ATLANTIC ZONE PROGRAMME

Report No. 54
Field Report No. 100

PLANTATION FORESTRY IN THE NORTHEN ATLANTIC ZONE OF COSTA RICA

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May 1993

CENTRO AGRONOMICO TROPICAL DE
INVESTIGACION Y ENSEÑANZA - CATIE

UNIVERSIDAD AGRICOLA
DE WAGENINGEN - UAW

MINISTERIO DE AGRICULTURA Y
GANADERIA DE COSTA RICA - MAG

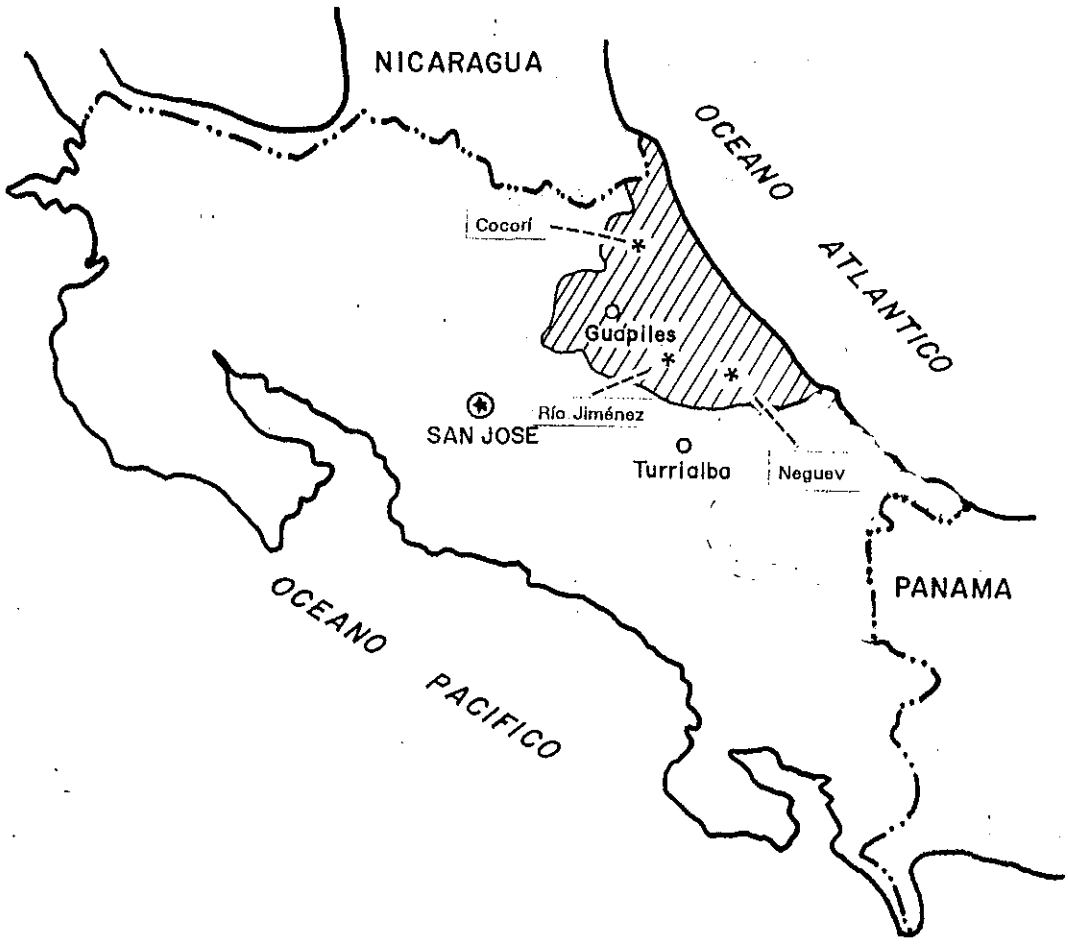

Figure 1. Location of the study area.

PREFACE

General description of the research programme on sustainable Landuse.

The research programme is based on the document "elaboration of the VF research programme in Costa Rica" prepared by the Working Group Costa Rica (WCR) in 1990. The document can be summarized as follows:
To develop a methodology to analyze ecologicaly sustainable and economically feasible land use, three hierarchical levels of analysis can be distinguished.
1. The Land Use System (LUS) analyses the relations between soil type and crops as well as technology and yield.
2. The Farm System (FS) analyses the decisions made at the farm household regarding the generation of income and on farm activities.
3. The Regional System (RS) analyses the agroecological and socio-economic boundary conditions and the incentives presented by development oriented activities.

Ecological aspects of the analysis comprise comparison of the effects of different crops and production techniques on the soil as ecological resource. For this comparision the chemical and physical qualities of the soil are examined as well as the polution by agrochemicals. Evaluation of the groundwater condition is included in the ecological approach. Criterions for sustainability have a relative character. The question of what is in time a more sustainable land use will be answered on the three different levels for three major soil groups and nine important land use types.

Combinations of crops and soils

	Maiz	Yuca	Platano	Piña	Palmito	Pasto	Forestal I	Forestal II	Forestal III
Soil I	x	x	x		x	x	x		
Soil II						x	x		
Soil III	x			x	x	x	x		

As landuse is realized in the socio-economic context of the farm or region, feasibility criterions at corresponding levels are to be taken in consideration. MGP models on farm scale and regional scale are developed to evaluate the different ecological criterions in economical terms or visa-versa.

Different scenarios will be tested in close cooperation with the counter parts.

The Atlantic Zone Programme (CATIE-AUW-MAG) is the result of an agreement for technical cooperation between the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), the Agricultural University Wageningen (AUW). The Netherlands and the Ministerio de Agricultura y Ganadería (MAG) of Costa Rica. The Programme, that was started in April 1986, has a long-term objective multidisciplinary research aimed at rational use of the natural resources in the Atlantic Zone of Costa Rica with emphasis on the small landowner.

SUMMARY

In order to make a land use planning you have to know the functioning of current Land Use Types (LUT). Plantation forestry is a LUT in the northern Atlantic Zone of Costa Rica and this study describes the way it is currently practised.

To obtain the information needed the farmers who have plantations in three research areas as chosen by the Atlantic Zone Programme were questioned about their way of managing the plantation. Also their stands were measured and described. The three research areas Neguev, Río Jiménez and Cocorí represent the three phases of colonization apparent in the Atlantic Zone. The Neguev is a government controlled settlement, Río Jiménez is an old settlement area whereas Cocorí is just recently colonized.

The research is based on two interviews with the farmers who were available for questioning at the time of the research and the measuring of their stands. The first interview was a means to find the farmers who were willing to participate in the study and an inventory of their motives for establishing a plantation. The second interview was more indepth. The farmers were questioned about the way they managed their plantations, the amount of time and resources they needed for it and about their plans for future maintenance, thinning and harvesting work.

Less than 10% of the farmers in the research areas have plantations. Most are smaller than 10 ha though there were two plantations in Cocorí with more than 100 ha. The most common tree used was the local species *Cordia alliodora* or laurel. Second was *Gmelina arborea* originally from Asia. A variety of local species is often used in combination with laurel. Laurel was chosen by the farmers for its relatively rapid growth, reasonable quality of timber, availability of stock and pest resistence. Gmelina on the other hand was preferred for its high yields.

Without government subsidies only very few farmers would have plantations. Only those who expect a shortage of timber for their own use in the not so near future and who are convinced they still will be farming at that time would have reforestation projects. There are only a few of those because a lot of people settling in the area come either from the city or have been previously labourers on banana plantations and only have basic farming skills.

Nearly all the plantations in the research areas were therefore started after 1987 when the government introduced the subsidies for reforestation projects of small farmers. Most of them started even later since UPAGRA, a farmers union based in a town near the Neguev and Río Jiménez, only started promoting plantation forestry in 1989. To get a subsidy small farmers have to be member of an organisation.

Because of this short period of growth there is little to say about the performance of the plantations, especially in regard to the three soil types which are used in the Atlantic Zone Programme. Mortality in the first year ranges from 5-15% if the planting was done in the rainy season but out of ignorance some farmers planted in the dry season and lost up to a 100%.

The only common denominator in the management of the stand was the planting distance of 3*3 m recommended by the government and necessary to reach the minimum target of 1111 trees/ha required for obtaining the subsidy. The frequence of weeding, the use of herbicides and fertilizers, the frequence and amount of thinning planned and the frequence of pruning all depended on the knowledge of the farmer, their will to succeed with the plantation and the time available to work on the plantation.

ACKNOWLEDGEMENT

I would hereby like to thank everybody working at for the Atlantic Zone Programme at 'Los Diamantes' for their support. Especially my invaluable assistant Pipi without whom I couldn't have survived the interviews.

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1 INTRODUCTION

This study is part of the research done within the CATIE/AUW/MAG Atlantic Zone Programme in Guápiles, Costa Rica. The Atlantic Zone Programme is a cooperation between the AUW (Agricultural University Wageningen), CATIE (Centro Agrónomico Tropical de Investigación y Enseñanza) and MAG (Ministerio de Agricultura y Ganaderia).

In 1991 the second phase of the Programme started and this phase has as title 'A methodology for planning of sustainable land use: a case study in Costa Rica'. The Department of Forestry participates in it with a PhD-research project that is conducted by Arthur van Leeuwen. The title of the project is 'Integration of trees and forests in farming systems: An intertemporal LP model on farm level as a tool for land use planning in the Atlantic zone of Costa Rica'.

To collect the data needed for the PhD-research, several MSc-students will do studies about the different aspects of the way forestry is practised in the Atlantic Zone of Costa Rica. This research has to provide the information on plantation forestry in a format which can be used in linear programming as well as to give a description of the Land Use Type (LUT) 'plantation forestry on farms'. A Land Use Type is 'a specific kind of land use under stipulated biophysical and socio-economic conditions (current or future), seen as a sub system of a farm' (HUIZING ET AL., 1987). A land use can be described according to its setting, technical specifications and requirements (HUIZING ET AL., 1987).

In this report the following definition of a forestry plantation is adopted: 'a forest crop or stand raised artificially either by sowing or planting with as main goal the production of timber' (EVANS, 1982). This definition does not only include the pure timber stands, but systems like taungya and line planting as well. The emphasis of this study is therefore on the production of timber. There are other by-products of plantations e.g. food, tannins, dyes and medicins which are not discussed within the given timeframe.

The study has been conducted in three research areas. These are Cocorí, Río Jiménez and Neguev. They were chosen in the first phase of the programme, because they represent three different phases in the colonization of the Atlantic Zone. Río Jiménez is an area that has been colonized for a relatively long time, Neguev is characterized by an organized colonization of I.D.A. (Instituto de Desarrollo Agricultura = Institute for agricultural development) and Cocorí is an area on the "agricultural frontier" which is just recently, spontaneously colonized.

2 OBJECTIVES AND METHODOLOGY

2.1 Problem identification

Since the colonization of Atlantic Zone started at the end of the nineteenth century with the establishment of banana plantations and the settlement of farmers, the rate of deforestation has been high and the remaining forest areas are highly fragmented (VERBRAECKEN, 1988). The Atlantic Zone has been, and still is, a net exporter of timber but if deforestation continues, which is likely due to continuing colonization, the forest reserve will soon be depleted (HUIZING et al., 1987).

One of the ways to produce timber is plantation forestry. Already cleared but for agriculture unsuitable land can be converted into plantations, timber can be an alternative cash crop for farmers. On a regional level the establishment of plantations can indirectly preserve remaining natural forests as well as jobs in the timber industry.

Most of the land in Costa Rica is privately owned, due to policies that encouraged colonization of the public domain that consisted mainly of vast areas of virgin forests. At the same time the constitution guarantees the freedom of land use, which makes land use planning by law impossible (ROMEIJN, 1987). Land use planning by law enables government to determine the land use on private lands, e.g. a forest can't be used as agricultural land if it is designated as forest land. If plantation forestry shall contribute to the production of timber will depend on the number of farmers who establish plantations, the amount of land they allot for it and the quality of the timber which is produced.

Farmers will only establish plantations if they think that the balance between the benefits they get from a plantation is positive be it government incentives, a financial security in times of need or a way to use otherwise unsuitable land and the costs for establishing, maintaining and harvesting. This also in comparison to other LUTs.

2.2 Objectives

The general objective of this study is to describe the land use type plantation forestry as part of a farm for each of the three research areas Cocorí, Río Jiménez and Neguev situated in the northern part of the Atlantic Zone of Costa Rica.
The objectives of the study are:

- To make an inventory of the motives for establishing a plantation and expectations of the future importance of the plantation for the farmer.

- To make a detailed analysis of the establishment, maintenance and harvesting practices of the plantations in each of the three research areas.
- To make an inventory of the policies of regional governmental organizations dealing with plantation forestry, thereby determining their goals and means.
- To give an overview of silvicultural requirements of the tree species which farmers use.

The questions which have to be answered to achieve these objectives are:
- What is the reason for having a plantation?
- Which amount of inputs (labour, skill, land, capital) does the farmer use for his plantation?
- What are the outputs (timber, subsidies, security) of these plantations?
- What are the natural (pests, diseases, erosion) and management (lack of skill, machines, capital) constraints of plantations or the species used?
- Can the current system be improved in a feasible way?

2.3 Methodology

The definition of a land use type, given in chapter 1, states that the land use, here plantation forestry, has to be described in its specific biophysical and socio-economic conditions. Chapter 3 will describe the climate, geomorphology, geology and soils in the three research areas as well as their history of colonization, infrastructure and other aspects which might influence the way plantation forestry is practised.

The characteristics of the research areas are not the only socio-economic conditions which influence plantation forestry. The government as well as non-government organizations can influence the establishment of plantations by providing subsidies or extension services. The government might also hinder by making laws which make (plantation) forestry economically less attractive. To determine this influence chapter 4 details the government policies and their consequences.

