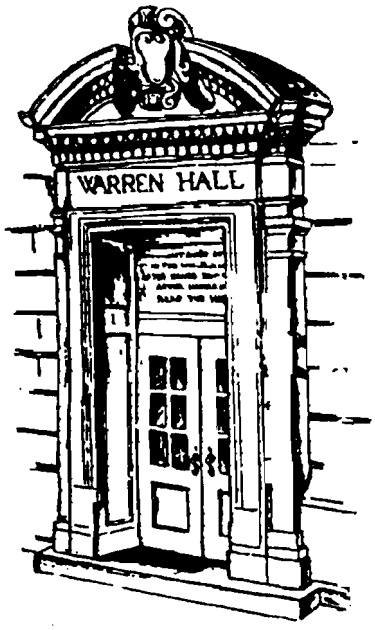

WP 97-11
July 1997

Working Paper

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FARMER PARTICIPATION IN REFORESTATION INCENTIVE PROGRAMS IN COSTA RICA

by

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Selected Paper presented at American Agricultural Economics Association Annual Meetings, July 27-30, 1997, Toronto, Canada.

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Comments by Erick Fernandes and anonymous reviewers of an earlier draft are gratefully acknowledged. The research reported herein was funded by a National Science Foundation Research Training Grant on the "Ecological and Social Science Challenges of Conservation" and by the Cornell International Institute for Food, Agriculture and Development.

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ABSTRACT

Reforestation programs are a common policy response among developing country governments in the tropics attempting to deal with environmental and economic problems caused by widespread deforestation. The objective of this paper is to examine participation by small- and medium-sized farms in two reforestation programs undertaken in recent years by one country, Costa Rica, which has been at the forefront of developing country environmental protection efforts. Analysis of a survey of 243 program participants and non-participants shows that farm households participating in reforestation programs had generally larger farm sizes, were dedicated to low labor-intensive, land-extensive agricultural activities, faced significant family on-farm labor constraints, were more heavily dependent on off-farm income sources, and had more extensive contact with local extension efforts. Logistic regression is employed to econometrically identify demographic, economic, and land use determinants of farm household participation in reforestation programs; the implications of these findings are analyzed. The limitations of reforestation programs, especially with regard to management factors and quality of reforested plots, are reviewed. Implications for improving the efficiency of reforestation programs and the merits of other policy alternatives are also discussed.

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Introduction

In recent decades, accelerated rates of deforestation have caused growing environmental degradation throughout the developing nations of the tropics. The loss of primary forest cover has caused widespread soil fertility loss and erosion, watershed deterioration, and destruction of coastal fisheries habitats [Leonard, 1987]. As a result, biological diversity has been also been widely threatened [Wilcox and Murphy, 1985].

Costa Rica, a small country in Central America, has been at the forefront of developing country environmental protection efforts [Utting, 1993]. Nonetheless, Costa Rica has experienced one of the highest rates of deforestation in the tropics [World Resources Institute, 1994]. Estimates of the extent of deforestation range between 30,000 ha/yr to 50,000 ha/yr since 1965, principally through forest conversion to expand the agricultural frontier [Segura, 1992]. World Bank estimates for 1992 show that clearcutting of primary forest stands had declined to 8,500 ha/yr; however, 39,500 ha/yr were being converted from pristine forest to some form of mixed use [World Bank, 1993]. By 1993, only an estimated 320,000 hectares of intact primary forests, or six percent of Costa Rica's land area, remained outside of registered protected areas [Batchelder, 1993]. These remaining tracts of original forest are expected to largely disappear by the end of the century.

This loss of forest cover raises several concerns. The potential scarcity of future timber resources is the first direct consequence. Declining forest resources are projected to generate $350 million in wood product import demands by the beginning of the next century [Segura, 1992]. Second is the loss of biodiversity protection which forested lands provide. Third, nearly two-thirds (65%) of those lands deforested since 1966 are deemed not suitable for uses other than forestry

[World Bank, 1993]. Clearing of inappropriate lands has lead to moderate soil erosion on an estimated 24% of land area and severe erosion on an additional 17% of land area in Costa Rica [Thrupp, 1990], threatening the long-run viability of the country's agriculture, on which Costa Rica is still heavily dependent for domestic food production, employment and the generation of export earnings.

Concerns that deforestation will lead to future timber shortages, creating pressure on protected natural forests or necessitating timber imports, have led many tropical countries, including Costa Rica, to establish incentive programs for reforestation [Godoy, 1992; Utting, 1993]. These programs frequently use subsidies to overcome the reluctance of landholders to invest in an activity in which returns are realized only over the very long term, and in order to maintain the social benefits of forests even when they provide low private returns [Godoy, 1992; Ascher, 1995]. Since the reforested areas in Costa Rica are often steep hillsides, one of these broader social benefits of reforestation programs is the watershed protection function to which they contribute.

The Costa Rican government has promoted reforestation by landowners through a series of incentive programs having the goals of decreasing pressures to exploit remaining remnant forests and providing a productive and regenerative use for degraded landscapes. In 1988 and 1989, respectively, the Forestry Bond Certificate in Advance (CAFa) and the Forestry Development Fund (FDF) were created to provide reforestation grants to small- and medium-sized farmers organized in reforestation associations. These incentive programs have several objectives, including achieving a sufficient level of reforested timber production to satisfy national market demand, decreasing soil erosion, and reducing the degradation of marginal lands [Martinez et al., 1994].

