demand in the long run if labor is more profitable when employed off-farm. Some studies have confirmed the influence of income and debt on a particular adoption or participation outcome (Sureshwaran, Londhe, & Frazier, 1996; Thacher *et al.*, 1997). Incentive payments may be perceived as a way to reduce short-term liquidity constraints and thus positively influence the participation decision.

Many participation and adoption studies have confirmed the role of household head or decision-maker characteristics such as age and education on the participation decision (Ayuk, 1997, Chambers & Foster, 1983; Nagubadi *et al.*, 1996; Rahm & Huffman, 1984; etc.). Because decision-making is an activity intensive in human capital variables such as age and education, these are often significant in influencing the participation or adoption decision. Education is related not only to the ability to obtain and process information, but is often conducive to implementing knowledge-intensive conservation and sustainable agricultural technologies (De Souza Filho, 1997). The role of age is more ambiguous because age as a proxy for experience may be offset by a greater reluctance to try new things, including new technologies or government-sponsored programs.

A broad spectrum of adoption and participation studies have also examined the role of information access and diffusion. Adesina and Chianu (2002), Adesina, Mbila, Nkamleu, and Endamana (2000) and Thacher *et al.* (1997), for example, all found information access and diffusion to be positively related to the adoption of reforestation and/or agroforestry activities. Since effective participation in market-based incentive programs requires a high level of knowledge, the issue of information and access is directly relevant to this study. Some studies have analyzed and discussed motivational and attitudinal aspects of agroforestry program participation (Arnold, 1992; Hosier, 1989; Thacher *et al.*, 1997). Hyman (1983) has focused on the motivations for commercial timber production. Most studies indicate farmers and forest owners are motivated by a diverse set of benefits, including economic program benefits, the production of multiple outputs such as timber, fuel wood, fruits and nuts, as well as expected soil improvement benefits. Gregersen, Draper, and Elz (1989) conclude that "farmers compare the expected net benefits [of agroforestry] with the benefit they could obtain from using their land, resources and time in the next best use in the farming system." This opportunity cost approach is relevant here, since participation involves landowners' tradeoffs of expected net program benefits with the opportunity costs of participation.

4. ESTIMATION PROCEDURES

The methodology for this research draws from the previous literature on the economics of technology adoption and farm and forestry program participation. Participation in agricultural and forestry programs has been modeled for farm resource management in the United States (Boisvert, Nelson, & Bailey, 1988; Chambers & Foster, 1983; Lee & Boisvert, 1985) and for participation in reforestation programs in Costa Rica (Thacher *et al.*, 1997). Much research has been done in the developing world on agricultural technology adoption (Adesina & Chianu, 2002; Adesina *et al.*, 2000; Ayuk, 1997). Modeling technology adoption and program participation is similar in many ways since both approaches involve modeling a binary outcome dependent on a set of hypothesized behavioral determinants.

The decision of a land or a forest owner to participate in a forest promotion program can be analyzed with a binary or a multiple-choice model, depending on the programs' provisions and requirements. In both cases, the model is based on maximization of an underlying utility function, which is assumed to be consistent with individual household behavior. Neoclassical production theory assumes that the farmer/landowner is a profit-maximizing individual who chooses an optimal resource allocation over a period of time, given his/her available resources (land, labor, capital) and subject to natural and institutional constraints (De Graaff, 1993). Based on previous research on farm program participation by Brotherton (1989), Chambers and Foster (1983), and Lee and Boisvert (1985), the utility of participation is a function of two vectors Z and X, $U_i^{\mathrm{p}} = V(Z_i^{\mathrm{p}} X_i) + \varepsilon(Z_i^{\mathrm{p}}, X_i, \mathrm{e}_i^{\mathrm{p}})$, where p denotes participation (1 if yes; 0 if no), and V represents a vector of unknown parameters. Vector V is broken down into component vectors Z and X, where Z represents technological or economic attributes associated with the program, and X denotes mainly socioeconomic attributes of the individual decision-maker. While elements of Z may be considered endogenous to the decision of whether to participate, X is typically exogenous. The factors that ultimately influence the farmer's decision to participate in any of the three PSA programs will be those that affect the farmer's perception of the economic and conservation value associated with participation versus the value of the next best alternative. The decision-maker is assumed to do what gives him/her the largest net expected utility (Rahm & Huffman, 1984); more formally,

$$\text{Participation:} \quad P_i = 1 \quad \text{if } U_i^0 < U_i^1,$$

$$\text{Nonparticipation:} \quad P_i = 0 \quad \text{if } U_i^0 \geqslant U_i^1.$$

The probability of participation can be derived from the above utility function and a specific probability model can be developed. The probability of participation Pr ($P_i = 1$) is a cumulative distribution function of F evaluated as a function of a set (X) of explanatory variables and vector β of unknown parameters. The logistic cumulative distribution function is the basis for the logit regression model(s) used in this research, where the probability of participation can be modeled as

$$\mathrm{Prob}(Y_i = j) = \frac{\mathrm{e}^{\beta' x_{ij}}}{1 + \sum_{k=1}^{J} \mathrm{e}^{\beta' x_{ij}}} \quad \text{for } j = 0, 1, 2, \ldots, J, \tag{1}$$

where J is the number of choices. Greene (2000) shows that the multinomial case ($J > 1$) is just an extension of the binomial case ($J = 0, 1$). The actual estimation form of the model is given after the logit transformation of the probability of participation and takes the following form:

$$\log\left[\frac{P_{ij}}{1 - P_{ij}}\right] = \beta_j' x_i. \tag{2}$$

The logit transformation has desirable properties in that it is linear in its parameters, can be continuous, and ranges from $-\infty$ to $+\infty$ depending on the scale of the explanatory variables. Maximum likelihood estimation (MLE) is used to estimate the parameters of those variables that are assumed to influence the participation decision.

