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FARMING SYSTEMS IN THE NEGUEV SETTLEMENT

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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.

Location of the study area.

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SUMMARY

This study quantifies the in and outputs of eleven sample farm in the Neguev settlement (Costa Rica) from January till June 1991. It describes the cropping systems of maize (*Zea Mays*), palmheart (*Bactris gasipaes*) and plantain (*Musa AAB*) and pays special attention to the labor input at the different farms. Farm income and labor input for the sample farms are also described. Motives and choices of farmers are characterized based upon the data of the sample farms with the help of a linear model. The study formulates the connection between land-type (soil type), land-use and economic returns. Land-use in the Neguev settlement is extensive and differences between farms and cropping systems are large. This extensive land-use is caused by the profitability of off-farm work in relation to agricultural production and not only by poor soils. Land-units do influence the land-use, simply by limiting agricultural production possibilities on poor soils, thereby reducing the options farmers have. Poor soils are however not necessarily related to low economic returns. Regional planning should therefore include more factors than soil-type to asses production possibilities.

INTRODUCTION

This study was executed within the Programma Zona Atlantica. A cooperation between the Centra Agronomico Tropical de Investigacion y Enseñanza (CATIE), the Costarican Ministry of Agriculture and livestock (MAG) and the Agricultural University of Wageningen. The main goal of the Programma Zona Atlantica is the development of a planning methodology with emphasis on sustainable land use.

This study was a joint project of the department of Development Economics and Tropical Crop Science of Wageningen Agricultural University. The main goal is to quantify the physical and economic in- and output relations of different cropping and farming systems thereby establishing the relationships between land units, land-use types and economic returns. The fieldwork started in december 1990 and will continue for several years.

This first study was executed in the Neguev settlement, one of the larger settlements schemes in the Atlantic Zone. The Neguev settlement is somewhat different than other settlements. It is one of the larger settlements and has received more financial support, extension and research than most of the other settlements. In deterrence to this high input of resources, land-use is still extensive in the settlement and several farms are virtually abandoned. This report will partly explain why the land use is extensive and highlight the relation between land-unit, land-use and soil type.

1 THE STUDY

1.1 Introduction

This first study was located in the Neguev, a 5300 hectare large settlement scheme. The main reason for selecting the Neguev settlement was the availability of a detailed soil and parcel map.
This chapter will describe the objectives of the study, the structure, the stratification and the data processing. The various advantages and disadvantages of this setup will also be reviewed.

1.2 Objectives of the study

The objectives of the study were:
1. The establishment of the relationships between land units, land-use types (crops and, or livestock) and economic returns, within a farm system.
2. Establishing physical and economic in- and output relations per crop.
3. Describing the cultivation methods of the main crops.
4. Establishing the availability and use of other factors, such as labor and capital.
5. Establishing the economic returns (incomes) obtained.
6. Describing the objectives and strategies of farm households.

1.3 Structure of the study

The study was divided in four parts:
1. Preparation in October, November 1990.
2. Selection of participating farmers in the first and second week of December and obtaining general information of the farm and household composition.
3. A weekly interview on each farm from January 1991 onwards. This interview recorded the hours spend in different activities, the use of different inputs and the output of the past week.
4. On farm maize & palmheart trials were conducted in order to obtain an impression of the production possibilities and to get more interaction with the farmers by experimenting on their fields. The results of the trials will be mentioned in a separate report.

1.4 Stratification

Constructing the sample
A database was constructed to start the stratification. This database included: all the farms in the Neguev settlement, the owner, the area, the prevalent soil types and the previous studies and development programs. Qualitative information about the land-use was later added. The data base is shown in appendix I.

This database was sorted on the agricultural relevant soil type in eleven different strata [1]. Several strata were combined to form two different groups, consisting of 43 farms located on fertile soil not subject to flooding (Parismina, Ligia and Bosque) and 151 farms located on poor Neguev soil. A relation between land unit, land-use type and economic returns would be easier to detect using two extreme soil types. An ad random number was allocated to the remaining farms and the database was sorted on this number. A few farms which had been studied in recent previous studies were excluded from the strata to avoid over interviewing.

From this list a maximum of fifteen farms[2] could be selected, five farms on poor soils, five farms on poor soils with palmheart and five farms on fertile soils.
The listed farms were approached if they were interested to participate in the research. The study proceeded with a stocktaking interview if the farmer was willing to participate. This stocktaking interview is included in appendix II.

The field experience

How well set up the stratification might seem, in practice it was a small disaster. Previous studies were always done without ad random selection and often directed at one crop or arable farming. The sheer number of reports on arable farming only, gave the impression that arable farming was a mainstream activity in the settlement. Exploratory field visits also focussed on arable crops, driving from crop to crop through extensive pasture area's. Arable farming as a mainstream activity turned out to be an illusion during the field selection of sample farms when the stratification list forced us to exclude this bias.

The first farm selected and willing to cooperate was a farm also studied in 1987 in a study of intensive dairy systems. In december 1990 the same farmer worked as a wage laborer, before he had an accident. He had sold all his cattle but still could not pay his debts. A hectare land was hired by a neighbor and the rest of his land was pasture and woods. We didn't proceed with further interviews since so little was happening at this desolating farm.

The second selected farmer was an admirable and assertive lady. She had problems with obtaining a title on the land since her husband ran away and still had a shared right on the farm. The farm itself consisted of pasture but the cows where also often relocated on other farms. A considerable amount of forest remained on the farm, which she intended to protect as a small wildlife refuge to avoid further environmental deterioration. We initially included the farm in the research since it was listed second on the stratification list and the land-use itself seemed quite representative for the settlement. After two months and three visits the research was also ended at this farm since nothing was going on at this farm. How the charming lady obtained an income remained obscure, until I was told about logging in the back of her parcel.

The Neguev settlement was explored in every corner. Working down the stratification list, and narrowing down the stratification towards farms with at least some arable farming. The study was explained to wives, brothers and fathers.

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[1] More information about the different soil types can be found in chapter 2.3 and appendix VI.

[2] This number was quite arbitrary chosen and based upon the assumption that one day was spent visiting the Eastern part of the settlement, one day visiting the Western and one reserve day for respondents not encountered. This left two days for data-base development, background reading and field trials.

Encountering deserted farms and very little arable farming (even on soils classified as fertile). After two weeks we finally completed the first selection of farms.

During the research sixteen farms were for a longer or shorter period included in the research. The research was discontinued at five farms in January and February. At four farms the owners/administrators could not be interviewed with a reasonable frequency because of their off-farm work. At one farm virtually nothing happened. Three replacements were found. The research was continued with eleven farms (five located on fertile soils and six on poor soils. Two farms dropped out around May. One of them preferred to stop the research and the other (an administrator) moved to an other canton leaving the farm behind. Five palmheart farmers were included in the sample.

The stratification database was extended with qualitative information of land-use along the roadside of the parcels in order to compare the land-use of the sample group with the land-use in the settlement. This information confirmed the extensive land-use in the settlement and the relative small importance of arable cropping. The land-use of the sample group, with its emphasis on arable farming, is therefore not representative for the Neguev settlement[3].

1.5 Data processing

Data were recorded on schedules. One of the field schedules is included in appendix III. The information was coded and stored into a Dbase database. Appendix IV gives the structure of the Dbase database and a printout of a small part. The data were analyzed with Pepe IV, a Lotus based calculation program developed at CATIE which had to be adapted considerably for this study. Pepe IV calculates gross margins per crop, separates activities between family and hired labor and calculates input costs on a total and a monthly basis.The data had to be converted from Dbase into Lotus, moved and recalculated to obtain the desired configuration for Pepe IV. This was possible with the help of a two page macro. The macro is included in appendix V. Pepe IV does not separate the different in- and outputs but summarizes them on a monthly basis. The weekly data and input quantifications have therefore been calculated manually.

1.6 Reviewing the setup of the study

The combination of regular repeating interviews with trials certainly increased the contact with farmers and provided a lot of information, otherwise never obtained. The quantitative information is based on these repeating interviews. The interpretation of these data would not have been possible without many accidental conversations with farmers and extensionists during the survey.

[3] The sample includes twenty three percent of all the farms with palmheart in the Neguev while only seven percent of the farms is cultivating palmheart. More surprising is the fact that two farms combined a small grocery store with arable farming and off-farm work. The sample included therefore thirty percent of the grocery stores in the settlement.

Single interviews versus repeating interviews
Locating farmers regularly is more difficult than obtaining a single visit interview. The recordings of "grand event" data such as the number of harvested bags and fertilizations are not very different between single interview studies such as Brink (1987) and this study. But the willingness of farmers to cooperate and thereby the accuracy of single survey interviews has declined after at least twelve surveys during the last five years.

The large advantage from regular repeating interviews is the accurate estimation of inputs in time. More and different quantitative and qualitative information is obtained over a longer period. Thereby providing an perspective of the development in time based on homogenous information.

Stratification
The ad random stratification was difficult but provided a clear picture about the relevance of the sample group in relation to the population. The formation of the database and the qualitative description of land-use was an excellent way to asses the present cropping systems and their relevance in the settlement.

Statistical relevance
Obtaining a statistical relevant sample in a broad study is difficult. It was unclear which parameters would be encountered and their relevance towards the farming system. For instance the importance of off farm work was unknown. The variation of parameters is large and not always normal distributed. Interaction and confounding is common and its source often difficult to quantify. Covariance is also varying and originating from many different sources (previous land-use but also life histories). Fortunately variables such as gross margin per hectare per crop turned out to be quite distinct.

Obtaining a statistical relevant sample for a regional planning model based on weekly interviews was impossible considering the available resources. We opted therefore for a small number of detailed studies. Obtaining in-depth information and relating the results towards other studies. Each sequential study could be adapted towards the insights obtained in previous ones. The disadvantage of this setup is the longer duration of data collection and time spent connecting studies. The advantage is a better and different information. Feedback with farmers is much larger and over-interviewing is easier avoided.

Feedback
Returning the information to the farmers proved to be very difficult. Their objectives are directed towards production increases. In practice this meant generating a separate information flow towards the farmers.

2. THE RESEARCH AREA

2.1 The Atlantic Zone

The Atlantic Zone of Costa Rica is located east of the Central Valley, the traditional heartland of Costa Rica. It is separated from the Central Valley by a mountain range. Two winding mountain roads connect the Atlantic Zone with the Central Valley. The main port is the Caribbean port of Limon. The total population of the zone exists of 220.000 people. (DGEC, 1991).

Climate

The average annual rainfall at CarmenII, which is the closest weather station to the Neguev, was 3646 mm between 1972 and 1991. The monthly division of rain is given in figure 1.

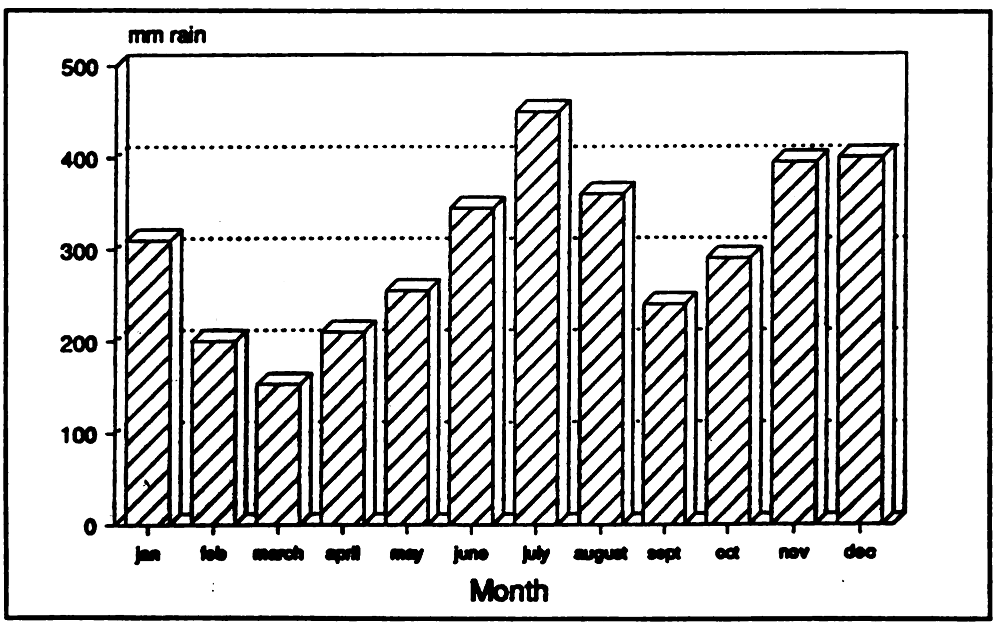

Figure 1. Annual monthly precipitation at CarmenII from 1972 - 1991 (Bandeco, 1991).

