FORESTRY INCENTIVES TO ESTABLISH AND MANAGE TIMBER TREES IN COFFEE FIELDS

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Resumen
El estudio se realizó en Grecia, Costa Rica mediante encuestas y entrevistas a los productores y mediciones de crecimiento de los árboles maderables sembrados en cafetales. La limitante más importante que se encontró fue la densidad de siembra inadecuada de los árboles de los productores que recibieron incentivos; la misma corresponde a plantaciones forestales puras y no es apto para sistemas agroforestales (combinación café/maderables). Como consecuencia de esa recomendación incorrecta de siembra, el crecimiento de los árboles fue mejor en las fincas de agricultores que no recibieron incentivos para reforestación.

Palabras claves: Agroforestry systems, Costa Rica, *Eucalyptus saligna*, silviculture, tree growth

Introduction

The Costa Rican reforestation policy has two objectives: to reclaim lands that are being incorrectly used for purposes other than forestry and to produce wood on a commercial scale to meet the internal demand. After 19 years, 152,000 ha of land have been reforested. Of this area, 15,000 ha was reforested using agroforestry systems (AFS) (Godoy, 1997; Fundación Neotrópica, 1991; Segura, 1992; Wyeth, 1994). The introduction of timber species into coffee plantations is a strategy utilized by Costa Rica farmers to diversify their production and confront problems caused by coffee yield variations and unstable international coffee prices. The purpose of this study was to analyze the importance of reforestation incentives in the adoption of agroforestry systems (coffee/timber trees) among coffee farmers and to conduct a silvicultural evaluation of the agroforestry plantations established with and without incentives in Grecia, Costa Rica.

Methodology

The study was carried out in the district of Grecia in the Province of Alajuela, Costa Rica (10°05' N, 84°12' W; 700 to 1,600 masl). The mean annual precipitation is between 2,500-3,000mm and the mean temperature between 18 and 24°C. The majority of the soils are volcanic, deep, fertile and have good physical characteristics (Ministry of Agriculture and Livestock, 1994). Data was collected using a combination of surveys, interviews and the measurement of temporary tree sample plots in each one of the selected farms. Twenty-nine farmers that had introduced timber trees into their coffee fields, either with reforestation incentives (21 farmers) or with their own funds (8 farmers) were interviewed. Together they represented 10% of the total population of coffee producers in the study zone. The evaluation included both the trees planted within the coffee fields (blocks) and along the borders and roads (lines).

Temporary sample plots were established on farms that had timber trees at least one year old and a minimum surface area of 0.5 ha for the block agroforestry system, or 38 trees

planted in a row, for the line plantings. The size of the evaluation plot in both systems was 36 trees leaving a border of at least one line of trees in the block system and one tree at each end of the line plantings. The silvicultural variables evaluated in the sample plots were: age, planting density, survival, total height and stem breast height diameter.

Results and discussion

Land use and farm size

Considering farmers who received reforestation incentives, 75% of their farm area was planted with coffee and the coffee/timber associations (AFS) occupied 78% of these coffee plantations. Only two farms had less than 50% of the coffee plantations dedicated to AFS, since these farmers only applied for incentives to reforest one hectare of land. Among the farmers who did not use reforestation incentives, 81% of the total farm area was planted with coffee but only 19% of the coffee area was used for the AFS. Nevertheless, excluding one atypically large farm from the average, the area being managed under AFS was 29%. Some 67% of the farmers that received the incentives had farms with more than 5 ha while only 50% of the farmers that had not received the incentive had farms 5 ha or larger.

Tree species used in coffee/timber tree systems with and without incentives and some silvicultural characteristics

Fifty-two percent of the farmers that had AFS and who had received incentives planted *E. saligna* and 48% planted *E. deglupta*. Of the farmers without incentives, 74% planted *E. saligna*, 13% *Cedrela odorata* and 13% *Cupressus lusitanica*; i.e. none of them chose *E. deglupta*. The age of the plantations varied between 19 and 56 months for the AFS without incentives (average 28 months) and between 21 and 82 (average 53 months) for the AFS planted with incentives. The differences in age of the plantations suggest that the farmers without incentives became interested in planting the trees after seeing the reforestation practices established with incentives on neighbouring farms.