This study uses binary logistic regression analysis to model the decision of a landowner to participate in the reforestation program (*reforestation program participation model*) and a multinomial logistic regression analysis for the decision of a forest owner to participate either in (a) *forest protection*, (b) *sustainable management*, or (c) in both aspects of the program (*forest program participation model*). A separate analysis is necessary here since landowners not possessing forestland are, in principle and in practice, not eligible for the forest incentive programs. The probability of participation for a noneligible individual is zero and measuring probabilities becomes irrelevant.

Based on the theoretical framework above, a farmer or forest owner in Costa Rica chooses the program option (or nonparticipation) that generates the highest utility, subject to available resources as well as natural and institutional constraints. The factors hypothesized to influence landowner utility and profit, and thus the participation decisions in all three program modalities, are given in Table 3. They relate to the characteristics of the household and forest owner, the farming system (including forests), and nature of information diffusion, and include variables such as farm size, land and tree tenure, income, income sources, debt and credit usage, family size and labor availability, farmer age and education, accessibility of information, interaction with informants, and other variables, many of which have been shown to be relevant factors in previous empirical studies (Adesina & Chianu, 2002; Adesina *et al.*, 2000; Besley & Case, 1993; Feder, Just, & Zilberman, 1982; Thacher *et al.*, 1997).

Farm size (*AREA*) is hypothesized to be positively associated with program participation. Farmers with large farms are more likely to be able to sacrifice a portion of land for reforestation, without jeopardizing household food security or short-term income-generating potential. For those farms with forests, farm size is a proxy for forest area. Within the group of farms with forests, larger farms usually also have more forestland (forest and farm size are

Table 3. *Explanatory variables and expected signs*

Variable	Description	Expected signs[a]		
		R	P	SM
AREA	Farm size in hectares (continuous)	+	+	+
TITLE	If a farmer/landowner possesses legal land title (binary)	+		
AGE	Age of household head (continuous)	±	±	±
EDU	Years of education of household head (continuous)	+	+	+
FFL	Available farm family labor days (continuous)	±	±	±
DEBT	The farmer had debt liabilities within the last five years (binary)	±	+	+
FARMINC	Total farm operation income (continuous)	±	±	±
%OFFINC	Off-farm income as a percentage of total income (continuous)	+	+	+
%DEGRAD	Percentage of total farm system with poor soil quality as perceived by the farmer (continuous)	+		
%SLOPE	Percentage of farm system with steep slope (>35°) as perceived by the farmer (continuous)	+	+	–
MEET	Number of meetings attended to inform landowner about participation in reforestation program (continuous)	+	+	+
EXTEN	If the farmer had been visited by a forest organization or a forest professional to be informed about participating in PSA (binary)	+	+	+

[a] Program modalities: R = reforestation; P = forest protection; SM = sustainable management.

highly correlated in the sample here with a simple correlation coefficient of $r_{12} = 0.678$).

The land title variable (*TITLE*) represents possession of a legal land title and cadastral plan. Both legal land title and a cadastral plan are required for participation in forest conservation and sustainable management, but are not necessary for participation in the reforestation program modality. While all forest conservation and sustainable management program participants were found to be in possession of legal land title and a cadastral plan (consistent with requirements), not all of the reforestation program participants were. The nonvariation of the *TITLE* variable within the forest protection and sustainable management group poses a potential problem for the empirical analysis. This is commonly known as the "zero cell count" problem (Menard, 1995), and the variable was thus excluded from the forest model.

The influence of the age of the household head (*AGE*) on the participation decision is not clear *a priori*. An older farmer is often considered more risk averse, and thus less likely to be involved in new and possibly risky contractual arrangements with the government. On the other hand, reforestation, if perceived as a way to decrease the scale of the farm operation, could represent an attractive option for older farmers. Likewise, for a young forest owner in need of short-term revenue, participating in the sustainable management modality may be more attractive than participating in forest protection.

Years of education (*EDU*) are expected to be positively associated with participation in all three program modalities. This hypothesis is backed by a vast literature on technology adoption (Lin, 1991; Rahm & Huffman, 1984; Zepeda, 1990; etc.). Education has a number of positive externalities. In addition to enhancing a farmer's ability to acquire and process information, it may also be correlated with the level of information access which is hypothesized to be key for participation. Farmers with higher formal education are usually more experienced in handling administrative tasks, engaging in contractual arrangements and dealing with government agencies. Of course, if there is a potential economic benefit associated with participation in a new program, landowners with higher educational levels are more likely to recognize this.