February, March and April are usually drier than other months. In the past twenty years only three years had two subsequent months with less then 100 mm rain. The "dry" season of 1991 was exceptionally dry with three subsequent months of less than 100 mm rain. The total amount of rainfall was in the first three months of 1991 280 mm, while the average for this period is 675 mm. Average monthly temperature ranges between 24.4 and 27.2°C. Evaporation fluctuates between 30 and 69 mm month^{-1} (Bandeco 1988).

Land-use

Land-use in the Atlantic Zone is dominated by protected forests, banana plantations, palmheart plantation, horticultural plantations, cattle ranches and IDA (Instituto de Desarrollo Agrario) settlements. IDA has acquired 163.000 ha land in Limon province and settled at least 12.000 families in different settlement schemes (IDA, 1988). Table 1 provides a global idea of land-use in the zone (DGEC, 1987). The relative small share of arable farming in total land-use, as encountered in the settlement, is also existing at regional level.

Table 1. Land-use in the Atlantic Zone according to the 1984 census (DGEC,1987)

	Number of farms	Total area (ha)	Production Total (hundreds of kg)	
Total	9.316	285.316	-	
Forests	1.978	59.033	-	
Sec. forest	2.408	27.059	-	
Pasture	3.605	106.026	-	
Permanent crops	3.605	48.708	-	
Arable cropping	5.202	39.703	-	
Annual crops	5.202	17.292	-	
Fallow	5.202	17.562	-	
Cacao	-	16.600	-	(1)
Banana	934	22.705	8333.993	(2)
Sugarcane	196	213	55.190	
Pine apple	440	200	-	
Coffee	541	927	26.803	
Coconut	1.227	4.322	119.207	(3)
Plantain	1.716	4.678	308.811	
Beans	982	724	2.803	
Maize	2.739	8.842	94.213	(4)
Rice	1.379	7.244	173.764	
Cassava	813	775	60.595	
Orange	906	91	57.242	
Protected areas	5	230.000	-	(5)

(1) SEPSA 1987
(2) about 20.000 ha bananas have been planted since 1984
(3) units
(4) white maize
(5) estimated since a small part of Chirripo & La Amistad is part of other provinces.

Land distribution

Sixty-three per cent of the farms is between five and fifty hectare. The distribution of land is quite uneven. Fifty-three per cent of the zone is used by farms larger than hundred hectare and twenty per cent of the zone is used by farms larger than 500 hectare, representing only 2.8 per cent of the total number of farms. The number of farms related to their area is present in figure 2.

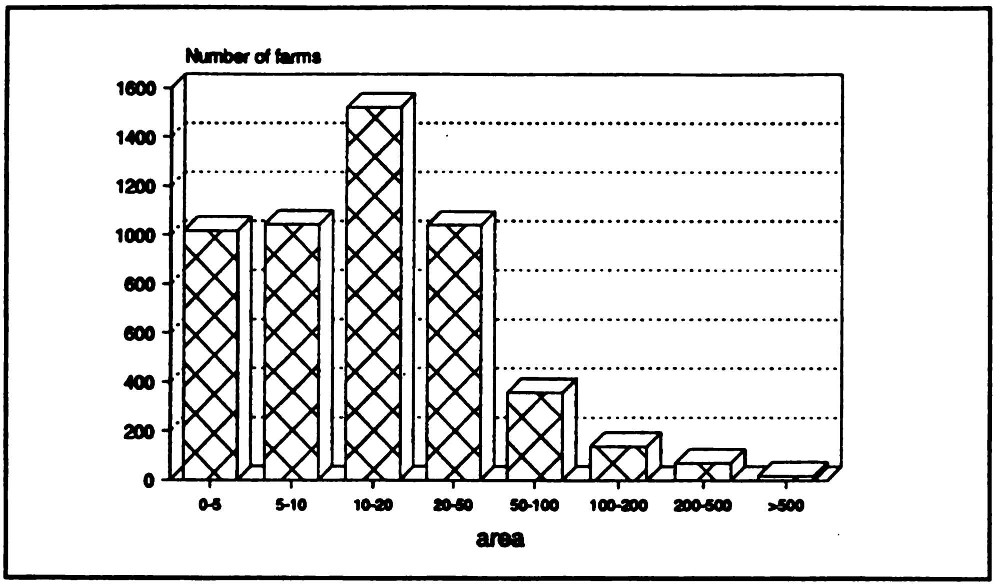

Figure 2. Number and size of land holdings in Limon province (DGEC, 1984).

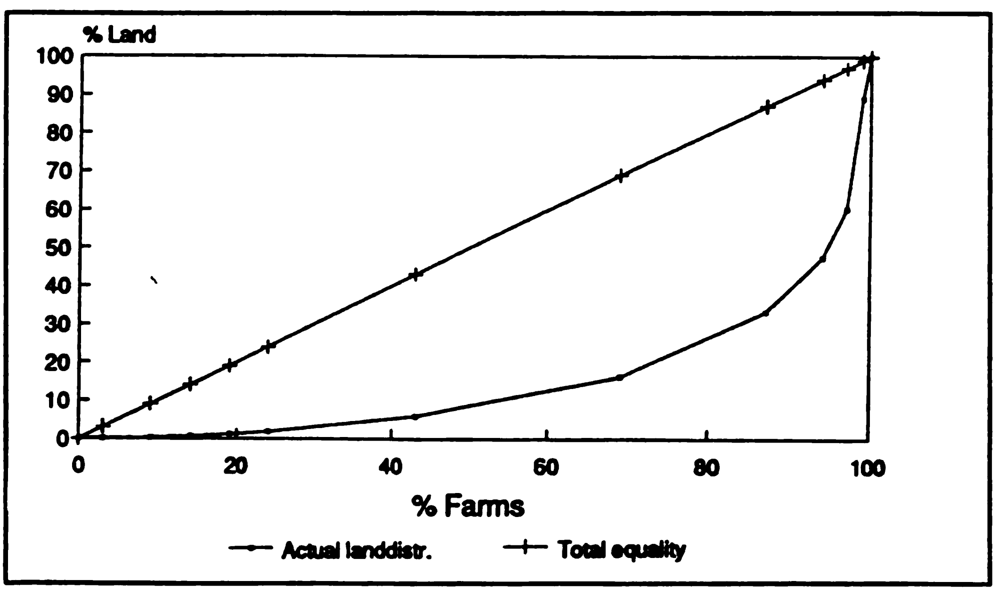

Figure 3. The Lorenz curve expressing the equality of land distribution in Limon province (DGEC,1988).

Figure 3 presents the Lorenz curve which can be used as a measure of the extent of the inequality of land distribution. The area below the curve shows the accumulated actual distribution of land. The 45°line demonstrates the situation where all farms have the same size. The Gini ratio coefficient equals the area between the curve and the 45°C line, divided by the total area below the 45°line. The Gini ratio approaches 1 if the inequality of land distribution increases (Colman, 1989). The Gini ration for the Atlantic zone is 0.71.

2.2 The Neguev settlement

The settlement Neguev was the largest hacienda east of Guapiles (ICTO, 1983). The main occupation took place in 1978. Three hundred hectares close to the Reventazon were occupied by settlers before march 1973 ICTO (1981). Since the occupation the majority of the remaining forest at the hacienda has been cleared and transformed into pasture and cropping fields.

The total area of the settlement is 5340 hectare, which is divided into 308 parcels of ten, fifteen and seventeen hectare (Mudde, 1987). The settlement has five sectors; Milano, Bella Vista, Silencio, El Peje and La Lucha. Each sector has a small center with a community center, soccer field and store. A wild life reserve is located in the North of the settlement. The settlement is geographically divided in two parts. The large part west of the Parismina and the smaller "La Lucha" part east of the Parismina. Nearby the settlement are three large banana plantations, a horticultural plantation a large cattle ranch and recently also a card box factory. Transportation within and from the settlement has been recently improved with a bus service. The construction of an airstrip is underway.

2.3 Soil types in the Neguev settlement

Four groups of soils can be distinguished in the settlement.

I Fertile soils close to rivers, Dos Novillos (DO), Destierro (DE), Parismina (PA), Ligia (LI), La Lucha (LU), Bosque (BO) and Willemsburg (WI).
II Intermediate fertile Milano (MI) soils.
III Low fertility, acid Neguev (NE) soils.
IV Silencio (SI) soils, comparable to Neguev soils but lower in fertility, found in a hilly landscape with swamps between the hills.

The international standardized names of the different soil types are provided in appendix VI. The classification of the Neguev soils (De Bruin, 1990) is based on topography, profile descriptions, soil analyses. The division of soil types on the Neguev farms is shown in table 2. Subdivisions in the main soil type are not incorporated because discrepancies with reality are more frequent within soil types than between soil types.

Several subdivisions are partly based on the drainage situation of the soils. The drainage situation of many soils has changed during the past years due to the changing vegetation and construction of drainage channels and is therefore different than the original encountered drainage class. The total number of classified farms is somewhat higher than the official number of farms (308) since several farms have been subdivided.

Table 2. Frequency of soil types on Neguev farms.

Soiltype	Frequency	Soiltype	Frequency
Bo X	5	Ne X	151
De X	28	Pa X	28
Do X	3	Si X	53
Li X	8	U X	6
Lu X	6	Wi X	9
Mi X	20	Total	317
Bo = Bosque		Ne = Neguev	
De = Destierro		Pa = Parismina	
Do = Dos Novillos		Si = Silencio	
Li = Ligia		U = Suampo	
Lu = La Lucha		Wi = Williamsburg	
Mi = Milano		X = second soil type (see appendix I)	

Within a soil type spatial variation can be quite large. Table 3 presents the differences for aluminum levels as found on some of the farms on Neguev soil[4]. Aluminum levels above 0.5 meq $100g^{-1}$ soil are toxic for most crops. The variation within Neguev soil on field level creates significant differences in production possibilities.

Table 3. Differences in aluminum content on Neguev soil.

farm	Al (meq/100g)	farm	Al (meq/100g)
VII	2.7	IX	1.1
VII	2.1	X	0.5
VIII	0.1	X	1.9
VIII	0.6	XI	2.8
IX	0.8	XI	2.0

Farmers know and exploit this variation. Obtaining a suitable field plot for the on-farm trials was difficult because most of the suitable land at their farms was already used for palmheart. The remaining parts were often too hilly, had a bad texture due to logging before 1978, were stony or extremely poor.

[4] The soil samples of these farms were obtained from the experimental field. A sample was obtained by collecting ad random a number of soil samples of the first ten cm topsoil. These samples were mixed and a sub sample was taken. This sub sample was sieved and separated in two parts in order to obtain a duplicate.

3. THE SAMPLE COMPOSITION

3.1. Introduction

This chapter describes the composition of the sample farms with regard to soil type, land-use, equipment, cattle stock and family composition as encountered during the initial stocktaking interview.

3.2 Land-use and soil types in the sample

Methodology

The area for the different crops was estimated for each field with the help of aerial photographs. The field boundaries were copied and enlarged on mm paper. A indirect measuring of these fields by a planimeter provided unreliable results. The number of squares of each field were therefore counted and multiplied with a scale factor. A few fields were measured with a tape and compass. The goniometric program designed to calculate the area is included in appendix VII. Large discrepancies between the photographic method and the field measurements were not found. The area for the different soil types was estimated per farm with the soil map of the Neguev copied and enlarged at mm paper. The results per farm are included in appendix VIII.

