# A proposal for financing agroforestry systems as a compensation for environmental services in Costa Rica

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*Key words*: carbon, farmers, incentives, organizations, perennial.

## Introduction

The origin of Agroforestry as a scientific discipline in Costa Rica can be traced back to the early '70s, thanks to the pioneering research carried out at CATIE. Nevertheless, our farmers have successfully practised some traditional agroforestry systems (AFS) since long before, specially those involving perennial crops, such as coffee and cocoa. The former, for instance, covers some 99,960 ha, on which 45,000 farmers and 125,000 families depend upon, generating 17% of the agricultural production gross value and 13.6% of the national exports (various authors, cited by Galloway and Beer, 1997). Currently, a great deal of projects, institutions and peasants' organizations (NGOs) are involved in agroforestry duties, as a response to the farmers' real needs and the acknowledgement of AFS as a viable option for sustainable development by cooperation agencies. Moreover, their socio-economic and environmental impact is becoming increasingly significant and documented. Surprisingly, despite of all the comparative advantages of AFS, they are not liable yet to the relatively successful forest incentive program launched by the State since the late '70s. Therefore, this proposal aims at financing AFS as a compensation for environmental services under the specific conditions of Costa Rica, particularly $CO_2$-mitigation, to comply with the Kyoto Convention on global climatic change.

## Materials and Methods

This proposal is the final outcome of a long participatory process in which the knowledge and experience of both technicians and farmers was compiled, systematized and complemented with recent scientific data on the topic. Thus, a first proposal was brought out (Araya, 1994), which defined the main technical, financial and administrative criteria to finance AFS. Yet, only limited funding was obtained through the Forest Development Fund (FDF) for the 1995-96 period. Later on, a national workshop was held to discuss the main achievements, limitations and priority actions to be undertaken in four areas: research, training, extension and policy (National Agroforestry Network and Commission, 1997). Indeed, the present proposal is the follow-up to one of the recommendations made in such workshop.

## Results

*Incentives and establishment costs of AFS*

In 1986, a new era for forest development in our country began with the creation of the Peasants' Forest Development Program. Thus, in 1988 the State grants the first incentives to organized small and middle farmers, but only for block planting. Nevertheless, in 1989 the FDF was established through an external debt swap with the Dutch, Swedish and Finnish governments. Such incentive consisted of US $267/ha (US $215 for the farmer and US $52 for the organization) during the first three years after planting. Although mainly meant for block planting, it also allowed finacing the

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trees in some 2,000 ha of AFS for US $533,333 (1989-94). Afterwards, through a participatory process (Araya, 1994), the incentive was readjusted to US $0.44/tree (US $0.37 for the farmer and US $0.07 for the organization), so financing 173,472 trees in AFS for US $77,099 (1995-96).
Likewise, based on several studies carried out in Costa Rica and Central America, Gómez and Reiche (1996) determined the establishment costs for various types of AFS, which ranged between US $0.24 and US $0.59/tree (Table 1). They point out some important differences between costs until year 3, associated to the particular characteristics of each system (density, species, management, etc.).

Table 1. Costs of four common AFS in Costa Rica (US $/ha, June, 1996). US $1=ø270, December, 1998.

| System | Year | N° work-days | Inputs | Total cost | Cost/tree |
|---|---|---|---|---|---|
| Tree rows | 1 | 31.80 | 103.26 | 247.88 | |
| | 2 | 12.80 | 19.56 | 77.77 | |
| | 3 | 10.60 | 22.14 | 70.36 | |
| | Total | 65.20 | 144.96 | 396.01 | 0.59 |
| Windbreaks | 1 | 46.10 | 125.73 | 335.40 | |
| | 2 | 6.90 | 0 | 31.38 | |
| | 3 | 4.30 | 0 | 19.56 | |
| | Total | 57.30 | 125.73 | 386.34 | 0.35 |
| Groves | 1 | 54.00 | 129.70 | 375.30 | |
| | 2 | 23.10 | 8.67 | 113.73 | |
| | 3 | 18.10 | 1.78 | 84.10 | |
| | Total | 95.20 | 140.15 | 573.13 | 0.51 |
| Coffee and trees | Trees | 7.20 | 11.96 | 44.71 | 0.35 |
| | Coffee | 149.70 | 289.77 | 970.62 | |
| | Total | 156.90 | 301.73 | 1015.33 | |
| Beans and trees | Trees | 17.00 | 45.51 | 122.83 | 0.24 |
| | Beans | 64.40 | 33.14 | 326.04 | |
| | Total | 81.40 | 78.65 | 448.87 | |

Source: After Gómez and Reiche (1996)