The success of reforestation incentive programs such as Costa Rica's CAFa and FDF programs depends fundamentally on a proper understanding of the motivations underlying farmers' decisions whether or not to participate. By targeting incentive programs at those most likely to participate and those predisposed to active and responsible participation, program efficiency can be improved. This paper reports the results of a comparative analysis of CAFa and FDF program reforesters and non-reforesters in the Canton of Coto Brus, Costa Rica. The research seeks to analyze farmers' participation in government-sponsored reforestation programs using logistic regression analysis to identify a set of economic, social, and land use factors associated with participation in these programs. Using these "targeting" criteria, the paper discusses how successful incentive programs might better reflect these factors. The underlying hypothesis is that farm system attributes and farm household characteristics play a significant role in determining participation in and efficiency of reforestation programs. The broad implications of this analysis for reforestation programs in general, for multiple output agroforestry systems, and for reforestation programs relative to other types of policy interventions are also discussed.

Reforestation Programs in Costa Rica

In 1979, the Costa Rican government initiated efforts to actively promote reforestation. These efforts included income tax deductions, subsidized credit, municipal forestry tax funds to promote the reforestation infrastructure, and bonds to reimburse prior investment [Segura, 1992]. These early programs suffered from a number of problems: high investment costs, accessibility primarily by large, wealthy landholders, and corruption and mismanagement. As a result of these limitations, these programs had been discontinued by the early 1990's.

In 1988, the Rural Forestry Development Department (DECAFOR) was formed within the Ministry of Natural Resources and Mining (MIRENEM) to implement the Forestry Bond Certificate in Advance (CAFa) and the Forestry Development Fund (FDF). These programs provide grants to small-sized (up to 30 hectares) and medium-sized (30-150 hectares) farmers to encourage the establishment of reforested plantations. While the earlier programs had benefitted only a small segment of the population, the CAFa and FDF programs were aimed at democratizing the reforestation incentive programs by offering upfront investment capital to farmers [Segura, 1992]. The research detailed here focuses exclusively on the CAFa and FDF programs.

The CAFa was established in 1988 as a grant of 100,000 *colones* per hectare but had increased by 1994 to 120,000 *colones* per hectare (approximately US $765 at the average 1994 exchange rate of 157 *colones* = *1* US$). Of this amount, 24,000 *colones* (20% of the total) is allocated to the reforestation association and the remaining 96,000 *colones* is utilized by the farmer. The grant is disbursed over the first five years of plantation establishment [Morales, 1992]. The FDF was initiated in 1989 with funds from the government of Holland. The FDF is a long-term rotating loan system wherein farmers receive 58,000 *colones* (roughly US $370 in 1994) per hectare, distributed over a period of three years [Morales, 1992]. The reforestation association receives an additional 14,000 *colones* per hectare distributed over a five-year period [Martinez et al., 1994].

In the Coto Brus area the decision regarding which incentive program a farmer may participate in is made not by the individual farmer but by the reforestation association which, in effect, pools funds from both programs and allocates them to selected farmer participants. The farmers interviewed for this analysis perceived the CAFa and FDF as a single reforestation incentive

program, and thus the program participation decision addressed in this research should be viewed accordingly.

As in other locations, the effort to promote tree planting among farmers through the use of economic incentives has met with varied success in Costa Rica [Current, 1995; Howard and Valerio, 1996]. The rate of participation in reforestation programs is often low and long-term results are uncertain. The quality of management and of the reforested plots themselves is typically low. The financial burden on the national government necessitates that incentives be efficiently targeted to achieve their goals. Doing so depends greatly on accurately understanding the motivations and intentions of individual farmers. Limited research has been done to identify the motivations of households participating in reforestation programs such as the CAFa and FDF. The comparative approach adopted here -- that is, comparing program participants and non-participants -- can more clearly discern the factors which motivate farmers to participate in such reforestation programs. Results of the research can help in the design of more effective programs in countries electing this policy approach.

Factors Influencing Farmers' Reforestation Efforts

This analysis of factors affecting reforestation efforts in Costa Rica draws from several distinct areas in the literature on agroforestry, forestry, and program participation . For instance, the issue of land and tree tenure has been found by many authors [Hyman, 1983a; Skutsch, 1983; Murray, 1985; Cernea, 1992; Dewees, 1992; Godoy, 1992] to be a significant constraint to tree cultivation among small landholders. The current efforts by the World Bank and other agencies to promote private land-titling throughout the developing world presumes that assuring land and tree tenure rights will

significantly enhance the rates of reforestation and agroforestry adoption. This issue is relevant to this study since land and tree tenure are required for participants in the CAFa and FDF incentive programs.

Other studies in other developing nations [Dewees, 1992; Murray, 1985; Skutsch, 1983] have highlighted a scarcity of fuelwood as one of the necessary factors to motivate reforestation. However, Godoy [1992] and Wiersum and Veer [1983] question the simple assumption that high fuelwood demand stimulates tree production, suggesting that this is only the case when there is a fuelwood scarcity. In the research site for this study, Coto Brus, Costa Rica, fuelwood is the principal energy source for household needs. Yet, as a major coffee producing region, fuelwood supplies are often obtained from the periodic prunings and thinnings of coffee tree plantations. The CAFa and FDF programs are, moreover, restricted to the production of mature timber for construction, not for fuelwood resources.

Within the developing world, there has also been a strong emphasis in promoting communal social forestry. There is a substantial literature concerning the social and economic factors which influence the success of community forestry projects [Boonkird, Fernandes, and Nair, 1984; Shiva, Bandyopadhyay, and Jayal, 1985; Gregersen, Draper, and Elz, 1989; Cernea, 1992]. Studies in countries such as India and Haiti have provided evidence that reforestation on individual private landholdings can also be successful [Shiva, Bandyopadhyay, and Jayal, 1985; Murray, 1985]. Despite the importance of these individual reforestation initiatives, studies of factors influencing private reforestation efforts (aside from feasibility studies) are relatively limited.