Soils included in the sample area

The combined area of the 11 sample farms is 145 hectare. Divided into 61 hectare Neguev, 21 hectare Bosque, 35 ha Parismina soil, 10 ha Suampo and a rest group of six different soil types, together 18 hectare large[5]. Table 4 shows the area of different soil types in the sample. The variation of soil types is much larger in the strata for fertile soils. Although the farms are divided into two strata, considerable differences exists between farms in one stratum. Farm VI for instance has got 9 hectares of fertile soil. But he is only able to use three, four hectares due to frequent flooding and drainage problems. Following the definitions of the soil map on micro level might lead to a wrong estimation of his land-use capacity. Figure 4 are 5 are visualizing the composition of the strata for farms with mainly on fertile soils and farms with mainly poor soils.

Table 4. Soil types in ha of the sample.

Farm	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Total
Neguev	5	12	1				7	10	8	9	8	61
Parismina	6		7	11	6	6						35
Bosque	1		5	4	8	3						21
Suampo	1	3	2	1	1	4					1	10
Floris		1		1								4
Silencio						4						4
La Lucha	3											3
Williamsburg							3					3
Destierro							2				2	4
Milano									2			
Total	16	15	15	17	16	17	11	10	10	9	11	145

[5] Based upon the information of the soil map.

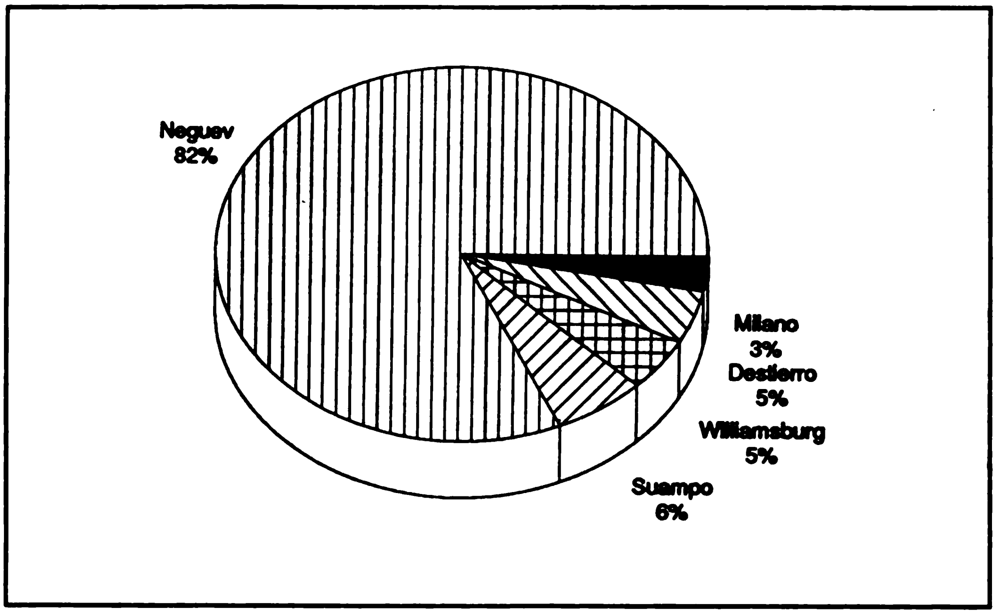

Figure 4. Soil types on the farms with mainly poor soils.

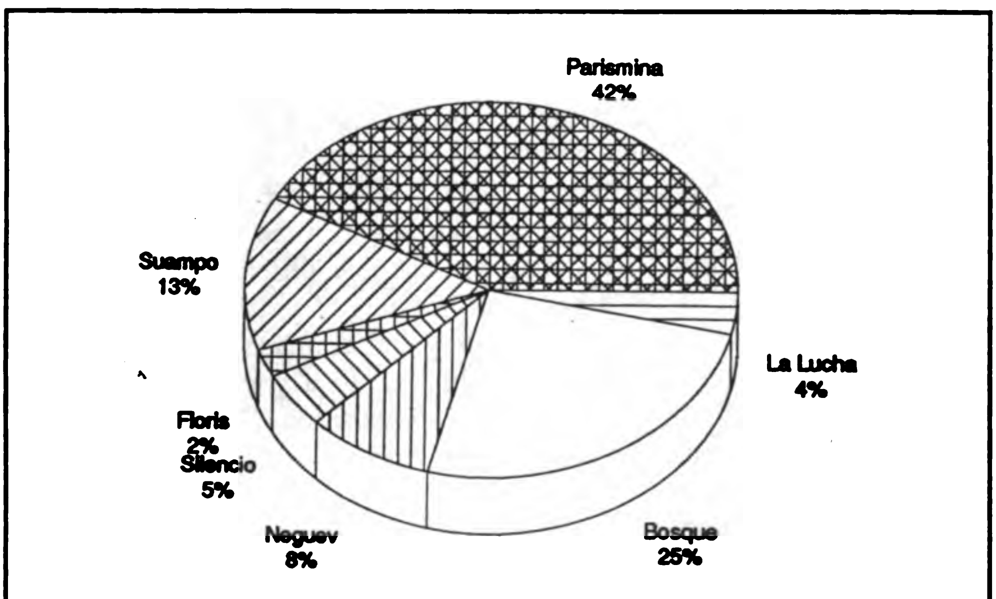

Figure 5. Soil types on the farms with mainly fertile soils.

The stratum with mainly fertile soils consists of farm number: I, III, IV, V and VI. The stratum with farm with mainly poor soils consists of farm number II, VII, VIII, IX, X and XI.

Land-use on different soil types
The different soil types of the sample are combined in three main groups. Fertile soils such as Parismina, Bosque, La Lucha and Floris. Poor soils such as Neguev and Silencio and poorly drained soils such as Williamsburg, Destierro and Suampo. The land-use per soil group is indicated in table 5. Detailed information about the cropping pattern per soil type is provided in appendix IX.

Table 5. Land-use (ha) of the sample farms for three main soil groups.

	pasture & forest	waste-land	maize	cacao	palm-heart	cass-ava	plan-tain	others	Total
fertile	14	4	17	6	3	5	4	6	59
poor	53	1	0	3	7	2	0	1	67
poorly-drained	4	14	.0	0	0	0	0	0	18
Total	71	19	17	9	10	7	7	7	144

Differences in land-use between fertile and poor soils are striking. Over eighty per cent of the cacao and nearly all the maize and plantain are cultivated on fertile soils. Land-use in the sample is extensive. Eighty per cent of the poor soils are used as pasture & forest or wasteland. Thirty per cent of the fertile soils is utilized as pasture, forest or wasteland. Farmers are apparently using a part of their fertile soil extensive in the form of pasture and forest. The motives for this extensive land-use will be further elaborated in chapter four and five.

Relating land-use to soil type
Bluntly relating soil type and soil fertility towards land-use, with these tables would be inappropriate.
- The soil map is not detailed enough to reflect the production possibilities on field level. Errors occur in the description of the soil type. Spatial variation within a soil type creates on field level significant differences in production possibilities. On Neguev soils this affects especially soil fertility while on the fertile soils drainage and flooding are éffecting the production possibilities.
- Soil type is only one component determining land-use. Location and other production possibilities also contribute towards the land-use as will be described in chapter five.
- The land-use is differentiated towards crops. Different cropping systems for example for maize as a cash crop, maize-cassava or maize as subsistence crop are not taken into account.

3.3 Household structure of the sample farms

Household composition
Families are often extended, in the sense that sons are living with their partners in the parents house or in a nearby house sharing meals. Regularly visiting parents and brothers do sometimes have a house on the same compound.

Relations of this type existed with four families in the sample. Relations between man and woman are often quite mobile [6]. The family composition is presented in table 6 and further elaborated in appendix VIII.

Table 6. Household composition of the sample farms.

Age	<12		12-15		16-20		21-45		46-60		61-70		Total	working at the farm	
Farm	M	F	M	F	M	F	M	F	M	F	M	F		100 %	<100%
I						1	2			1	1		5	1	2
II	1								1	1			3		1
III					1		1	1					3		2
IV							1						1	1	
V		2					1	1					4		1
VI					1	1	2	1					5		3
VII	1	1	1				1	1					6		1
VIII	3						1	1			1		6	1	
IX	3		1	1				1	1				8	1	6
X		1				1	3			1	1		7		5
XI	3	1					1	1					6		
M = male F = female															

Labor availability and use

To use family size in order to asses labor availability is complicated. First a distinction between sexes and age categories has to be made. Women are participating in farm work, such as harvesting cobs, pumpkin, processing palmheart, sowing beans and pruning palmheart. They work seldom on a regularly basis in the fields.
A second distinction has to be made between ages. But working with age classes does not take in account the activity itself and the particular skills of the worker. Family size is therefore only a rough indication of labor availability.

Labor is not exclusively used at the farm as table 6 indicates. The "average" pattern for a household in the Neguev is that the "husband", works full time at the farm or part time. Off farm work consists of working as a wage laborer or trading products. The women is occupied with the household task and helps occasionally. Children are going to school and may work part-time at the farm. Children older than 16-20 years work often full time off-farm.

The family as unit of analysis

The study uses the allotted IDA parcel as unit of analysis and takes mainly the farm operator in account. It was assumed that farm and family activities were limited towards the IDA parcel. Table 6 shows that off-farm work is an important activity especially at farms with more than one male older than 16-20 years.

[6] The IDA tries to give women more security by allotting half of the land to the man and the other half to the women when they are married. The land is allotted to the woman in the case of an "union libre". Currently the preparation of titles of farms where people are living in an union libre halted, since a court case declaring this policy unconstitutional is pending. This case affects 2500 farms located in the Northern Zone (La Nacion, 1991).

The income obtained on a farm is therefore composed of a number of farm and off-farm activities by various family members. These incomes are partly shared with the family living at the farm but can remain partly personal, as will also be discussed in chapter five. Using the family as the unit of analysis seems more appropriate because it is not only the basic decision-making unit of consumption and expenditure but also determines the nature of labor and other resource allocations as a whole (Kada, 1980).

3.4 Cattle

The total cattle stock at the sample farms is indicated in table 7 [7]. Most farms have some cattle. Three farms own more than fourteen animals. The cattle unit per hectare varies between 0 and 2.9 units per hectare. However wide differences exist between the pastures within and between farms ranging from secondary woodland towards well drained regularly cut pastures. Pastures are often exchanged or hired between parcels.

The profits of cattle are seldom incorporated in the gross margin since virtually no cattle was sold. But it is an potential important income source. Earning 20.000 colones buying and selling a young animal is very feasible. A ten hectare farm might have ten animals and earn with these 200.000 colones without much labor and continuing to work elsewhere. This sample is too small to make a valid comparison between the size of the livestock component with the size of the arable component but it could be an interesting relation.

Table 7. Cattle stock at the sample farms (December 1990).

Farm	Cows <1	Cows 1-2	Cows >2	Cows total	Milk Cows	Bulls <1	Bulls 1 - 2	Bulls >2	Repr. Bulls	Horses	Ha pasture	Cattle units/ha
I		1	1	2						1	1.3	2.0
II												0
III			2	2							1.8	1.1
IV							15				6.7	1.3
V			2	2							2.8	0.7
VI										1	1.5	0.7
VII	6		9	15	6				1	1	8.0	1.6
VIII	1	1	3	5			1			1	4.0	1.4
IX	2		2	4						1	6.0	0.6
XI			18	18	3		2		1	1	7.5	2.9
Total	9	2	37	48	9		18		2	6	39.6	

[7] The live stock units have been calculated with the following weights.
Cows < 1 year 0.3 unit bulls < 1 year 0.3 unit
Cows 1-2 year 0.6 unit bulls 1-2 year 0.6 unit
Cows > 2 year 1 unit bulls > 2 year 1.2 unit

3.5 Farm equipment

All the farms possessed one sprayer and several machetes. Normally the value of a sprayer (two years old) and two machetes is around 4000 [8]colones. Motorbikes were only found at La Lucha farms and value between 100.000-150.000 colones. Axes and spades are present at most farms but were not recorded during the stocktaking. Appendix VIII provides more information about the farm equipment.

3.6 Cropping systems

The different types of cropping systems encountered in this study at the sample farms are listed in table 8.