*Economic benefits of AFS*
The CATIE/GTZ Agroforestry Project has conducted some pioneering research on multi-strata perennial AFS in Costa Rica and Panama. Thus, Platen (1996) estimated that the net benefit of the laurel (*Cordia alliodora*)-maize (*Zea mays*)-ginger (*Zingiber officinali*)-arazá (*Eugenia stipitata*) mixed system-US$13,656/ha-and of the laurel-maize Taungya system-US$8,867/ha-were significantly higher than that from a pure reforestation-US$2,841-on a 15-year rotation. The posts and timber value accounted for US$9,808, US$7,183 and US$4,761 for each system, respectively. Similarly, Calvo and Platen (1996) calculated the net benefit for the cocoa (*Theobroma cacao*)-plantain (*Musa spp* )-laurel system under different densities, obtaining a maximum of US$14,486 at 256, 768 and 69 plants/ha, respectively, after 12 years. Standing wood supplied 14% of the income (US$4,386/ha). Also, Calvo and Somarriba (1998) determined that the gross margin for the cocoa-madero negro (*Gliricidia sepium*) system-US$378/ha/year-was greater than that from the cocoa-poró (*Erythrina poeppigiana*)-US$279/ha/year-and of the cocoa-guaba (*Inga edulis*)-US$244/ha/year-systems, with a benefit/cost ratio of 1.93, 1.67 and 1.59, respectively, for a 15-year period.

## Discussion

*Contribution of AFS to $CO_2$-mitigation*

Unfortunately, the environmental services provided by AFS to society have not been fully realized in our country, although there seems to be a growing scientific evidence about the valuable contribution of AFS to $CO_2$-mitigation (various authors, cited by Kürsten and Burschel, 1993). For instance, Houghton *et al.* (1991) estimate the potential AFS tropical agricultural area between 356-499*$10^6$ ha, with an average $CO_2$-mitigation capacity of 60 t/ha for America and Asia and 30 t/ha for Africa. On the other hand, Winjum *et al.* (1992) consider an average value of 95 tC/ha, and Swisher (1991) one of 38 tC/ha, the latter equivalent to 75% of a block plantation with a 35-year rotation in the Wet Premontane Tropical Forest. Nevertheless, data from Central America indicate that AFS with a relatively dense tree crop, such as shade trees in coffee and cocoa, would permanently store only a normal stock (50% of the final stock) of 3 to 25 tC/ha, resulting in a mitigation effect of 0.1 to 3.6 tC/ha/yr. Although this may seem rather low, its role becomes significantly enhanced when other effects are also included, particularly the conservation of existing forests. Table 2 summarizes the overall contribution of AFS trees to C-mitigation.

Table 2. Estimated $CO_2$-mitigation effects of AFS (tC/ha).

| *Accumulation and conservation of C stores* | |
|---|---|
| Trees in AFS | 3...60 |
| Wood products | 1...100 |
| Soil organic matter | 10...50 |
| Protection of existing forests | 0...1,000 |
| *Sum* | *(14...1,210)* |
| *Reduction of $CO_2$-emissions within 50 yrs* | |
| Energy-substitution | 5...360 |
| Material-substitution | 0...100 |
| Reduction of fertilizer-input | 1...5 |
| *Sum* | *(6...465)* |
| *Total* | *(20...1,675)* |

Source: Kürsten and Burschel (1993)

*Economic appraisal of $CO_2$-mitigation by AFS*

The above data points out the need to allocate an economic value to the important C-mitigation effects provided by AFS. For example, a study carried out in the Peruvian Amazon (Smith et al., 1997) determined an annual compensation of US $218/ha required for forest conservation and US $138 for conversion to AFS without considering environmental services, whereas these values dropped to US $67 and US $41, respectively, when those services were taken into consideration. The cost per tC ranged between US $8-10 for forest conservation and AFS, both for high and low C prices, similar to the US $12 (range between US $3-35) reported by Ridley (1997) and the US $3-25 by Swisher and Masters (1992). Moreover, the latter found out that USA companies could reduce their C-emissions between 35-40% at a marginal cost of US $100-200, respectively, by partly substituting natural gas by coal. These values are similar to the US $165 (range between US $50-429) estimated by Ridley (1997). Therefore, Smith *et al.* conclude that there exist a substantial comparative advantage in paying a compensation to small farmers for C sequestration, who are willing to forgo potential significant income from shifting cultivation to get the local environmental services provided by forest conservation or AFS. Yet, they recommend that other environmental services be assessed in the future.

## Conclusions

From the foregoing, it is clear the great contribution of AFS to C-mitigation. Therefore, we propose the following criteria to compensate farmers for such environmental service:

- To finance only the tree component of AFS (the crop/animal component is excluded).
- To finance only timber species (in windbreaks all species should be financed, but at least one stratum should be a timber species).
- To finance the AFS according to estimated average value per tree.
- To finance the following types of AFS: Perennial Crops (coffee, cocoa, others) under Shade Trees, Bordering Trees, and Windbreaks.
- To utilize the cost structure proposed by Gómez and Reiche (1996, Table 1) and update such costs, including a 10% for capital goods.
- To assure full access of women to this kind of financing.
- To disburse resources during the first three years (65, 25 and 10%, respectively).
- To allocate a maximum of 16% of the resources to the NGO.
- The NGO should submit a Collective AFS Reforestation Plan, elaborated and followed-up by a Forest Regent or Agroforestry Specialist authorized by the College of Agronomic and Forest Engineers, which should be approved and supervised by the respective Conservation Area (MINAE).
- To consider in the future the financing of other AFS with great potential, but on which more experience is still lacking (e.g., silvopastoral systems, home orchards).
- To consider in the future the integral financing of AFS (i.e., trees-crops-animals).

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