The average survival rate of the timber trees was 64% in the plantations of farmers that had not received incentives and 70% in those that did; although in the plantations with incentives, replanting was carried out to maintain the initial population and hence the real figure is lower. The low survival rate of the trees in some plots was due to the attack of leaf cutter ants (*Atta sp.* and *Agromyrmex sp*) during the first two years of the trees' life. On average, the survival rate of the species was 65% for *E. saligna* and 74% for *E. deglupta*. Montenegro et al (1997) reported similar values for *E. deglupta* but lower values for *E. saligna* in a coffee plantation in Turrialba, Costa Rica. There was no significant statistical difference between the survival rates in the systems with or without incentives.

Growth of *Eucalyptus saligna* established with and without reforestation incentives

E. saligna growth in the AFS system established without incentives was significantly better (Table 1). However, the AFS with incentives showed better volumen increments per unit area, but not per tree, due to the large differences in planting density. There were no significant statistical differences for site indexes, possibly due to the fact that farmers with and without incentives managed their coffee in a similar way, thereby providing similar site qualities.

Table 1. Growth of *Eucalyptus saligna* established with and without reforestation incentives in coffee plantations in Grecia, Costa Rica.

Growth increments	Agroforestry System						Significance of difference between means
	With incentives			Without incentives			
	Minimum	Mean	Maximum	Minimum	Mean	Maximum	
Diameter (cm yr^{-1})	1,7	4,0	5,7	4,4	5,5	6,7	***
Height (m yr^{-1})	1,2	3,1	4,4	3,5	4,0	4,9	**
Volume (m^3 ha^{-1} yr^{-1})	2,7	14,1	26,8	1,0	7,6	26,7	*

Significance with a probability of: *0.1, **0.05, ***0.01

The better growth rates of *E. saligna* on the farms that did not receive incentives was not due to poor silvicultural management by farmers who received incentives (and technical training), but rather was due to incorrect recommendations of planting densities for timber trees associated with coffee. The reforestation incentive program demanded an initial tree density of 1,111 trees ha^{-1} and replanting if the mortality rate in the first year was $\geq$ 20%. Farmers that did not receive incentives had plantation densities (initially $\leq$ 200 trees ha^{-1}) closer to those appropriate for AFS (Table 2). The densities utilized by the farmers that received the incentives are typical of pure tree plantations, and negatively affected coffee production due to excess shade and competition between the trees and the coffee for nutrients and water.

Table 2. Initial density and current density of timber trees in coffee plantations in Grecia Costa Rica

Type of farmer	Agroforestry System					
	In line (trees km^{-1})			In blocks (trees ha^{-1})		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Incentives						
Initial	496	705	1434	151	1262	2584
Current	208	388	583	177	917	2540
No incentives						
Initial	125	293	502	156	174	192
Current	108	166	271	101	123	144

Reforestation objectives

The main objective of farmers without incentives, when planting timber trees in coffee, was to produce wood (75%), while the farmers that received incentives claimed more diverse goals than just timber production: e.g. posts, protection of the soil and the crop, scenic beauty (Table 3). Forty-three percent of the farmers that received incentives would not be willing to continue reforesting their coffee fields with timber trees without incentives. In contrast, all the farmers that had reforested without incentives were willing to continue reforestation without incentives.

Conclusions

The coffee farmers in the study area had a positive attitude toward the use of incentives to introduce timber species into the coffee fields. They were optimistic about the potential

benefits that this practice could bring in terms of obtaining timber products (mainly lumber) and hence diversifying production in order to reduce the financial risks related to coffee price variability. The most important limitation encountered was the inadequate planting density recommended to farmers who entered the reforestation incentive program. These planting densities correspond to pure tree plantations and not to an AFS (timber/coffee combination). In this system, most of the farmers consider coffee to be the most important component. As a consequence of this incorrect planting recomendation, tree growth was better on farms that had not received incentives.

Table 3. Farmers' objetives when planting timber trees in coffee in Grecia, Costa Rica

Proposed use of trees	With incentives		Without incentives		Total (%)
	(n)	(%)	(n)	(%)	
Fuelwood	2	10	1	12,5	10
Protection/soil conservation	5	24	1	12,5	21
Posts	3	14	0	0	10
Lumber	9	42	6	75	52
Scenic beauty	2	10	0	0	7

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