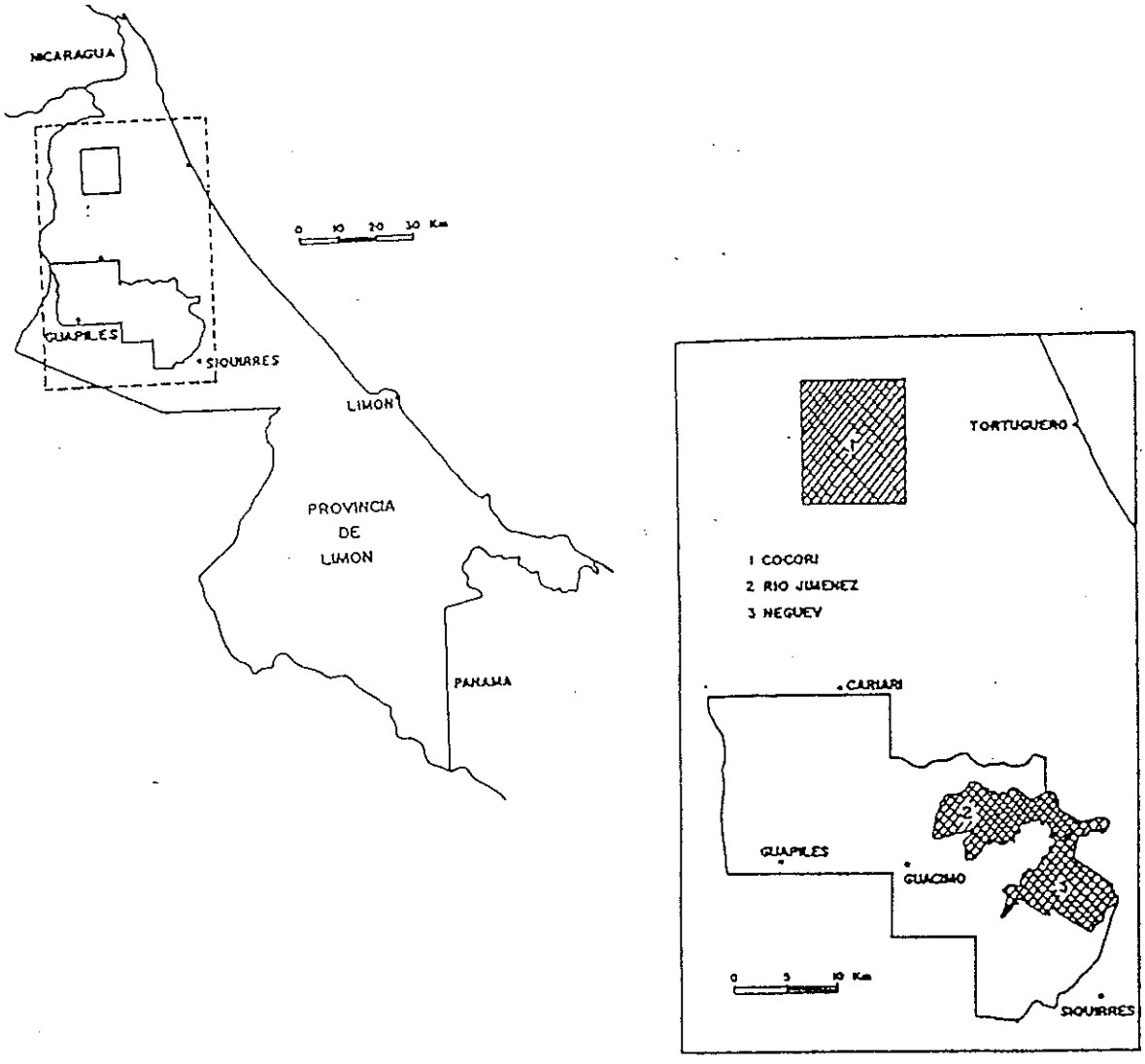
Although conditions might be the same for a group of farmers, only some of them chose to establish a plantation. Chapter 5 gives the results of an inventory of the socio-economic circumstances of the farmers with reforestation projects and of their motives to establish them. On the basis of this inventory an attempt is made to classify the farmers into different groups, with as criteria farm size, land use and motivations to establish a plantation.

The land use plantation forestry is described in chapter 6, with regard to the setting, technical specifications and requirements of plantation forestry. An overview of the sizes, species distribution, soil types of the stands is presented. Then, the characteristics of the management of the species in the survey as well as their projected yields are given. Based on foregoing analyses the possibilities to improve the current practices of plantation forestry are also discussed.

3 RESEARCH AREAS

3.1 Introduction

The three research areas (see figure 3.1) are chosen as representative of different phases of colonization in the Atlantic Zone. Río Jiménez has been colonized for a comparatively long time, Neguev is an organized settlement by I.D.A. and Cocorí is just recently colonized. The three research areas will be described in this chapter.



Source: Atlantic Zone Programme

Figure 3.1 Topographic map of the Atlantic Zone

3.2 Neguev

3.2.1 Introduction

The Neguev settlement is situated between the towns Siquirres and Guácimo in the province Limon. The settlement is surrounded by big commercial farms and companies, like Matas de Costa Rica (ornamentals), CODELA (hardboard) and a newly established banana plantation. They need a lot of labourers which makes labour scarce in the area.(OÑORO DE, 1991).

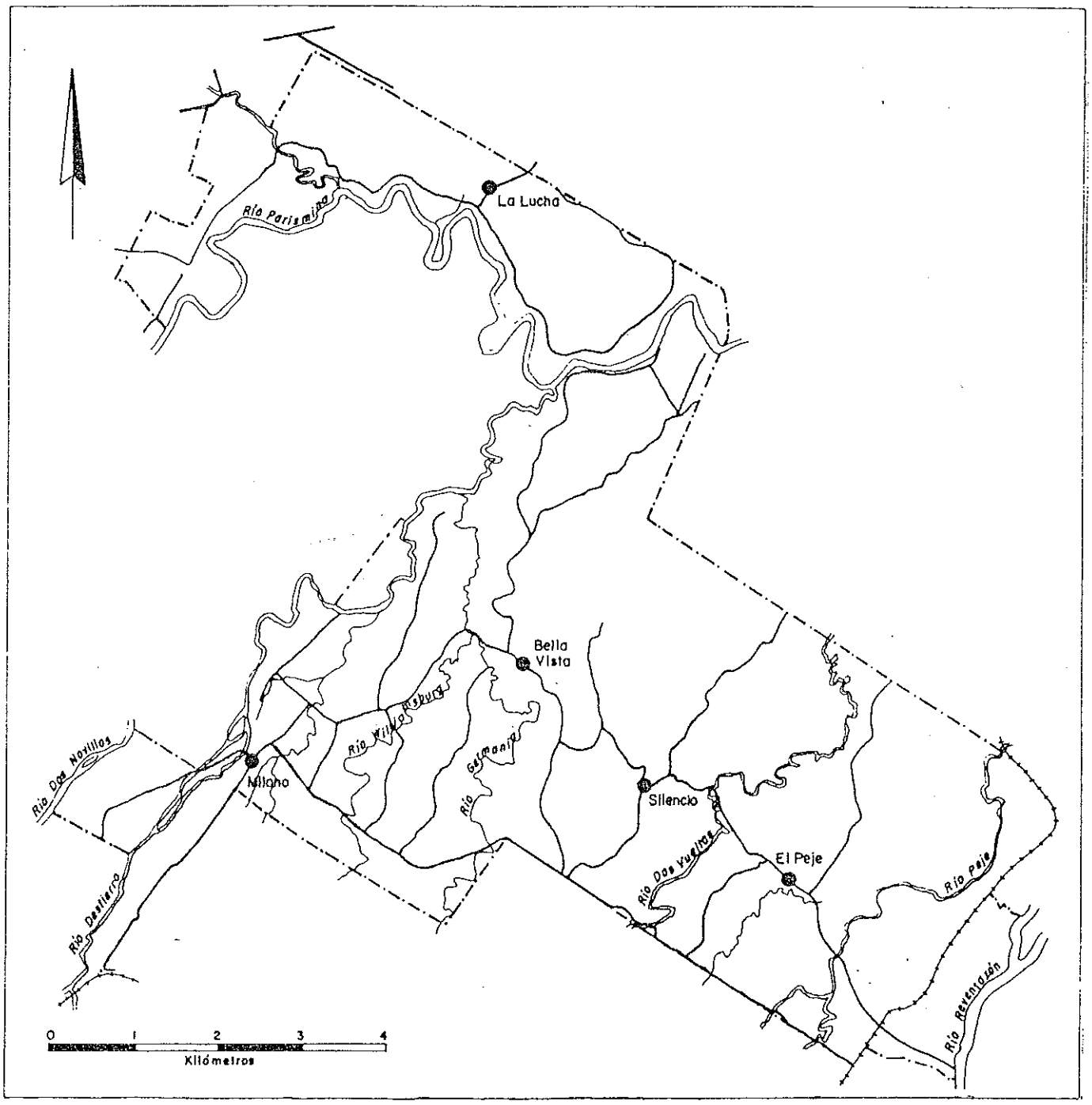
Formerly the Neguev was a large estate belonging to a company named "Empresa agrícola ganadera Neguev S.A". In 1979 it was seized by a group of farmers organized by UPAGRA, a farmers union. Within a year the government intervened in the dispute between the company and the new occupants, by buying the estate and dividing it under supervision of the I.D.A..(OÑORO DE, 1991).

The current settlement is divided into five sectors, La Lucha, Milano, Silencio, Bella Vista and El Peje (see map 3.2). It covers an area of 5,340ha with 311 farms. Farm sizes ranges from 10 to 17 ha. (MUCHER, 1992).

The sectors La Lucha and Milano are less hilly than the others which are strongly dissected. Most badly drained swampy areas are found in Bella Vista, Silencio and Milano. Bella Vista even has a swampy area which is not being cultivated. The sectors in the eastern part are less accessible than Milano. The roads are unpaved, with many small bridges. La Lucha is isolated from the other sectors by the river Parismina, but is easy accessible from Río Jiménez.(ONORO DE, 1991).

3.2.2 Climate

The weather of the Atlantic zone is characterized by high temperatures and abundant rainfall during the whole year. The wet months are June, July and August as well as October, November and December. March, April and May are relatively dry and therefore called summer months.(OÑORO DE, 1991). The mean monthly rainfall is not that much lower in the dry month, but dry spells of days or weeks without rain can end in days of intensive downpour. In the rainy season a daily ritme of dry mornings and wet afternoons occur.



Source: OÑORO DE, 1991.

Figure 3.2 Topographic map of the Neguev

The mean annual temperature is 25^{0}C, the average rainfall 3666 mm, the potential evatranspiration is 2500 mm per year and relative humidity more than 80% during the whole year. Figure 3.3 shows the data on precipitation of the weather station "El Carmen", which is situated just outside the research area.(ONORO DE, 1991)

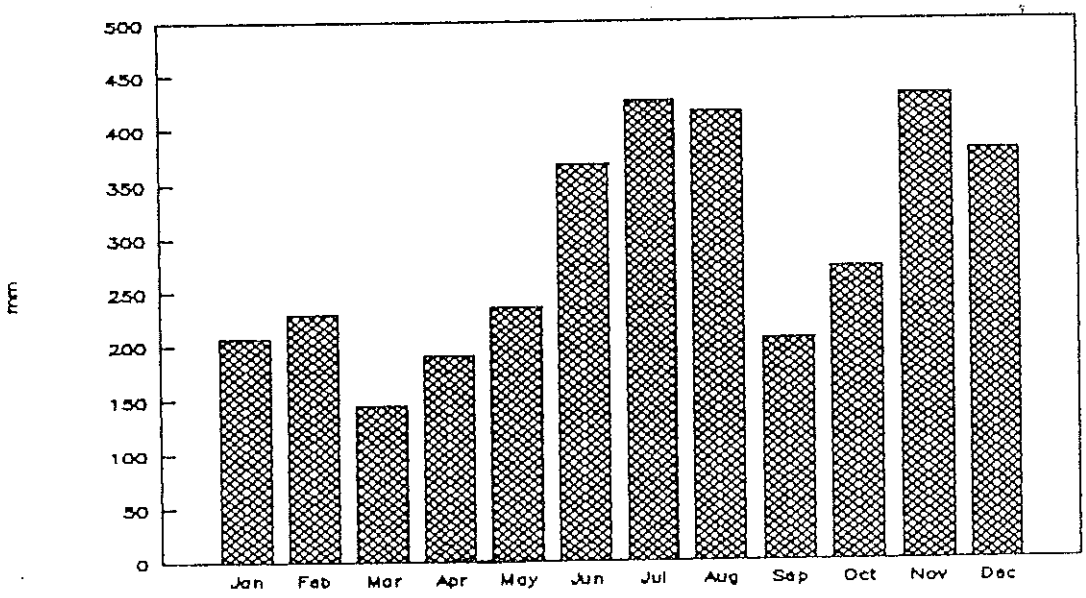


Figure 3.3 Average monthly precipitation in "El Carmen"

3.2.3 Geology and geomorphology

The study area is situated at the northeast section of the foot of the volcano Turrialba which is a part of the "Cordillera central". The smoothly undulating landscape of the Neguev is formed by lahar (volcanic mud streams) deposits of different ages, and is strongly dissected by many rivers. In most places the lahar material is strongly weathered resulting in clayey soils. The sediments have a fluvial origin with a large component of pyroclastic material. The deposits of the river Parismina and Destierro are the most recent and have a high mineral content, mainly due to pyroclastic material that mineralizes quickly.(OÑORO DE, 1991).

3.2.4 Soils

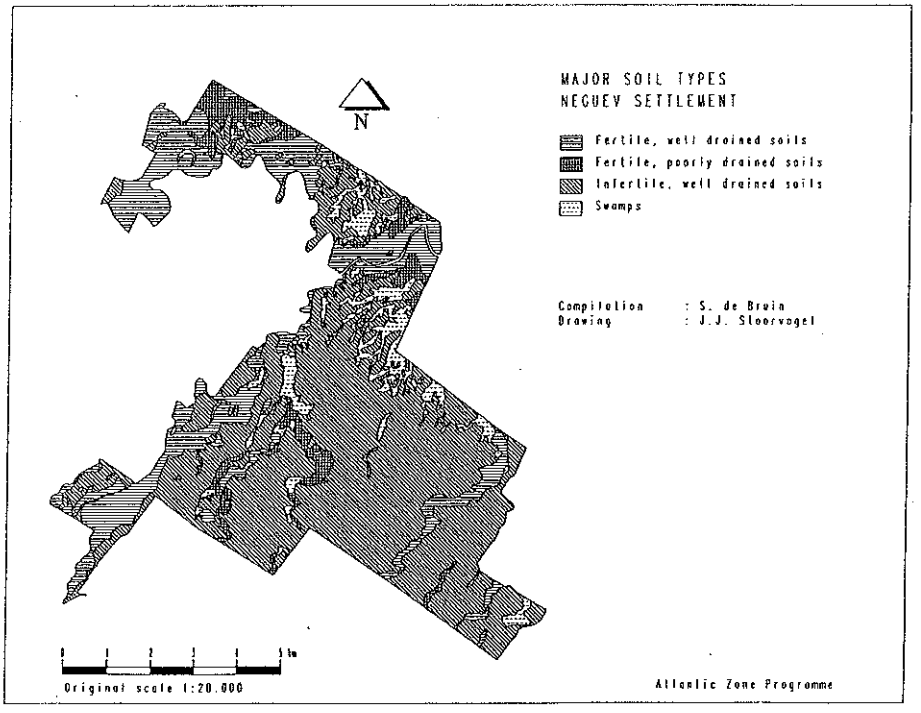
The soil classification by which the soil use class of the plantations will be determined, is based on the soil map and land classification prepared during the first phase of the Atlantic Zone Programme. By evaluating the soil properties fertility and drainage of each mapping unit of the soil map the simplified classification in following three soil use classes was made.

