International Journal of Sustainable Development & World Ecology
Vol. 17, No. 3, June 2010, 208–216

Social and environmental impacts of payments for environmental services for agroforestry on small-scale farms in southern Costa Rica

Rebecca J. Cole*

Environmental Studies Department, University of California Santa Cruz, Santa Cruz, CA 95064, USA

Agroforestry on small-scale farms has potential to provide important ecological services, such as carbon sequestration and maintenance of biological diversity, while also providing on-farm products for domestic use and marketing. Payments for environmental services (PES) are an increasingly popular mechanism for encouraging production of ecological services on agricultural lands and may also contribute to poverty reduction and sustainable farming practices through adoption of new farming technologies. There is little current information, however, on the degree to which PES increase tree planting relative to a baseline or the effects of program participation on farmer livelihoods. This study examined the initial impacts of a recent PES program for agroforestry in southern Costa Rica by: (1) assessing the efficiency of PES in increasing reforestation relative to baseline tree planting activities; (2) examining farmer perceptions of socioeconomic and environmental impacts of PES; and (3) exploring obstacles to adoption of agroforestry practices. Thirty-six participant and non-participant farmers were given semi-structured interviews. Key informant interviews were conducted with forestry engineers, farmers' associations, NGOs, and government agencies. Farmers reported positive economic benefits in the first 2–3 years of program participation. PES participants also planted substantially more trees and more species than non-participant farmers. The PES program was effective in overcoming initial economic and technical obstacles that made adoption of agroforestry unattractive. Strong local organizations played a key role in facilitating adoption. Additional investment in short- to medium-term technical support will likely be necessary for broad retention of agroforestry practices beyond the life of the PES contracts.

Keywords: agroforestry adoption; ecological services; environmental payments; payment for environmental services; socioeconomic impacts; small-scale farms

Introduction

Agricultural landscapes are the focus of growing conservation efforts because they can provide valuable ecosystem services, such as conservation of biodiversity, soil retention, protection of watersheds, and carbon sequestration. Over the past decades, extensive tropical deforestation has caused the loss of environmental services and raised concerns in tropical countries over the future supply of forest products. As a consequence, there is interest in developing effective finance mechanisms to encourage farmers in tropical regions to adopt practices that increase the production of these services (Landell-Mills and Porras 2002; Pagiola et al. 2005).

One such mechanism is payments for environmental services (PES). PES create market incentives for land owners to supply definable ecological services to a broad range of users. These services are generally bundled into four main categories: watershed protection, carbon sequestration, conservation of biodiversity, and aesthetic features of natural landscapes (Millennium Ecosystem Assessment 2006). Numerous programs have been developed in the last decade with almost 300 ongoing and proposed initiatives worldwide (Landell-Mills and Porras 2002). Latin America has been particularly open to experimenting with new PES schemes with Costa Rica, Honduras, Mexico, Colombia, and Ecuador currently implementing programs, and other countries in the planning and preparation phases (Díaz et al. 2002; Echevarría 2002; Kosoy et al. 2007; Pagiola et al. 2007).

To date, the vast majority of PES programs have been targeted at forest conservation, but several programs designed for implementation in active agricultural lands have emerged in recent years. For example, the Regional Integrated Silvopastoral Ecosystem Management Project is testing PES for silvopastoral practices in Nicaragua, Colombia, and Costa Rica (Pagiola et al. 2007). The Scolel Té project in Chiapas, Mexico, compensates farmers for increasing carbon sequestration in agroforestry systems (Tipper 2002). In 2004, Costa Rica added an agroforestry component to its existing suite of PES programs [National Forestry Financing Fund (FONAFIFO 2005)].

Although PES have received considerable support and interest, important questions remain as to their efficiency in increasing the production of environmental services (Wunder 2007). One of these questions relates to the additionality of PES, or the increase in environmental benefits relative to what would have occurred in their absence (Shrestha and Timilsnia 2002). The few studies that have assessed additionality have reported mixed results. A GIS analysis of forest cover in Costa Rica (Sanchez-Azofeifa et al. 2007) showed that deforestation rates were not significantly lower in areas receiving payments. This was attributed to the success of other earlier conservation measures and ongoing changes in land-use practices (Sanchez-Azofeifa et al. 2007). A comparison of forest protection by PES farmers and non-participant farmers in southern Costa Rica also found similar levels of conservation between the groups (Sierra and Russman 2006). PES programs that

*Email: cole.rebeccaj@gmail.com

ISSN 1350-4509 print/ISSN 1745-2627 online

DOI: 10.1080/13504501003729085
http://www.informaworld.com

encourage farmers to adopt new practices are likely to provide additionality because they directly fund changes in land use. For example, initial results from the silvopastoral project for smallholders in Nicaragua suggest it has been successful in inducing farmers to adopt environmentally beneficial practices (Pagiola et al. 2007). There is little current information, however, on the degree to which PES in agricultural lands increases implementation of these practices relative to a baseline of existing farmer land management activities.