Motivations for the adoption of agroforestry practices are also discussed in a large literature [Arnold, 1987, 1992; Hoskins, 1987; Hosier, 1989; Caveness and Kurtz, 1993; Current and Scherr,

1995]. To a lesser degree, research has also focused on the motivations for commercial timber reforestation [Hyman, 1983a, 1983b; FAO, 1988]. These studies have generally indicated that multiple-use agroforestry systems which incorporate short-term rotations and produce multiple outputs such as fuelwood, fruits and nuts, and forage and which also improve soil conditions, provide more immediate benefits to farm households than do single-purpose systems promoting long-term timber production [Murray, 1985; Hoskins, 1987; Hosier, 1989]. For example, Gregersen, Draper, and Elz [1989] conclude that, "farmers compare the expected net benefits [of tree cultivation] with the benefits they could obtain from using their land, resources and time in the next best use in the farming system." For this reason, and the oftentimes high fixed costs of establishment and high opportunity costs of land, multiple-purpose systems are often more highly competitive.

The quality of land available also may significantly influence farmers' choices to dedicate land to long-term versus short-term tree cultivation. Agroforestry systems employing multiple-purpose tree species have been adopted, for example, in Senegal and the Philippines where available land is productive and fertile, though scarce [Hyman, 1983b; Caveness and Kurtz, 1991]. Conversely, when benefits are long-term, perceived value is low and market access is not secure, farmers tend to reforest less productive or marginal lands [Hyman, 1983a; Francis and Atta-Krah, 1989]. Timber reforestation efforts in Costa Rica and Peru have been more successful when available land permits tree cultivation without the loss of currently productive agricultural lands [Thrupp, 1981; and FAO, 1988].

Long-term reforestation and timber production may still be the best possible use for a parcel of land if labor or capital constraints or other factors faced by the farmer preclude alternative investments which are economically viable. Additional non-economic benefits such as erosion

control, water conservation, improved soil fertility, and wind protection have also been cited as reasons for farmer tree cultivation [Scherr, 1992]. The diffusion of information through farmer interaction with agricultural extension and community organizations can also strongly affect adoption of technologies and agricultural practices as well as participation in farmer programs [Raintree, 1983; Romero Pastor, 1985; Smit and Smithers, 1992; Besley and Case, 1993; Arellanes, 1994].

Explaining Reforestation Program Participation

The analytical approach employed in this paper to identify the determinants of farmer participation in Costa Rica's reforestation programs draws from the previous literature on the economics of program participation. Prior analyses have commonly been applied to a variety of farm and resource management programs in the United States in which farmers' program participation is modeled econometrically as a function of a variety of economic, demographic, and farm system variables [Chambers and Foster, 1983; Lee and Boisvert, 1985; Rahm and Huffman, 1984]. The extension of this type of analysis to reforestation programs is straightforward as the latter also involves farmers' tradeoffs of net program benefits with the opportunity costs of participation.

The decision to participate in the reforestation incentive program can be framed as a dichotomous choice model based on maximization of an underlying well-behaved utility function which is assumed to be consistent with individual farm household behavior. A farm household can be expected to allocate land, labor, and capital resources to reforestation efforts if that strategy yields the largest utility for the household [Chambers and Foster, 1983; Rahm and Huffman, 1984]. Based on previous research on farm program participation by Chambers and Foster [1983], Lee and

Boisvert [1985], and Boisvert, Bills, and Bailey [1988], the following utility function can be defined:

$$U_i^p = V (Z_i^p, X_i) + \epsilon (Z_i^p, X_i, e_i^p)$$

where the parameter p denotes participation in the program of the ith individual, vector Z represents attributes attained from program participation which allow a comparison with competing land uses, and vector X_i denotes attributes of the individual, household, and farm system which are exogenous to the decision to participate. The vector V represents the unknown parameters associated with variables of vectors Z and X. The factors which ultimately influence a farmer's decision to participate in reforestation will be those that affect the farmer's perceptions of the economic and conservation value of reforestation versus the value of competing land uses. An individual farmer is assumed to participate in the reforestation incentive program if the utility attained from participation is larger than that which is attained from not participating:

Participation: $D_i = 1$ if $U_i^o < U_i^1$

Non-participation: $D_i = 0$ if $U_i^o => U_i^1$

The probability of program participation, $Pr(D_i=1)$, is a cumulative distribution function of F evaluated at $X_i\beta$, where X_i is a vector of all explanatory variables and β is a vector of unknown parameters [Rahm and Huffman, 1984]. This cumulative distribution function is often modeled using the logistic distribution in empirical studies [Polson and Spencer, 1991]. The logistic cumulative distribution function is the basis for the logit regression model which has the following form:

$$\textit{Probability of Participation} = \textit{Prob}(y_i=1) = \frac{e^{\beta_0+\beta' X_i}}{1+e^{\beta_0+\beta' X_i}} = P \qquad (1)$$

The estimation form of the "logit" transformation of the probability of program participation, P(y=1), can be represented as:

$$ln\ [\frac{P(y_i = 1)}{1 - P(y_i = 1)}] = \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_i \qquad (2)$$

The logit transformation has desirable properties in that it is linear in its parameters, can be continuous, and may range from $-\infty$ to $+\infty$ depending on the scale of the independent variables. Maximum likelihood estimation is used to estimate the parameters of those variables affecting the probability of participation in the reforestation incentive program.

Factors related to the farm household, farming system, and information diffusion are hypothesized to influence the decision to participate in the reforestation incentive program. The literature on the adoption of technology, agroforestry, and commercial reforestation practices collectively identify a variety of specific determinants: land tenure, farm size, farm income, household labor usage, farmer age, farmer experience and education, household size, and access to information and agricultural extension [Feder, Just, and Zilberman, 1982; Polson and Spencer, 1991; Rauniyar and Goode, 1992; Caveness and Kurtz, 1993].