Table 8. Cropping systems encountered at the sample farms.

pure stands	inter cropped with	area (ha)
maize		10
maize	cassava	3
maize	palmheart	2
cassava		7
palmheart		5
palmheart	beans	½
palmheart	plantain	1
pumpkin		2
pumpkin	maize	½
pineapple		1
pasture	varying occupancy by trees	71
cacao		5
cacao	orange/coconut/plantain	2

Pasture is often fenced with Poró (*Erythrina spp.*) or Madero Negro (*Gliricidia sepum*). Pruning takes place once, twice a year. Trees in the pasture are remaining from the rainforest or sometimes planted. Laurel (*Cordia alliodora*) is one of the more popular trees but not always performing well.

An elaborated system of crop rotation does not exist. Maize is often preceded by three or four years of maize cultivation. Before that the maize land was used as pasture. The cacao area is decreasing due to low market prices.

Maize (*Zea mays*), palmheart (*Bactris gasipaes*) and plantain (*Musa AAB*) will be highlighted in chapter 4. Pineapple (*Ananas comosus*) and cassava (*Manihot esculenta*) have a longer growing season and data of these crops are not yet completely available for a crop cycle.

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[8] One U.S. dollar is approximately 130 colones.

Cacao (*Theobroma cacao*) is being cut down by the majority of farmers and not contributing significant towards the farm gross margin. Pumpkin (*Cucurbita spp.*) did contribute significant towards the farm gross margin but its high gross margin is probably short lived due to its fluctuating market. In- and output data of all crops are mentioned in appendix VIII.

3.7 Characterizing the sample

Land-use in the sample is extensive and characterized by pasture with waste land (percent of the area) and some crops. All the farms on fertile soils cultivate maize and often cassava. Farms on poor soils are restricted to low demanding land-uses as pasture, cassava and palmheart.

Relating land-use to land-type is difficult. The poor soils in the sample are clearly limiting land-use possibilities but the agricultural potential of the fertile soils is under utilized. Thirty percent of the fertile soils are used as forest, wasteland or pasture.
Soil type is therefore only partly determining production possibilities. The land-use reflects the combination of production possibilities influenced by factors as capital, labor and market conditions.

Family size ranges from 1 to 8 persons. Joint families are common and older sons work off farm. There is very little equipment present at the farms with a total value of around 4000 colones. Several farmers or sons own a motorbike enhancing their mobility. Cattle is present at nearly all farms.

4. THE QUANTIFICATION OF CROPPING SYSTEMS

Introduction

This chapter tries to quantify the in- and outputs of maize (*Zea Mays*), palmheart (*Bactris gasipaes*) and plantain (*Musa AAB*). Quantifying in detail the different in- and outputs proved to be very difficult. Several reasons are responsible for this.

- Intercropping. Analyzing the in- and outputs per crop when several crops grow together is difficult. Intercropping also involves an allocation of in- and outputs over time. For example farm IV is intercropping palmheart with maize and plantain, dividing some inputs over two crops and making a reasonable allocation per crop difficult. The farmer also applied a fertilization at the palmheart just before the harvest of maize at the same field. This gift was benefitting the palmheart, the plantain and the future crop of maize.

- Size of the study. The number of data on similar activities is often small. Only a few very diverse farms participate in the study, the number of data on one activity is limited. The obtained data have often a large variation partly due to the interrelation of activities. Generalizing these data is therefore often difficult.

- Biased information. The labor data of farm XI in palmheart are extremely high. The workload at the farm is probably overestimated by the caretaker since he might have felt controlled by the farm owner. One of the advantages of weekly interviews is the possibility to relate information of one farmer towards the usual practice and discuss discrepancies at the spot, reducing errors in data collection.

- Estimating the correct yield per hectare. Yields are often provided by the number of bags harvested per hectare. Using small sample plots measuring the exact yield level and combining this with the input data will provide more accurate information if fields are not too heterogenous.

- Comparing data with other studies is difficult since often only final results are presented and background information, regarding soil type or even location is not provided.

The presented data are all subject to these constraints. The original data are all entered into a Dbase database to facilitate future analysis.

4.1 MAIZE

This part describes the cropping system and the reasons for maize (*Zea Mays L.*) cultivation in La Lucha. It quantifies the different in- and output levels of maize production. The weekly use of labor and inputs per farm has been calculated and is shown in appendix X. Only a summary of the data will be given here. The results of the different producers are evaluated and compared with data collected by other studies.

4.1.1 Maize cultivation in the Neguev

Maize exist only as a cash crop on the fertile soils along the Parismina. The total maize area included in this survey was 15 hectare (an average of 3.05 hectare per maize farm). This area includes three different cropping systems. Maize-maize, maize-cassava and maize-palmheart (see also table 8). Table 9 shows the occurrence of maize in the sample.

Table 9. Area and cropping systems of maize in the sample.

Farm number	maize (ha)	Soil type	Production level (kg/ha)	Inter crops	Soil preparation
I	3.2	Parismina	2420	Cassava	ploughing
II	0.9	Parismina	-	none	zero - tillage
III	5.0	Bosque	3171	none	zero - tillage
IV	2.3	Bosque	3219	Palmheart	zero - tillage
V	3.9	Bosque/Parismina	-	none	zero - tillage

Some maize is grown for subsistence on Neguev soil.

4.1.2 Maize cultivation techniques

Land preparation

Two different land preparation systems exist. Zero tillage and ploughing. Farmer I ploughed the field and sowed with a plant stick. The other farmers cut the remaining stalks, burned the fields and started sowing with a plant stick. Farmer II was the only one to use previous fallow land. He first cleared the field and waited a few weeks. Then he applied herbicides before burning in order to burn more efficiently and reduce the amount of herbicides after sowing. The burning of fields is often incomplete due to the wet climate. By applying herbicides at fallow land before burning, the weeds will obtain a higher dry matter content and burn better. Table 10 presents the land preparation costs divided into labor (hours ha^{-1}) and herbicide costs (colones ha^{-1}). Family labor has been excluded from the labor costs but included in the labor hours. Ploughing is definitely more expensive than zero tillage but requires less labor.

Table 10. Land preparation inputs, method and previous land-use.

farm	labor (per ha)		herbicide (per ha)				
	costs	total hours	costs	liters	product	plowing	previous landuse
I	10658	5	948	4.6	gramoxone	yes	maize
II	0	44	4235	6.24	gramoxone & karmex	no	fallow
III	3977	68	1470	3.75	gramoxone	no	maize
IV	5639	70	292	0.49	2,4 D & karmex	no	maize
V	0	>10	484	3.37	2,4 D & 71 LS, kasagrin,gramoxone	no	maize

Besides a large difference in labor costs also a large difference in hours exists. The hours of farmer V are underestimated because it was impossible to locate him after he started working at a banana plantation. Farmer II used less labor for soil preparation but spend later more time in applying herbicides.

The use of herbicides for land preparation varies extremely. Farm II used more then three times as much herbicides as the other farms but was also the only one who sowed on previous fallow land. All the farmers with the exception of farmer V gave a second application of herbicides after 2 - 3 weeks.

Sowing

Sowing takes places after burning. The burning itself is often partial and incomplete. According to local custom the best sowing time is with rising moon. Maize seed was always obtained from the previous harvest (except for farmer II who bought certified seed). This enables farmers to save approximate 2100 colones per hectare (16 kg *133 colones kg^{-1}). Part of the better cobs of the previous harvest are stored for this purpose and are often dried in front of the house. Some farmers in the region are selecting and marking the better plants during the bending of the cobs (C.Calderon, pers.comm). Table 11 provides an estimation of the different planting densities. Fields are often quite heterogenous and large differences of planting distances are existing within fields.

Table 11. Planting densities in different maize systems.

farm	crop	planting distance	no.plants hectare	inter crop	planting distance	plants hectare
I	maize	0.50 * 0.75	53.000	cassava	0.50 * 0.75	53.000
III	maize	0.50 * 0.75	53.000			
IV	maize	0.50 * 0.66	40.000	palmheart	2 * 1	5.000
IV	maize	0.50 * 1.00	20.000	palmheart	2 * 1	5.000
VI	maize	0.80 * 5.00	2.500	pumpkin	4 * 1	2.500

Weed control

Weeds can be controlled manually or chemically, which takes less labor. Table 12 provides the number of manual weedings and the total hours spend per hectare. Only farm I and IV spend a considerable amount of time in manual weeding. Both farms also have intercrops between the maize. Weeding incidence and inter cropping seem to be related in this study although CATIE (1986) does not differentiate between the labor needs of maize-maize and maize-cassava cropping pattern. It was often mentioned that only 3-4 years ago manual weeding was more common than nowadays.

Table 12. Manual weeding in hours ha^{-1} $farm^{-1}$.

farm	week 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	total labor
I *										4			16	9	8						8	45
II									4													4
III																						0
IV *			1	10	9			1										1	17		4	43
V									16													16

* intercropping
week 1 is the first week in the year

The application of herbicides during the growing season varies considerable as shown in table 13. Generally, herbicides are applied directly before or after sowing. A second application follows a few weeks after sowing.

The initial amount of herbicides used is very varying. The total herbicide use is quite constant (5-8l). The labor spend in fumigation varies considerable. Partly because it wasn't always possible to separate the first fumigations from land preparation.

Table 13. Labor (hours/ha) and input use per ha in fumigation.

farm	week 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	22	total labor	herbicide use (l/ha)
I	8	3	6	2	3		3								5		29	6
II		44				9				26						16	94	16
III															1		1	5
IV		35			8	2	2						8	6			61	7
V	4					6		12									22	8
week 1 is the first week in the year																		

The most common used herbicides are Gramoxone, Karmix, 2,4D and mixtures of both. Farm II used exceptionally much herbicides and labor but was the only one who cultivated maize on previous fallow land. He had severe weed problems aggravated by sowing two-three weeks later than other farmers getting more drought problems which resulted in a poor stand, subsequent resowing and a late closing of the canopy.
Surprisingly no insecticides or nematicides were used by the sample farms although both uses were mentioned in other studies.

Fertilization and related yields

The use of fertilizer is very varied. The actual production has been calculated multiplying the number of bags with the dry weight per bag (25.3 kg) [9]. Table 14 provides the different applications, theirs costs and related yields per hectare.

Table 14. Fertilization, costs and related yields per hectare.

farm	I	III	IV	V
N (kg)	43	111	75	37
P2O5 (kg)	0	0	29	63
K2O (kg)	0	0	15	21
actual yield	2378	2698	3219	-
costs of fert.	3737	7462	9106	6741

In order to asses the sustainability of maize production on Parismina and Bosque soil the withdrawal of nutrients by maize has to be compared with the supply of nutrients. Figure 6 gives the nutrient cycle of maize (Rouanet 1987).

[9] First the total yield was establish using a dry weight of 40.2 kg bag^{-1} (Erenstein, 1988). After several discussions the calculation was changed. Dividing the total price per bag (503 colon) by the kg price of maize (both paid by the Consejo Nacional de Producion for 18% humidity). This resulted in a weight of (503/20 = 25.25 kg bag). The cob weight provide similar problems. In order to include the fresh harvested cobs in the total yield a weight of 200 grams maize per cob was used based on maize research in La Lucha by the university of Heredia. This estimation is probably too high. Using an average of 1.5 cob per plant and a density of 53.000 plants ha^{-1} creates an yield of 16.000 l kg ha^{-1}. A weight of 50 grams maize per cob resulting in a yield of 4000 kg ha^{-1} seems therefore more realistic.

The precipitation data were recorded at "La Selva" hundred km west of the Neguev (Bruynzeel 1990). Several "loss factors" as mineralization, leaching, runoff and the supply of minerals by the Parismina are not known. Soil fertility is more or less maintained, with regard to nutrient removal with a fertilization of roughly 75 kg N, 29 kg P_2O_5 and 15 kg K_2O (farmer IV). The sustainability of maize production with regard to declining organic matter or nematodes is not assessed but might be of equal importance.

Doblar

Doblar, the bending of the cobs, takes place from twelve to fifteen weeks after sowing. The upper half of the plants is bent to prevent rain from entering the cob.

Harvesting

Harvesting is done seventeen - eighteen weeks after sowing. Part of the maize along the Parismina had to be harvested in an emergency after inundations. The harvest is done by the farmers themselves and hired labor that gets paid for each bag filled with cobs. The harvest of maize was the only time when I observed women working in the fields.