In the case where the PSA is perceived as a secure and on-going source of cash, participation may be further attractive to forest owners with debt liabilities (*DEBT*). This variable is thus expected to be positively related to participation in forest protection and sustainable management. On the other hand, reforestation—an activity with no expected short-term returns—may be unattractive if the farmer needs to generate short-term returns. But, as shown by Thacher *et al*. (1997) in an earlier study of Costa Rican reforestation programs, if the upfront cost for reforestation can be met by family labor, cash payments may be used to pay debts. Thus, for reforestation, the role of debt is ambiguous.

Family labor availability has been found to be an important determinant of many technology adoption and program participation decisions (Ayuk, 1997; Hyman, 1983; Thacher *et al*., 1997). Godoy (1992), for example, indicates that some farmers may perceive reforesting land as a way to decrease farm labor needs in the long run. Sustainable management has a similar labor demand pattern to reforestation. Labor demand is expected to be high at the time of tree planting and harvesting, but in all other years, relatively low. If family labor is scarce and externally available labor expensive, then forest conservation may be the logical choice for a forest owner as opposed to participating in sustainable management.

A similar argument can be made with respect to the role of off-farm employment. The percentage of household income from off-farm sources (*%OFFINC*) is hypothesized to have a positive relationship with participation in all three program modalities. Reforestation can be a convenient way to decrease family labor demand associated with the farm operation (Godoy, 1992). Off-farm activities also have positive externalities. Many farmers who engage in off-farm activities work in administrative or management-type positions that give them a professional network and good information access.

The influence of income from farm operations (*FARMINC*) on the program participation decision is difficult to discern. The literature suggests that higher incomes are generally associated with a willingness to undertake the risk involved in entering a contractual arrangement with the government. Farmers with higher incomes and often greater management capacities are typically more aware of the specific structure of cost and returns of each of their production alternatives, and are thus in a better position to identify and take advantage of a program having net economic benefits. On the other hand, farmers with greater management capacity may see agricultural production as economically more rewarding compared to planting trees.

Landowners with more marginal lands in their farming system are more likely to participate in reforestation given the lower opportunity costs of the land. Consequently, the variables measuring farmers' perceptions of land degradation (*%DEGRAD*) and steepness (*%STEEP*) are presumed to be positively related to participation in reforestation. As no such production alternative exists for forestland, only the steepness variable enters the forest model. It is assumed, however, that an owner of steep forestland is more likely to participate in forest protection rather than sustainable management since harvesting timber on steep slopes presumably increases the costs of timber harvesting.

Finally, as above, diffusion of information has been previously shown to be an important factor in such participation programs (Adesina & Chianu, 2002; Adesina *et al*., 2000; Besley & Case, 1993; Thacher *et al*., 1997). Information variables representing both access to extension resources (*EXTEN*) and meetings attended (*MEET*) are expected to be positively related to participation in all three programs.

Given these hypothesized determinants for participation, the general form of the *reforestation program participation model* equation is

$$\ln\left[\frac{P(y_i=1)}{(1-P(y_i=1))}\right] = \beta_0 + \beta_1 AREA + \beta_2 TITLE + \beta_3 AGE + \beta_4 EDU + \beta_5 DEBT + \beta_6 FFL + \beta_7 FARMINC + \beta_8\,\%OFFINC + \beta_9\,\%DEGRAD + \beta_{10}\,\%SLOPE + \beta_{11} MEET + \beta_{12} EXTEN + \varepsilon_i \quad (3)$$

for j = 0, 1; where y_i = 1 equals participation in the reforestation program, and y_i = 0 corresponds to nonparticipants. The general form of the *forest program participation model* is given in the following equation:

$$\ln\left[\frac{P(y_{ij}=1)}{(1-P(y_{ij}=1))}\right] = \beta_{0j} + \beta_{1j} AREA + \beta_{2j} AGE + \beta_{3j} EDU + \beta_{4j} DEBT + \beta_{5j} FFL + \beta_{6j} FARMINC + \beta_{7j}\,\%OFFINC + \beta_{8j}\,\%SLOPE + \beta_{9j} MEET + \beta_{10j} EXTEN + \varepsilon_i \quad (4)$$

for j = 0, 1, 2, 3; where y_i = 0 denotes a nonparticipant (who fulfills the basic forest land requirements); $y_i = 1$ corresponds to participation in the forest conservation option, $y_i = 2$ equals participation in sustainable management option, and $y_i = 3$ represents participation in both options.