Table 1 summarizes the variables hypothesized here to influence farmer participation in the reforestation incentive programs. Total farm size, the variable AREA, has been shown to be positively related to the adoption of tree cultivation [Chambers, Saxena, and Shah, 1989; Caveness and Kurtz, 1993]. Greater land availability is assumed to permit reforestation without the sacrifice

of agricultural production necessary to meet household food and income needs.

The variable reflecting the possession of legal land title (TITLE) is hypothesized to be positively related to program participation. The form of tenure enjoyed by farmers surveyed in this study included both official title and "bill of sale." The possession of title affects participation in two ways. First, the more lucrative CAFa incentive requires legal title of participants. Second, the process of obtaining legal title may denote a level of experience in dealing with legal and government bureaucracies that may impart a willingness to participate in government programs.

The influence of farmer age (variable AGE) on participation in the incentive program is unclear. Older farmers are often viewed as less flexible, more risk averse, and less willing to engage in a new or innovative activity. However, if reforestation is perceived as a way to decrease the scale and intensity of farm operations, it follows that farmers approaching retirement may be particularly interested in reforestation incentives because of the lower labor requirements and lower household needs [Dewees, 1992].

Tree cultivation is labor-intensive in the planting stage but is generally perceived to be less labor-intensive in the long-term than the cultivation of most crops. Farmers have widely cited a shortage of available household labor for crop production as a motivation for tree planting [Hyman, 1983b; Dewees, 1992; Scherr, 1992]. Arnold [1987] and Godoy [1992] link reforestation with households where family labor has been allocated to off-farm employment which generates greater returns than would be possible from on-farm activities. Therefore, the variable representing the number of available work days of family labor per hectare (FAMLAB), is expected to be negatively associated with participation in the reforestation program.

Complementing the above argument, the percent of household income from off-farm sources

(%NFARMINC) is hypothesized to be positively related to participation. When household income is derived principally off-farm and/or farm income is low, investment in low labor-intensity practices which are associated with lower farm capital requirements are favored. Thus, participation in the reforestation incentive program complements existing patterns of family labor allocation to off-farm activities and provides a use for land which cannot otherwise be exploited. As tree cultivation does not yield short-term benefits to the household, households with higher alternative sources of income should be more likely to participate in the reforestation effort [Arnold, 1992; Dewees, 1992].

Farmers with outstanding debts need short-term profits to make their monthly payments. At first glance, the long-term returns of reforestation would not seem compatible with debt servicing. However, the reforestation incentive programs examined here provide an immediate cash flow which can be employed to help service debt and, moreover, which may be obtained without any significant capital investment and largely through the self-employment of family labor. The ability to obtain credit may further denote a level of experience and interaction with the banking system which may predispose farmers to participation in government programs. For these reasons, the variable DEBT is hypothesized to be positively associated with participation in the incentive programs.

The diffusion of information which has previously been shown to be an important determinant of technology and crop adoption and program participation [Raintree, 1983; Smit and Smithers, 1992; Besley and Case, 1993] is here incorporated in two ways. Visitation by an agricultural extensionist during the prior year (variable EXTENSION) indicates farmer interaction with existing information and education networks. It is assumed that the more integrated farmers are into these systems, the more likely they will be open to innovative practices such as reforestation, and thus, a positive association is expected between the EXTENSION variable and program

participation. Second, the degree to which farmers have sought out and obtained information about the reforestation incentive program should have a positive correlation to participation. The binary variable REFMEET represents whether a farmer attended a community-wide meeting, workshop ,or field day about the reforestation activity prior to enrolling in the incentive program, and is also expected to be positively associated with participation.

Previous research suggests that farmers will choose first to reforest the more marginal lands within their farm system. Both of the land quality variables included here are thus assumed to exhibit a positive relationship with participation in the incentive programs. The variable %DEGRADED represents the percent of the farm system which the farmer reported to have "poor soil quality." Similarly, the variable %STEEP indicates the percent of the farm system which the farmer described as being "steeply sloped."

In addition to the above variables, the availability of direct information on the profitability (discounted net benefits) of participation in the reforestation programs would be useful in understanding farmers' participation decisions. Unfortunately, consistent and comparable economic data applicable to southern Costa Rica are not readily available. A recent World Bank study (Kishor and Constantino, 1993) does examine the profitability (net present values (NPVs)) of several forest management options in Costa Rica -- forest "liquidation" (harvesting all wood of commercial value), managed natural forestry, plantation forestry, and cattle ranching -- under various price, tax, and subsidy scenarios. The study concludes that with low discount rates (5-10%), plantation forestry is by far the most profitable management option, with NPVs on the order of $3,200 per hectare (1989 dollars) at an 8% discount rate. At the higher discount rates more appropriate to small landholders, however, NPVs decline sharply and alternative management options, particularly forest "liquidation"

and cattle ranching, become relatively more profitable. At a 20% discount rate, for example, an estimated NPV of $228 per hectare for plantation forestry makes it the *least* profitable of the four alternatives. With the introduction of reforestation subsidies, both managed forests and plantations become, predictably, more profitable, although at a discount rate of 20% and above, plantation forestry is again the least profitable alternative.

Another recent study by Current (1995) evaluates selected agroforestry systems in Costa Rica (although not in the southern region of the country where the current study was conducted). This analysis finds that, at the same 20% discount rate, NPVs for two different woodlot (*Gmelina arborea*) and intercropping (coffee and *Cedrela mexicana*) systems range between $-77 and $222 per hectare, and $-21 and $120 per hectare, respectively. With the adoption of subsidies, these systems become (more) profitable, but their adoption still has to contend with numerous sources of risk experienced and perceived by farmers --instability in log prices, management risk, lack of markets for woodlot thinnings, etc. -- which may decrease their attractiveness.