In addition to improving environmental practices, PES are often thought to have the potential to contribute to poverty reduction by providing an additional source of income and enabling the adoption of new farming technologies (e.g. Lipper and Cavatassi 2004; Pagiola et al. 2005; Wunder 2008; Zilberman et al. 2008). Agroforestry in particular is widely viewed as a potential way to improve socioeconomic sustainability (Alavalapatti and Nair 2001). Agroforestry systems can provide a mix of subsistence and market products such as food, fodder for animals, and wood for construction and future sale. Farmers also view tree planting as a way to make marginal farm areas more productive (Diaz 1995; Korhonen 2002). Poorer farmers who own marginal land may also find PES attractive because of the low opportunity costs (Jack et al. 2008; Wunder 2008). Past studies, however, have reported that poorer households have been underrepresented among PES recipients (Landell-Mills 2002; Pagiola et al. 2005). Zbinden and Lee (2005) found that wealthier, better educated landowners with larger holdings were more likely to participate in PES in Costa Rica, where enrolment is on a first come-first served basis. Recent PES programs have employed additional measures to target poor populations at a national level (Vietnam, South Africa, Mexico, China, and Costa Rica) (Turpie et al. 2008; Wunder 2008). For example, Costa Rica replaced the requirements for formal land title with a system for 'locally recognized land tenure' in order to improve program access to poor landowners and landowners in indigenous reserves (Pagiola et al. 2007).

The Systemas Agroforestales (SAF) program introduced in Costa Rica in 2004 attempts to remedy some of these deficiencies by targeting small-scale farmers in regions with low socioeconomic status (FONAFIFO 2005). Although the program has been limited in scope up to this point, information on its initial effects relative to baseline practices will be valuable for expanded implementation and the design of future programs. The aims of this study are to (1) explore obstacles to adoption of agroforestry practices by small-scale farmers, (2) examine farmer perceptions of the socioeconomic and environmental impacts of the program, and (3) assess the efficiency of SAF in increasing practices that produce environmental services relative to a baseline.

SAF in Costa Rica

PES in Costa Rica are managed by a non-profit organization, The FONAFIFO, which is empowered to issue and regulate contracts. The application process for landowners is complicated, and forest engineers (*regentes forestales*) and forestry organizations act as intermediaries between landowners and FONAFIFO. Forestry engineers are responsible for establishing a management plan for tree planting on participating farms and certifying the project for payments based on standards for management and tree survivorship. They are also primarily responsible for providing technical assistance. Preference is given to applicants in designated conservation priority areas, areas with a low socioeconomic index, members of community organizations such as farmers' associations and indigenous development organizations, and single, female heads of households.

Unlike the other PES modalities, SAF beneficiaries must have active areas of agriculture or cattle grazing on their land. In 2007, farmers were paid a total of US$1.30 per tree, with 350 trees as the minimum and 3500 as the maximum allowed per contract. Tree planting is funded for six overlapping categories: (1) hardwoods in perennial crops; (2) multiple-use trees; (3) windbreaks; (4) forestry planting in fence lines; (5) forestry plantations in blocks; and (6) improvement of taungya (inter-planting trees with agricultural crops) and *barbecho* (fallowing) systems on indigenous reserves. The program allows small-scale forestry blocks of 1 ha or less, with a maximum of three blocks per contract. SAF contracts are issued for a five-year period during which the farmers must maintain the planted trees. Payments are made over the first three years (65% in the first year, 20% in the second, and 15% in the third year), and are contingent on tree survivorship of 85% or better. Farmers who want to plant more than 1000 trees may apply for an advance on the first payment. The program is funded through loans from the World Bank and a Global Environmental Facility grant, and pays for planting of up to 600,000 trees per year. In 2007, there were 547 SAF contracts in Costa Rica. A total of 1,259,255 trees have been planted since 2004 (FONAFIFO 2007).

Methods

Study sites

The study was carried out between January and April 2008 in Buenos Aires County in southern Costa Rica (Figure 1). The county spans the range of major land uses employed by smallholders in the southern part of the country, including cattle production, coffee, cacao, sugar cane, annual crops, and subsistence farming. The county has received a relatively high number of SAF contracts in southern Costa Rica because of the presence of several major priority areas for conservation, including the La Amistad International Park (PILA) and six indigenous territories.