Beyond identifying factors that lead to participation in the PSA program, information on the profitability of participation in all three programs would be useful for understanding farmers' decision behavior. Three previous studies address the profitability of forest management options during the pre-PSA period and may be relevant to the current analysis (Haltia & Keipi, 1997; Howard & Valerio, 1996; Kishor & Constantino, 1993). All three studies compared the profitability (net present value, NPV) of different land uses such as cattle ranching, forest plantation and sustainable management. Kishor and Constantino (1993), for example, found that reforestation (plantation forestry) is by far the most profitable management option with NPVs on the order of $3,200 per hectare (1989$). Surprisingly, at the same discount rate, sustainable forest management was least profitable with NPVs of only $854, following cattle ranching with an NPV of $1,319 per hectare. But, at higher discount rates (20%), the order is reversed; NPVs for reforestation and sustainable management declined sharply, and forest clearance and cattle ranching became considerably more profitable. With an incentive system, the order does not change although the differences become smaller. Howard and Valerio (1996) examine sustainable forest management in southern and northern Costa Rica and find substantial differences between the regions and with the profitability of cattle ranching. At an intermediate discount rate (10%), sustainable forest management has estimated NPVs of $1,340–1,612 per hectare in the South and $671–1,142 per hectare in the North. The authors conclude that in both cases, sustainable forest management would be more profitable than cattle ranching but probably not with other agricultural uses such as crop production. Conversely, Haltia and Keipi (1997), by slightly changing the methodology used in Kishor and Constantino' study (1993), find that sustainable management is less profitable than cattle ranching at any discount rate. At discount rates lower than 12%, a forest plantation is more profitable than cattle ranching. They conclude that a rational decision-maker would choose reforestation for open land over cattle ranching, but imperfections and distortions in the capital market may weaken the attractiveness of reforestation considerably. Current (1995), in examining the NPVs of selected agroforestry systems concludes that, although forestry becomes more profitable with the implementation of government incentives, their adoption (or participation) has to contend with numerous sources of risk perceived by farmers—instability in timber prices, management risk, and lack of markets for woodlot thinning—that may decrease their attractiveness.

More research needs to be done on the profitability of the programs of the current PSA system. Although expected net benefits of the programs play an important role in the decision to participate in the PSA-programs, as seen above, profitability is not the only determinant. As Current and Scherr (1995) write, "profitability is not necessarily a good predictor of adoption." Economic incentives may generally help make certain land and forest uses more profitable, but they are often too low to fundamentally change the profitability ranking. Kishor and Constantino (1993) conclude that subsidies would have to have been doubled (in the pre-PSA period) in order to make sustainable management a viable option for forest owners. The lack of data on the profitability of the current PSA system and the varying results from past studies provide further motivation for analyzing factors influencing the participation decision.

5. SURVEY, DATA, AND SUMMARY STATISTICS

Data for this analysis were collected in mid-2002 by conducting a survey (personal interviews) of 246 land- and forest-owning households in the northern lowlands of Costa Rica. The area covered three cantons (Los Chiles, San Carlos, Sarapiqui), stretching from near the town of Quesada (at an altitude of about 650 metres above sea level) and the tropical highlands of Braulio Carillo National Park, to the San Juan River on the border with Nicaragua at only a few meters above sea level. The survey area encompassed areas of temperate climate, rich volcanic soils, and intensive dairy cattle production (near the town of Quesada), as well as areas of beef cattle production in the hot, humid lowlands near Nicaragua. This research site was selected based on the higher absolute and relative frequency of PSA projects compared with other areas of the country, and thus the greater experience with the program in this region. Moreover, existing institutional contacts in the area also facilitated conducting the survey. A stratified sample of 71 forest conservation, 26 sustainable management and 36 reforestation participants was randomly selected from a master list provided by local government offices, which contained 445 projects approved during 1997–2001 (212 forest protection participants, 82 sustainable forest management participants, 151 reforestation participants). Several participants participated in more than one program. A sample of 141 nonparticipants was drawn through randomized pairing with participants, subject to decision rules regarding ordinal direction (next nonparticipating farmer to the South of the participant) and a minimum farm size of five hectares. Unless otherwise specified, the data collected refer to farm system, household characteristics, and production decisions occurring in the calendar year 2001. Sampling weights were computed and incorporated into the econometric analysis in order to compute unbiased and efficient coefficient estimates, required for choice-based sampling (Greene, 2000). These were computed based on the list of all participants and population data from the last Agricultural Census (1984). In the descriptive statistics reported below and in the econometric model, participants in the *reforestation program participation model* were contrasted against all eligible nonparticipants ($N_{\mathrm{RPPM-NP}} = 141$). Participants in the *forest program participation model* were contrasted only with those nonparticipants ($N_{\mathrm{FPPM-NP}} = 67$) that met the minimum forestland requirements.

Key summary statistics from the survey are presented in Table 4. Significant differences between participants and nonparticipants were found in a number of farm system and socioeconomic variables. Participants in all three programs were shown to have considerably larger farms than nonparticipants, and forest conservation and sustainable management participants had larger farms than reforestation participants. The average forested area among nonparticipants was 7.4 hectares (median = 9.9 hectares). But, only 67 of all nonparticipants had more than two hectares of forest that would have made them eligible for participating in forest conservation or sustainable management program options. Participants in sustainable management tended to have the largest areas of forest, nearly 160 hectares; they also had the highest share of forest as a percentage of the total farm system. The area submitted to the PSA was highest among forest conservation participants, with an average of 91.4 hectares (median = 64 hectares). Consistent with the requirements for participation in forest conservation and sustainable management, all participants in these programs were in possession of land titles.