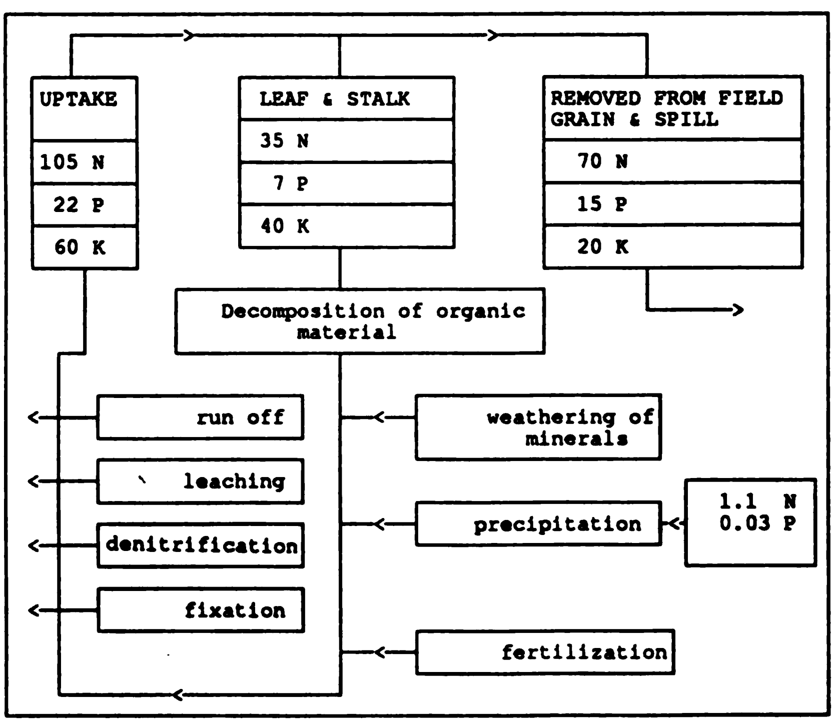

Figure 6. Nutrient cycle in kg of 1 hectare maize with a yield of 5000 kg $hectare^{-1}$ (Rouanet, 1987).

4.1.3 A comparison with other studies

In order to relate this study to other studies and to asses the validity of the obtained data an overview of the results of different studies is provided in table 15.

The CATIE-MAG data are from a CATIE-MAG study which assessed the present technology on small farms in Guacimo Pococi. An alternative cropping system for maize-maize and maize-cassava was developed and tested (CATIE, 1986). The data of the Banco Nacional are from an internal study of 1987 and the data of Brink are the combined data of two groups of farmers who used plowing or zero-tillage as soil preparation.

Labor

The labor hours per activity as found in the study have been corrected for missing data with the data of the CATIE study. The labor of farm I has been corrected for manual landpreparation. After correction, 270 hours are spend on average on a hectare maize with a standard deviation of 37 hours. Taking in account the differences in cropping systems and farming conditions this is a reasonable estimation.

Table 15. Labor hours,input use and outputs per hectare of the sample farms (I-V) and several maize studies (CATIE 1986, Banco Nacional 1987, Brink 1987).

Activity	I	II	III	IV	V	CATIE	Banco Nac.	Brink I	Brink II	MAG fert.
landpreparation	5	44	68	70	10	90	80	-	-	-
sowing	47	46	-	-	20	36	80	-	-	-
fertilization	17	4	13	30	6	18	16	-	-	-
weeding	16	12	-	58	-	0	16	-	-	-
app. herbicides	0	0	-	0	-	12	24	-	-	-
fumigation	29	94	1	28	22	0	16	-	-	-
doblar	11	-	-	25	-	24	24	-	-	-
harvesting	63	-	6	67	-	90	56	-	-	-
total	188	200	88	278	58	270	312	-	-	-
corrected total	273	314	196	278	252	n.r.	n.r.	-	-	-
Pesticides (l)	6	16	5	7	8	6	6	8	8	-
N (kg)	43	-	111	75	37	50	45	52	60	20
P2O5 (kg)	0	-	0	29	63	0	24	13	8	60
K2O (kg)	0	-	0	15	21	0	12	6	4	20
yield (kg)	2364	-	2540	3219	-	1500	2171	3144	3953	-
green maize (no.)	282	-	3175	0	-	0	0	0	0	0
total yield	2378	-	2698	3219		1500	2171	3144	3953	-
gross margin (colones)	18.866	-	50.115	32.334						

n.r. - not relevant

Pesticides

The use of pesticides expressed roughly in liters per hectare is quite constant (5-8 l). An exception is farm II (see also table 13). Surprisingly no insecticides or nematicides where used in maize cultivation at the five sample farms while their use was recorded in the other studies.

Fertilizer

The use of fertilizer is very varied as has been discussed before.

Actual yields
Actual yields of the sample farms are quite high and also higher than the Banco Nacional and CATIE studies. Brink (1987) recorded higher yield levels.
The high yields at the sample farms may partly have been caused by the extreme fertile soils, the excellent climate during this season in relation to other years and the year of data collection.

The gross margins per hectare vary considerable. The low Gross Margin of farm I with 18.866 colones per hectare is partly caused by the high costs of ploughing the field and the relatively low yield. The extremely high gross margin of farm III is partly caused by the high product value of green maize cobs used for consumption. Contrary to what was said by some farmers the selling of green maize can be more profitable than harvesting the grain and serve as a source of income during a slack period.

The overall data of this study are quite similar compared to the CATIE study and the Banco Nacional. However larger differences exists between labor hours allocated towards different activities and the use of inputs.

4.1.4 Labor input for maize

The average labor input for maize during the growing season has been calculated in order to support the modeling work at the Programa Zona Atlantica. The data were obtained from this study (mainly from farm I and V) and partly supplemented by the CATIE-MAG (1986) study. The results are presented in table 16. More information can be found in appendix X. The most important aspect of maize is the division of labor in two peak periods at sowing and harvesting. Crops as palmheart and plantain require continuous labor input throughout the production period.

Table 16. Labor input(hours) for 1 ha of maize.

week	land prep.	fumig-ation	sowing	fertili-sation	weed-ing	harv-vest	doblar	total
4	40	40						80
5			20					20
6			10	12	19			41
7		6						6
8		6						6
9-14								0
15		14						14
16						4		4
17							12	12
18							8	8
19							5	5
20					8			8
22						67		67
Total	40	66	30	12	27	71	25	271
week 1 is the first week in the year								

4.1.5. Factors influencing the choice for maize

Maize as cash crop is only cultivated in a few areas along the Parismina river. The first two kilometers along the river with considerable amounts of fertile soils are mainly used for pasture. Some cassava, pumpkin, yam and colocasia is also cultivated. Maize is abundant around the "village" of La Lucha but virtually nonexistent across the river. Maize fields are not distributed ad random on the same type of soil but are concentrated in blocks reflecting the limited influence of land qualities on land-use. Especially when land quality is not limiting land-use.
The choice for a crop is a combination of land qualities, the possibility and income from off-farm work, the availability of capital and the additivity of activities. Different combinations can lead towards the same land-use. Figure 7 shows the relation between the time spent on farming activities, capital and the resulting land-use. Table 17 relates the model to reality by applying the criteria to several sample farms in a matrix.

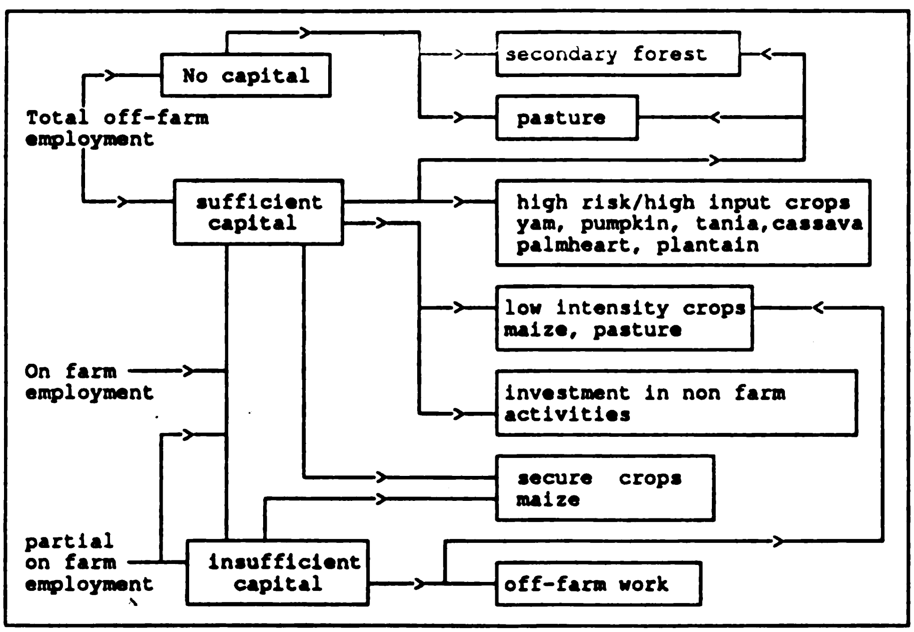

Figure 7. Different crop choices and their relations.

Table 17. Different combination possibilities.

Employment	Sufficient capital	Insufficient capital
Total off-farm employment farm number	high risk/ high input crops non farm act. low intensity crops VII	low intensity crops pasture, forest XI
Partial on-farm employment farm number	maize non farm act. IV,VII	maize I
Total on-farm employment farmnumber	high risk/ high input crops IV	pasture, forest II

Type of employment

The first factor of this model is the time spend on farming activities. This is done by classifying three different categories: total off farm employment, partial on farm employment and total on farm employment.

The group with total off-farm employment exists of three subgroups.

1) Farmers employed at banana plantations and ranches earning a more or less constant wage. For instance farmer V.
2) Farmers operating small enterprises with a fluctuating income. For instance farmer III who is selling and buying plantains, oranges etc.
3) Farmers not living at the farm using the farm as an investment or second home. Decisions regarding the farm are not always taken with the farm as departing point.

This classification does not imply that all farmers are able to chose for a on- or off-farm employment. The availability of capital and social networks are determining their employment options.

Capital availability

Capital is used in the model in the form of money but also in the form of land quality and quantity. Capital in the form of money is crucial for the operation of more intensified cropping systems. If no money is available the land-use will be restricted to pasture or secondary forest. If money is available, high risk, high input crops are an option. Credit regulations often also limit the use of soil, thus restricting the cropping pattern. For instance, cacao credit regulations forbid the cutting of cacao. Unpaid cacao credits are therefore one of the reasons why a present low yielding crop like cacao is not being substituted by higher yielding crops. Informal credit has not been assessed in this study but is an important aspect of financing crops and overcoming cash flow problems.

Capital in the form of land quality and quantity is partly determining the area and profitability of crops. Thereby determining the cropping pattern and farming system. Soil fertility is so poor on the Neguev soil that maize cultivation for commercial purposes is not possible.

Full time farmers with sufficient capital can also cultivate high risk, high input crops. Farmer IV provide a example. Some of the farmers do have sufficient capital to cultivate maize but not enough to risk crops like palmheart or plantain. They would also lose their possibility to work for several months outside if they would opt for these crops.

Activity/land-use options

Several activities/land-uses are resulting from the combination of labor availability and capital as shown in figure 7. They can be divided in five main groups.

1) Low intensity land-uses, demanding a relative small labor and capital input. Examples are: secondary forest and pasture.
2) High risk & high input crops. Crops demanding high often long term investments such as plantain and palmheart or have fluctuating market prices.

3) Secure crops. Crops with a secured market and price. Maize has is such a crop, but only if it is meeting quality standards. Contract growing is also an option to obtain a more or less secure income from crops.

4) Off-farm work, which does not require much capital and can provide a secure and direct income source.

5) Non-farm activities such as selling cattle. This does often require a certain amount of capital.

The same land-use can be the result of different combinations of labor and capital as is shown in table 17. Pasture for instance is resulting from sufficient capital and total off-farm employment as a low intensity crop but also from total on-farm employment with insufficient capital.