These studies together suggest that economic evaluation of reforestation depends, to a considerable extent, on farmers' risk assessments and the rate at which they discount expected future net economic benefits from alternative farm and forest management strategies. Although expected economic profitability plays an important role in influencing the adoption of reforestation and agroforestry systems, as Current and Scherr (1995) conclude in their recent review, "profitability was not necessarily a good predictor of adoption" (p. 95). Further, while the levels of existing subsidies have the potential to turn non-profitable management strategies into profitable ones, this is not a necessary or inevitable outcome. Kishor and Constantino (1993) conclude, for example, that subsidies would have to be increased more than 50% above current levels to make managed forestry

a viable management option for smallholders. These results provide further motivation for the importance of analyzing factors other than solely economic ones influencing reforestation program participation, especially the farm system variables enumerated above.

Given the above hypothesized determinants of program participation, the general form of the reforestation incentive program participation equation is:

$$\ln [P(REFOREST = 1) / (1 - P(REFOREST = 1))] =$$

$$\beta_0 + \beta_1 AREA + \beta_2 TITLE + \beta_3 AGE + \beta_4 EXTENSION +$$

$$\beta_5 FAMLAB + \beta_6 \%NFARMINC + \beta_7 DEBT + \beta_8 REFMEET +$$

$$\beta_9 FARMINC + \beta_{10} \%DEGRADED + \beta_{11} \%STEEP + \epsilon_i$$

Survey Design and Sample Data

The data used to estimate the above model were gathered from personal interviews with 243 farmers in the District of Coto Brus, Costa Rica, in June-August, 1994. The data collected refer to production decisions occurring in the February, 1993, to January, 1994, period (unless otherwise specified). A population of 114 reforestation program participants lived in the districts of Limoncito, San Vito-Pittier, and Sabalito, representing three percent of all farms in the region and 10% of farms with five hectares or more. A stratified random sample of 80 program participants was selected from this population. A sample of 163 farmers who were not program participants was drawn through randomized pairing of reforesters with non-reforesting neighbors who had ownership of at least five hectares of land. This group represented seven percent of all farms and 15% of farms of at least five hectares. Including only sample farms with five hectares or more was based on the empirical observation that smaller farms very infrequently engaged in reforestation efforts. The 1984

Agricultural Census shows that 44% of the farms in Coto Brus were at least five hectares and these accounted for 84% of the land area of the county. Within the sample of non-participants, 10 farmers were identified who were reforesting part of their land on their own, with no government incentives. These observations were deleted in estimating the program participation model. Using logistic regression yields unbiased and efficient coefficient estimates when choice-based sampling is employed, as was the case here [Hosmer and Lemeshow, 1989]. In this case, the intercept parameter cannot be reliably interpreted.

The sample data suggest several differences between the characteristics of reforestation program participants and those not participating (Table 2). Those reforesting were shown to have larger farm size and hold legal title to their land in a greater proportion than non-reforesters. Although program participants had higher mean household incomes, farm income per hectare is significantly lower than for non-participating farms indicating that program reforesters were typically dedicated to less profitable, land-extensive activities. A greater proportion of participants' household income was derived from off-farm sources and outstanding debt was more common. Although mean household sizes and age of head of household were similar across the two groups, the amount of family labor that was available for agricultural work was lower for the participant sample. Adjusted for farm size, the quantity of family labor provided per hectare was much higher for non-participants than for those participating in the reforestation programs.

Program participants attained a slightly higher mean level of education than non-participants. Their level of interaction with agricultural extension and community organizations was significantly greater. Also confirming the importance of information diffusion, a greater proportion of participants had sought out information about the incentive program prior to their enrollment than

was evident for non-reforesters.

The motivations farmers cited for participation in the reforestation program and the characteristics of land which had been converted to forest were also recorded. Table 3 presents the primary motives for enrollment in the incentive programs. Only 30% of reforesters cited the production of timber products as their primary motivation for participation. The most frequently cited reason (35% of reforesters) was concern about the effects of deforestation in damaging the local environment, particularly their farm (e.g., soil and water conservation). Another 30% mentioned compensation or atonement for past tree-cutting on their part as their primary motivation (this high response may in part reflect widespread environmental education efforts in Costa Rica). Only five percent of participants directly responded that cash incentives were the main factor behind their participation, although this figure is likely understated.

Farmers' opportunity costs of reforestation are important and can be understood in part by identifying previous land uses and farmers' perceptions of the best alternative uses of reforested land. As evidenced by the statistics in Figure 1a, it is clear that primarily marginal, less productive lands have been reforested under the CAFa and FDF programs. Half of the reforested area was previously in fallow for a year prior to tree planting. The second most common prior land use was cattle pasture (31% of reforested area). Coffee and basic grain production had been stopped in favor of tree planting on only 5% and 12%, respectively, of the reforested area. In terms of opportunity cost of the reforested land, farmers cited pasture as the best alternative use for 62% of this land (Figure 1b). Nineteen percent of the reforested area was deemed suited for basic grain production with only 12% suited for coffee production.

Farmers' emphasis on reforestation of marginal lands is further confirmed by the fact that

farmers surveyed strongly preferred to reforest land with moderate to steep slopes (82% of the reforested area) rather than less steeply inclined cropland. A majority of the reforested area was perceived by farmers to have only poor to fair soil fertility. Only 18% of the reforested area was roughly level agricultural land which farmers also perceived to possess good soil fertility.

