

**BIOSOCIOECONOMIC ANALYSIS OF THE FORESTRY COMPONENT
OF AN AGROFORESTRY OPERATION IN
THE AREA OF TURRIALBA, COSTA RICA***

**OSVALDO CARLOS ROCKENBACH, M.Sc.
Empresa Catarinense de Pesquisa Agropecuaria,
S.A. (EMPASC),
Brasil.**

Paper prepared for the "Técnicas Agroforestales para el Trópico Húmedo"
Short Course, sponsored jointly by CATIE and the Deutsche Stiftung für
Internationale Entwicklung (DSE), Turrialba, Costa Rica, December 8-16,
1980

Publication prepared with the financial support of the Swiss Cooperative
Development Program.

CENTRO AGRONÓMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA, CATIE
Department of Renewable Natural Resources
Turrialba, Costa Rica, 1980

*(Translation from Spanish N.Price.)

CONTENTS

	<u>Page</u>
I. INTRODUCTION -----	1
II. SYMBOLS USED IN THE ELABORATION OF THE DIAGRAM -----	4
III. THE FARM SYSTEM -----	5
IV. THE FORESTRY COMPONENT -----	6
A. <u>Eucalyptus deglupta</u> -----	6
B. <u>Pinus caribea</u> -----	10
C. <u>Cordia alliodora</u> -----	10
D. Other trees on the Farm -----	11
E. The natural forest on the Farm -----	12
V. RELEVANT ASPECTS OF THE FARM SYSTEM -----	13
VI. BIBLIOGRAPHY -----	15
VII. APPENDIX -----	16

I. INTRODUCTION

Farms are agricultural units that produce food for Man, through the combination of both physical and biological factors, They are complex systems that when taken collectively form a region, and as such form a subsystem of it.

On the farm we come face to face with the reality of a farm household: with the father or manager, his wife, children, relatives and friends, needs for communication and the entire "problematique" inherent in their community relations. This group has physical and spiritual needs, and together they form part of a web of relationships designed to meet these needs.

Besides the farm household we find that the farm is influenced by the environment, determined in part by the rainfall, radiation and the temperature experienced.

These factors together with others determine the resources available the whole system being characterized by the nature of the topography, soil fertility, trees, crops, animals, and existing infrastructure.

The farmer must manage this complex system of production every day, and not only as a part of the social, political and economic region and of the Country to which he belongs.

To understand how the farm works and to be able to suggest changes it is necessary to analyze and visualize it as a unit, as it is seen by the farmer.

The objective of the present discussion is to present an analysis of the forestry component of a farm located in the region of Turrialba Costa Rica. On this farm trees are managed in association with coffee and in an interesting manner with pasture: This analysis was undertaken

with the following intentions: a) to become familiar with the farm system and those agroecosystems which included trees, b) to measure the annual growth increment of the trees and to quantify it in both biological and economic terms.

To achieve these objectives measurements of diameter at breast height (DBH) and heights of planted trees were made. The values obtained were used to calculate the economic worth of the trees. Additional data were taken in order to describe the complete farming system.