4.1.6 Maize as an intermediate choice

The choice for a crop is a combination of land qualities, the possibility and income from off-farm work, the availability of capital and the additivity of activities. Maize is easy to combine within a range of farming systems with different amounts of capital and different objectives.
It can be cultivated totally with off-farm labor. Thereby making it a suitable crop for totally off farm working land owners with sufficient capital. It can also be cultivated with hired labor during the peak periods of sowing and harvesting. The farmer and or his household members are then able to work off-farm work between sowing and harvesting when maize requires little labor. The least capital intensive option for maize cultivation is when labor is only supplied by the farmer. This option restricts the maximum area of maize towards roughly a hectare since he is not able to provide sufficient labor during the harvest.

This wide range of optional cropping systems within the option for maize makes maize a very flexible crop and attractive for a wide range of farming systems even when farmers objectives and capital are very different.

4.2 PALMHEART

Peijebaye (*Bactris gasipaes HBK*) was already cultivated in Costa Rica in pre-colombian times (Corrales & Mora Urpi, 1990). Excavations around Guacimo, close to the Neguev, exhumed carbonized peijebaye seeds of around 300 B.C. Peijebaye was part of an agricultural system based upon peijebaye, cassava and avocado extended with maize and other seed crops between 300 B.C. and 300 A.C. This system existed until the arrival of the Spaniards. They encountered in 1575 plantations up to 50.000 palms which supplied the major staple food in Talamanca.

Commercial cultivation of *B. gasipaes* for palmheart started only recently in Costa Rica. Around 1974 only 140 hectare were cultivated. The area is now approximately 2700 hectare (Programa nacional,1989).

The majority of palmheart is grown in agro-industrial farms with several hundreds hectares of palmheart. These companies play, besides the extension services, a large (informal) role in knowledge transfer. Small farms started participating in palmheart cultivation stimulated by IDA programs and credits. Palmheart is with pineapple and passion fruit one the few crops who tolerate the high acidity, low pH and phosphate levels of the Neguev soil.

Palmheart production starts from the second year onwards, coming in full production around the fourth year with annual yields up to 10.000 palmhearts a hectare (Programa Nacional,1989) which provides a gross income of 230.000 colones per hectare. This explains why palmheart farmers are able to make a living even on the poor Neguev soil.

4.2.1 Palmheart in the sample

Of the selected farms, five cultivated palmheart. The division in hectares and ages is shown in table 18. The ages of palmheart were recorded in December 1990. All the palmheart is grown on Neguev soil with the exception of farm IV.

Table 18. **The division in hectares, ages and previous land-use of palmheart plots in the sample.**

farm	age 4	2	1	0.5	earlier land-use	intercropping
IV				3	maize	maize & plantain
VIII	1				pasture	-
IX	2		1	1	cacao/forest	beans (small part)
X		0.7		1.4	pasture/forest	cassava,maize &beans
XI				0.3	pasture/cacao	maize & beans

According to the stratification base, palmheart was present on twenty-two farms in the Neguev (see also appendix I). Three of these farms cultivated palmheart on fertile soils A large part of this palmheart is cultivated around El Peije where a few farmers have organized themselves in a palmheart cultivator group.

4.2.2 Palmheart cultivation techniques

Only a brief review of the different techniques is provided here. More information about palmheart can be found in De Haan et al (1990). Appendix XIV includes a list of cultivation techniques and terms used by farmers.

Sowing and establishment
Plants are sown from seeds in nurseries which are established either on the ground (in poly-bags) or on a platform (without poly-bags) above the ground. Getting sufficient seeds is sometimes a problem. The young seedlings are transplanted in poly-ethylene bags. The bags are moved to the field after a few months. This transplanting system requires the farmer to establish his own nursery since transportation of the poly bagged plants is bulky and expensive. Transplanting plants without using poly bags was earlier done with poor results.

The establishment of palmheart is difficult. The best planting time is between March and November when rain is sufficient. The most dramatic failure I came across was a caretaker who planted and replanted 10 hectares three times. Palmheart is planted in rows with 2 meters between rows and 1 meter between plants. Older plantations have sometimes row distances of 3 meters with 1 meter between plants resulting in a density of 3333 plants ha^{-1}. The optimal density for maximum production is still discussed by the farmers.
Extrapolating the planting densities of commercial plantations towards the poor Neguev soils is probably not realistic since the cropping system is totally different. The agro-industrial plantations are using higher levels of fertilizations and have a higher harvest frequency. The optimal density has probably a large range. Palmheart compensates a suboptimal spacing better than non suckering palms. The root system will probably also adapt towards different spacings like oilpalm (*Elaeis guineensis*). The genetic background of the seeds is often diverse and that also contributes to a wide optimal spacing range (Wood, 1990).
Palmheart is frequently intercropped during the first year with beans, maize and cassava varying from a few rows for self sufficiency, towards a complete closed field.

Weed control
Weed competition is fierce in the first year since no shade and mulch decreases the weed incidence as happens in older plantations. Weed control is done chemically but palmheart is extremely sensitive for gramoxone and especial young palmheart is often damaged by fumigations. Up to 16 liters gramoxone (2.9 l paraquat ha^{-1} $year^{-1}$) are used.

Intercropping provides a partial solution for the weed problem by decreasing the development possibilities for weeds and providing some shade for the young palmheart. Both intercrops and weeds compete with palmheart for nutrients and light but competition by intercrops is less fierce than most weeds. The suitability of intercropping depends also on the age of palmheart and the crop combination. Mulching starts after the second year when the harvested palmleaves become available. More shade is also provided by the taller palmheart after the second year. Intercropping does therefore not occur after the second year with the exception of a single fruit tree.

4.2.3 Nutrient balance palmheart

Figure 8 gives an estimation of nutrient removal by one hectare palmheart with a production of 4800 palmhearts per year. Herrera (1989) obtained these data with one hectare palmheart with 3200 palms and a production of 9600 palmhearts a year. These data are, divided by two order to asses the lower production situation in the Neguev. This assumption is only valid when a fifty per cent production decrease is equally reflected in a fifty per cent production decrease in leaf and leaf base parts. Precipitation data were measured in La Selva (Bruynzeel, 1990). Information about leaching and organic decomposition is lacking. Leaching has to be large considering the high permeability of the soils and high rainfall. Other losses from the system such as denitrification are also large. The denitrification level in palmheart nearly equals banana plantations and is among the highest data measured in crops in present literature (L.Bouma, pers.comm.).

Present fertilization levels of farms range from 118 kg N^{-1} ha^{-1} $year^{-1}$ to 495 kg N ha^{-1} $year^{-1}$, in most cases also with an additional phosphate and potassium fertilization. Data of present fertilization are provided in appendix XI and table 24. Fertilization levels on the sample farms are much lower than on the agro-industrial farms, where applications of 700 kg N^{-1} ha^{-1} $year^{-1}$ are common.

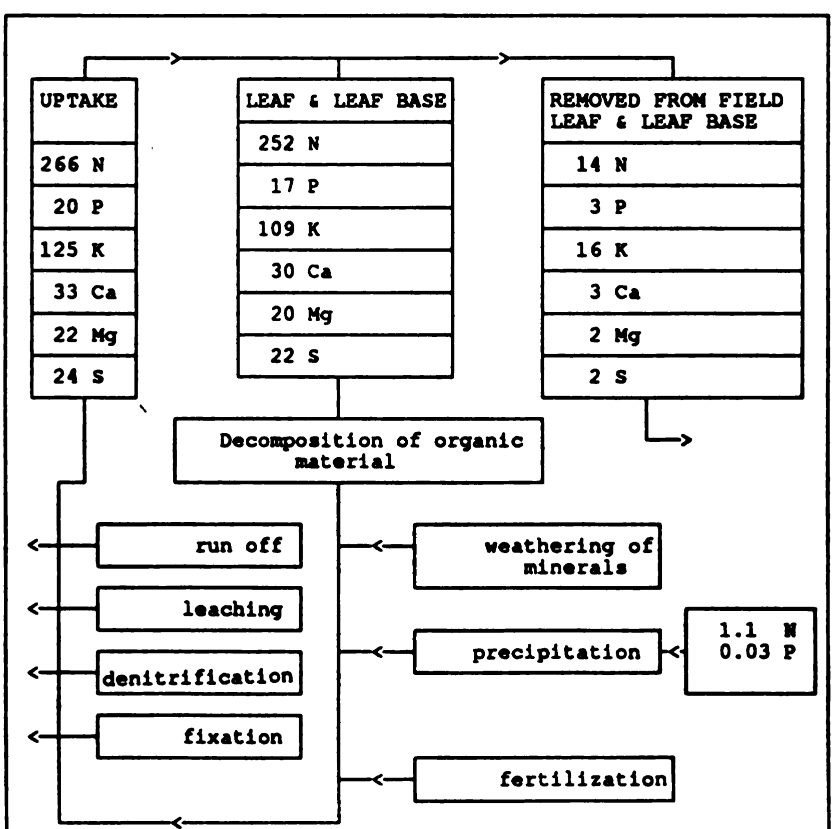

Figure 8. Nutrient removal by one hectare palmheart with a yearly production of 4800 palmhearts (Herrera, 1989).

4.2.4 Harvesting and marketing

Harvesting is done in the early morning. The palmheart is cut, the outer leaf sheaths are removed and the palmheart is transported to the roadside where it is protected from the sun by leaves. Palmheart is mostly sold to brokers. Prices paid by one of them were considered too low by the farmers and they organized a different contract. Prices increased with this new contract but the quality of the palmheart had to be better and harvesting became more time consuming since the palmheart had to be delivered free from mud.

4.2.5 Quantifying operations and outputs

For each farm a review of the activities on a weekly basis has been compiled. These data are incorporated and reviewed in appendix XI. Appendix XI also provides a list with terms used by farmers to describe activities. Table 19 shows the labor use in palmheart cultivation per hectare as found in the study on the different farms and studies conducted by other institutions. Comparing the sample farm data with the data of the Programa National, IDA (only the second year deviating from the Programa Nacional) and the Banco Nacional shows large differences in labor hours, input use and output.
Strange enough does the Programa Nacional not account for the changing labor needs by subsequent higher yields. Also the large number of hours spend removing suckers is much higher than in other studies. Extreme large differences exist between the various studies. This is partly caused by the difficult separation of activities. Partly also by the interrelation between activities. Many hours spent in removing suckers might combine with less fertilization.

Table 19. Operations (hours) and outputs per ha, of the sample farms and several other studies.

Activities	IV	XI	X	XIII	IX	PN	PN	PN	PN	BN	BN	BN	BN
Palmheart age (years)	1	1	1-2	4	1-4	1	2	3	4	1	2	3	4
Land preparation						64				120			
Drainage										56	16	8	40
First fumigation						48				32			
Pruning (acordonar)	-	-	-	202	63								
Sowing	8	-	97	96	24	392				288	32		
Harvesting	4	-	52	86	130		80	80	80		232	431	487
Removing Suckers	4	143	10	96	12	32	352	352	352	12	36	24	56
Fumigation	20	473	123	77	102	96	96	96	96	24	32	48	32
Clearing (ordenar)	-	-	-	51	4								
Fertilisation	29	176	-	2	39	96				48	32	48	64
Weeding	98	1221	26	39	22	96				160	96	96	
Removing leaves	49	-	-	33	0					12	36	24	56
Plant protection						8	8	8	8	32	16	32	
Total	212	2013	307	680	397	824	528	528	528	752	512	679	735
Pesticide use (l)	3.0	68.6	21.4	11.0	9.0	18.0	12.5	12.5	12.5	18.0	15.0	10.0	7.0
Fertilization (kg)													.
N fertilisation	118	495	0	283	286	228	348	348	348	100	248	297	120
P2O5 fertilisation	53	282	0	99	0	53	26	26	26	69			359
K2O fertilisation	26	95	0	83	0	55	77	77	77	23			120
Ca fertilisation						5	6	6	6				
Leaf fertilisation						3				3			
Yield level	86	0	4154	2685	6431	0	4000	8000	10000	0	2333	4333	4900

PN = Program Nacional (Programa Nacional Sectorial, 1989)
BN = Banco Nacional (Banco Nacional, 1987)

4.3 PLANTAIN

Plantain (*Musa AAB*) originated in Asia and was introduced into tropical America soon after the discovery of the New World (Purseglove, 1988). The total production area in Limon province was 4678 hectare divided over 1716 farms (DGEC, 1988). This area is mainly concentrated in the southern Talamanca region and smaller areas along the Parismina and Chirripo river. Previous research concentrated on plantain production in Talamanca (Roseboom et al, 1988).