Empirical Results

The estimated results for the reforestation program participation model are presented in Table 4. The table also reports the "odds ratio" and change in probability associated with a given increase in each variable, and summary regression statistics. The odds ratio indicates the level of association between an explanatory factor and program participation. An odds ratio greater than one signifies that the likelihood of farmer participation in the reforestation incentive program increases with higher levels of the specified variable.

Seven of the eleven logistic regression coefficients are significant at the $\alpha = .10$ level or higher. As hypothesized, farm size (AREA) exhibits a positive relationship to participation in the incentive programs. The coefficient of AREA is significant and its associated odds ratio of 1.19 implies that a farmer with 10 additional hectares in farm size is about 20 percent more likely to participate in the reforestation programs.

The coefficient of variable TITLE also is significant and demonstrates a positive relationship with participation. The odds ratio indicates that a farmer who holds a land title is more than three and a half times as likely to enroll in the incentive programs as one who does not. The experience with governmental bureaucracies gained from obtaining land title and the socio-economic status implied by title possession may favor program participation. Also, title permits one to receive

benefits from the more lucrative CAFa incentive program.

The coefficient of the variable representing family labor available per hectare (FAMLAB) is significant at the five percent level and exhibits the hypothesized negative sign. The odds ratio of 0.76 reflects the fact that the farm household which is able or chooses to allocate one additional month (24 working days) of family labor to the farm operation is about 24 percent less likely to participate in the incentive programs. This provides some confirmation of the earlier hypothesis that program participants are likely to have limited family labor resources available for on-farm agricultural production and/or that they choose to allocate family labor to off-farm activities.

The results regarding the estimated effects of non-farm income are also consistent with those pertaining to family labor allocation. The coefficient of %NFARMINC (representing percent of non-farm income) is highly significant and positively related to program participation. A farm household with 10% greater non-farm income is almost 20% more likely to be enrolled in the reforestation incentive program. These programs may represent a means by which farm households can take advantage of relatively low labor availability by complementing their ability to pursue off-farm employment which is also often more highly remunerative. Tree-growing also generates other benefits for households, including low maintenance requirements, serving as a store of value to meet contingencies, and flexibility in harvest time and quantity [Chambers and Leach, 1990].

The coefficient of the variable DEBT is significant at the 10% level and displays the expected positive relationship to program enrollment. A farmer who has long-term outstanding debts has 90% greater odds of participating in the reforestation programs. These farmers are likely utilizing the incentive payments from the program at least in part for debt servicing. In addition, farmers who are able to obtain credit from the banking system are likely to have a level of knowledge and expertise

in financial management which may correlate with their willingness to participate in the reforestation programs.

The coefficients of the extension variables both are significant and suggest strong influences on program participation. The coefficient of the EXTENSION variable has the expected positive sign and its associated odds ratio of 2.28 implies that farmers are over twice as likely to join the reforestation programs if they had previously received government technical assistance for other agricultural activities prior to enrollment. The coefficient of REFMEET is also positively signed and indicates that a farmer who attended a workshop or field day to obtain information about the reforestation program prior to enrollment was four and a half times more likely to participate.

The coefficients of the last three variables in the model presented in Table 4 -- farm income (FARMINC), land quality (%DEGRADED), and land slope (%STEEP) -- exhibit the expected relationships with program participation. However, they are not statistically significant and thus inferences as to the nature of their impacts on participation cannot be strictly made.

Table 4 also presents three statistics which assess the goodness-of-fit of the model. The likelihood ratio test statistic of 78.65 is significant at the one percent level, indicating that the estimated model is significantly different than the model where all coefficients are set equal to zero. The Hosmer-Lemeshow test statistic is used to compare the probability of participation for each individual generated by the specified model and by the "saturated" model employing the observed data. The H-L statistic of 12.94 compared to a Chi-square distribution with 8 degrees of freedom yields a p-value = .114, suggesting a relatively good fit. Finally, the estimated model correctly classifies 80% of the observations in the sample.

Conclusions

The findings of this analysis show that factors regarding farm system characteristics, household livelihood strategies, and access to information are significant in explaining farmer participation in Costa Rica's reforestation incentive programs. The reforesters participating in the program generally had larger farm sizes dedicated to low labor-intensive, land-extensive agricultural activities, compared to their non-participating neighbors. The majority of land converted to tree cultivation was less productive and of marginal quality. The household livelihood strategies of reforesters depended to a greater degree on off-farm income sources, as a consequence of having less family labor available for on-farm agricultural work. Interaction with the local agricultural extension network and attendance at workshops or field demonstrations on reforestation had strong effects in increasing enrollment in the reforestation program.

The principal conclusion inferred from these findings is that farmers may perceive participation in the reforestation incentive programs as taking advantage of a government-sponsored set-aside of marginal, unproductive land for conservation purposes. Reforestation appears not to be viewed by farmers primarily as the adoption of a long-term economic production objective. Rather, farmers seem to be primarily motivated by alternative short-term economic and non-economic benefits which the household derives through participation in the incentive programs.

The decision to participate in the incentive programs appears to be part of a farmer's two-fold strategy. First, in the short-run, farmers can derive financial benefits from lands which are not otherwise suitable for crop or cattle production, due to land quality or capital and labor constraints. Farmers cited improving soil moisture content, and conservation of soil and water as benefits associated with reforestation. In addition to providing supplementary cash income, the long-term

timber harvest is commonly viewed as a "savings account" for the next generation. Moreover, 84 percent of the reforesters also expected their land values to appreciate as a result of reforestation. Second, reforestation is a land use option which complements a diminished role of the farm operation within the household livelihood strategy. For households participating in the program, the farm operation is not yielding income comparable to farms of similar size, in large part due to family labor constraints which limit on-farm income-generating activities. Alternatively, when household labor can be more profitably allocated to off-farm activities, the low labor demands of reforestation are additionally attractive.