1. fertile soils with good drainage
2. infertile soils with good drainage
3. soils with bad drainage.

(KOSTER, 1993)

If soils were classified as having either on of the following soil properties:
- very poorly drained
- poorly drained
- imperfectly drained

it belonged to soil use class 3 otherwise it was classed in 1 or 2. Soil use class 1 consists of the relatively young holocene soils and in soil use class 2 the relativly old pleistocene soils are grouped together (KOSTER, 1993). Figure 3.4 shows the distribution of the three soil use classes in the Neguev.



Source: Atlantic Zone Programme

Figure 3.4 Soil use classes of the Neguev

In the part of the Neguev south of the river Parismina there are mainly soils from the soil use class 2 whereas north of the river the soil use class 1 is prevalent. Furthermore there are some swampy areas which belong to soil use class 3 (see figure 3.4).

3.2.5 Land use

Most of the farmers in the Neguev grow one or more crops and keep animals. Nearly all of them have pasture as well as crops, whereby the area for pasture is on average half of the total area compared to about a third which is used for crops.

In general it can be said that the best soils are used for annual crops like maize and beans. The red soils are mostly used for cash crops like palmheart and pineapple, if they are not covered by forest or pasture. The swampy areas are generally left under forest or under pasture. Near the houses one will find perennials like coconut palms and fruit trees.(MUCHER, 1992)

3.3 Río Jiménez

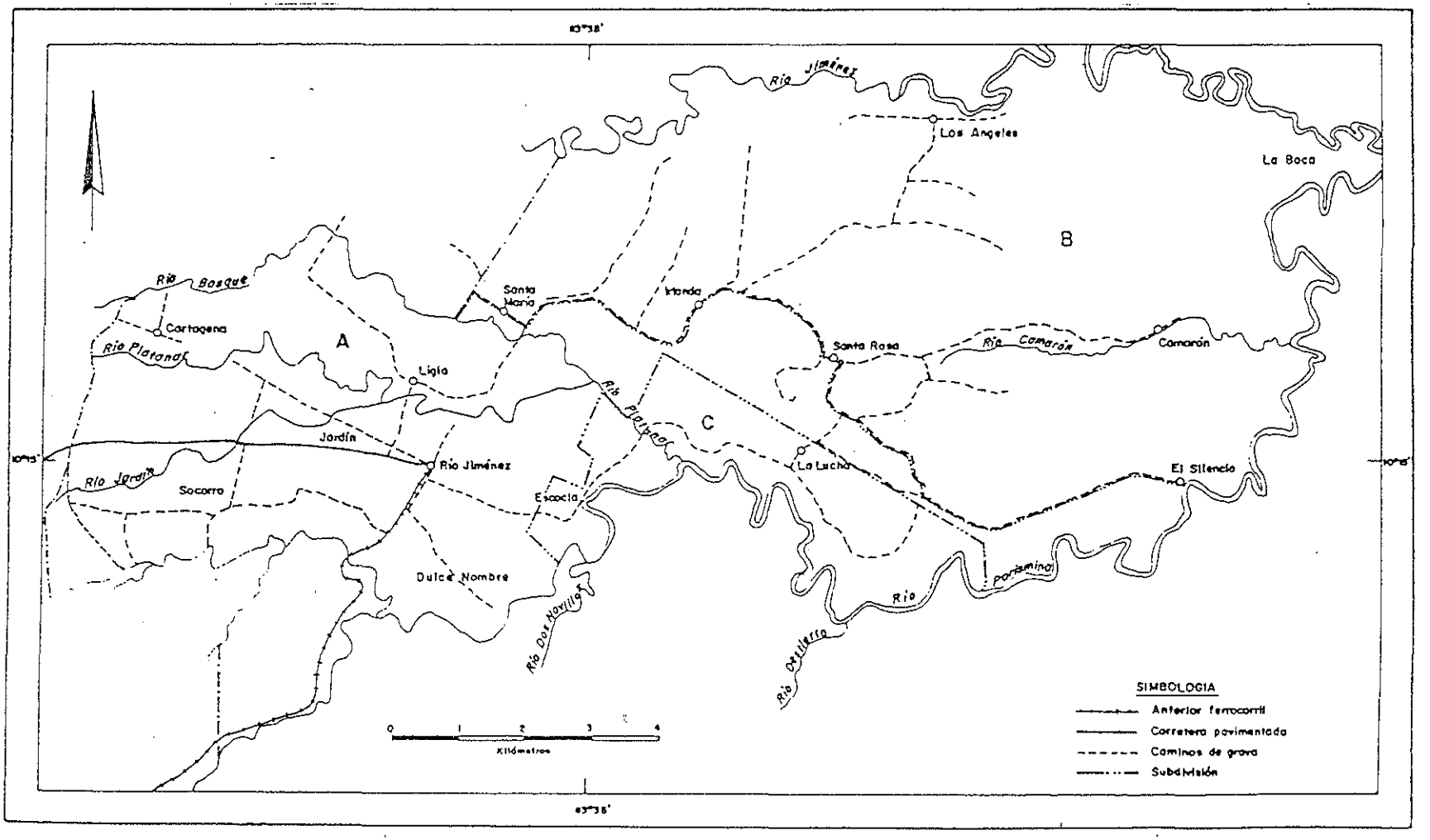
3.3.1 Introduction

Río Jiménez is the fourth district of the canton Guácimo, province Limon. It has a surface of 113 km^2 and a population of 4102 inhabitants in 1987 (see figure 3.5) (WAAIJENBERG, 1990).

At the beginning of this century the deforestation began with the construction of the railway from San José to Limon and the subsequent establishment of banana plantations, extensive cattle-breeding and cultivation of crops for subsistence (WAAIJENBERG, 1990). This process of deforestation is nearly finished and only small pockets of rainforest still exist (VELDKAMP et al, 1992).

3.3.2 Climate

The study areas Río Jiménez and Neguev are situated next to each other and have approximately the same rainfall distribution as well as the same temperature regime. For both the areas, the weather station "El Carmen" is the nearest and the most representative, so the figures given in 3.2.2 are representative for Río Jiménez as well (WAAIJENBERG, 1990).



Source: WAAIJENBERG, 1990.

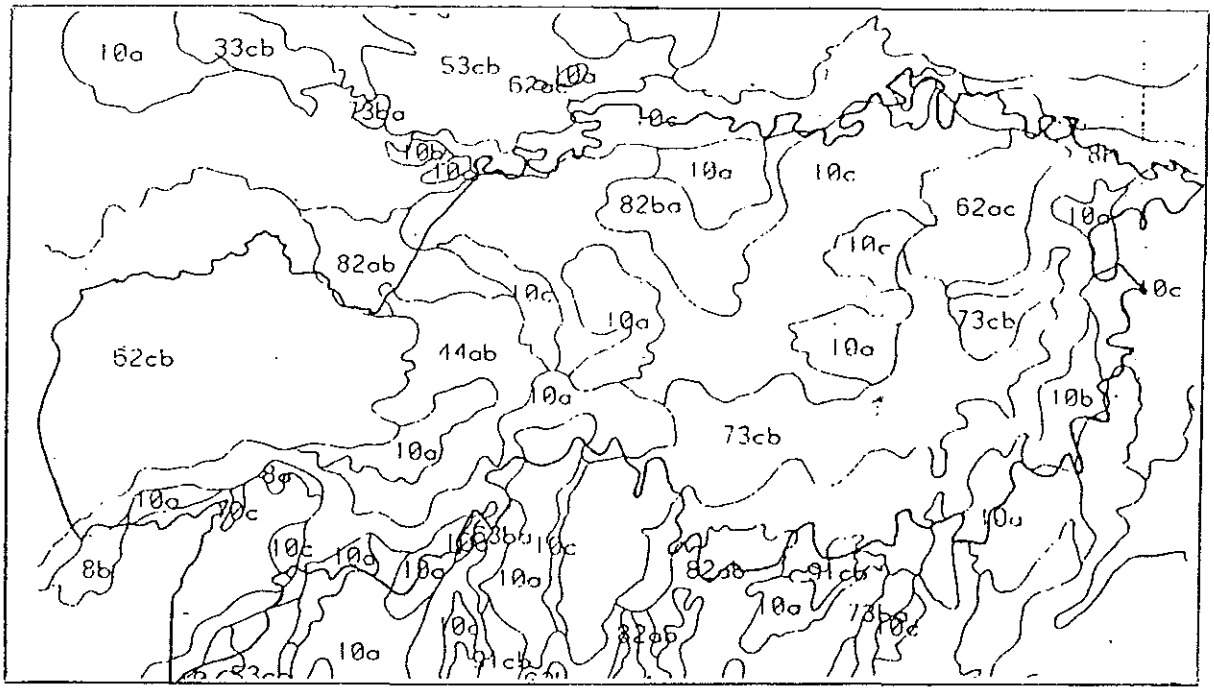
Figure 3.5 Topographic map of Río Jiménez

3.3.3 Geology and geomorphology

Río Jiménez is part of the Limon basin, which is very deep and consists of thousand or more meters of tertiary and quaternary sediments. The source of the sediments is the "Cordillera central", which consists of pyroclasts of andesitic basaltic composition in the fluvial deposits. (WAAIJENBERG (ED), 1991)

3.3.4 Soils

Figure 3.6 shows the association of soil use classes 1=a (fertile soil well drained), 2=b (infertile soil well drained) and 3=c (badly drained soil) in Río Jiménez. There is a large tract of land in the east which has soils of low fertility or which are poorly drained. In the rest of the district the three soil types are approximately equally distributed.



- boundary of the district of Río Jiménez
- boundary of the soil use classes

(#,#,#)a,b,c fraction of soil use class 1,2,3

Source: Atlantic Zone Programme.

Figure 3.6 Soil map of Río Jiménez

3.3.5 Land use

In Río Jimenez there are several banana plantations which each cover several hundreds of hectares. Apart from those, about 60% of the farmers have a farm of less than 20ha, 30% has 20-50ha and 10% have farms of more than 50ha.(HULSEBOSCH, 1992)

The big farms are mainly involved in cattle breeding or dairy farming, but they often have small areas of cash crops like papaya, cassava or maize as well. The small and medium sized farms have on average half of their land under pasture and the rest is cultivated with crops. The most common crops are maize, cassava, plantain. A lot of farmers are specialized and cultivate for instance peppers, papayas, coconuts, etc. Although the farmers mainly produce for home consumption, most of them sell part of their production too. (WAAIJENBERG, 1990)

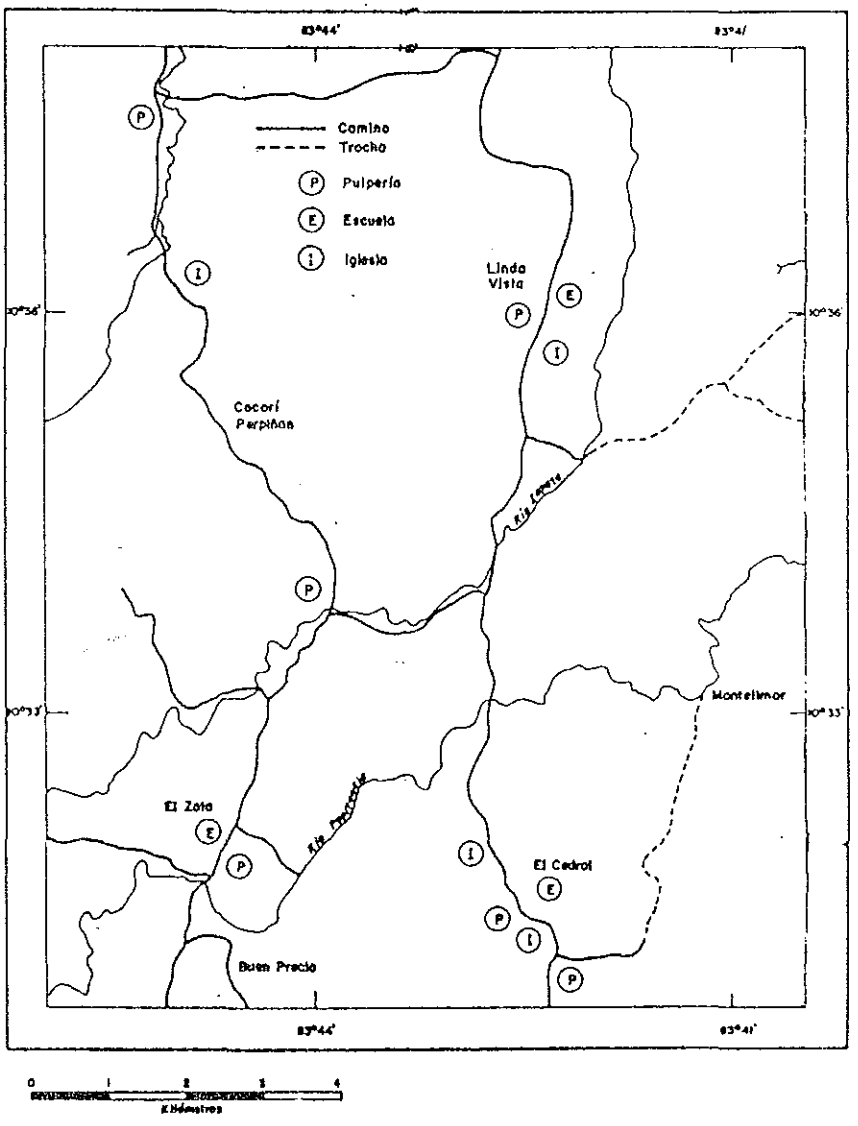
3.4 Cocorí

3.4.1 Introduction

The Cocorí area (12000 ha) is situated in the northeast of the Atlantic Zone, close to the border with Nicaragua and about 25 km from the nearest town Cariari. It is still a remote area though the accessibility of the area has improved due to the construction of two roads in 1986, one in the west and one in the east (see figure 3.7).