MODELO CUALITATIVO

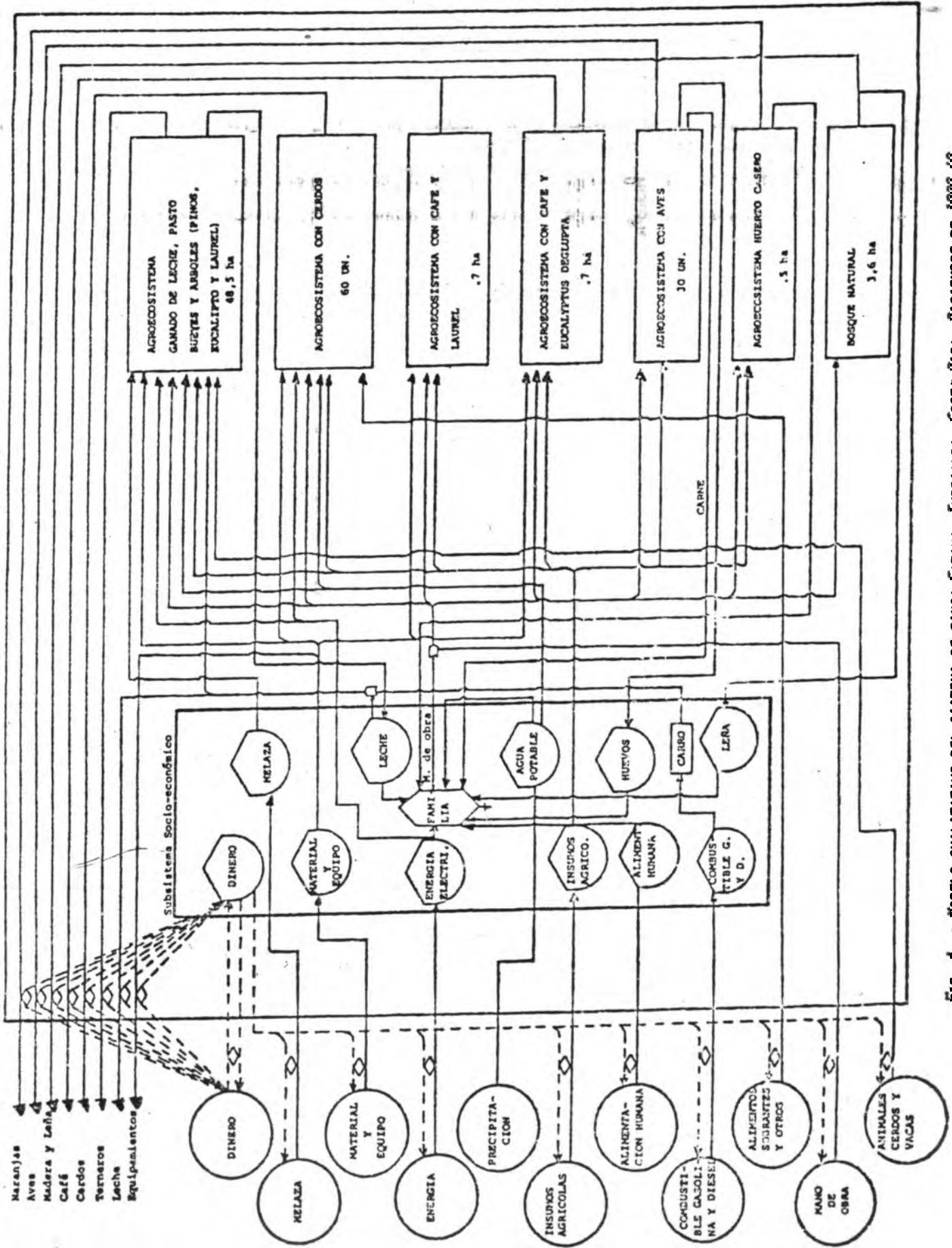
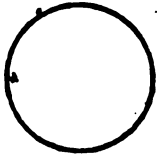
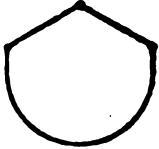


FIG. 4. - MODELO CUALITATIVO DEL SISTEMA DE FINCA FATIMA, TURRIALBA, COSTA RICA, DICIEMBRE DE 1980 (G. RUCKENBACH, CATIE, TURRIALBA, COSTA RICA, 1980) SIMBOLOGIA H. OGIH (II).

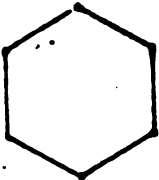
II. SYMBOLS USED IN THE ELABORATION OF THE DIAGRAM (11)



Means "source". These are inputs that supply the elements of production. They are external to the farm system and outside its control. eg. the Sun, springs, etc.



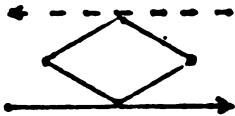
This symbol represents a reservoir of a product, water, etc.



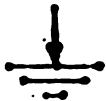
Represents the symbol for living beings. In the diagram it is used to indicate the family.



The rectangle represents the components of the farm (our system) without entering into the internal processes of the component.



This symbol describes an economic transaction and indicates the exchange of money in one direction, the discontinuous line, for materials that enter the system in the other direction (the continuous line). The relationship between one and the other is the price per unit of production.



Indicates the losses that occur in the different processes.