One of the clear conclusions of this research is that most farmers participating in the CAFa and FDF programs appear not to be generally pursuing the goal of high quality timber production. The majority of farmers do intend to harvest timber eventually, however, most prefer to make minimal investments in the long-term management of the trees. Many farmers view plantation reforestation akin to natural forest growth and expect a viable harvest to naturally result over the long term.

Given their documented reasons for participating in the reforestation programs, it is perhaps not surprising that these programs have been criticized for their poor record of long-term management and quality control of reforested plots. A 1993 external audit of the Forestry Development Program [Martinez et al., 1994) determined that only 17% of reforested stands were actually capable of producing quality timber; 21 percent of the plots were deemed a complete loss. Immediate intervention was needed in 62% of the reforested plots if the trees were to survive long-term. The timber quality problem may reflect the fact that farmers are fundamentally motivated by economic and non-economic benefits which complement a shift in the household livelihood strategy,

rather than the long-term economic benefits of a high quality timber harvest. The results reported here suggest that reforestation programs in southeastern Costa Rica could be made more efficient by targeting households which share the characteristics identified in this analysis; that is, larger farms with a high proportion of steep, low quality land which also face significant labor and capital constraints, employ a high proportion of family labor off-farm, are used to dealing with extension and NGO programs, and possess land title but also face high debt loads. In other regions of Costa Rica -- or in other countries having similar programs -- surveys and empirical analyses comparable to those discussed here, and undertaken earlier in program development, could be similarly employed to help in the efficient targeting of reforestation and other resource management programs to achieve desired policy goals.

Aside from the increased efficiencies in targeting potential participants, quality management is vitally important if the growing domestic demand for wood products and other societal goals is to be satisfied through reforestation efforts. Although trees unquestionably serve many functions for the farm household [Chambers and Leach 1990], the long-term nature of the primary benefits farmers realize from reforestation suggests the importance of integrating cropping alternatives into agroforestry systems which provide multiple, including short-term, benefits. The importance of encouraging improved forestry management within the context of farm diversification strategies which jointly increase agricultural and forestry productivity was also emphasized in a recent CATIE-IFPRI-World Bank review of agroforestry projects in Central America (Current and Scherr, 1995). Efforts to design low labor- and capital-intensive management practices which conform to farmers' underlying motivations for reforestation would also appear to be particularly important. Policy changes ranging from enhancing land and tree tenure to increasing research efforts devoted to improving forest management practices would help make reforestation and agroforestry systems

more viable over the long-run. Additional policy improvements should take advantage of the proven value of information networks and extension programs and their ability to deliver information to farmers, and, in the case of reforestation programs themselves, to enhance the quality and breadth of program participation through improved targeting strategies. If encouraging farmers' aggregate crop and forest productivity is a desired policy goal, other policy strategies which take advantage of the complementarities of crop and tree-planting should also be given close attention.

Table 1. Explanatory Variables and Expected Signs for Participation Analysis

Variable	Description	Expected Sign
AREA	Farm system size in hectares.	+
TITLE	Farmer possesses legal land title to at least part of farm system: 1 = yes; 0 = no	+
AGE	Farmer age in years.	?
FAMLAB	Family on-farm labor days available per hectare.	-
%NFARMINC	Percent of household income earned from off-farm sources.	+
FARMINC	Total farm operation net income.	-
DEBT	Farmer has one year or more of outstanding debt liabilities: 1 = yes; 0 = no	+
EXTENSION	Farmer was visited in past year by agricultural extensionist: 1 = yes; 0 = no	+
REFMEET	Farmer attended workshop or field day about reforestation (prior to enrollment in program): 1 = yes; 0 = no	+
%DEGRADED	Percent of farm system with degraded soil as perceived by farmer.	+
%STEEP	Percent of farm system with steep slopes as perceived by farmer.	+

Table 2. Mean Comparisons of Sample Non-reforesters and Reforesters

Variable	Non-Reforesters (n = 135)	Program Reforesters (n = 80)
Total Farm Size[a]	17.89 has.	43.34 has.
% Farmers Possessing Legal Land Title[b]	69%	88%
Non-Farm Income as % of Household Income[b]	18%	33%
% Farmers Possessing Long-Term Debt[b]	25%	44%
Family On-Farm Laborers[a]	1.82	1.38
Family On-Farm Labor Days/Ha/Yr[a]	52	27
Household Size	5.05	5.24
Farmer Age	47.00 years	48.73 years
Farmer Education[a]	4.16 years	5.09 years
Farmers Visited by Agric. Extension in Past Year[b]	19%	34%
Community Development Meetings Attended by Farmer in Past Year[a]	5.12	8.75
% of Farmers Attending Reforestation Workshop Prior to Enrollment[b]	9%	36%

[a] Difference significant for two-sample t-test at $\alpha = .05$.
[b] Difference significant for z-test of binomial proportions at $\alpha = .05$.