Until 1970 there was not much agricultural activity in the area. Along the rivers bananas were cultivated and there was some timber logging. Clearing of selective forest areas took place near the rivers. This was controlled by the "Atlantic Trade Company" together with Cuban merchandisers. The Atlantic port of Tortuguero was important at that time. After the Cuban revolution and the subsequent disappearance of private enterprise overthere, this trading stopped (SLUYS et al, 1992).

From 1970 onwards the area became more populated and agricultural activities increased. In other parts of Costa Rica (e.g. Guanacaste) the forest had been cut and extensive cattle ranches didn't give many opportunities for work, so a lot of people who didn't have land or jobs moved to the Atlantic Zone. Apart from Costarican settlers many people from Nicaragua came to the area in the last few years.(SLUYS et al, 1992).



Source: SLUYS et al, 1992.

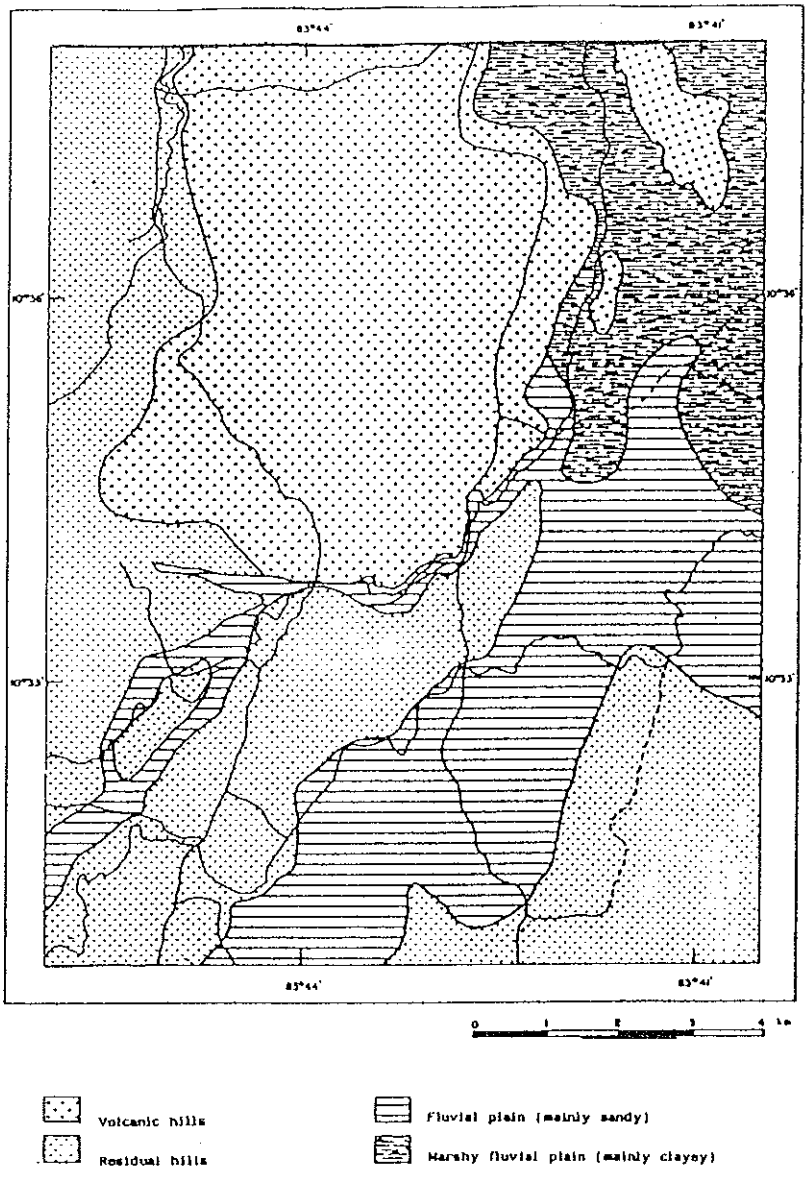
Figure 3.7 Topographic map of Cocorí

3.4.2 Climate

The climate of Cocorí is characterized by high temperatures and precipitation throughout the year. There is no meteorological station in the area and therefore the data of Guápiles (40 km to the south) and Tortuguero (20 km to the east) are used. In Guápiles the mean annual precipitation is 4500 mm and at Tortugera 5500 mm. February, March and April are relatively dry months with around 200 mm compared to up to 800 mm in other months (WIELEMAKER, 1990).

3.4.3 Land forms and soils

The area of Cocorí comprises 4 contrasting landscapes (figure 3.8):
- volcanic hills
- residual hills
- fluvial plains (mainly sandy)
- marshy fluvial plains (mainly clayey)



Source: SLUYS, WIELEMAKER & WIENK, 1988.

Figure 3.8 Principal land forms of Cocorí.

The volcanic hills, which are 20-250 m high, are deeply dissected remnants of late tertiary to early pleistocene volcanos. They consist of old lava flows with intercalated pyroclastics, mainly of basaltic composition. Their slopes are steep and covered with a well structured clay mantle of 1-2m. The soils are of soil use class 2, wich means they are infertile but well drained.

The residual hills are the remnants of a pleistocene alluvial plain and low outcrops of deeply weathered basaltic rocks. The hills which are 8-25m higher than the valleys, are covered with a mantle of deep reddish to brownish clay. Like the volcanic hills the soils of the residual hills belong to soil use class 2. The small valleys are poorly drained and swampy, soil use class 3, or even occupied by small lakes.

The sandy fluvial plain consists of holocene fluvial sediments of volcanic origin. The rivers, which deposited the plains, dissected the residual hills in a northern to northeastern direction. Many sediments are coarse sandy and gravelly which indicates that once river discharges were much higher than today. This reduction of discharge are attributed to a loss of activity of the volcano Irazú. The soils are fertile and flat, therefore of soil use class 1 if the drainage is not too poor, otherwise the soils are classified as soil use class 3, badly drained soils.

The marshy fluvial plain is situated in the northeast at an altitude of 10 m above sea level and is poorly drained, soil type 2. The deposits are mainly clayey and often poorly consolidated. (SLUYS, WIELEMAKER & WIENK,1988).

3.4.5 Land use and natural vegetation

Extensive cattle breeding is the most important agricultural activity in the area. Large farms exist who are managed for the owner by labourers who live on the farm. Crops like maize, rice, beans, cassava and plantain are mainly cultivated for subsistence. Many farmers have fruit trees like coconuts, lemons, waterapple and breadfruit.

4 INSTITUTIONAL CONTEXT FOR PLANTATION FORESTRY

4.1 Government policies

The Ministry of Energy and Mining (MIRENEM) is responsible for the management of the natural resources of Costa Rica, which includes natural forests and plantation forests. The regional office for the northern Atlantic Zone is stationed in Guápiles. Ir. Jose Luis Gonzales of this regional office provided the following information on the policies of the government concerning plantation forestry.

There are two different afforestation schemes, which are managed by MIRENEM. The first is the FDF (Fondo de Desarollo Forestal = Forestry Development Fund) and the other is CAF (Certificado de Abono Forestal = Forestry Subsidy Certificate). The prerequisites and rewards are presented below.

	FDF	CAF
Documents needed	- passport - map of the farm - forest plan by a forestry engineer	- passport - cadastre plan of farm - forest plan by a forestry engineer - **land title**
Amount of subsidy	66.700 colones paid out in year 1: 50% year 2: 20% year 3: 15% year 4: 10% year 5: 5%	100.000 colones paid out in year 1: 50% year 2: 20% year 3: 15% year 4: 10% year 5: 5%
Restrictions	- organization necessary - 1-5 ha/year - max 25 ha/person - min 1111 trees/ha	- organization **not** necessary - no restrictions - no restrictions - min 1111 trees/ha
note:	- 15% of the total sum are for administrative costs. It is not important that the trees are planted in one block. It is possible to spread them but the subsidy remains the same. It is also possible to plant in an alley.	- 20%

Recommended is a spacing of 3*3 m. The species should preferably be native to the region and suitable for timber production, but exotic species are also accepted.

For farmers with a land title but whose farm size is less than 50 ha there is a possibility of applying for CAF through a farmers organisation. They then are not required to hire a forestry engineer to make a forest plan, because the organisation will do that. They receive the same amount of money as the farmers with FDF.

CAF was introduced in 1976 to increase the domestic timber production. After a few years it became apparent that only people with large tracts of land and enough capital could obtain this incentive. Therefore, the government created in 1987 DECAFOR (DEsarrollo CAmpesino FORestal), a department within MIRENEM which concentrates on reforestation projects on small and medium sized farms. It distributes FDF to the organizations which participate in afforestation schemes.

The main goals of DECAFOR are:
- change in the mentality of farmers towards a better understanding of the need for reforestation.
- strengthening of farmers organizations and farmers unions.

To stimulate the production of timber is only a minor goal of this department.

The way the government distributed money for afforestation in the past and does so at present has several consequences for plantation forestry:

- farmers who live in an area where there is no organisation which participates in the FDF programme can't get the incentives, this is the case in Cocorí.
- investors can buy cheap forest land, then harvest the trees and have it a few years under pasture, wherafter the government pays for the reforestation. This transforms rainforest in monoculture plantation forests, an ecologically questionable pathway. For example, an owner of a saw mill near Guápiles has a 400 ha farm in in Cocorí. He bought the land 10 years ago for 25.000 colones/ha, harvested the trees with unknown profits, kept cattle for a couple of years and then received 100.000 colones/ha reforestation subsidy.
- the quality of the plantations with FDF depends on the knowledge and skill of the farmer or/and the organisation. There are no standards for the participating organisations, increasing the risk of failing plantations due to bad stock or management techniques. Nearly every farmer participating in this study would have wanted technical assistance with either the choice of species and/or the actual management of the plantation.
- the incentives are the same in the whole country though there are huge differences in climatic as well as socio-economic preconditions in the regions. For example the Pacific area might need more incentives because deforestation and erosion are far more serious there than in the Atlantic zone, whereas the Atlantic zone might need incentives for the proper

management of the remaining forest areas. In Cocorí there are still vast areas of forest left. After clearcutting there is no need for monoculture reforestation, secondary forest will be established within a few years.
- the subsidies are given with no qualitative requirements. Farmers who are tempted by the possibilty of aquiring a considerable amount of money with a minimum amount of effort can establish a plantation without thought or care and which might never produce anything apart from fire wood.

4.2 The farmers union UPAGRA: a case study

There are several organisation for farmers in the northern Atlantic Zone of Costa Rica through which farmers can obtain FDF. UPAGRA is the organisation through which the farmers in this study got their subsidies and therefore it is described in this chapter. This chapter is based on two interviews with Mrs. J. Sanchez She is a forestry engineer and responsible for the implementation of the FDF programme for the farmers who are members of UPAGRA.

The Union of Small Farmers UPAGRA was founded in 1978 by a group of workers from the banana plantations in the area between Guápiles and Siquirres who were dissatisfied with the situation. They were strongly influenced by the Sandinist revolution in Nicaragua and wanted to take the land away from the big landowners in the area. They subsequently occupied the land which belonged to the company Empresa agricola ganadera Neguev S.A., which by government intervention is now an I.D.A. settlement.

After this success the organisation shifted its interests to programmes which would help small farmers to cope with their specific problems. This true to their motto: ' Por el derecho a la tierra, a producir más y a recibir lo justo por lo que se produce' which means: For the right to landownership, to produce more and to receive a fair price for it. Examples for such programmes are: courses in practical skills like sewing and carpeting and the forestry programme. In 1985 UPAGRA built an office in Guácimo, which is situated between Guápiles and Siquirres. This enables them to conduct courses and design programmes in a professional way.

The organisation has no board of directors, policies are therefore decided by the general assembly. The costs are covered by memberships fees and government and non-government subsidies for specific programmes. UPAGRA tries to get more members in other areas especially in the north but still the most members live in the Neguev. They can profit the most from the facilities provided by UPAGRA, like training courses, because the office is situated just outside of this settlement.

In 1989 they decided that the FDF incentive should be available for their members in order to stimulate the development of the area.

The goal is to create a system in which the members of UPAGRA will produce enough timber to keep a saw mill and a little furniture factory full time running. The factory should be situated in Milano the village nearest to the road Limon-San José.

In order to make their members eligable to receive FDF they hired the forestry engineer required by MIRENEM. This engineer has to make the forestry plans for the plantations, give technical assistance and organize the ditribution of the money. Mrs. J. Sanchez is payed by FUDACOR, an organisation interested in the development of the Atlantic zone. The administrative costs which are part of the FDF are, in case of UPAGRA, being used for covering the cost of transportation and office necessities. Mrs Sanchez stated that amount set aside for administrative costs couldn't maintain an engineer and make his work effective at the same time. Without FUDACOR, UPAGRA wouldn't be able to pay for the implementation of the FDF programme.

The forestry engineer is responsible for the planning of the programme, the distribution of the money, the control as well as extension services. This is too much for one person to do, which had several consequences:

- all farmers who started in 1990 or 1991 had to rely on their own knowledge and skills so some planted in the dry season which means a nearly 100% chance of failure. The extension part of the job was not carried out.
- there was a sudden need for stock, so it was bought were it was available, which didn't guarantee the quality of the stock.
- the choice of species depended on the availability of stock not the best economic or ecological interests. The lack of knowledge about best choice of species for a certain production goal in connection with the quality of the soil was mentioned by 60% of the farmers in the study
- there are still no plans for the sawmill or the furniture factory so the choice of species is not related to their future needs.