The mean age of reforestation participants was found to be slightly higher than in the other groups. Differences exist in the years of schooling and the percentage of university degree holders. Participants in forest conservation and sustainable management were shown to have on average more than twice as many years of schooling than nonparticipants. Reforestation participants were somewhere in the middle of these two groups. Consistent results were found in the percentage of respondents holding a university degree. About one-third of forest conservation and sustainable management participants did so, while only about 6% of nonparticipants and about 11% of reforestation participants were university graduates.

Differences were also found in the household variables and income patterns. About three-quarters of forest conservation and sustainable management participants live away from the farm, typically in or near a regional urban center or in San José, the country's capital. But, among nonparticipants, more than three-quarters of households live on the farm, and among reforestation participants' households, about half did so. Nonparticipant households devote significantly more family labor to farm activities as compared to the other groups. Another major difference was found in income levels and sources of income. Participants in forest conservation and sustainable management had considerably higher incomes but also more off-farm income. Fully 45% of forest conservation and 58% of sustainable management participants indicated that off-farm income was their major income source. Debt was widely used by sustainable management participants, and slightly less so among forest conservation participants. Reforestation participants tended to be the best informed, with regard to both measures included in the survey.

In general, participants in the forest conservation and sustainable management program options appear to possess similar characteristics in many respects. These two groups were considerably different from the reforestation participants and nonparticipants. With regard to many measured characteristics, the reforestation participants tended to be in an intermediate range between the group of nonparticipating

Table 4. *Mean comparisons of sampled participants and nonparticipants*

Variable	Unit	Nonparticipants (N = 141)	Participants in program[a]		
			R (N = 36)	P (N = 71)	SM (N = 26)
Farm system					
Mean farm size	ha	34.9*	85.6*	169.7*	199.7*
Forest[b]	ha	7.4*	32.2*	103.4*	159.9*
Area submitted to PSA	ha	–	36.6	91.4	58.6
Land title[c]	%	79*	86*	100*	100*
Household head					
Age	years	47.3*	54.1*	47.5*	46.8*
Schooling	years	5.6*	7.9*	11.1*	12.2*
University degree	%	6*	11*	31*	38*
Household, labor and income					
Family lives on the farm	%	77*	46*	21*	27*
Family farm labor days[d]	days	491*	399*	343*	278*
Total household income[e]	US$	1,577*	3,169*	6,507*	8,822*
Off-farm income/total income	%	11*	29*	51*	64*
Outstanding debt liabilities	%	27*	29*	54*	81*
Information					
Farmers informed by a forest organization or forest engineer[f]	%	13*	86*	79*	88*
Meetings and information days[g]	No.	0.17*	2.63*	1.05*	1.36*

[a] Program modalities: R = reforestation; P = forest protection; SM = sustainable management.
[b] Does not included reforested plots.
[c] Proportion of farmers with legal land title and a cadastral plan for at least 50% of their farm holdings.
[d] On-farm labor days accomplished by family members during January–December 2001.
[e] Household income generated during January–December 2001 for all household family members includes: all revenues from farm and off-farm activities, pensions and other incomes. Farm products produced on the farm for household consumption are not included. All revenues and cost associated with participation in the PSA programs are not included (in 2001 US$).
[f] Proportion of farmers who have been actively visited by a representative of a forest organization or a private forest engineer to be informed about PES programs *prior to the decision* to participate (for nonparticipants within the last five years).
[g] Number of meetings attended to learn more about PSA programs *prior to the decision* to participate (for nonparticipants within the last five years).
* Different from other means, Bonferroni test at $\alpha = 0.05$.

households and those participating in forest conservation and sustainable management activities.

6. REGRESSION ESTIMATES

Logistic regression and multinomial logit models were estimated for Eqns. (3) and (4) based on the survey data using the LIMDEP software package. Maximum Likelihood Estimation was used to estimate the coefficients, which, along with the appropriate test statistics, are reported in Tables 5 and 6. Binary logistic regression estimates, t-ratios, odds ratios and marginal effects for the *reforestation participation program model*, are presented first in Table 5. The coefficients of eight of the 12 explanatory variables included in the model were found to be significant at the 10% level or better. Farm size (*AREA*) was found to be positively associated with participation with an odds ratio of 1.27, implying that a farmer with 10 additional hectares of land is 27% more likely to participate in the program. Possession of legal land title (*TITLE*), as expected, significantly increases the probability of participation in the reforestation program. A farmer possessing land title and a cadastral plan is roughly 16 times more likely to participate in the reforestation program option than a farmer who does not. Although the law allows landowners who do not possess both of these documents to participate, the forest organization which adminis-

Table 5. *Binomial logit regression estimates and test statistics for the reforestation program participation model*[a]