Data collection

A list of all active SAF contracts (2005–2007) was obtained from the regional FONAFIFO office in Palmar Norte. Because in most cases farmers must wait 1 year following planting to receive payments, only contracts from 2005 to 2006 were included in the study. The initial database included 76 individual contracts, most of which were clustered within

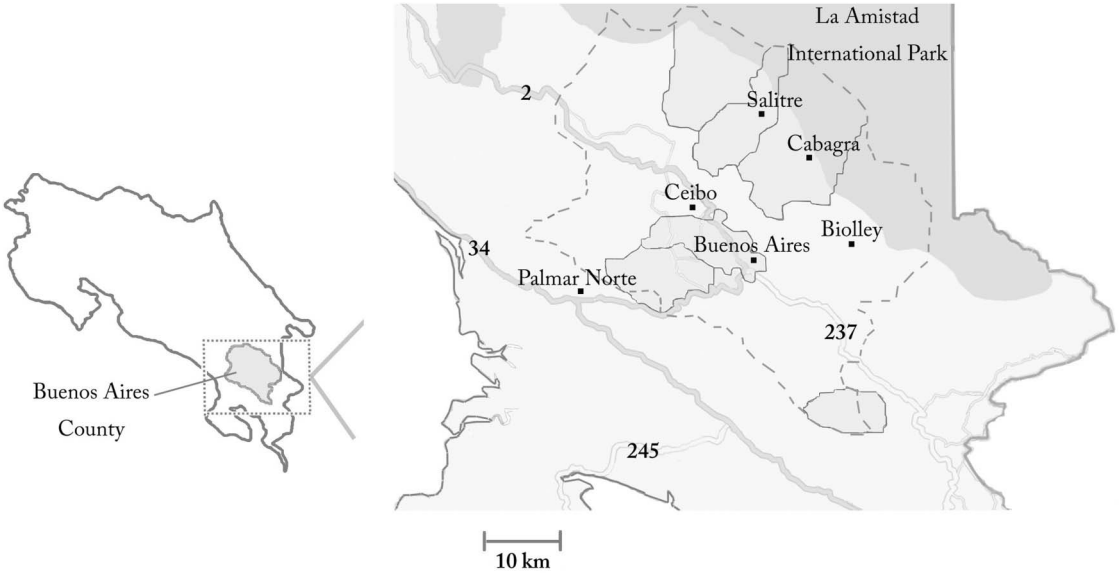

Figure 1. Map of the study area in southern Costa Rica. Areas in dark gray (right) are national parks and protected areas, and areas in light gray are locations of indigenous territories. Numbers indicate major roads.

communities due to FONAFIFO's policy of working with groups and organizations. Four of the communities containing 44 individual contracts were selected because they represented the types of landowners targeted by SAF, including both indigenous and non-indigenous groups, independent and organization-managed contracts, and a broad range of land uses.

Two of the study communities, Cabagra and Salitre, are indigenous reserves and are included within the PILA protection area (Figure 1). Information provided by the respective development organizations indicated that the primary agricultural activities in the communities were subsistence farming and cacao. The third community, Biolley, is located within the PILA buffer zone and is primarily dedicated to coffee and vegetable production. Agriculture in the community of Ceibo included cattle production, some commercial vegetables, and subsistence agriculture. A total of 18 SAF farmers were interviewed, based on availability of head of household at the time of the interviews (~24% sampling intensity at the county level).

A list of 8–12 non-SAF households in each community was compiled from several sources, including farmers' associations, development organizations, and public schools. The criteria for selecting the non-participant farmers were the same as needed to qualify for the SAF agroforestry program: locally recognized land tenure and areas of active agricultural or cattle grazing. In addition, I selected farmers who engaged in the types of agricultural production that were common to the particular community. Eighteen farmers from this list were randomly selected for interviews. If a farmer was not available at the time of the interviews, I selected the nearest-located farmer on the list.

Data were collected through semi-structured interviews using a questionnaire. The questions focused on (1) tree planting activity in the previous three years, (2) the role of trees in farm management, (3) perceived benefits and disadvantages of agroforestry, (4) the socioeconomic impact of program participation, and (5) obstacles to further tree planting. The questionnaire was pre-tested in five households in Coto Brus County (also in southern Costa Rica) and then improved. In each case, the head of household was interviewed on the farm. During the interviews, direct observations of farm trees, planted areas, and land uses were made as necessary to clarify information. In addition, 10 key informant interviews were conducted with forestry engineers, the leaders of development organizations and farmers' associations in each community, and with personnel at the FONAFIFO central and regional offices (hereafter called 'experts'). The expert interviews addressed benefits and disadvantages of the SAF program, the socioeconomic and environmental effects of the project, and obstacles to increased agroforestry practice by smallholders.