The whole programme of UPAGRA concerning the integrated production and utilisation of timber shows a lack of planning. The rush to get the incentives overshadowed the original goal of the programme, an integration of the timber production, industrialisation and commercialisation as part of the development of the area. It would probably have been wiser to spend a year or two on the planning of an integrated program. That way the required number of plantations, the required management, the species and much more would have been known so that the implementation could be controlled and hopefully be successful. The long rotations in forestry compared to agriculture should oblige those who are newly establishing plantations to plan as best as possible, because losses can be staggering when calculated with interest.

In the present situation a lot of farmers are attracted to the, in their eyes, enormous amount of cash they can get for the establishment of a plantation. Without realising, that spread over a five year period they can't sustain their families on it till you can harvest the trees. This may especially be true for farmers who don't have a great affinity with farming anyway and therefore see this as an easy way to make a living. They risk high mortality rates and failing yields more than others due to their lack of skill which may jeopardise the programme and destroy an originally good plan, because good farmers might never establish plantations when they see so many have failed.

5 THE FARMERS

5.1 The inventory

In order to be able to tell something about plantation forestry in a certain region, you have to visit farmers who have established a plantation. The farmers with plantations in the farm inventory which was carried out on behalf of the Atlantic Zone Programme between October 1991 and March 1992 by P. Hulsebosch were the first to be interviewed. This first interview was an inventory of the motives to establish a plantation, the choice of species and sites. The farmers were also asked if they knew others with reforestation projects. Together with inquiring in shops and restaurants as well as with a random number of farmers if they knew people with projects it was possible to discover the majority of the reforestation projects.

The farmers who receive subsidies are registered by UPAGRA (see chapter 4.2) and after checking these records it became clear that all the registered plantations were in the survey. Only the ones we didn't discover and who weren't registered are not in the survey. There was no time to make inquiries with every individual farmer. Those farmers who weren't in the farm inventory were not only questioned about there motives but also about the socio/economic situation of the farm. This in order to get an impression of which types of farmers established plantations.

There were 22 farmers with reforestation projects in the three research areas, 11 in the Neguev, 7 in Río Jiménez and 4 in Cocorí. Of the 11 in the Neguev, 3 had owners who either lived elsewhere, and were not traceable, or were always absent during the time of the interviews, so they were not included in this research. Due to temporary absence during the second interview and field measurements two more farmers, one in the Neguev and one in Río Jiménez were excluded from the research. Of the original twenty two farmers, there were seventeen who participated in the study, seven in the Neguev, six in Río Jiménez and four in Cocorí.

Unfortunatly the number of farmers farmers in the research area who have plantations is very small. To include farmers from outside the research area would have involved extensive research into the history of the area were they live in order to be able to compare the results with those from the project research areas. This was not possible within the timeframe of this study. It is therefore neccesary to view the following results of the interviews and the measurements as indications of what is happening and not as statistically viable data.

After it was known which farmers participated in the project the second and more indepth interview was carried out. The farmers were questioned about the way they managed their plantations, the amount

of time and resources they needed for it and about their plans for future maintenance, thinning and harvesting work. The list of questions of both the two interviews combined is given in appendix 1.

Although the farmers in this study have on thing in common, the plantation, the group is far from homogeneous considering other criteria like farm size, choice of crops, level of agricultural knowledge, etc. Table 5.1 shows the most important data of the farmers involved in this study. The letters indicate the research area were the farmer lived, N=Neguev, R=Río Jimenez, C=Cocorí and the number indicates the farmer. More detailed figures are given in appendix 2.

Table 5.1 Type of farms with plantations

Farm nr	Farm size (ha)	Plant size (ha)	Manage own farm	Sub-sidy	Use subs	Why plantation
N1	17	6	y	FDF	main	sub,fut,eco,copy
N2	18	5	y	FDF	main	sub,fut,eco
N3	17	5	y	FDF	main&pl	sub,fut,eco
N4	17	5	y	FDF	pl	sub,fut,copy
N5	17	1	y	FDF	main	sub,fut,copy
N6	10	5	y	FDF	pl	eco,fut
N7	17	5	y	FDF	main&pl	sub,fut,eco,copy
R1	42	3	y	CAF	main	sub,eco
R2	73	5	y	CAF	pl	sub,fut
R3	87	3	y	no		fut,eco
R4	10	1	y	FDF	main&pl	sub,fut,eco
R5	10	1	y	FDF	main	sub,fut,eco
R6	7	3	y	FDF	pl	fut,eco
C1	88	.25	y	no		ouse
C2	136	.5*	n	no*		sub,eco
C3	400	100	n	CAF	pl	sub
C4	125	100	n	CAF	pl	sub

Use of income received from subsidy:
main: for the maintenance of the family
pl : for investment in the plantation
Reasons for establishing a plantation:
sub : availabilty of subsidies
ouse: own future need for timber on the farm
fut : future security of the family
eco : preservation of natural resources
copy: following example of somebody else
* : plans to plant 40 ha more with CAF

The farm sizes in the Neguev are nearly all the same since the I.D.A. distributed the land in equal proportions and the farmers were not allowed to sell their land untill now. The size of the plantations vary considerable, some want to have a small plantation as a source of cash when needed others want to make the production of their livelyhood. The farm sizes in Río Jimenez are more variable but the reasons for establishing a plantation are the the same as in the Neguev. In Cocorí farm sizes are much bigger. Apart from one farmer who thought that he would need more timber in the future for his own use, the other three saw it as a business investment and they planted or intended to plant a considerable amount of land.

Ecology was mentioned by more than half of the farmers as one of the reasons to establish a plantation. This is the consequence of many reports on television about the ill-effects of deforestation. Reforestation is seen as something very positive. They don't question if plantations have the same ecological value as forests.

Without the subsidies 75% would not have established a plantation, especially the bigger ones in Cocorí. In combination with the copy effect which occured in the Neguev when one farmer started a plantation with FDF and the was then followed by several others, subsidies are an important instrument if somebody wants to increase the rate of reforestation in this area. In the present economical climate only people who foresee a future need for timber or who have a great affinity with plantation forestry will have one.

5.2 Farm types

The sample size, the number of farmers, is too small to make a statistically acceptable division into an existing framework of farm type analysis. From analysing the data given in table 5.1 three different types of farmers can be distinguished in this group of seventeen:

1) Subsistence farmers
2) Commercial farmers
3) Investment farmers

The names of this groups are descriptive of the way the farmers managed their lives and their farms. Since the terms subsistence, commercial and investment are well defined, other terms should be found for a statistically backed farm type analysis. The key by which the farmers can be ascribed to one of these groups are:

- farm > 100 ha, a labourer manages the farm => group 3;
- no subsidy for reforestation => group 2;
- subsidy used mainly in the establishment and maintenance of the plantation and not for family maintenance => group 2;
- subsidy used mainly for family maintenance => group 1.

In the following paragraphs the three groups are described in more detail.

Subsistence farmers:

Farming requires skill and determination if you want to succeed on a long term basis. Farmers in this group lack both. They are generally former labourers from banana plantations who gained land through the I.D.A. settlement scheme or who cleared a piece of land and now wait for the land title at the end of ten year settlement. Since most of them didn't finish primary school and came originally from a different part of the country they lack the knowledge to make a farm profitable. Land is used only to the point which is neccessary to support the immediate needs of their families. The subsidies given for the reforestation are perceived as a considerable amount of cash and used for family maintenance. The future need for investment in the plantation is not considered in their spending pattern.

Commercial farmers:

The commercial farmers are farmers in the true sense of the word. They tend to have farms with more than 50 ha, but two of the farmers in the Neguev also belong to this group. Except one, all of them have spent at least two years in secondary school. They are interested in improving their management techniques and often experiment with different crops and one of those crops is timber. If they get subsidies they invest it in the establishment and maintenance of the stand.

Investment farmers:

Three of the four farmers in Cocorí are investment farmers. In the last ten years they bought hundreds of hectares. They hired labourers to clear the forest and manage the farm. When they could reforest their land with government subsidies which amount to up to four times the original price per ha they hired a forestry engineer who handled the project.

The distribution of the different groups in the research areas is shown in figure 5.1.. Río Jiménez and Neguev only have farmers in group 1 and 2, with about double as many farmers in group 1 as in group 2, while reforestation in Cocorí is mainly the business of investment farmers.

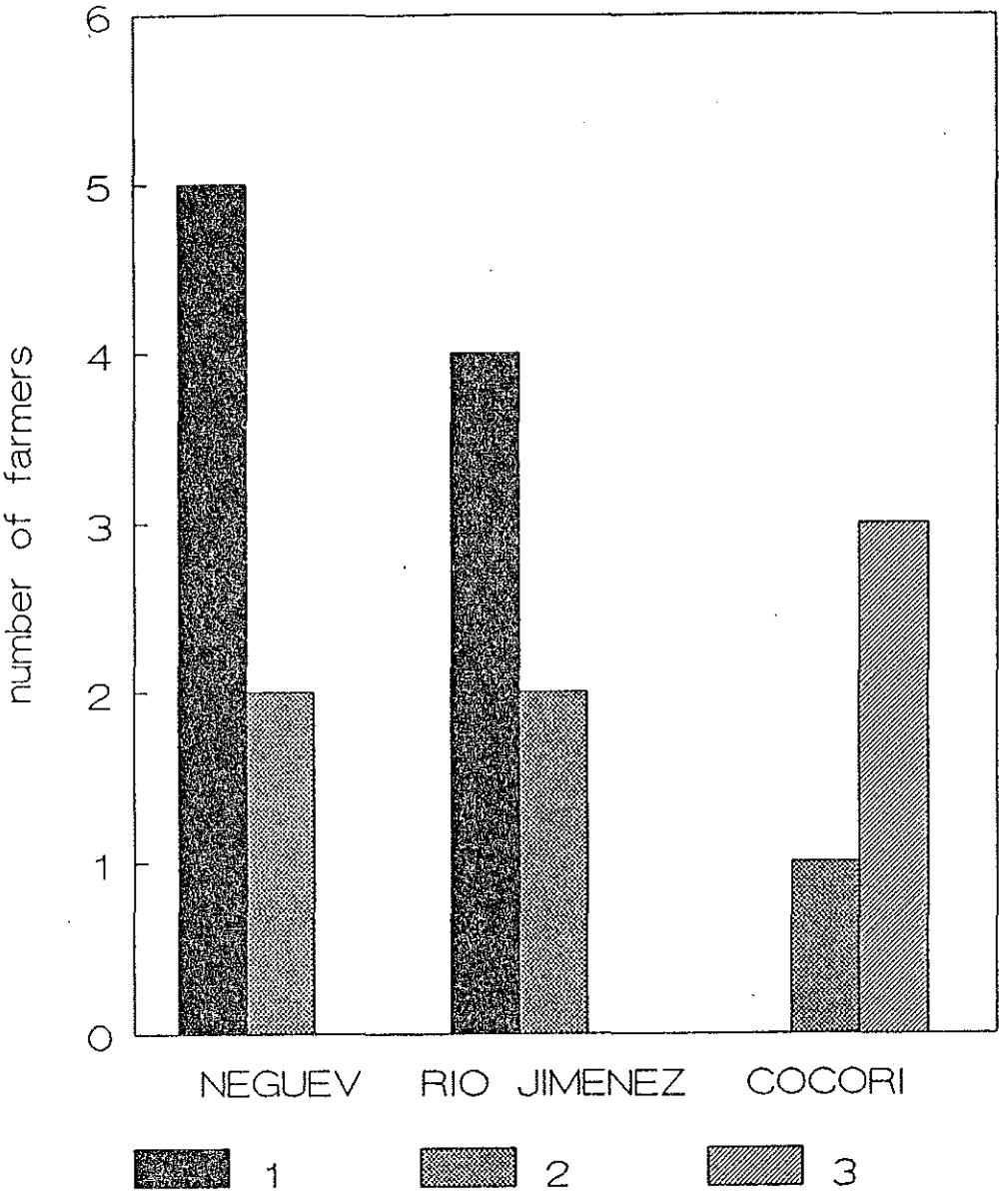


Figure 5.1. Percentage of farmers in group 1, 2, 3 in the research areas.

The Neguev doesn't have investment farmers because it has only farms smaller than 20 ha. Río Jiménez does have them but due to fertile soils and a good infrastructure the investment farms are either used for cattle farming or cash crops like ornamentals. Since the infrastructure is far worse in Cocorí and since the soils are mainly low in fertility, the reforestation of former pastures and of secondary forests is an economically very interesting option for people with land who don't depend on the yield as a main source of income. This is especially true when a subsidy like CAF, covers the initial costs.

The commercial farmers in Cocorí and Río Jiménez have more land than the ones in group 3, but even if a farmer has more land he doesn't fall automatically in group 2 since knowledge and attitude are the main determining factors if a farmer belongs to the subsistence or the commercial farmers. Farmers who know the management of crops, who invest, innovate and are interested in optimization of their production belong to group 2 the others to group 1.

6 MANAGEMENT OF PLANTATIONS

6.1 Method of investigation

The second time the farmers were visited during this research, they were questioned about the way they established and maintained the plantation as well as about their plans concerning maintenance, thinning and harvesting. In the following chapters it will be discussed how the farmers chose their stock, when they planted, if they have a thinning regime and many things more concerning the management of the plantation.

The location of the different stands on the farm, their approximate size, age and spacing were given by the farmer. Afterwards these stands were measured to obtain information about the growth of the plantations. The actual sampling was done systematically, every (N/n)th tree was measured with a randomly selected starting point. Of every tree the dbh (diameter at breast height) and the height were measured and it was recorded if the tree was straight and if it had any forks. If it had a fork the height of the fork was also measured.

Since many of the stands were less than one year old and below 1.5m of height they were not measured. After calculating the volume of these trees with excisting equations by BEER & SOMMARIBA (1986) for laurel and MURILLO & VALERIO (1991) for melina negative volumes occurred (see chapter 6.4).

The sample size, the number of trees measured was determined by the following formula from AVERY & BURKHARDT (1983):

$$n = \frac{1}{(A/(t*CV)) + (1/N)}$$

n sample size
N number of trees in stand
A allowable error as percent of mean
CV coefficient of variation
t t value at probability level.

After consulting with T.Jansen a statistician working for the Atlantic Zone Programme the allowable error was set on 5%, the probability level at 90% and the expected CV (coefficient of variation) on 20%. The CV is the ratio of the standard deviation to the mean (AVERY & BURKHARDT,1983). After the measurements the CV was calculated and if it exceeded 20% more trees were measured.

The instruments used for measuring were:
- tape measure for the dbh
- stick for trees up till 7 meters
- a Suunto altimeter for trees ≥ 7m.