Variable	Coefficient	*t*-Ratio	Odds ratio	Marginal change in probability
Constant	−13.101***	−3.16		
AREA[d]	0.0254**	2.16	1.27	0.00104
TITLE[b]	2.7692**	1.97	15.9	0.01176
AGE[b]	0.0661	1.48	1.07	0.00028
EDU[b]	0.2078*	1.85	1.23	0.00088
FFL[c]	−0.0042*	−1.83	0.64	−0.00179
DEBT	0.2631	0.26		
FARMINC	>0.001	0.49		
%OFFINC[d]	0.0599**	2.45	1.82	0.00254
%DEGRAD[d]	0.0414*	1.69	1.51	0.00176
%SLOPE	0.0119	0.39		
MEET[b]	0.6169***	2.58	1.85	0.00262
EXTEN[b]	2.3268**	2.19	10.3	0.00988
N	177			
Likelihood ratio test	49.95*** (12 d.f.)			
McFaddens R^2	0.437			
Correct predictions	83.9%			

[a] Definitions for variables in Table 3. Odds ratio and change in probability if significance level lower than 0.2 (evaluated at the sample means and computed using $\delta P/\delta X_i = e^Z/(1 + e^Z)^2 \beta_k c$, where $Z = \alpha + \beta X_i$ and c = unit change).
[b] Odds ratio and change in probability for a 1 unit change in x.
[c] Odds ratio and change in probability for a 100 unit change in x.
[d] Odds ratio and change in probability for a 10 unit change in x.
*Significant at $\alpha = 0.10$.
**Significant at $\alpha = 0.05$.
***Significant at $\alpha = 0.01$.

ters such cases may charge more for this service, making it less attractive for those without full legal title. Years of education (*EDU*) was found to significantly influence participation. Entering a new contractual arrangement and the establishment of the reforested plot require administrative skills and may involve the acquisition of new knowledge, both of which can be enhanced by education.

With respect to labor, the availability of family farm labor (*FFL*) was found to be negatively associated with participation. The estimated odds ratio of 0.64 implies that a 100-day increase in available family farm labor per year decreases the probability of participation by 36%. This finding is consistent with expectations. Families with sufficient labor resources typically choose to engage in labor-intensive agricultural production activities which are more highly profitable. This finding is supported by examining the influence of off-farm income on reforestation participation. A 10% increase in proportion of income generated off-farm (*%OFFINC*) increases the probability of participation by 82%. Employment in off-farm activities not only decreases labor availability (making nonagricultural activities relatively more attractive) but may also generate positive externalities such as better information access and the acquisition of administrative skills.

Regarding farming system characteristics, the variable measuring the area within the farming system perceived as degraded (*DEGRAD*) was estimated to be positively related to participation, indicating that a 10% increase in degraded area increases the probability of participation by 51%. The coefficients of both information variables—*EXTEN* (denoting whether a farmer had been visited prior to the decision to participate) and *MEET* (indicating the number of informational meetings attended prior to the decision)—were estimated to be significant at the 5% and 1% levels, respectively. The coefficient of the visitation variable (*EXTEN*) had an associated estimated odds ratio indicating that the visited farmer is roughly 10 times more likely to participate than one who has not. Coefficients of the other included variables did not exhibit statistically significant influences on the decision to participate in reforestation.

Table 6. *Multinomial logit regression estimates and test statistics for the forest program participation model*[a]

Variable	Forest protection			Sustainable management			Forest protection + Sus. management		
	Coeff. (*t*-Ratio)	Odds ratio	Marginal effect	B (*t*-Ratio)	Odds ratio	Marginal effect	B (*t*-Ratio)	Odds ratio	Marginal effect
Constant	−10.29*** (−3.59)			−15.88*** (−2.70)			−18.88*** (−3.19)		
AREA[d]	0.019*** (2.83)	1.21	0.0070	0.027** (2.50)	1.31	0.0006	0.025** (2.57)	1. 28	0.0004
AGE	0.082 (0.26)			−0.066 (−0.17)			0.040 (0.06)		
EDU[b]	0.323*** (2.71)	1.38	0.011	0.484* (1.94)	1.62	0.011	0.533** (2.07)	1.71	0.008
FFL	0.012 (0.50)			−0.006 (0.146)			0.002 (0.51)		
DEBT[b]	1.826* (1.74)	6.21	0.066	2.487′ (1.34)	12.03	0.006	1.913 (1.10)		
FARMINC[c]	>0.000* (1.87)	1.04	0.001	>0.000 (0.77)			>0.000 (1.22)		
%OFFINC[d]	0.035** (2.29)	1.42	0.012	0.062* (1.92)	1.86	0.001	0.057* (1.80)	1.76	0.001
%SLOPE	0.074 (0.36)			−0.005 (−0.68)			−0.006 (−0.62)		
MEET[b]	0.527** (1.96)	1.69	0.019	0.372 (0.75)			0.654′ (1.53)	1.92	0.001
EXTEN[b]	3.107*** (2.61)	22.36	0.112	4.122** (2.01)	61.68	0.010	4.149** (2.25)	63.37	0.009
N		167							
Likelihood ratio test		80.8*** (30 d.f.)							
McFaddens R^2		0.331							
Overall correct predictions		69.2%							

[a] Definitions of variables in Table 3. Odds ratio and change in probability if significance level lower than 0.2 (evaluated at the sample means and computed using $\delta P/\delta X_i = e^Z/(1 + e^Z)^2 \beta_k c$, where $Z = \alpha + \beta X_i$ and c = unit change).
[b] Odds ratio and change in probability for a 1 unit change in x.
[c] Odds ratio and change in probability for a 1000 unit change in x.
[d] Odds ratio and change in probability for a 10 unit change in x.
*Significant at $\alpha = 0.10$.
**Significant at $\alpha = 0.05$.
***Significant at $\alpha = 0.01$.
′Significant at $\alpha = 0.20$.