Data analysis

Socioeconomic conditions between SAF and non-SAF households were compared using paired *t*-tests for continuous data. Kruskal–Wallis non-parametric tests were performed to determine if there were any statistically significant differences in land uses and rate of adoption of different agroforestry systems between groups (Systat 12.0, 2006). Standard deviations are reported throughout. Statistical analyses were supplemented by qualitative information collected during the interviews.

Results

Comparison of program participants and non-participants

The landholdings of SAF farmers and non-participants were similar in size (mean 17.4 ± 18.6 ha, range 2–70 ha). The two groups were also similar in the percentage farm area

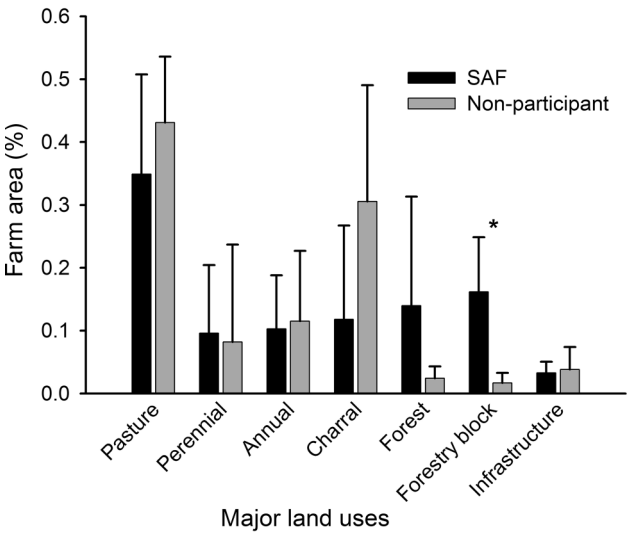

Figure 2. Mean percentage of farm land area allocated to major land-use types. Significant differences between SAF and non-participant farms are indicated by an * ($P > 0.05$). Error bars represent 1SD.

under common land uses, including pasture, perennial agriculture, annual agriculture, charral (early successional growth), and infrastructure. SAF farmers, however, dedicated a larger percentage of their land to forestry plantations (0.16 ± 0.9 ha) compared to non-participants (0.02 ± 0.17 ha; $P > 0.043$; Figure 2). The number of years of education was the main differing socioeconomic indicator between the groups: SAF farmers had an average of 2.2 more years of education than non-participants ($P < 0.023$; Table 1).

The main sources of household income and farm agricultural activities differed between program participants and non-participants. Nearly half of the landowners who received SAF payments ranked subsistence farming as their main economic activity (44%) compared to only 6% of non-participant farmers (Table 2). By contrast, half of the program non-participants ranked commercial agriculture as a main source of income compared to 22% of SAF farmers. Fifty-five per cent of non-participants also ranked outside jobs as their primary or secondary source of income, whereas only 22% of SAF farmers said off-farm employment was important to their household income.

Table 1. Mean socioeconomic comparison of sampled SAF and non-participant farmers.

Variable	SAF $n = 18$	Non-participant $n = 18$
Farm size (ha)	21.59 ± (22.7)	13.36 ± (10.57)
On-farm income as % of household income	71.11 ± (30.6)	60.28 ± (33.2)
Household income (US$)	1616.7 ± (1024.4)	1895.5 ± (703.8)
Household size	5.89 ± (2.6)	5.67 ± (2.0)
Farmer age	48.22 ± (13.0)	44.72 ± (10.6)
Farmer education*	9.61 ± (1.1)	7.44 ± (0.7)
Children under 16	1.78 ± (1.5)	2 ± (1.7)
Years tenure*	27.01 ± (14.1)	18.5 ± (13.4)

Notes: Values are means ± 1SD. *Differences are significant for a two-sample t-test ($\alpha = 0.05$).