III. THE FARM SYSTEM

The analysis of any system begins with its description. This description can be realized by means of diagram or a mathematical equation, which are models of the system. A model, consequently, is a simplified version of reality; in simplifying, the most important elements are identified for inclusion in the model.

Using information obtained from a farm survey, in the area of Turrialba, a qualitative model of one farm was elaborated (fig. A). This model permits visualizing the farm as a system, showing the inputs, outputs and internal flows of materials, energy, radiation, money, water, etc. The solid lines represent the limits of the system and the dynamic flows entering the system and within the system. The outputs from the system are also represented by the solid lines. The discontinuous lines represent the flow of cash entering the system through the sale of a product, and which leaves when the farmer acquires materials in order to maintain his system of production.

The farm system in question is composed of two parcels of land which are managed directly by the farmer. The components or subsystems of the farm are:

- the socioeconómico subsystem
- the different agroecosystems, including:
 - . dairy cattle and oxen
 - . pasture with trees
 - . coffee with laurel and Eucalyptus deglupta
 - . pigs
 - . home garden
 - . chickens
 - . natural forest

The participation of each component and its interactions is shown in detail in the model.

On the farm are found associations which contain three stata, with excellent economic returns; these vegetative communities are

formed by Cordia alliodora (lumber tree) in plantings of coffee with shade of Erythrina poeppigiana, and as an intermediate crop you find citrus, banana and plantain. The pasture area is sprinkled with trees of Psidium guajava, and Anthocephalus cadamba. All these are associations that help conserve the soil, maintain a biological balance and produce as products lumber, firewood and fruits.

IV. THE FORESTRY COMPONENT

A. Eucalyptus deglupta

According to Ugalde (13) the majority of studies on E. deglupta show that this species has a rapid growth and requires good exposure to the sun for best development. As can be seen from the table in the Appendix, the trees of eucalyptus that have an age of 10.7 years have acquired an average breast height diameter of 32.5 cm, which corresponds to figures given in the literature (13,5); the younger trees have an average diameter of 20.5 cm.

There are 340 trees of E. deglupta planted on the farm and the current volume of timber is 433.4 M³. The trees are not planted according to a regular spacing arrangement given that they have been interplanted with pasture and crops. In 1979 the farmer, aware of the value of planting these trees, planted 800 more, which at the time of writing have reached a height of 5 .

During the month of April the farmer, following the advice of Personnel from Diversificación Agrícola*, carried out a selective thinning of the different plantings of eucalyptus eliminating 80 trees which showed defects in form and which were being adversely affected by adjacent trees. This thinning represented the removal of 23.4% of the E. deglupta on the farm. The results of this thinning and the products obtained are given in the following tables (Table 1 and 2).

Table 1. Sawmill products from the thinning of 80 trees of Eucalyptus denlupta 10.7 and 5 years of age. The measures are given in local units of board onches (ie. pulgadas madereras Ticas (PMI)) and the values in Costa Rican colones.

Sale of sawed timber	PMI in each board	Total PMI
410 boards (3/4" x 5" x \$ va)	3,75"	1.537,50"
30 boards (3/4" x 8" x 4 va)	6"	180,00"
200 boards (3/4" x 4" x 4 va)	2,25"	450,00"
53 boards (3/4" x 3" x 3 va)	1,68"	89,04"
<u>Boards</u>		
125boards (1/2" x 3" x 4va)	1,50"	187,50"
46 boards (1/2" x 3" x 4 va)	1,13"	51,98"
	Total	2.496,02"
Sold as logs: 4030 inches at ₡ 1,00 e/o		₡ 4.030,00
Sawed inches: 5831 inches		
Usable inches: 2496,02		
<u>Logging costs</u>		
Transport: 22 km at ₡2,50/km	₡55,00	₡ 354,64
Choffer: 12 hr at ₡10,37/hr		₡ 124,44
Worker: 24hr at ₡ 7,30/hr		₡ 175,20
Supervision by forestry foreman from Diversificación Agrícola:		₡ 138,24
Total cost from extracción:		₡ 492,88

- 1/ PMI= a piece of lumber measuring 1 cm x 1 cm x 3,36 m.
- 2/ Prices given in colones of Costa Rica. US\$1= ₡ 8,54.
- 3/ A vara is equivalent to 132".