There is some 10 - 20 hectare plantain production in La Lucha and Santa Rosa. Some banana companies are starting with out-grower programs, try to buy land. This might change land-use in La Lucha considerably in the next years. Four farmers in the sample cultivated plantain. One parcel was not yet in production, two parcels were smaller than 0.25 ha and one parcel came in full production during the research. The presented data are all based on this parcel and obtained with record keeping by the farmer.

4.3.1 Cropping system

This parcel at farm number IV was a former cacao parcel with plantain as shade. About 1.5 ha was transformed into a plantain-palmheart intercropping system. Part of the remaining cacao was cleared later to expand the plantain production. Besides plantain some older Laurel (*Cordia alliodora*) trees were present. This parcel was still pasture before 1978. A part of the cacao was cleared and planted with plantain during the research. Pumpkin was grown on mounds besides the new plantain.

The plantain is spaced approximately four meters apart in a square design. Two palmheart rows are planted between the plantain rows. The distance between palmheart rows as two meters and the distance between palmheart in a row one meter. This provides a normal planting density of 5000 palms per ha combined with 625 plantains per ha. The average spacing for plantain is about 3-3.5 meters (Purseglove, 1988) resulting in a density of 950 plants per hectare.

The plantain will gradually disappear when the palmheart comes in production. This system is protecting the young palmheart from sun during its initial development and provides as a system a higher net present value than palmheart can achieve alone. It is yet unclear how many plantains can remain in a mature palmheart field.

The combination of palmheart and plantain is rare in the Neguev. Both crops start yielding relatively late and both crops need an high initial investment. By combining the crops the advantage of combined operations remains, but a different combination with for instance maize would provide an earlier return on investment, without capital destruction.

This particular farm is special in the sense that capital is sufficiently available to risk experimentation with an unknown system. The soil is fertile and plantain seedlings are present at the parental farm. There is a considerable exchange of labor and capital between the parental farm and this farm.

Using the settlement plot as unit of analysis for this farming system is therefore arbitrary. It is expected that palmheart and plantain will provide a combined higher return, diversifying the farm and postponing the option to concentrate on palmheart or plantain cultivation. The costs of this option are for this farm relatively low, since seed and labor are partly provided by the parental farm.

4.3.2 In- and output use

The different in- and outputs have been mentioned separately in table 20. Table 21 is providing the weekly in and output data for the whole farm area. Only the plantain component of the cropping system is evaluated here but fertilizer and herbicides used for the palmheart grown in combination with plantain are also included. This has been done by separating the palmheart inputs according to the area.

Allocating inputs and outputs towards an specific crop or area is difficult due to the integration of crop systems. Output and expected output of this system can be divided in six components:
- plantain bunches from the old cacao shade plantains
- plantain bunches from the new established plantation
- cacao
- future output from the laurel trees
- future output from the pumpkin
- future output from the palmheart

Table 20. Inputs and outputs per week in plantain production.

Weeks	quantity	unit	product	quantity	unit	product	quantity	unit	product
5									
6									
7	129	kg	Urea	100	bunches	plantain			
8	2.14	l	Gramoxone	50	bunches	plantain			
9				14	bunches	plantain			
10				10	bunches	plantain			
11	0.76	l	Gramoxone	86	kg	12-24-12	53	kg	Counter
12	12	kg	Counter	91	bunches	plantain	0.3	l	Roundup
13									
14				91	bunches	plantain			
15									
16	86	kg	Urea						
17	86	kg	Urea	25	bunches	plantain			
18	43	kg	12-24-12	35	bunches	plantain	0.2	l	Roundup
19			new parcel	20	bunches	plantain	0.2	l	Roundup
20									
21				45	bunches	plantain			
22									
23				30	bunches	plantain			
24				51	bunches	plantain			
25									
26				50	bunches	plantain			
27									
28									

week 1 is the first week in the year

Table 21. Inputs and outputs in plantain production. February - July 1990.

products	quantity	per ha
gramoxone	2.9 liter	1.93 l
roundup	0.7 liter	0.47 l
counter	65 kg	43 kg
urea	172 kg	115 kg
12-24-12	46 kg *	92 kg
plantain	612 bunches	408 bunches
* new parcel		

4.3.3 Plantain cultivation activities

Cultivation techniques are already qualitatively described by Roseboom (1988). The data of this study are presented in table 22 to quantify the existing information. A large problem in allocating hours to activities is the overlapping of activities. Suckers might be removed while at the same time old leaves are cut. The total use of labor in plantain is at this farm 369 hours in 22 weeks, excluding land preparation and sowing. This are 609 hours ha^{-1} yearly.

Table 22. Activities (hours) per week in plantain production.

Weeks	Activities Land-prep.	Fumi-gation	Suppor-ting	Clear-ing	Weed-ing	Removing Suckers	Har-vest	Fertili-sation	Removing Leaves	Total
5						32.5			32.5	65
6										0
7							5	9		14
8		15			36		5		9	65
9					12		1.5		4	18
10							7			7
11	97	5				5			8	115
12		17	5			30	5			57
13										0
14							5		5	10
15						8				8
16										0
17							2	7		9
18		2					3	3		8
19		2					2			4
20										0
21							3			3
22										0
23					5		2			7
24				21		18	4		5	48
25				8		8			8	24
26	52						4			56
27	33									33
28										0
	182	41	5	29	53	102	49	19	72	551

week 1 is the first week in the year
data are not divided by acreage

Sowing and land preparation
A total of 182 hours were spent in sowing and land preparation. The data have been separated from the other data in order to obtain a clearer impression of the in and outputs on an established plantation. Landpreparation included the cutting of the remaining plantain and cacao. The digging of holes and planting of the seedlings.

Weeding
Fifty-three hours have been spent in manual weeding, cutting weeds with an machete.

Fumigation
Forty-one hours have been spent in fumigation, comprising the use of herbicides as well as nematicides. No fumigation took place against leaf spot (*Mycosphaerell musicola*). No plastic bags were used to protect the bunch in an early stage.

Clearing
Twenty-nine hours have been spent cleaning and clearing the circle around the plantains (rodajear).

Removing suckers
Hundred-two hours have been spent removing suckers. Ideally 2 suckers will remain besides the oldest plant.

Removing leaves
Approximately seventy-two hours are spent removing leaves.

Supporting
This includes supporting the bunches with bamboo sticks. Some bamboo has been sown in order to supply future sticks.

Fertilization
Ninety-two kilograms of 12-24-12 were applied. This is equivalent to 11 kg N, 22 kg P_2O_5 and 11 kg K_2O. Removal of nutrients by a 25 ton banana crop is in the order of 17 28 kg N, 6 -7 kg P_2O_5 and 56-78 kg K_2O yearly. The applied fertilization on a yearly basis is at a low level especially regarding loss factors.

Harvesting
Nearly fifty hours have been spent in harvesting. Some of the records show the actual time spent on harvesting, two or three hours per harvest while others also incorporate time spent in marketing the bunches.

5. FARM ECONOMICS

5.1 Introduction

The previous chapter quantified the in- and output use on crop level. This chapter describes and specifies the gross margins and labor use on farm level. This information forms the basis of a linear model which will be described and compared with the actual situation.

5.2 Total gross margins

Figure 9 depicts the gross margins of the sample farms from January till June 1991. The gross margin has been calculated as the financial yield of a crop or its components, minus the hired labor costs and other input cost such as fertilizer and herbicides. Family labor is therefore not included as a cost in this gross margin. The gross margins per activity per farm are further elaborated in appendix VIII.

Figure 9. Gross margins of the sample farms

Gross margins vary between minus 94.000 colones[10] and plus 290.000 colones for a 5 month period. The minimal income level should be between 75.000 and 100.000 colones estimating that an average family needs 15.000 - 20.000 colones for food and clothing monthly.

[10] One U.S. dollar is approximately 130 colones. Annual inflation is around 30 %.

Most of the farms do reach this income level, with the exception of farm II, VII and X [11].

5.3 The composition of the gross margin

Table 23 shows the composition of the total gross margin for each farm, based upon appendix VIII.

Table 23. Gross margins per farm and their components

Farm	maize	pumpkin	cassava	cacao	coconut	plantain	off-farm	palmheart	pineapple	pasture	charcoal	Total
I	60183	83958	6355	-2200								148296
II				5956			41400					47356
III	248569			-1189	13920							261300
IV	73399		31964	20569		16289	0	-30506				111715
V	196317						108000					304317
VI		88941		-1306			5700					93335
VII			-1992						-63558	-28940		-94490
VIII							560	41134		17000	20400	79094
IX			-2131				127211	172434		-6440		291074
X							36720	9285				46005
XI							2131	-9249		75000		67882

Maize and pumpkin are important cash crops on fertile soils. Palmheart is an important cash crop on poor soils. Off-farm work related to agricultural production is important at most farms. The contribution of cassava to the gross margin is varying. This is mainly caused by the recording of only a part of the crop cycle and the extreme variation in cassava prices. The contribution of cacao to the gross margin is generally small or negative. The large differences are caused by yield differences and labor input differences. The negative results of pineapple are caused by the high establishment costs without yet a harvest. Plantain production was just starting at one farm and will become more profitable. Charcoal was produced by one farmer.

5.4 Restrictions of the gross margins

The presented gross margins do not take into account.
The whole crop cycle for long duration crops. The research covers only January - May. In the case of longer duration crops such as pineapple and cassava input costs are incorporated while no output was realized. This is the main reason for the dramatic negative gross margin of farm VII where the costs of establishing pineapple where high and virtually no other farm activities where developed.

Costs of (often informal) credit. Informal and short term credit plays an important role in the rural economy (pers. comment W.Brooijmans). The amount, kind and terms of credit were not incorporated in this study.

[11] Farm II is poor, but an expected maize yield of roughly 30.000 colones is not included in this gross margin. Farm VII and X are obtaining the majority of their income from off farm work excluded in these gross margins.

The actual cash flow at a farm. Incomes from agriculture are surprisingly high in this study. But the actual amount of received cash is more crucial for the farmer. The value of several harvests are included in this gross margin but not always already received by the farmers.

Off-farm work by sons or daughters. All the sons older than 15 - 18 years work off-farm. At banana estates, palmheart plantations or cattle ranches. It is unclear in what amount their income contributes to the farm-income. Joint cultivation of crops by family members or friends is quite common, thereby sharing or separating labor and capital provision.

Off farm work not directly related to agricultural production. This includes small enterprises which were not included in the study. Farmer VII is a cattle merchant while his wife has a shop [12]. Farmer III transports and sells plantain, oranges etc. on farmers markets in Cartago and Heredia. Farmer X worked a few months in the afternoons in a local store.

5.5 Gross margins of different cropping systems.

Table 24 shows the wide range of gross margins and labor requirements of different cropping systems based upon appendix VIII. Maize-cassava has got the highest gross margin ha^{-1}, followed by pumpkin. Cassava has got the highest labor requirements caused by the labor involved harvesting cassava. Off farm work has got the highest gross margin per hour. Table 24 demonstrates also that cultivating crops still has an attractive gross margin per hour.

Table 24. Gross margins of different cropping systems.

Crop combination	Gross Margin (per ha)	Labor hours (per ha)	Gross Margin (per hour)
maize (green maize)	57.024	196	291
maize cassava (9 colon/kg) cassava (3 colon/kg)	32.800 63.500 500	188 362 362	174 175 1
maize palmheart	46.466 -5.149	278 103	108
pumpkin	61.212	240	255
Poor soil cassava (9 colon/kg) cassava (3 colon/kg)	 500 -11.500	 320 320	 1 -36
pasture	20.000	40	500
palmheart	49.942	255*	196
* average between farm VII and IX			

Other activities		hours	Gross Margin (per hour)
charcoal		1	74
off-farm banana plantation*		1 1	90 156

[12] The negative gross margin of this farm is caused by the exclusion of off-farm work, the establishment costs of pineapple (82.500 colones) and drainage construction in the pasture (24.000 colones).

```
* based on 56 hours a week and
  15.000 colones every 14 days.
  Cassava yield on fertile soils = 9000 kg/ha
  Cassava yield on poor soils    = 2000 kg/ha
  Input costs of cassava cultivation = 17.500
                  (MAG data from IDA settlement Agrimaga)
  All other figures based on appendix VIII.
  Gross margin = financial yield - input cost
  excluding hired labor
```

5.6 Labor use

5.6.1 Labor use

Figure 10 depicts the labor use of the sample farms from January till June 1991. Labor hours are not differentiated for task of person. The same weight is allocated to an hour maize harvesting by a thirty-five year old person or an hour spraying by a twelve year old person.