Multinomial logistic regression estimates, *t*-ratios, odds ratios and marginal effects for the *forest program participation model*, are presented in Table 6. For participants in the forest protection program, the coefficients of seven of 10 hypothesized factors were significant at the 10% level or greater. For the two other groups, the coefficients of only four hypothesized determinants of landowner participation were found to be significant. The coefficient of farm size (*AREA*) was estimated to be positively signed, as expected, and significant at the 1% level for all three program options, exhibiting odd ratios between 1.21 and 1.28. High transaction costs and the high fixed cost component of participation may partially explain the significance. This confirms what various authors have suggested with respect to the potential scale economies associated with the PSA (Chomitz *et al.*, 1998; Heindrichs, 1997; World Bank, 2000). Since fees paid to intermediaries such as forest engineers and forest organizations are limited as a proportion of the program payments, these intermediaries have a vital interest in handling larger rather than smaller projects. As with the reforestation model, the coefficient of the education variable (*EDU*) was estimated to exhibit a significant positive relationship with participation in all three cases. Education regarding the forest management programs may be even more important than with reforestation because contractual arrangements and program requirements are more complicated. Again, education may also entail positive externalities conducive to participation.

Farm debt and income variables are also estimated to have a significant influence on participation in the forest protection and sustainable management programs. The coefficient of the farm debt variable (*DEBT*) is positively signed and significant at the 10% level for forest protection participants (only moderately so for sustainable management participants). The estimated odds ratios indicate a considerable influence of farm debt status. A farmer with debt liabilities is 6–12 times more likely to participate in the forest protection and sustainable management programs, respectively. This finding appears to confirm the hypothesis that the guaranteed payments for forest protection program participation over a five-year period (assuming the landowner fulfills contractual obligations) is perceived as a secure and ongoing income source to repay debts incurred earlier. The coefficient of the variable representing farm operation income (*FARMINC*) is also positively signed and significant for the forest protection participants. The interpretation of is rather difficult. As discussed previously, higher farm operation income may be associated with better management skills and ability to better assess the future costs and returns of a program. The coefficient of off-farm income (*%OFFINC*) is positively and significantly related to participation in all three programs. Positive externalities may play a more important role in this outcome as well as labor allocation aspects. If off-farm labor for timber stand management and harvesting is cheap and available, peaks in short-term labor demand may easily be overcome, especially for the forest participation program participants, who fall in a much higher income group compared to nonparticipants (see Table 4).

With regard to other estimated effects, the coefficient of the variable indicating meetings attended prior to participation (*MEET*) was found to be positive and significant at the 5% level for the forest protection participants (less so for individuals participating in both programs). Forest owners having attended such a meeting were 69% and 92% more likely to participate in the forest protection or both programs, respectively. The sign of the coefficient was positive for the sustainable management group but was not statistically significant. The coefficients of the extension visitation variable (*EXTEN*) were estimated to be significant at the 1% and 5% levels, respectively. A participant in the forest protection program is 22 times more likely, a sustainable management participant 62 times more likely, and an individual participating in both programs 63 times more likely to participate in the corresponding programs than neighboring landowners who have not been visited. These strong estimated influences likely reflect the observation that forest professionals actively and selectively seek forest owners whom they think would participate in a program. While the coefficients for the extension visitation variable were estimated to be significant in both models, the nonrandom visits of these intermediaries could introduce a potential source of bias. In the absence of more information on extension visitation patterns, however, it is difficult to control for this. The coefficients of other included program determinants (representing age, available family farm labor, and land slope) were estimated to have the expected signs but were not statistically significant at conventional levels.

Regression test statistics are also reported in Tables 5 and 6. Likelihood ratio test statistics for both models exceeded the critical χ^2 values at the 0.01% level. McFadden pseudo-R^2 (similar to Greene's Likelihood Ratio Index) are not directly comparable to the R^2 from ordinary least squares, but are widely used to evaluate the fit in logistic regression (Caffey & Kazmierczczak, 1994). McFadden R^2 values of 0.437 for the *reforestation program participation model* and 0.331 for the *forest program participation model* were estimated, indicating fairly good fits and well within the 0.2–0.4 range typically estimated for logit models (Harper, Rister, Mjelde, Drees, & Way, 1990). An additional evaluation method—computing the proportion of correct predictions against the observed outcomes—yielded 84% correct predictions for the *reforestation program participation model* and 69% for the *forest program participation model* at a 10% significance level. (It is, however, not uncommon to use the 20% level in logit analysis (e.g., Caffey & Kazmierczczak, 1994; Harper *et al*., 1990). Due to the absence of suitable instruments, the analysis is subject to potential endogeneity which might be associated with farm income and the proportion of nonfarm income, as well as extension visitation. In addition, the fact that the participation decision was made several years before the data were collected could be a potential source of estimation error.