Table 2. Fence posts obtained from thinning 80 trees of Eucalyptus deglupta aged 10.7 and 5 years. Included in the table is a summary of the total income received from the sale of the products obtained from the thinning.

Sale of posts of Eucalyptus deglupta

Diameter	vol/unit (m ³)	No. of posts	m ³
2-3	0,00665	84	0,5586
3-4	0,01303	75	0,9772
4-5	0,02153	116	2,4974
5-6	0,03217	86	2,7666
6-7	0,04493	72	3,2349
7-8	0,05982	82	4,9052
15 feet	0,08204	13	1,0665
Total:		528	16,0064

Sale of posts

16,0064 m³ at £306,00/m³ £4.897,95

Costs

Transport of posts

15 km at £2,50	£ 37,50
Driver: 5 hr at £10,37	£ 62,22
Workers: 12 hrs at £7.30	£ 87,60
Total	£ 187,32

Supervision by a forestry foreman

from Diversificación Agrícola: 16 hrs at £8,64 £ 138,23

Summary

Sale of posts	£4.897,95	
Sale of lumber	£4.030,95	
Logging costs		£1.560,00
Extraction costs		£. 818,55
Income to farmer		£6.594,10

The results presented only refer to the costs of falling the timber and carrying it to the sawmill. To these costs needs to be added planting and maintenance expenses before we can talk about the cost of production of the material thinned. What is important, however, is that the forestry component can supply the farmer, periodically, additional income without demanding much expense.

Additional information may be obtained from the appendix.

*Diversificación Agrícola is an institution affiliated with the Municipality of Turrialba and which has as its objective the extension of services and materials directed towards the diversification of farms in the area.

B. Pinus caribea

Initially, the purpose of the farmer was to plant trees to landscape the farm, because of this, along the borders of the roads pines are found that, after 10 years, have an average height of 22.4 M and a diameter (DBH) of 29.5 c. (Further information is given in the table in the Appendix) Until today none of these trees have been cut, although near Turrialba there is a chipping mill which will buy any quantity of pine available for sale.

The pine on the farm shows fast growth given that the soils are good and that there is no problem with lack of water. Pine wood is neither hard nor heavy compact, it is elastic and it is durable when put in contact with the soil. It is acceptable as firewood and is used for posts, railway ties - when treated, construction in general, for pulp, etc. The trees are also planted for their resin from which kerosene is manufactured.

The farmer has a number of trees planted along the border of his coffee. In association with coffee fruits and their later harvest. In pasture, likewise, the fallen needles make it difficult for the cattle to feed on the grasses below. Due to this problem the pine is not a good species for associating with crops, especially coffee and pasture. However, there are a lot of data from places like New Zealand, Honduras, and Australia which indicate that the practice of combining pines with pasture is widespread.

C. Cordia alliodora

Associations with Cordia alliodora (laurel) are common and, on the farm studied, are of much greater economic importance than any other combination. The laurel for its many advantages is especially appropriate for forming the upper strata in the traditional agroforestry associations (2). Some of the advantages that can be mentioned are:

1. It is easy to regenerate in openings.
2. It has the ability to resprout, even in isolated conditions.

3. It forms naturally a straight, cylindrical trunk, with a sparse canopy.
4. It is deciduous during dry periods.
5. It provides a considerable quantity of organic matter to the soil.
6. It produces a lumber highly valued locally.

On the farm studied, laurel is combined with pastures and coffee, and it is also found in the natural forest. The trees of laurel in pasture and coffee originate from natural regeneration before the use of herbicides became practical on the farm. The trees do not receive any special treatment.

In the table given in the Appendix a summary of the available data for the laurel is given. The exact age of these naturally regenerated trees is not known, but the farmer believes that they are between 15 to 18 years of age.

D. Other trees on the farm

Besides the species mentioned the farmer has on his farm approximately 3 km of living fence posts. Gliricidia sepium or madero negra is the species used. The use of living fence posts, besides saving the farmer money in maintenance costs also posts are obvious.