In addition to the measurements, the soil coverage and the crown closure were estimated and other features like the presence of crops, the approximate amount of shade, and visible damage (by pests, diseases or environmental stress) were recorded.

6.2 The stands

The investment farmers in Cocorí are so different that they must be discussed separately. The other farmers generally have one, sometimes two or three stands on their property, with an area ranging from 0.25 to 5 ha. Except for one stand, they were planted in the last five years, 70% even in the last three years. In the Neguev and on the small farms in Río Jiménez the plantation is about 20-50% of the whole farm. The plantations on the farms bigger than 50 ha are only 5-15% of the total area of the farm. In table 6.1 it is shown which tree species the fourteen non-investment farmers, farms > 100 ha managed by labourers, planted and how many ha they planted overall of specific species. The translation of common names to scientific names is based on the list of scientific names given in ZAMBON (1989).

Table 6.1 Frequency tree species used in plantations

Tree species		number of farmers	ha
Cordia alliodora	(laurel)	13	26.9
Gmelina arborea	(melina)	2	6.1
Cedrela odorata	(cedro)	3	3.1
Tabebuia rosea	(roble sabana)	1	0.6
Bombacopsis quinata	(pochote)	1	0.5
Carapa guianensis	(caobilla)	1	< 1
Hyeronima oblonga	(pilon)	3	< 1
Terminalia oblonga	(sura)	1	< 1
Virola spp	(fruta dorado)	3	< 1
Minquartia guianensis	(manu negro)	3	< 1

As you can see in table 6.1 *Cordia alliodora*, laurel, is planted by all the farmers apart from one exception who had planted on soils which are regularly inundated and therefore not suitable for laurel. Laurel is chosen by the farmers because as they say the wood quality is good, the growth is relativly rapid and the tree remains straight, it is easily grown in pure stands and stock is readily available either from the wild or from nurseries.

Gmelina arborea is only used by the two big farmers in Cocorí and by two farmers in the Neguev who had conections with a nursery

which provided the stock. Other farmers are eager to plant melina because of its rapid growth but they can't obtain stock. It is questionable if the low quantities of pulpwood produced by these farmers will be profitable to harvest.

The farmer who planted on regulary inundated land used *Tabebuia rosea*, roble sabana, and *Carapa guianensis*, caobilla. These species are suited for these conditions, which is confirmed by WEBB et al (1984). Many farmers would like to plant *Cedrela odorata*, cedro, because of its high quality wood. Some of them tried, but the shootborer *Hypsipyla*, a larvea of a moth, causes mortality up till a hundred percent in pure stands. The other species mentioned in table 6.1 are mostly planted together with laurel and they will make up 10-20% of the stand.

Two of the three investment farmers planted 100 ha each with about 50% laurel and 50% melina. Alone they already have planted more than the rest of the farmers together. The third planted only 0.5ha of *Bombacopsis quinata*, pochote, but he plans to do 40 ha more of the same species next year. He already bought seed and was raising stock in a nursery. Pochote is a species originally from the northwest of Costa Rica with good wood properties when not growing too rapidly (ANONYMOUS b, 1991).

From all the above mentioned species laurel is probably the safest bet the farmers can take concerning the choice of species. The tree produces an abundant supply of seed from an early age and seadlings are easily raised in nurseries. Plantations can be readily established using normal silvicultural practices and it yields quality wood. (GREAVES & McCARTER, 1990).

Melina might have rapid growth but the market situation for small quantities of pulp wood in Costa Rica is unknown (but probably not very good). Pochote is a species of another zone and not tried in the Atlantic zone. Results of this first plantation might tell if this species is suitable here. The other native species are relatively unknown, apart from the cedro and the roble sabana. The farmers expect them to take about thirty years before harvesting. That is nearly double the time for laurel.

There are several non-indigenous species which might be suitable for this area, namely *Eucalyptus deglupta*, *Tectona grandis* and *Terminalia ivorensis*. La Cabaña, a reforestation project of nearly 1000 ha situated south of the town of Siguirres, has planted the Eucalyptus on several hundreds of ha and has some trial plots of teak as well as *Terminalia ivorensis*. The manager of this project reported that they had not measured the stands untill now since all of trees were planted after 1987. The measurements are scheduled in 1993. Those results and those of subsequent years would be very interesting for further research on plantation forestry in the Atlantic Zone. The impression of the manager about the three species was, that teak and the *Terminalia ivorensis* showed rapid

growth, he didn't know if the wood quality of the teak would reduce. *Eucalyptus deglupta* had a high mortality rate due to ant or termite attacks.

There are of course many more species suitable for plantation forestry in this area, but in order to compare them with species currently used, trials have to be established. It is easy to compare climatic and soil requirements of a species with the given circumstances but forestry has long production cycles and many unexpected things can happen, like the occurence of unknown pests and diseases. Only after trying you can estimate the suitability of a species and that takes time and money. There are already some projects who do this, but it was not possible in the timeframe of this study to search for them. Since reforestation is only becoming an issue in the Atlantic Zone for the last 5-10 years results of reforestation projects are probably more valuable in a couple of years.

6.3 Plantation management

As told in 6.1 the second interview questioned the farmers about their management practices. The results of this interview are presented for the different steps in the establishment, maintenance and harvesting of a plantation. The exact data per farmer are given in appendix 3.

Origin of plants

The origin of the stock differs per species. Melina isn't an indigenous species, so it is purchased in nurseries. One farmer in the Neguev started a little commercial nursery and sells stock to the other farmers. Laurel is taken from the forest in 30% of the cases and otherwise purchased from nurseries. Farmers associated with UPAGRA get their stock from suppliers this organisation has contracts with. One stump normally costs 10 colones ($ 0.08).

The big investment farmers established their own nurseries before planting. The origin of the laurel and melina seed was unknown to the current manager. The seed of the pochote from the other investment farmer was purchased in Guanacaste at the price of $15 per kg. Information on the nurseries which several of the farmers established is given in appendix 4.

The other species used by the farmers for reforestation are all natives and were mostly taken directly from the surrounding forest or the seed was collected there and then raised in small nursery beds. All planting stock were stumps since these are robust, easy to handle and to transport (GEAVES & McCARTER, 1990).

The stands of melina in this study all had a good form. Since melina is prone to fork and to bend (WEBB et al, 1984), the stock

must have been of a high quality. The form of laurel is normally acceptable (GREAVES & McCARTER, 1990) but there were several stands three years and older which had 10-20% forks at about three quarter of the total hight. In these stands there were often large differences in the form of the trees. The stock from those stands was generally from nurseries. The best stand was that of a commercial farmer who went to the forest, picked the best tree, collected its seed and raised it in his own nursery.

Soil preparation

Apart from five farmers all the other farmers first clear the whole surface of the plantation by removing the grass or the shrubs, if it is planting in secondary forest, with a machete or herbicides. On the investment farms they use herbicides, on the other farms the machete. The farmers who didn't clear the area planted on land that was previously used for agriculture. Before the actual planting the area where the individual plants were going to be planted was totally cleared with the machete. This area generally has the surface of a circle of about 1m.

The first clearing took the farmers 30-60 hours/ha, the second 10-25 hours/ha. One commercial farmer paid labourers 12,000 colones (~ $90) per ha which is at 150 colones/hour around 80 hours of work.

Planting

Planting of all the species should take place in the rainy season from May till November in order to prevent high mortality rates due to dehydration (ANONYMOUS a, 1991). Most of the farmers did so, but two subsistence farmers did not and one of them already new that he lost all of his trees planted in March 1992 and the other still hoped to have trees left since he had planted in the end of April.

For the actual planting farmers use shovels or plantsticks used in sowing maize. Somewhat more than half of them use sticks to mark the plants. The time the farmers say they used for planting differ considerably from 15-80 hours/ha, but half of them needed around 40 hours/ha. Two farmers weren't sure about the time spent and it is probable that the other farmers gave rough estimates. They are not used to accounting their working hours.

Fertilizer is only used during planting by two of the fifteen subsistence and commercial farmers. Both of them had some spare from other activities and applied ~50 kg of the 10-30-10 N,P,K fertilizer on one ha of laurel. One of this stands was on soil use class 3, infertile soils well drained, the other on soil use class 1, fertile soil well drained. The investment farmers did use fertilizer during planting. One administered 50 g/tree of 10-30-10 N,P,K and 5 g/tree of borax for melina and laurel. The other

gave laurel 250 g/tree of 10-30-10 N,P,K and melina some calcium to prevent the leaves turning yellow, an indication of low pH.

In GREAVES & McCARTER, 1990 it is told that little research has been done on the nutritional requirements of laurel so no recommendations can be given. Melina is a species more widely used around the world so there are more data available about it. MURILLO & VALERIO, 1991, mention that the performance of melina improves with the fertility of the soil and fertilizers improve the growth. No exact recommendations are given.

The planting distance is generally 3*3m which is required to establish the minimum amount of 1111 trees/ha in order to receive the FDF or CAF. Only one commercial farmer in Río Jiménez who doesn't receive a subsidy experimented with a planting distance of laurel at 2*10m in a system with coconut tree or plantain at 3*10m. The laurel in these stands looked very good, far more straight than in other stands. This might have been because the farmer really tried to pick the best seed tree from the forest as he told.

GREAVES & McCARTER, 1990 report that researchers recommend spacings from 2*2m to 4*4m, so they are inconclusive about the optimal spacing. The older stands of laurel didn't reach crown closure of more than 70%, From the point of view of maximum utilization of resources smaller spacing might be more advantageous with as side benefit better forms of the trees. Gmelina reaches crown closure at two or tree years after planting when planted at 3*3m and grown on good soils so even wider spacing might be possible, although 3*3m leaves a better opportunity to select nice trees when thinning (MURILLO & VALERIO, 1991).

The agroforestry system of laurel and plantain or coconut seemed to work very well and the suitability of laurel as a tree for agroforestry systems is widely reported (GREAVES & McCARTER, 1990). Three of the farmers used laurel in a taungya system with maize in the first year. They said that the yields were as to be expected on those fields.

Mortality in the first year was estimated by the farmers to be between 5-15% for laurel and melina apart from the one farmer who lost all due to wrong timing of planting. The mortality of cedro was nearly 100%, the shootboorer *Hypsipyla* attacks every plant in monocultures. Two farmers replanted ~120 trees/ha within the first year which took them 10 hours. The investment farmers didn't replace generally. Some places where they planted laurel which didn't catch on, they cut the laurel and planted melina.

Three of the farmers planted either laurel or a mix of laurel and other indigenous species (manu negro, pilon, fruta dorado and cedro) in secondary forest. They have done this in the last year so there is little to say about the advantage or disadvantage of it.

Weeding and cleaning

Weeding is necessary in this warm and humid climate, were weeds grow very fast, otherwise the young plants won't survive the first year. The investment farmers are obliged under CAF regulations to clean three times/year in the first two years and two times in the third, fourth and fifth year. This is controlled by inspectors. Especially for melina this obligation is ridiculous in the last three years since it reaches two meters within the first two years. The cleaning is done with machetes or once a year with the herbicide DURON.

The other farmers plan to clean 4-8 times in the first two years, with half of them planning to do it 6 times. One farmer made a distinction between cleaning (4*) and spot weeding (3*). The two farmers with taungya didn't have to clean. Planning might not be translated to action in all cases since at least three farmers who planned to clean three times in the first year had not done it in 6 months before the interview. Except one all farmers did the cleaning with a machete, the other one used GRAMOXONE, about 7 litres/ha. Cleaning took the farmers 16-40 hours/ha with about half of them needing 30 hours/ha.

In GREAVES & McCARTER (1990) spot weeding around the laurel every month during the first six month is recommended as the cheapest and most effective way to reduce competition. The amount of weeds growing in the stands aged one year was so abundant that only spot weeding would not have been enough. Most likely a combination of thorough cleaning twice a year and two or three times spot weeding would be more effective. For melina with normal growth, cleaning after the first one and a half years might not be necessary, since it has such a rapid initial growth and crown closure will be reached in two to three years.

Pruning

Laurel is self-pruning (WEBB et al, 1984) so it shouldn't be necessary to prune. Five of the farmers do it anyway in the first one or two years in order to prevent the development of second shoots. It is mostly done when inspecting the stand.

Gmelina is not self-pruning and tends to heavy branching (MURILLO & VALERIO, 1991) and so pruning is necessary. The investment farmers have a scheme of pruning once a year in the first three years. Of the two other farmers with melina one prunes twice in the first year and once in the second, the other one does it three times in the first year. Pruning is done with the machete.

Fertilization

The investment farmers fertilize as mentioned above when planting. In the second year they do it again with 10-30-10 N,P,K fertilizer.

The amount depends on the growth and vitality of the stand, which is judged by the engineer working for the owner to manage their plantations. Four of the smaller farmers also use fertilizer after establishment of laurel at 0.5, 1.5 or 3.5 years. They use either 10-30-10 or 12-24-12 N,P,K fertilizer and the amount varies from 2 kg/ha, 23 kg/ha, 46 kg/ha to 69 kg/ha. They used fertilizers because they had something left and thought that it might benefit the plantation.

Pests and diseases

The farmers generally did not notice pest or diseases on the laurel and the gmelina. Two of the farmers did report defoliation at some of their trees by a larvae. This is probably *Dictyla monotropidia* which is known to cause defoliation of laurel in Costa Rica (GREAVES % McCARTER , 1990). *Cedrela odorata* suffers as mentioned above from the larvea of the moth *Hypsipyla* which bores itself from the top into the living matter of the stem of the cedro. One of the investment farmers reported 30% damage due to pigs on 8 ha of laurel.

Thinning

The commercial and subsistence farmers only have limited ideas how their thinning regime will be. Half of them didn't know the final number of trees they want to harvest, the other half varied in their opinion between 300-800 trees/ha. Thinning would begin after 3 or 4 years and most wanted to do selective thinning, no systematic basal area reduction. Most farmers indicated that they would favor good trees by removing imposing bad trees (high thinning). The others didn't know how they were going to proceed.

The investment farmers planned 5 thinnings and a harvest between 5-25 years of laurel and 4 thinnings and a harvest of gmelina from three to fifteen years with a first thinning of 250 trees/ha. This wasn't a certainty, it depended on the financial needs of the owner. One manager even suggested that everything might be cut after five years, the period of CAF, if the growth of the trees were disappointing.