Species selection and agroforestry systems

SAF farmers planted substantially more trees and a wider variety of species than did non-participant farmers. For example, SAF farmers had planted an average of 2614 ± 1279 trees per farm in the previous three years compared to an average of 352 ± 765 trees on non-participant farms. SAF farmers also planted twice as many tree species (44 species) as non-participants (22 species). A considerable number of non-participants did engage in reforestation activities, however, with more than half the farmers in this group (55%) reporting tree planting on their land over the previous three years. The most common species planted by both groups were amarillon (*Terminalia amazonia*), maria (*Calophyllum brasiliense*), guaba (*Inga* spp.), madero negro (*Gliricidia sepium*), and cedro (*Cedrella* spp.) (Table 3). The types of trees most often planted varied among the communities, likely due to differences in the predominant agricultural products. Guaba was frequently cultivated for fuelwood in the two indigenous communities, whereas madero negro was most often planted in the community of Ceibo as a living fence species. Farmers in the community of Biolley planted a broad variety of species as shade trees in coffee and in forestry plantations. Almost 90% of all the farmers who planted trees selected timber species for some area of their farm. Farmers who did not plant timber species tended to select trees useful for subsistence products such as fuelwood and fruit. SAF farmers planted trees most often in forestry plantations, followed by living fences, and perennial crops (Figure 3).

Benefits and disadvantages of tree planting

The main motivations for planting trees mentioned by the 10 reforesting non-participants were future timber sales (five farmers), increased property value (two farmers), and erosion control (three farmers). The perceived benefits of additional tree planting by all non-participant farmers included an increased wood supply for sale and construction (33%), improvements to existing agroforestry systems (17%), production of fuelwood (11%), and protection of the natural environment (11%). Five farmers (28%) said they saw no advantage in additional tree planting other than receiving economic incentives. This last result must be interpreted with caution as nearly all the program non-participants expressed interest in applying for SAF payments.

SAF farmers indicated several realized advantages from the trees they had planted, particularly in the perceived improvements to their farming systems (Table 4). Several farmers were already harvesting fruit and firewood from fast-growing nitrogen-fixing softwoods (*Inga* spp.) and utilizing the green mulch in agricultural plots. One farmer said that the shade trees she planted in coffee had been important in applying for organic certification. The main disadvantages

Table 2. Ranking of household economic activities for SAF and non-participant farmers.

	SAF $n = 18$			Non-participant $n = 18$		
	Primary	Second	Third	Primary	Second	Third
Cattle/livestock	11	11	6	6	28	6
Coffee and cacao	11	11	22	28	17	0
Subsistence agriculture	44	28	22	6	39	17
Annual agriculture	11	11	0	22	6	6
Forestry	0	6	0	0	0	0
PSA from forest protection	0	6	0	0	0	0
Off-farm work	11	11	17	33	11	11
Charity/retirement	11	6	0	6	0	0
Total households	18	16	12	18	18	7

Table 3. Tree species that farmers reported planting in the last three years in four communities in southern Costa Rica. The numbers correspond to the 10 most commonly planted species.

Common name	Botanical name	Common uses
Aguacate	*Persea americana*	Fruit
Aguacatillo	Lauraceae	Timber, fruit for birds
Amarillón (1)	*Terminalia amazonia*	Timber
Candelillo	*Tecoma stans*	Medicinal, ornamental
Caoba	*Swietenia macrophylla*	Timber
Cedro (5)	*Cedrela* sp.	Timber
Cedro amargo	*Cedrela odorata*	Timber
Chiricano, lorito	*Vantanea barbourii*	Timber
Colpachí, cascarilla	*Croton niveus*	Living fence, shade
Corteza amarilla	*Bursera ochroma*	Timber
Cristobal	*Platymiscium parviflorum*	Timber
Escobillo	*Malphighia glabra*	Medicinal, ornamental
Espavel (8)	*Anacardium excelsum*	Medicinal, shade
Fruta dorada	*Virola koschnyi*	Timber
Gallinazo	*Schizolobium parahyba*	Ornamental
Guaba (3)	*Inga* sp.	Shade, fuelwood, mulch
Guaba macho	*Inga* sp.	Shade, fuel ood, mulch
Guachipelín (6)	*Diphysa robinoides*	Living fence
Guanabana	*Annona* sp.	Fruit
Guanacaste	*Enterolobium cyclocarpum*	Pasture shade, construction
Guapiñol	*Cynometra hemitomophylla*	Timber, construction
Guayaba	*Psidium guajava*	Fruit, pasture shade
Guititie	*Acnistus arborescens*	Living fence, fruit for birds
Indio desnudo, Jiñocuave	*Bursera simaruba*	Construction, medicinal
Ira	Lauraceae	Timber
Jaul	*Alnus acuminata*	Construction, timber
Lengua de vaca	*Melastoma* sp.	Living fence
Leucaena	*Leucaena leucocephala*	Fodder
Limón	*Citrus* sp.	Fruit
Lorito, ardillo	*Cojoba arborea*	Ornamental
Madero negro (4)	*Gliricidia sepium*	Living fence
Maria, Cedro maria (2)	*Calophyllum brasiliense*	Timber
Mamon	*Melicoccus bijugatus*	Fruit
Mango	*Mangifera indica*	Fruit
Manzana de agua	*Eugenia malaccensis*	Fruit
Manzana rosa	*Eugenia jambos*	Fruit, medicinal, fruit for birds
Maria ve	*Pseudolmedia* sp.	Fruit, fruit for birds
Mayo	*Vochysia* sp.	Timber
Nance	*Byrsonima crassifolia*	Fruit, medicinal
Naranja	*Citrus* sp.	Fruit
Palma africana	*Elaeis guineensis*	Fruit
Pejiballe	*Bactris gasipaes*	Fruit
Pilón	*Hyeronima alchorneoides*	Timber
Poró (7)	*Erythrina* sp.	Shade, mulch
Quira	*Pseudolmedia spuria*	Timber
Roble	*Quercus* sp.	Timber
Ronron (10)	*Astronium graveolens*	Timber
Sota caballo (9)	*Zygia longifolia*	Soil conservation
Teca	*Tectona grandis*	Timber, construction