In the pastures the farmer has trees of guayabo (Psidium guajava) that, in previous years provided fruit for the pigs on the farm. The cattle are responsible for the distribution of the trees, eating the fruits and later depositing the seeds, which with their charge of organic matter and their seed coats scarified, are ready for rapid germination and growth. At present the lack of labor and its high cost are preventing the recollection of the fruits of guayabo for distribution to the pigs. The branches and the pruned trunks of the trees are used for firewood, the wood being noted for its high calorific value.

Fruit trees can be seen throughout the farm, associated with the crops or alone, in the pastures and even in the natural forest. The most

The most common are the citrus, the Manzana de agua" (Syzygium malaccensis), papayas (Carica papaya), etc., which supply the fruits eaten by the farmer's family and the employees.

In years past, the farmer under the influence of CATIE, planted a wide array of species. The most commonly encountered are Cadam (Anthocephalus chinensis), Araucaria (Araucaria spp.), Flame of the Forest (Spathodea campanulata) and Cedro (Cedrela odorata). These trees are on the farm because the farmer enjoys trees and, according to him, they enhance the farm and will eventually bring income.

E. The Natural Forest on the farm

The remnant forest on the farm has been a source of wood, posts and firewood. The farmer sold 11 logs of "cedro" and "anonillo" in 1978, taken from this forest. At present the forest plays a role in the conservation of local flora and fauna, in controlling the supply of water to the farm, and in protecting some of the sloping areas from erosion. It is widely known that soils with a vegetative cover have a greater potential for permitting infiltration and the storage of water, and consequently, constitute a key factor in the conservation and management of water supplies. The farmer found that after cutting and removing the forest around a water hole that the spring disappeared. On the basis of this experience the farmer decided to reforest the area with eucalyptus and pines in order to see if the spring would return to its' original location.

It is obvious that the natural forest is poorer as a source of income than the plantations of exotic species. When the farmer was asked about the reasons for maintaining the natural forest on his farm he alluded to the need for conservation and to the fact that he was obtaining indirect benefits from the forest. At the same time he made it clear that he understood the difference between a natural forest and a plantation of exotic species with respect to its' diversity of strata and its' economic productivity.

What is important is that the farmer is aware of the value of the

native forest and is trying to manage it in a conservative and non-destructive manner. At present he is protecting the natural regeneration of laurel, in this forest, by reducing some of the surrounding seedlings, thus reducing competition.

V. RELEVANT ASPECTS OF THE FARM SYSTEM

The agroforestry activities tend to complicate the diagram of the farm system, however, the reality of the situation cannot be sacrificed for fear of complexity. If research aims at solutions to practical problems in the short-term it must deal with this reality. According to Avila (1), the fact that agroforestry practices exist on the farm is enough to demonstrate their contribution to the productivity of the farm. Undoubtedly an investigation of these aspects of the farm can lead to exploration of means to help the farmer increase his efficiency.

Agroforestry practices are common in the tropics and, for this reason, deserve an evaluation similar to that given to any other activity on the farm. (1). In the example that we are considering the farmer wishes to improve his exploitation of trees on the basis of management practises which will increase his financial gain. In the past he has planted many trees without having sufficient information about their use or value, Many of these trees have not produced any income for the farmer while occupying land for years. In order that other farmers do not commit the same errors information on successful management practises must be extended to them as soon as these practises are tested; unproven practises should not be introduced to farmers.

The forestry component of the farm produces an average monthly income of about £1,300* with only the 593 trees that can be maintained, in dense forest, in a little more than one hectare. The expense of maintaining this agroecosystem is very low, which more than justifies its practise in economic terms.

* $1M^3$ laurel = 312 PMT; 1PMT = £1.75 (7)

* $1M^3$ Eucalyptus & pine = 0.77 Commercial Volume; $1 M^3 = £300.00$ (from tables 1 and 2)

The trees on the farm are like a bank account, if the farmer needs money quickly he can cut down a few trees to meet this need. If he does not need money then the trees, through continued growth, add a little more to the account.

To-date there has not been any problems with pests or diseases in the forestry component of the farm with the exception of some termites which were found in two trees when they were cut down, however, this is a problem that deserves attention. The diversity of species on the farm makes it improbable that any given pest or disease will find conditions enabling it to destroy any particular component on the farm.