For laurel there is little known about the required thinning regime (GREAVES & McCARTER, 1990) and MURILLO & VALERIO (1991) don't give any recommendations for melina either. GONZALES (1980) concludes that for melina high thinning works best but he worked with an initial spacing of 2*1m and 2*3m.

Harvesting

The estimates about the time of harvesting vary considerably. For laurel from 8-18 years, gmelina 8-10 years and the others 12-20 years. Growth curves in MURILLO & VALERIO, 1991 suggest that 12-14 is a good option. Later the annual rate of growth slows down

considerably. GREAVES & McCARTER, 1990 mention rotations of laurel of 20-25 years. Of the other species little is known, but since they grow slower their rotation would probably be 30-40 years.

6.4 Yields

The stands were measured using the method explained in 6.1. For the calculation of the volume of laurel the equation from BEER & SOMMARIBA (1986) is used and for melina the equation from MURILLO & VALERIO (1991) has been applied.

Equations:

Laurel: $Vt=-0.017615 + 0.000034(d^2h) - 0.000086(d^2) + 0.003358(h)$

Melina: $Ln(Vt)=-9,63 + 1.785*Ln(d) + 0.8189*Ln(h)$

Vt= volume tree
d = diameter
h = hight
Ln= natural logarithm

Figure 6.1 and 6.2 show the height and figure 6.3 and 6.4 the calculated volume of the average tree in stands of different ages of laurel and melina. Since there were not so many stands in the survey the factor site quality is not considered in the following figures.

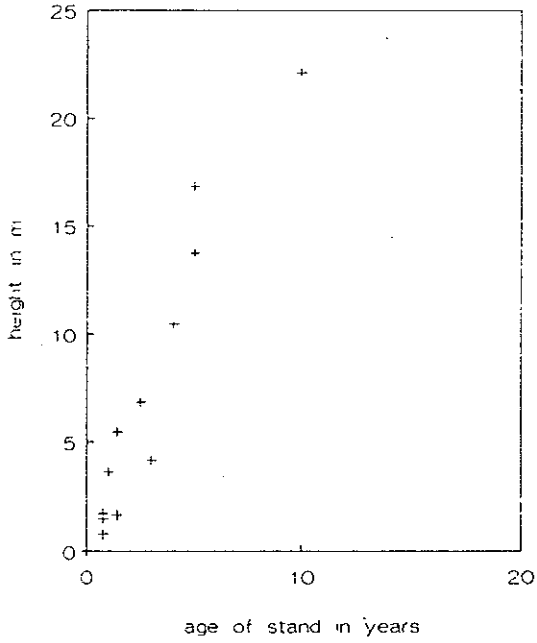


Figure 6.1 The height of the average laurel

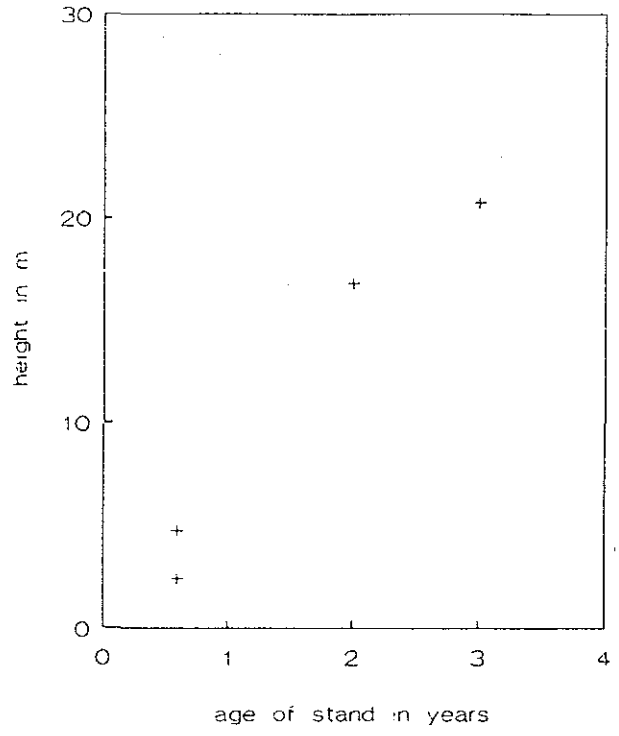


Figure 6.2 The height of the average melina

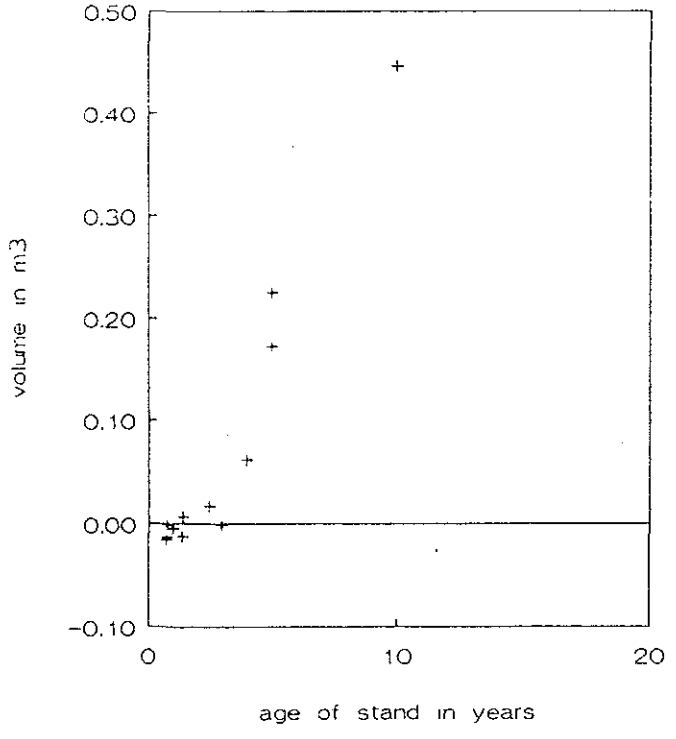


Figure 6.3 The calculated volume of the average laurel

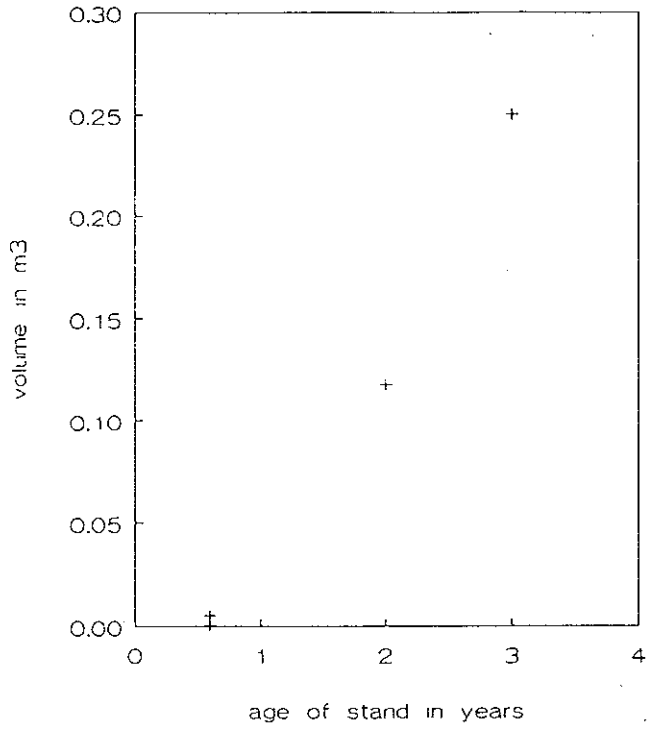


Figure 6.4 The calculated volume of the average melina

As you can see from figure 6.1 and 6.2 there are not so many stands in the survey which are old enough to be of any significance. Half of the stands of laurel have a negative volume when calculated with the equation of BEER & SOMMARIBA (1986). The four measurements of melina seem to be extremely high compared with the curve given in MURILLO & VALERIO (1991). It is likely that the stands which the farmers said were age 2 and 3 years were older.

If these measurements are repeated in 3-5 years time they would give far more interesting results. Especially if you can compare them with data from projects like La Cabaña, a reforestation project with laurel and eucalyptus, that is situated just south of the Neguev and Río Jiménez.

7 DISCUSSION

The sample size on which this research was based is small due to the restriction that only the farms in the three research areas were included. The information extracted from the farmers and the stands is therefore to be viewed as an indication of what might be happening.

The data on the height and volume of the stands are at this moment not very useful since they are very young. Apart from one, all are planted after 1987, most of them even later. Half of the stands are too small to be measured now. If all the stands measured now could be remeasured in a couple of years a much broader base is given to the results.

The sample size is the quantative side of information gathering, but even statistically correct data are worth nothing if the source is not reliable. The project requires students to investigate a LUT in five months. In five months you can only gain data by questioning farmers. This is far less reliable than joining the farmers during their actual work and record the data.

This is especially true when questioning farmers with a relatively low education. They have little grasp of the aim of our study and they are not used to account things like their working time and the exact amount of inputs per hectare. Further complication is the relative unimportance of maintenance work in the plantation. Farmers tend to do that at moments when they have some spare time. During the course of the year they forget what they have done.

8 CONCLUSIONS AND RECOMMENDATIONS

Plantation forestry is currently a land use type in the Atlantic Zone of Costa Rica but only on a small scale. There wouldn't be even less than a third of this if the government didn't subsidise reforestation projects.

In Río Jiménez and the Neguev the plantations are ranging from 0.5 to 10 ha. Most of the farmers get a subsidy through the farmers union UPAGRA. Since there is no organisation like that in Cocorí small farmers there can't receive the subsidies. Two business men who have invested in land in this area have 100 ha reforestation projects with government subsidies. They are paid to reforest an area in which a secondary forest would develop within 10 years because there is still a lot of primary and old secondary forest left over. The government should make its subsidy to these farmers dependent on the need for reforestation of the specific area. Otherwise this is a waste of money on a ecologically questionable venture.

The subsidy for smaller farmers has other objectives than purely the increase of timber production. It mainly aims to strengthen the local farmers organisations. UPAGRA is convinced that the subsidy can be used as a mean to start a scheme were timber production helps to start a small furniture factory in the area. They hired a forestry engineer. The problem with the programme of UPAGRA is the lack of extension, because the engineer has a full time job just dealing with the subsidies. They probably will therefore not succeed in starting the factory. If the government wants to strenghten the farmers organisations through reforestation projects it should back the schemes with good extension programmes.

The people who settled in the area are not from a homogeneous background. The level of knowledge and skill differs considerably so it is logical that some stands are managed well while others are mismanaged. This will only change if research manages to give standardized information on the choice and management of species and if local organisations are able to spread this knowledge through extension programmes. This is often done in agriculture and since plantations are tree crops it should be done for them too.

Even if there was a good extension plan it would only succeed in teaching basic skills like planting techniques. There is too little known about the relative performance of the tree species in this zone to give advise from an ecological as well as an economical point of view. Choice of species now depends on availability of stock and acquaintance of the farmer with the tree species.

There are several reasons for the farmers to establish a plantation. Around 25% solely have a plantation because they predict a shortage of timber or have a great affinity with trees.

The other 75% established one because the subsidy was available. With that subsidy it became a viable option for them. They hope that it will provide a security for the future for them and their families.

After planting the farmers carry out work on the plantation as part of their daily chores. If something needs doing it is mostly done together with work on other crops. Farmers have therefore often no clear picture about the amount of work which is put into the maintenance of the plantation. It is likely that they under-estimated the work required for maintenance.

There are no statistically viable data concerning the growth of the plantations because the sample size was small and most stands were younger than three years. If you want to use the information in a linear programming model which aims to give relations between management alternatives, soil use class and yield it should at least be verified by repetition of this study in three or four years time.

The actual performance of the existing plantations might be less than the farmers expect if they used poor stock or didn't manage the stand properly. When this is the case in a high proportion of the plantations, this might be such a bad example for other farmers that plantation forestry will have a bleak future until the economic reality makes it far more certain that it will be profitable.

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APPENDIX I List of questions

General

1 Human aspects

1.1 What is your age?
1.2 How many years have you lived an this farm?
1.3 How many children do you have?
1.4 How many children work on the farm?
1.5 Do you have workers, if yes how many?
1.6 What level of education do you have?
1.7 Who taught you to work with trees?
1.8 How many days per month do you have off-farm work?

2 Land use

2.1 How many hectares does your farm have?
2.2 How many hectares pasture?
2.3 How many hectares crops?
2.4 How many hectares forest?
2.5 How many hectares fallow?
2.6 How many hectares plantation forestry?
2.7 Which species and of what age?
2.8 Do you have fruit trees?
2.9 Do you sell fruit?
2.10 Do you have dispersed trees?
2.11 Do you have living fences?

3 Motivations

3.1 Why do you have a plantation?
3.2 Why did you chose the site?
3.2 Why did you chose the species?

4 Others

4.1 Are you going to expand the plantation, if yes with how much and with what species?
4.2 Do you receive the subsidies on time?
4.3 What do you do with the subsidies?
4.4 Do you want more information on plantation forestry?
4.5 In how many years will commercial timber become scarce in the Atlantic Zone?
4.6 Do you think that the number of plantations will increase in the next couple of years?

Management

1 Establishment

1.1 Do you have a tree nursery?
1.2 From where is the seed and what did it cost?
1.3 What is the surface of the nursery?
1.4 Does the nursery have shade?
1.5 Do you use any pretreatment of the seeds?
1.6 Do you use fertilizer in the nursery?
1.7 What type and how much?
1.8 Do you have pest or diseases in the nursery?
1.9 Do you use pesticides in the nursery?
1.10 What type and how much?
1.11 What is the spacing of the seed?
1.12 At what time do you plant?
1.13 What kind of drainage do you have?
1.14 Which tools do you use in the nursery?
1.15 If you don't have a nursery, where do your plants or seeds come from?
1.16 What method of planting did you use?
1.17 How many plants or kg of seed have you bought, from whom and at what price?
1.18 How did you prepare the soil before planting?
1.19 Did you use tools or herbicides, if the latter what kind and how much?
1.20 How many hours work for the soil preparation?
1.21 In which months did you plant?
1.22 Which tools did you use for planting?
1.23 Did you use dead stakes?
1.24 What is the spacing of the plants?
1.25 Do the plants have shade?
1.26 Did you use fertilizer during planting, if yes what kind and how much?
1.27 How many hours work for the planting?
1.28 What is the mortality rate?
1.29 Do you restock?