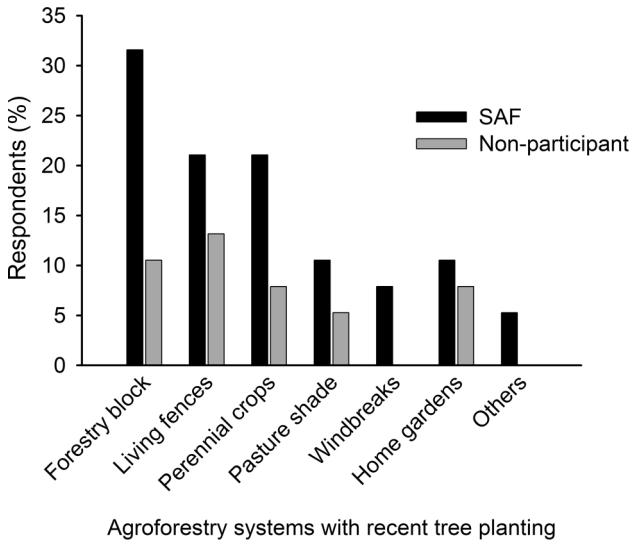

Figure 3. Most common agroforestry systems for tree planting cited by SAF and non-participant farmers in the four communities under study in southern Costa Rica.

to more tree planting cited respectively by SAF and non-SAF farmers were reduced crop and pasture production because of shading (22%) and high costs associated with tree planting and maintenance (17%).

Environmental effects

Because the SAF program is relatively new, only the short-term changes in land uses and farming practices could be evaluated. Although participation in the SAF program was associated with increased tree planting, farmers did not reduce the area of land under active agriculture and tended to reforest areas of the farms for which opportunity costs were low. The majority of planted trees (68.2%) were put into forestry blocks. Seventy-two per cent of farmers reported the previous land use of forestry blocks as abandoned pasture, charral, or steep slopes unsuitable for cultivation.

In general, farmers had a positive view of the environmental effects of the program. A common observation was that trees decreased soil erosion and improved soil quality (72%). The majority of SAF farmers (61%) said they believed that trees were important to protecting the natural environment. According to the experts interviewed, the main contribution towards more environmentally sound practices was a reduction in seasonal burning for slash-and-burn agriculture and pasture renovation.

Table 4. Main benefits citied by SAF farmers as a result of payments for tree planting.

Type of improvements	Respondents (%)
Farm and farming systems	
Purchase of additional livestock	11
Intensification of annual agricultural production	6
Improvement to existing agroforestry system	28
Purchase fencing material/improve existing fencing	28
Increase fuelwood supply	22
Increase forage supply	6
Protection of water sources	17
Household and family wellbeing	
Structural improvements to house	11
Purchase of school supplies, clothes, or medicine	56
Payment towards debts	6
Secondary benefits	
Hire of day-labor for planting and maintenance	28

Socioeconomic impacts

The majority of respondents believed that the SAF program had a positive impact on their socioeconomic situation: 78% reported that their income level had increased as a result of program participation, while the remaining 22% said it stayed the same. However, only 44% said that their income was somewhat higher when the yearly payments were not taken into account, and two respondents reported that their earnings from farming had actually decreased because of agricultural de-intensification. The farmers who reported higher income levels when payments were not taken into account said that their household expenditures were moderately reduced because of increased subsistence products including fuelwood and wood for construction. Because the tree plantations were still young, none of the SAF farmers had sold timber, although the general outlook for a future market was positive. This viewpoint was shared by the experts interviewed, who mentioned the current scarcity of quality timber as a basis for increasing wood values in the future.