The trees on the farm hardly receive any attention from the farmer. Only once a year are some of the lower branches pruned in order to improve the development of the trunks, a practise which reinforces the conclusion of the profitability of the trees to the farmer.

The terrain on the farm is characterized by a number of rather steep slopes which, unfortunately, are managed as pasture and susceptible to erosion. It would be advisable to have trees planted on these slopes, associated or otherwise with pasture or crops. This would help secure the area from erosion and would permit its' continued contribution to the overall productivity of the farm.

Associations of trees with crops on the farm are beneficial from the point of view of a better utilization of solar energy, conservation of soils, the production of biomass, and the generation of income. The diversity of crops and their spatial arrangement bring benefits both to the environment and to the farmer with a wide range of possibilities for producing sustainable income.

VI. Bibliography

1. AVILA, M. et al. La importancia del componente forestal en pequeñas fincas ganaderas de Cosra Rica. Turrialba, Costa Rica, CATIE, 1978. 29p.
2. BEER, J.W. et al. Un estudio de da o sobre prácticas agroforestales tradicionales en el trópico húmedo: el proyecto "La Suiza ". Turrialba, Costa Rica, CATIE, 1979. 28p.
3. BENE, J.G., BEALL, H.W. y COTE, A. El bosque tropical: sobreexplotado y subutilizado. Trad. de Arturo Delgado Flores. Serie Técnica No. 5. Bogotá, Colombia, CONIF, 1978. 51p.
4. BUDOWSKI, G. Sistemas agro-silvo-pastoriles in los trópicos húmedos. Turrialba, Costa Rica, CATIE, 1978. 29p.
5. COMBE, J. y CEWALD, N., eds. Guía de campo de los ensayos forestales de CATIE en Turrialba, Costa Rica. Turrialba, Costa Rica, CATIE, 1970, 378p.
6. FUENTES F, R. Sistemas agrícolas de producción de café en México, In Taller Sistemas Agro-Forestales en América Latina, Turrialba, Costa Rica, 1979. Actas. Editado por G. De las Salas. Turrialba, Costa Rica, CATIE, 1979. pp 62-75. 15 refs.
7. GONZALEZ GONZALEZ, L. E. Efecto de la asociación del laurel (Cordia alliodora (Ruiz y Pav.) Oken) sobre producción de café (Coffea arabica L.) con y sin sombra de Poró (Etythrina poeppigiana (Walpos) O.F. Cook). Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, 1980. 110p.
8. HART, P. Agroecosistemas; conceptos básicos. Turrialba, Costa Rica, CATIE, 1979. 211p.
9. KING, K. F. S. y CHANDLER, M. T. Las tierras desperdiciadas. Nairobi, Kenya, ICRAF, 1978. 44p.
10. MURCIA, H. H. Fundamentos de economía agrícola. In Curso Interamericano de Planificación de la Reforma Agraria. San José, Costa Rica, IICA, 1971. 66p.
11. ODUM, H. T. Environment, power and society, New York, Wiley, 1971. 331p.
12. SPEDDING, C. R. W. The biology of agricultural systems. Academic Press, London, 1975. 161p.

VII. APPENDIX

Summary of measurements made on Eucalyptus deglupta (10.7 + 5 years of age) Pinus caribaea (10 years) and Cordia alliodora (15 years), on Finca Fátima, Turrialba.

		<u>Eucalyptus</u> 10.7 years	<u>Pinus</u> <u>caribaea</u> 10.5 years	<u>Laurel</u> + 15 years	<u>Eucalyptus</u> 5 years	Total
	N	275	117	136	65	593
cm	d	32,5	29,5	29,5	20,5	
m	h	20,0	22,4	21,5	18,0	
m ²	G	25,3	7,5	10,4	2,4	45,60
m ³	V	409,1	78,1	114,6	24,3	626,10
m ³	IMA	38,2	7,9	7,6	4,9	58,50
	ff	0,53	0,46	0,48	0,53	

IMA= Mid-year annual increment

ff= Form factor

Data given in the table refer to the trees as found on the farm (ie. mixed with other crops) and consequently measurements are not on a per hectare basis.

N= Number of trees ; d= mean diameter (DBH); h= mean height; G= Basal Area

V= volume