Table 3. Primary Motives Cited for Participation in the Reforestation Programs

Primary Motivation	% of Program Reforesters
(1) Obtain cash incentives	5%
(2) Produce timber products	30%
(3) Conserve water and soil	35%
(4) Compensate for past deforestation on their part	30%

Table 4. Maximum Likelihood Estimates, Odds Ratios, Changes in Probability and Goodness of Fit Measures for the Reforestation Incentive Program Participation Model

Variable	Coefficient	t-Ratio	Odds Ratio	Change in Probability
Constant	-3.3932[a]	-3.769	--	--
AREA[1]	0.0173[b]	2.073	1.19	0.0303
TITLE[3]	1.2648[a]	2.674	3.54	0.1499
AGE[1]	0.0139	1.014	1.15	0.0244
EXTENSION[3]	0.8249[b]	2.07	2.28	0.0821
FAMLAB[2]	-0.0112[b]	2.014	0.76	-0.0472
%NFARMINC[1]	0.0163[a]	2.902	1.18	0.0285
DEBT[3]	0.6405[c]	1.758	1.9	0.056
REFMEET[3]	1.5129[a]	3.637	4.54	0.1962
FARMINC[1]	-0.0048	-1.181	0.95	-0.0084
%DEGRADED[1]	0.005	0.784	1.05	0.0088
%STEEP[1]	0.0013	0.194	1.01	0.0023
Likelihood Ratio Test (G)	78.65[a]			
Hosemer-Lemeshow Test	12.94 (p=.114)			
# Correct Predictions	186 (80%)			

[1] Odds ratio and change in probability are for a 10 unit increase in x
[2] Odds ratio and change in probability are for a 24 unit increase in x
[3] Odds ratio and change in probability are for a 1 unit increase in x
[a] Indicates significance at $\alpha = .01$
[b] Indicates significance at $\alpha = .05$
[c] Indicates significance at $\alpha = .10$

Fig.1a. Previous Use of Reforested Plots

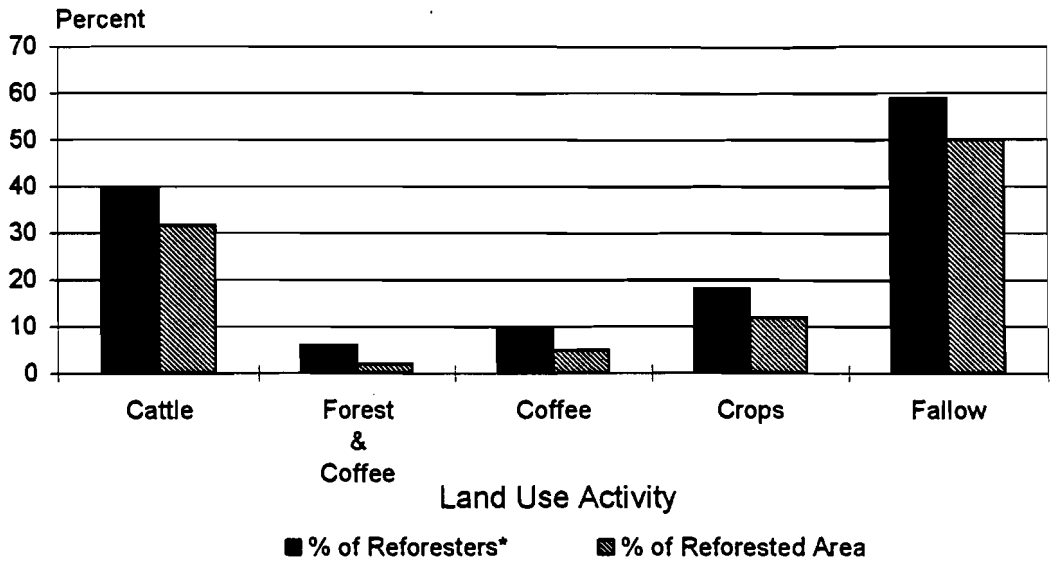
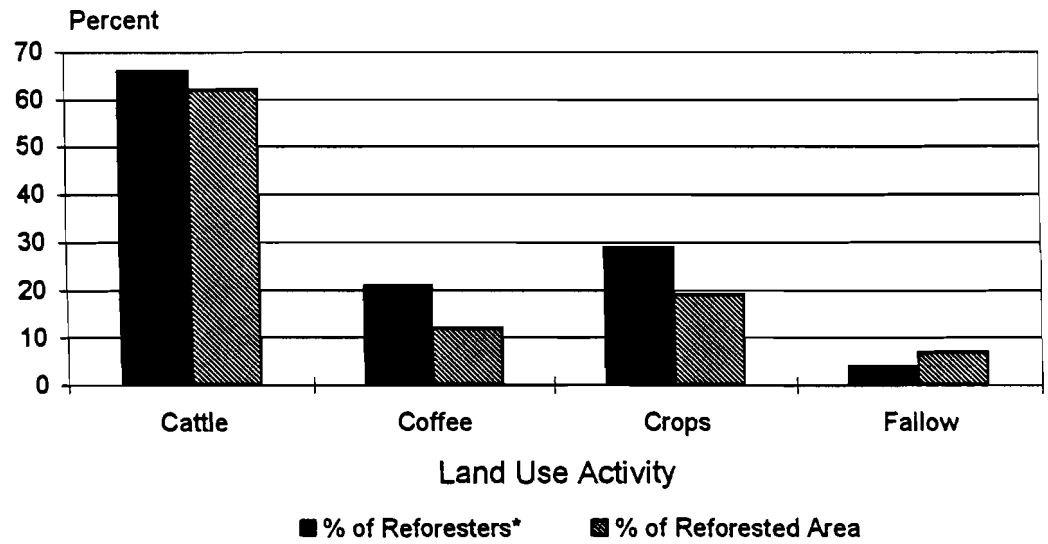


Fig.1b. Best Alternative Use of Plots



* Sums to >100% due to multiple plots with different characteristics.

Acknowledgements

Comments by Erick Fernandes and anonymous reviewers on an earlier draft are gratefully acknowledged. This research was funded by a National Science Foundation Research Training Grant on the Ecological and Social Science Challenges of Conservation and by the Cornell International Institute for Food, Agriculture, and Development.

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