The short-term impact of the payments differed among the communities. All of the SAF participants in the indigenous communities of Cabagra and Salitre indicated that they had money left over after planting and maintenance costs, compared to only 25% of farmers in Biolley and Ceibo. Fifty-six per cent of the farmers said they had enjoyed improvements in household wellbeing as a result of the additional money from payments (Table 4). According to the experts interviewed, the program had a greater positive impact in the indigenous communities because of their strong dependence on subsistence farming and limited opportunities for outside sources of income. Another factor associated with the reported positive socioeconomic effects was the efficiency of the local-level project management by either a development organization or farmers' association. For example, the development organization in Salitre arranged seed collections, establishment of tree nurseries, and provided transportation of materials, which helped to reduce costs for individual farmers. In contrast, the farmers with independently managed contracts in Ceibo reported high purchase costs for seedlings and stakes for planting.

There was some evidence for secondary socioeconomic effects from SAF. One-third of recipients indicated that they had hired outside day-labor for the planting and plantation maintenance. At a community level, the management fee collected by the development organization in Salitre used

the income collected from overseeing PES contracts to install a new water system for 10 households. The conservation aspects of tree planting on farms was cited by the farmer's association of Biolley as a helpful tool in grant-seeking and recruiting foreign volunteers and ecotourists to the community.

Obstacles

Both SAF farmers and non-participant farmers were asked what they believed were the main constraints to additional tree planting on their land. Non-participant farmers were most concerned with financial limitations. The cost associated with planting and maintenance at a significant scale (more than 100 trees) was viewed as a high-risk investment. Farmers in this group were also concerned about a lack of training in proper seed collection, nursery establishment, and the management of timber trees necessary to yield saleable wood. Only two program non-participants felt that additional trees would reduce their current crop yields. Conversely, SAF farmers cited a lack of space for more trees as the major constraint to more planting (Table 5).

Several problems in program-level management reduced the efficiency of SAF payments. Farmers in Ceibo, who had all entered into contracts independent of an organization, were particularly critical of the technical assistance and training they had received. Most farmers in Ceibo felt that they were allowed little choice in the trees they were financed to plant, and several of the species recommended by the forestry engineer were poorly suited to the region. A common complaint in this community was 'the trees they told us to plant have no use'. Leaders of the farmers' organizations in the other communities also indicated that a lack of sufficient capacity-building and technical assistance beyond the life of the contract was the main cause of failed or poorly developed agroforestry plantings. Poor communication and follow-through by program management were also viewed as significant problems. Late payments and frequently broken appointments by forestry engineers and program staff reduced farmer confidence and commitment to the program. At the local organization level, management varied but appeared to significantly facilitate transactions and information transfer compared to independently managed contracts. The main criticism of local management was the lack of a transparent system for the amount and use of money retained by the organization.

Table 5. Obstacles to tree planting by small-scale farmers in southern Costa Rica according to the interviews.

Obstacles	Comments
Economic constraints	• Need to maintain land area for subsistence and commercial crop production • Cost of materials and maintenance • Short-term financing • Perceived risk in long-term investment in forestry • Costs associated with program enrolment
Project management	• Lack of information about program • Complicated process for program enrolment • Inappropriate tree species selection by forestry engineer • Lack of technical assistance and training
Local-level management	• Lack of trust among local stakeholders • Lack of transparent system for payments from organization to farmers • Excessive percentage of payments kept by local organization managing contracts

Discussion

Impacts on environmental services

The results of this study indicate that the initial stage of the SAF program has increased several practices that contribute to environmental services. Landowners receiving SAF payments had considerably augmented the number of trees planted on their farms relative to the baseline levels of tree planting within the same communities. Program participants also planted a broader diversity of tree species than farmers who chose to reforest through their own means. A further positive change was the reported reductions in seasonal burning. The payments served to overcome several major obstacles cited by farmers as barriers to reforestation: high initial costs, perceived risk in investing in activities with long-term returns, and a lack of technical knowledge. The program, therefore, appears to have been effective in allowing farmers to engage in agroforestry planting at a level not accessible to the majority of program non-participants.