2 Maintenance

2.1 How many times do you clean?
2.2 Do you use tools or herbicides, if the latter what kind and how much?
2.3 How many hours does a cleaning take per ha.?
2.4 Do you know pests and diseases of the tree species in your plantation?
2.5 Do you have any of those in your plantation?
2.6 Do you use pesticides, which and how much?
2.7 Application of pesticides costs how many hours?
2.8 Do you apply fertilizer, which and how much?
2.9 Application of fertilizer costs how many hours?
2.10 Do you prune, if you do when?
2.11 Pruning costs how many houres work?
2.12 How do you prune?
2.13 Did you or are going to thin?
2.14 Why are you thinning?

2.15 What is the final number of trees you want to harvest?
2.16 Thinning costs how many hours work?

3 Harvest

3.1 When are you going to harvest?
3.2 Who will be doing the harvesting?
3.3 How is the accesibility?

APPENDIX II Farm data

Table 1

Farm nr	age	educ-ation	farm size (ha)	perenials (ha)	annual crops (ha)	pasture (ha)	Plant size (ha)	Manage own farm	Sub-sidy	Use subs	Why plantation
N1	44	pnc	17	0.25	0.75	2.0	6	y	FDF	main	sub,fut,eco,copy
N2	39	pnc	18	0.0	4.0	2.0	5	y	FDF	main	sub,fut,eco
N3	50	pnc	17	3.5	0.0	4.0	5	y	FDF	main&pl	sub,fut,eco
N4	37	pnc	17	0.5	0.5	6.0	5	y	FDF	pl	sub,fut,copy
N5	39	pc	17	1.0	0.0	15.0	1	y	FDF	main	sub,fut,copy
N6	33	snc	10	4.5	0.0	4.0	5	y	FDF	pl	eco,fut
N7	37	pc	17	1.0	0.5	2.0	5	y	FDF	main&pl	sub,fut,eco,copy
R1	75	n	42	0.0	2.5	7.0	3	y	CAF	main	sub,eco
R2	50	snc	73	3.0	1.0	60.0	5	y	CAF	pl	sub,fut
R3	47	pnc	87	15.0	0.0	55.0	3	y	no		fut,eco
R4	54	pc	10	0.5	0.0	2.0	1	y	FDF	main&pl	sub,fut,eco
R5	46	pnc	10	0.0	0.0	5.0	1	y	FDF	main	sub,fut,eco
R6	27	scn	7	1.0	1.0	1.0	3	y	FDF	pl	fut,eco
C1	31	pc	88	0.0	4.25	75.0	.25	y	no		ouse
C2	48	snc	136	0.5	3.0	35.0	.5*	n	no*		sub,eco
C3	ng	ng	400	ng	ng	ng	100	n	CAF	pl	sub
C4	ng	ng	125	ng	ng	0.0	100	n	CAF	pl	sub

N : Neguev
R : Río Jiménez
C : Cocorí
1,..,7: number of the farmer
ng : data not given

p : primary school
s : secondary school
nc: not completed
c : completed
n : no schooling

Use of income received from subsidy:
main: for the maintenance of the family
pl : for investment in the plantation
Reasons for establishing a plantation:
sub : availabilty of subsidies
ouse: own future need for timber on the farm
fut : future security of the family
eco : preservation of natural resources
copy: following example of somebody else
* : plans to plant 40 ha more with CAF

Table 2

Farm nr	Plantation							
	Site 1				Site 2			
	size (ha)	species	soil use class	age (yrs)	size	species	soil use class	age (yrs)
N1	5.0	90%la,10%nat	1	0.2				
N2	5.0	65%la,35%nat	1	0.4	0.5	la	1	5.0
N3	1.0	la	2	10.0	5.0	la	2	0.75
N4	1.3	la	2	0.1				
N5	1.0	la	1	0.2				
N6	2.0	gm	2	1.5	1.0	gm	3	3.0
N7	0.5	gm	3	0.6	0.5	gm	1	2.0
R1	3.0	la	1	0.25				
R2	1.25	la	1	2.5	4.0	la	2	1.0
R3	0.8	la	1	4.0	0.6	la	1	5.0
R4	0.5	la	1	0.75				
R5	1.2	50%ro,50%ca	3	0.75				
R6	1.0	la	2	0.75	0.5	gm	2	0.4
C1	0.25	la	1	3.0				
C2	0.5	po	3	2.5				
C3	50ha laurel and 50 ha melina mostly on soil use class 2							
C4	50ha laurel and 50 ha melina mostly on soil use class 2							

la : laurel
gm : melina
nat: native species (pilon, sura, fruta dorado)
ca : caobilla
ro : roble sabana
ce : cedro
ma : manu negro
po : pochote

soil use class:
1 (fertile, well drained)
2 (infertile, well drained)
3 (badly drained)

Table 3

Farm nr	Plantation							
	Site 3				Site 4			
	size (ha)	species	soil use class	age (yrs)	size	species	soil use class	age (yrs)
N1								
N2	1.0	ce,ma	1	0.4				
N3								
N4								
N5								
N6	0.5	la	1	0.75	2.5	nat	2	3.0
N7								
R1								
R2	2.0	ce	3	0.5				
R3								
R4								
R5								
R6	1.5	nat	2	0.75				
C1								
C2								
C3	50ha laurel and 50 ha melina mostly on soil use class 2							
C4	50ha laurel and 50 ha melina mostly on soil use class 2							

la : laurel
gm : melina
nat: native species (pilon, sura, fruta dorado)
ca : caobilla
ro : roble sabana
ce : cedro
ma : manu negro
po : pochote

soil use class:
1 (fertile, well drained)
2 (infertile, well drained)
3 (badly drained)

Table 1

Farm nr	Nursery	Type of plant stock	Origin of plant stock	Quantity plants bought	Price/ plant (colones)	Soilpreparation for planting	Type&Quant herbicide	Hours/ha work for soil prep
N1	N	st&wild	nat:1 la:2	5500	10	full:h;ring:m	?,?	40
N2	Y	st	3	0		full:m;ring:m		42
N3	N	st&wild	nat:1 la:4	1300	10	full:m;ring:m		10
N4	N	st	3	1400	10	ring:m		10
N5	N	st	3	1200	10	full:m;ring:m		40
N6	Y	st	2	0		full:m;ring;m		90
N7	N	st&wild	nat:1 gm:3	1100	10	full:m;ring:m		82
R1	N	st	4	3000	6	full:m;ring:m		32
R2	N	st	4	0		agriculture		?
R3	Y	wild	1	0		agriculture		?
R4	N	st&wild	1&3	375	10	ring:m		21
R5	Y	st	4	0		ring:m		16
R6	N	st	4	3300	10	full:h;ring:m	RANDON,?	?
C1	N	wild	1	0		full:m		30
C2	Y	st	2	0		full:m;ring:m		48
C3	Y	st	2	0		full:m;ring:h	?,?	?
C4	Y	st	2	0		full:m;ring:h	DURON,?	?

st : stumps
wild : wildlings
nat : local tree species
la : laurel
gm : melina
colones : 140 Colones= ± $ 1.00
full : weeding of whole area
ring : spot weeding on planting sites
h : herbicides were used to weed
m : machete was used to weed

Origin of plant stock:
1: forest
2: own nursery
3: nursery contracted through UPAGRA
4: other commercial nursery

Table 2

Farm nr	Plant when	Plant tool	Use stakes	Shade on stand 1	2	3	4	Plant distance (m) 1	2	3	4	Use fert while planting	Type&Quant fertilizer	Hours/ha work for planting
N1	3	sh	Y	N	N			3*3	3*3			N		40
N2	2	ma	Y	N	N	Y		3*3	3*3	3*3		N		10
N3	5-11	sh	Y	N	Y			3*3	3*3			Y	10-30-10,46kg/ha	80
N4	4	ps	N	Y				3*3				N		15
N5	3	sh	Y	N				3*3				N		40
N6	5-11	ps	N	N	N	Y	Y	3*3	3*3	3*3	3*3	N		40
N7	5-11	ps	Y	N	N	Y		3*3	3*3			N		16
R1	2	sh	Y	N				3*3				Y	12-24-12,46kg/ha	32
R2	5	sh	N	N	N			3*3	3*6			N		?
R3	5-11	sh	N	N	N	N		2*10	2*10	3*3		N		25
R4	10	ps	Y	N				3*3				N		16
R5	5-11	ps	N	N				3*3				N		?
R6	5-11	sh	Y	N	N	Y		3*3	3*3	3*3		N		?
C1	6,7	ps	N	N				3*3				N		40
C2	10	sh	N	N				3*3				N		48
C3	6-10	ps	?	N(all stands)				3*3(all stands)				Y	10-30-10,50g/tree	?
C4	6-10	sh	?	N(all stands)				3*3(all stands)				N		?

1-12 : month of the year
sh : shovel
ma : machete
ps : planting stick
10-30-10 : N(itrogen),P(osphor),K(alium) fertilizer
12-24-12 : N,P,K fertilizer

Table 3

Farm nr	Morta-lity (%)	Repl-ace	Weeding when	Weed-ing tool	Type&Quant herbicide	Hours/ha work for weeding	Know pest and diseases	Have p&d	Type&Quant pesticides used
N1	?	N	2,8,14,18	ma		28	la:ants	N	
N2	20	Y	5,7,9,11,13,17,24	ma		?	la:wasp	N	
N3	10	Y	3,6,9,12,15,18,21	ma		40	la:wasp	Y	MIREY,?
N4	5	N	3,6,9,12,15,18,21	ma		?	no	N	
N5	**100**	N							
N6	10	Y	3,6,9,12,15,18	ma		?	ce:hyp	100%	
N7	5	Y	3,6,9,12,15,18	ma		24	no	N	
R1	5	N	3,6,9,15	ma		32	no	N	
R2	10	N	3,6,9,12,15,18,24	he	GRAMOXON,6.7l/ha	32	la:wasp	N	
R3	?	Y	mais first 2 yrs				ce:hyp	Y	
R4	5	N	3,6,9,12,15,18,21	ma		?	la:ants	N	
R5	5	N	3,9,15,21	ma		16	no	N	
R6	5la,50ce	N	agriculture				ce:hyp	25%	
C1	10	N	2,12	ma		30	no	N	
C2	0	N	6*	ma		20	po:wasp	1%	
C3	?	N	3,6,9,12,15,18,24,30	ma		?	?	?	
C4	?	?	3,6,9,12,15,18,24,30	he	DURON,?	?	?	?	

1..30 : months after planting
ma : machete
he : herbicide
la : laurel
ce : cedro
po : pochote
hyp : *Hypsipyla* a moth larvae

Table 4

Farm nr	Pruning	Pruning tool	Pruning work	Fertilizer when	Type&Quant fertilizer	Thinning	Thinning when
N1	N					Y	->3 yrs
N2	N					Y	?
N3	N			6	10-30-10,46kg/ha	Y	?
N4	1*year	ma	?	2*first yr	12-24-12,69kg/ha	Y	?
N6	6,12,18	ma	.3h/tr			Y	la:5,7,10yrs,gm:4,6,8yrs200tr/*
N7	4,8,12	ma	12h/ha			Y	5*100tr
R1	N			18	12-24-12,23kg/ha	Y	?
R2	10	ma	8h/ha			Y	->3 yrs
R3	2,4,6,8	ma	?			N	
R4	N					N	
R5	24	ma	?			Y	?
R6	const	ma	?			Y	->3 yrs
C1	N			3.5 yrs	?,2kg/ha	Y	->4 yrs
C2	N					Y	->4 yrs
C3	6,18	ma	?	12	10-30-10,?	Y	depends on economic need owner
C4	2*	ma	?			Y	depends on economic need owner

2..18 : month after planting
ma : machete
tr : tree
h/tr : working hours per tree
la : laurel
gm : melina
10-30-10 : N,P,K fertilizer
12-24-12 : N,P,K fertilizer

Table 5

Farm nr	Thinning goal	Thinning regime	Harvesting when	Harvesting who	Acess-bility
N1	1100->500tr/ha	ht	la:8yrs,nat:12yrs	self	good
N2	?	ht&lt	la&ce:10-15yrs	self	good
N3	1100->800tr/ha	ht	la:10yrs	self	good
N4	1100->800tr/ha	sys	la:10yrs	self	good
N6	1100->350tr/ha	ht	la:15,gm:10,nat:20yrs	self	good
N7	1100->600tr/ha	ht&lt	la:10yrs	self	good
R1	?	ht	la:10yrs	others	good
R2	70%	?	la:12-14yrs	self	good
R3			la:18yrs	self	good
R4			la:10yrs	self	bad
R5	?	ht	la:20yrs	self	good
R6	1100->300tr/ha	ht	la:15,gm:8,nat:20yrs	self	good
C1	?	ht	?	self	good
C2	?	hts	po:15yrs	self	good
C3	?	?	la:25,gm:15yrs	self	good
C4	?	?	?	self	good

ht : high thinning
lt : low thinning
tr/ha: trees/ha
sys : systematic thinning
la : laurel
gm : melina
po : pochote
nat : local species

Table 1

Farm nr	Commercial	Size	Which species	Origin of seed	How much seed bought	Seed-bed	Seedbed size	Pre-treatment	Production	Shade
N2	N	3*3m	la,ce	forest		Y	3*1.5m	N		Y
N6	N	0.25ha	la,pi,fr	forest		Y	var	N	20.000 pl/yr	N
R2	N	?	la	forest		N		N		Y
C2	N	0.2ha	po	Guanacaste	4kg	Y	2*40m	N		N

Table 2

Farm nr	Germination when	Use fert	Type&Quant fertilizer	Use pest	Type&Quant pesticides	Seeding distance	When are tr planted	Drainage
N2	?	Y	12-24-12,12kg/yr	N		narrow ?	5,6month	superficial
N6	8-15 days	Y	?,a bit	Y	CONTER,4l/ha	20*20cm	5,6month	superficial
R2	2-3 weeks	N		N		?	1 year	no
C2	2 weeks	N		Y	MALATION,15kg/ha	12*12cm	6 month	superficial

la : laurel
ce : cedro
pi : pilon
fr : fruta dorado
po : pochote
Guanacaste : Region in the northwest of Costa Rica
12-24-12 : N,P,K fertilizer