7. CONCLUSIONS AND IMPLICATIONS

This study reveals that factors associated with the farming system, household and decision-maker characteristics, and information access and availability significantly influence the decision to participate in the PSA programs. These are in addition to other factors such as specific program-related factors and financing limitations that cannot be included in the analysis due to a lack of measurable and/or reliable data. The participants in the PSA programs have, on average, larger farms dedicated to labor-extensive and land-intensive agricultural activities compared to nonparticipants. Although not specifically identified as significant in the *forest program participation* model (given the zero cell count problem previously indicated), discussions with landowners and program technicians suggest that land tenure and legal land title are critical to participation. On average, participants in all programs were better educated, more likely to be urban-dwelling, had more income from and were proportionately more reliant on off-farm sources, and enjoyed higher farm incomes than nonparticipants. Age did not appear to be an influential factor on participation. Participants in forest protection and sustainable management had incurred relatively more debt than nonparticipants. Farmers also tended to participate when their soils had been degraded. Information about the system, which proved crucial to participation, was limited among nonparticipants.

In drawing general conclusions from both the descriptive statistics and the regression analysis reported above, three major influences appear to determine participation in Costa Rica's PSA program: farm size, human capital and household economic factors, and information. Each of these deserves further elaboration. As shown in the descriptive statistics, participants in all three programs typically own much larger farms than nonparticipants. This may be a function of the fact that participation may be more attractive for all involved parties with respect to larger farms having correspondingly larger plots to submit for a PSA contract. Importantly, under the current legislation, all involved actors—the government agency handling the contracts, the intermediary providing enforcement and management services (e.g., elaborating a management plan), and the farmer receiving program payments after incurring some fixed charges—benefit from scale economies associated with participation. From all sides, then, the incentives generated by these scale economies appear to make it more attractive for larger farms to participate, as confirmed by the survey results here.

Human capital and household economic variables associated with factors such as years of schooling, farm operation income as a proxy for management skills, and skills and experience gained from off-farm employment are also shown to be significant determinants of program participation. Establishing a PSA contract requires considerable knowledge and the ability to manage administrative tasks. Less educated (and presumably often poorer) farmers appear, on average, to be less likely to possess the skills needed to take equal advantage of the forest incentive programs made available by the government. Forest organizations which were established as intermediaries to try to redress this problem and make the program more available to smaller, poorer farmers have only partially overcome these obstacles.

Information variables are also shown to be of considerable importance in inducing participation in the PSA. Only 61% of nonparticipants in the survey indicated that they were familiar with the basics of the PSA program. Some indicated that they had heard about the program from a friend or a neighbor; some said their information came from television or the radio. Yet, this was apparently not sufficient to induce participation for many. Specific targeted information provided—and often personally delivered—by forest engineers and forest organizations was shown to be a key element in influencing participation. These intermediaries take on a central role in the PSA system. They not only furnish services for potential participants by providing administrative and management tasks, they also deliver information. The mechanism is quite apparent. An independent forest engineer or consultant is likely to manage carefully his own time and resources and is most likely to inform those potential participants from whom he thinks he will subsequently earn the highest returns to his time. The nonrandom visitations by these intermediaries makes it difficult, however, to strictly evaluate the actual effects of this factor on participation rates.

The ability of poor farm households and landowners to participate in programs such as Costa Rica's PSA program has been identified as one of the key factors influencing the effectiveness of market-based programs for forest services. Recently, the PSA system has been criticized on this score (Solís Riviera, Ayales Cruz, Madrigal Cordero, Hidalgo Chaverri, & Jiménez Elizondo, 2002). The major critique is that observed payment inequities fail to achieve the objectives formulated in the forestry law, including support and outreach for small and medium farmers and landowners, and providing income and employment generation in rural areas. The research reported here strongly suggests that PSA program payments tend to go disproportionately to better-educated, wealthier farmers who possess larger farms and forest areas, and who are better diversified into nonfarm income-generating sources. This research does not provide information on the impact of PSA payments on rural development, but these payments likely involve some tradeoffs. Indeed, equity in program payments may be a poor predictor of the ecological and environmental outcomes of the program, presumably their ultimate objectives. For instance, larger plots submitted for PSA participation (in particular, under forest conservation) may be preferred from a forest ecology standpoint, since forest species need a minimum area to survive. Thus, the value to biodiversity conservation of a 100-hectare forest area is presumably much greater than an area comprising just two hectares. Moreover, from an economic perspective, the factors and incentives previously discussed which result in targeting contracts to fewer larger farmers and landowners versus many small landowners, may make the system more efficient in terms of reducing administrative expenses, even though this increase in efficiency almost certainly decreases equity in the distribution of payments. Thus, 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.

Finally, it is worth noting that these findings appear to have parallels with findings from past experiences with integrated conservation and development projects (ICDP's). The difficulty in simultaneously achieving multiple policy goals with one program—or in this case, three components of a broader program—has been one of the common critiques of the ICDP approach (Brandon, 2001). It may be that here too the criteria by which some are judging the success of the PSA program are simply too ambitious and the sought-after objectives too many.

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