As has been the case in other agroforestry incentive programs in Central America, farmers planted trees more often in forestry blocks than in intercropping systems (Current and Scherr 1995; Fischer and Vasseur 2002). This is not surprising because most farmers depend on agriculture for their subsistence and cash incomes and are unwilling to engage in practices that risk reducing crop production (Muschler and Bonnemann 1997; Mukadasi et al. 2007). The forestry blocks were generally located on marginal land where there was no active agriculture and where opportunity costs were low. Although comparisons were only possible relative to the communities studied, there did not appear to be a bias towards participation by farmers who had overall low opportunity costs for their land, as was the case with other PES modalities in Costa Rica (Zbinden and Lee 2005). Farmers showed a preference for planting timber trees over trees that supplied fuelwood, fruit, or mulch for perennial crops. The high proportion of native trees that were selected for planting indicates a successful shift away from the non-native species previously popular for reforestation (Evans 1999).

Socioeconomic effects

Although PES have potential to contribute to poverty reduction, poor households have generally been underrepresented among PES recipients (Landell-Mills and Porras 2002; Pagiola et al. 2005). Past studies have also reported

that education level is an important determinant of program participation (Thacher et al. 1997; Zbinden and Lee 2005). This study found that although SAF farmers had more years of education than non-participants, the groups had similar levels of income. In contrast to most previous studies (Pagiola et al. 2005; Zbinden and Lee 2005), the PES recipients depended more often on farm-based products for their livelihoods than off-farm jobs. One possible explanation is that farmers who were more invested in farm-based products were more likely to apply and be accepted for SAF. Because the majority of SAF contracts were managed by organizations, the decision as to which farmers participated was often made at the local organization level and may therefore have minimized the importance of education and socioeconomic status. For example, the selection criteria for SAF recipients in Salitre and Cabagra were (1) the perceived ability of the individual farmer to successfully implement the contract requirements and (2) the degree of need in the given household. Contracts in these communities included a high proportion of poorer families and single, female heads of household. Local-level decision making may therefore play an important role in patterns of farmer participation, but clearly only benefits those farmers who are organization members.

The SAF program resulted in positive economic benefits for participants during the first two and three years of the contract. Farmers reported having a higher level of income during the payment phase and expressed a favorable view of the program. Payment money often exceeded planting expenses, particularly in the indigenous communities. These participants sometimes chose to use the money for farm improvements such as fencing and purchase of livestock, but more often for immediate household needs such as school supplies, clothes, and medicine. Although farmers indicated that planting trees had positive environmental benefits, the contributions of agroforestry products to household welfare were limited thus far. Because most of the planted trees were timber species, farmers commonly viewed the plantings as a 'savings account' for future generations and saw little short-term benefit. Several experts interviewed expressed concern that participants would minimize tree maintenance activities in order to save payment money for other uses. Ongoing technical support and capacity building are therefore likely to be important in enabling farmers realize longer-term benefits from the program.

Program management

The role of community-level organizations emerged as an important factor in farmer perceptions of program success and the value farmers placed on the agroforestry planting. In general, farmers whose contracts were handled by a development organization or a farmer association had a more positive view of the SAF program and the role of trees in their farming systems than those who entered into contracts independently. Farmers in this group also had a more positive view of information exchange and their role in decision-making. Program participants in Salitre and Cabagra frequently mentioned that the capacity-building workshops and technical assistance from the forestry engineer and from within the organization had been highly valuable. Conversely, SAF farmers in Ceibo with independent contracts were critical of technical assistance and project support. Several member of this community were confused as to the contract requirements and were distrustful of program managers due to lack of follow-through on visits and support. Local organizations appear to have the potential to build capacity, provide longer-term technical assistance, and assist in market development for agroforestry products. Competent management of these organizations, a transparent process for managing contracts, and a participatory approach to project design and implementation may also be important factors for adoption and retention of agroforestry practices.

Because of the small sample size of this study, I caution against making broad inferences and too strong conclusions. Nonetheless, to the extent that southern Costa Rica can be considered representative of tropical agricultural landscapes, the experience of SAF participants in this region may be informative to other PES programs. The study suggests that the SAF incentives are effective in overcoming the initial economic and technical obstacles that make adoption of agroforestry practices unattractive to smallholders. Strong local organizations can play a key role in the successful adoption of agroforestry practices through capacity building and support. Given the value that farmers place on the short-term PES payments, ongoing investment in short-/medium-term support is likely to be important for retention of these practices beyond the life of the contract. Further monitoring of farms exiting the payment phase of their contracts is necessary to assess long-term effects on livelihoods and the sustainability of practices that generate environmental services.

Acknowledgements

I would like to thank the NGOs, farmers' associations, and government institutions that assisted this project. Román Gomez provided valuable assistance with interviews. In addition, I would like to thank all the farmers who participated and shared their experience. Support for this project was provided by a NSF grant (DEB 0515577), the Marilyn C. Davis Memorial Foundation, the UCSC Environmental Studies Department, as well as a UCSC writing fellowship to the author.

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