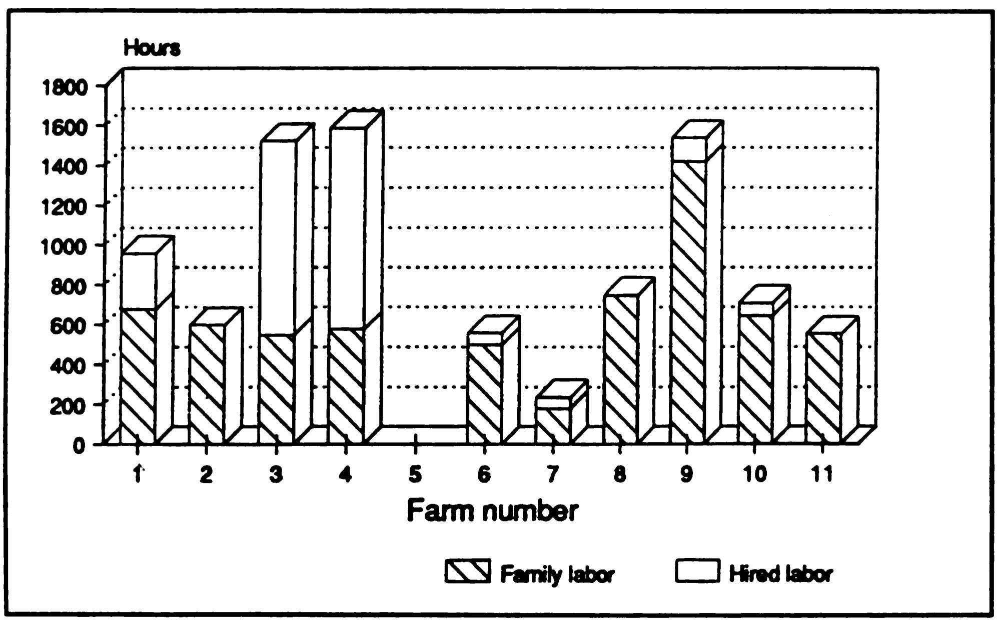

Figure 10. Labor use of the farms.

Table 25 provides the background data for this figure also indicating the contribution of different crops towards the labor use. These data are closely related to crop growing stages. Including a month more or less with or without the harvest of a crop can completely change the assessment. However the period January -May covers exactly the maize season thereby alleviating these problems partly. Farm V has been excluded since data were incomplete.

The total amount of labor used ranges between 235 and 1587 hours. The amount of family labor used is between 180 and 801 hours. The total amount of off-farm work by various family members is not included in these figures. Calculating an average amount of used labor per farm is therefore not appropriate also considering the wide range of strategies between farms.

Farms I, III and V all located on fertile soil used more hired labor than the farms located on poor soils or with small amounts of fertile soils. This is partly caused by the high peak labor demand of maize.
It seems logic to assume that labor is hired per hour of 6 hours when there is a demand. This assumption is not valid at farm III, IV and XI where hired workers are regularly employed. Sometimes work has to be found for them and the output of this labor can be substantially lower because the labor is already available. This explains the high laboruse in a low yielding crop as cacao at farm III.

Table 25. Labor use per activity per farm divided into family and hired labor.

Farm	maize		pumpkin		cassava		cacao		coconut		plantain	
	F	H	F	H	F	H	F	H	F	H	F	H
I	469	127	57	54	100	66	50	15				
II	206				68		46					
III	261	458			48	96	142	190	61	222	36	8
IV	176	403			66	224	94	51			150	115
V												
VI			168	58	98		100					
VII					98							
VIII												
IX					42							
X												
XI												

F = Family labor H = Hired labor

Farm	palmheart		pineapple		pasture		charcoal		Off-farm	Sub total		Total
	F	H	F	H	F	H	F	H	F	F	H	
I										676	262	938
II									278	598		598
III										548	974	1522
IV	90	218								576	1011	1587
V												
VI							57 *		76	489	58	557
VII			66		30	55	6 *			180	55	235
VIII		274			25		439	4	7	745	4	749
IX		570	118		189				617	1418	118	1536
X		122	65		40		22 *		459	643	65	708
XI		220			276		15 *		42	552		552

F = Family labor H = Hired labor * Other crops

5.6.2 Used labor compared with available labor

Table 26 has been compiled to compare the use of labor in agricultural activities on the farm with the availability of labor. Off- farm work is therefore excluded. The availability of labor has been calculated as the number of weeks (twenty) multiplied by five (days) again multiplied by seven (hours). This figure has been multiplied with the number of males above sixteen present at the farm while males from twelve to sixteen are accounted for only twenty per cent. It is assumed that women are not involved in agricultural work in the cash crops and pastures. This provides seven hundred available working hours per worker at the farm during a five month period.

Table 26. Used labor and available labor per farm.

Farm	Used labor (hours)			Available labor (hours)
	Sub total F	Sub total H	Total	Family
I	676	262	938	2100
II	320	0	320	700
III	548	974	1522	1400
IV	576	1011	1587	700
V	-	-	-	-
VI	423	58	481	2100
VII	180	55	235	840
VIII	738	4	742	1400
IX	801	118	919	840
X	184	65	249	2800
XI	511	0	511	700

F = Family labor H = Hired labor

It can be concluded that there is (with the exception of peak periods) no structural labor shortage at the farms. The extensive land-use is therefore unrelated towards a labor shortage on the farms.

5.7 Optimising farm production

5.7.1 Introduction

A linear model has been constructed in order to determine the profit maximizing combination of farm enterprises. This model contains several different possible farm activities, their gross margin per ha, their resource requirements and the constraints, limiting activities. The model is determining the profit maximizing combination of feasible activities with respect to the fixed constraints. The eventual combination of activities depends on the number of labor hours and capital needed.

5.7.2 Used variables in the model

Activities
Twenty-four different activities are distinguished in the model. The gross margins and labor requirements are based on table twenty six and appendix VIII. The estimation of capital is based on the direct starting costs of a crop ha^{-1} and the costs of hired labor in the first half year.

The allocation of the net present value to an activity in the model has been done with the expected net present value over a four year period. Longer term profits of crop combinations are then also included in this value. A four percent interest rate over six months has been used to calculated the net present value. This rate is more or less in accordance with the rate on a dollar account. It has been assumed that there was no inflation and the input-output ratio remains constant. The calculations, including the technical parameters such as yield are shown in appendix XII. The results are presented in table 27.

Table 27. Net present value, capital and labor requirements of several cropping systems over a five year period.

Code	Crop combination	% hired labor	NPV 4 %	Labor 1 year hours	NPV/ labor	Capital (colones)
MAI00	Maize, grain & green maize	0	317921	376	845.53	1470
MAI04	Maize, grain & green maize	40	267248	226	1184.6	9310
MAI08	Maize, grain & green maize	80	216576	75	2879.9	15680
MAC00	Maize - cassava	0	222269	550	404.12	11470
MAC04	Maize - cassava	40	148668	330	450.51	18990
MAC08	Maize - cassava	80	75068	110	682.43	26510
MAP00	Maize - palmheart	0	383408	715	536.23	1470
MAP04	Maize - palmheart	40	302620	429	705.40	15750
MAP08	Maize - palmheart	80	221832	143	1551.2	30030
PUM00	Pumpkin	0	412132	480	858.60	13000
PUM04	Pumpkin	40	347497	288	1206.5	22600
PUM08	Pumpkin	80	282863	96	2946.4	32200
PAS	Pasture	0	134655	40	3366.3	0
PAL00	Palmheart	0	336247	510	659.30	0
PAL04	Palmheart	40	267573	306	874.42	10200
PAL08	Palmheart	80	198899	102	1949.9	20400
PNP	Palmheart new poor soil	0	110351	752	146.74	25000
PNF	Palmheart new fertile soil	0	211752	752	281.58	25000
CAR	Charcoal	0	498	1	498.22	0
OF 1	Off farm work	0	673	1	673.27	0
OF 2	Banana plantation	0	1050	1	1050.3	0
PLA00	Plantain	0	190233	735	258.82	20000
PAL04	Plantain	40	91127	441	206.63	34720
PLA08	Plantain	80	-7979	147	-54.27	49440

Constraints
The constraints limiting the level of activities are shown in table 28. The labor constraint has been set at 1800 hours $farm^{-1}$ $year^{-1}$ based upon the survey labor data. The land area at 15 hectares, representing a normal size in the settlement. Capital has been set at 100.000 colones or nothing. The last situation being a real situation as encountered during the stratification.

The fertility is set at 1 or 0 per hectare, representing a fertile soil (1) or a poor soil (0) as has also been done by Marten and Sancholuz (1982). Maize, plantain and one of the palmheart options are restricted to the fertile soils. An other option would have been to distinguish more activities and create different gross margins for crops on different soils. The location has been set at a non restrictive level. It can be lowered, thus reflecting the fewer opportunities farmers have at isolated locations. The pasture, charcoal, pumpkin and PAL (existing palmheart) are all restrictions following present land-use or market restrictions (pumpkin).

Table 28. Constraints incorporated in the model.

labor	≤	1800	hours	charcoal	=	0	binary variable
land	=	?	ha	pumpkin	≤	2	ha
fertility	=	0	units	PAL area	=	?	ha
location	≤	30	units	OF 1	≤	?	hours
pasture	≥	0	ha	OF2	≤	?	hours
capital	≤	?	colones				

OF1 is the restriction on wage labor work. It can be a total restriction when the farmer is not able to work elsewhere or a partial restriction since it would be difficult to find a full time occupation as wage laborer for four years. The constraint on OF2 (working at a banana plantation) can be imposed when the farmer should not be able to work at a plantation.These data are the basic inputs of the linear programming tableau. The tableau and a part of the algebraic version of the model is shown in appendix XIII.

5.7.3 The results of the model

Table 29 shows the results of the model using different restrictions and indicates the reactions of the farming system towards different constraints.

Table 29. Performance of different farming systems with different constraints.

Farm	Fert-tility	Capi-tal (*1000)	Off farm	Palm-heart	Farming system & income (*1000) over a 4 year period	
1	0	0	no	0	15 ha pasture	2019
2	0	100	no	0	15 ha pasture	2019
3	0	100	yes	0	15 ha pasture 1200 hours OF 2	3279
4	0	100	yes	1	14 ha pasture 1 ha PAL08 1138 OF 2	3278
5	0	0	yes	1	14 ha pasture 1 ha PAL00 730 hours OF 2	2987
6	15	0	no	0	15 ha pasture	2019

7	15	100	no	0	3 ha MAI00 6 ha MAI08 6 ha pasture	3054
8	15	100	yes	0	6 ha MAI08 9 ha pasture 970 hours OF 2	3560
9	15	100	yes	1	9 ha pasture 5 ha MAI08 1 ha PAL08 955 hours OF 2	3502
10	15	0	yes	1	14 ha pasture 1 ha PAL00 730 OF 2	2987
11 30 ha	30	100	yes	0	24 ha pasture 6 ha MAI08 370 OF 2	4950
12 30 ha	30	100	no	0	23 ha pasture 1 ha MAI00 6 ha MAI08	4756
13 30 ha	0	100	yes	0	30 ha pasture 600 hours OF2	4668

Surprisingly incomes are not restricted by the level of soil fertility when there is no capital and no off-farm work. The land-use will become pasture as farm model VI and I are indicating.

Fertility becomes important when there is sufficient capital to exploit the relative advantage. Farm income is a third larger on fertile soils compared to poor soils when no off farm work is possible (farm VII and II). The maize area is also large at model VII since no alternative off farm activity is possible.

The farm income rises considerably when off-farm work becomes possible. The model always opts for working at a banana plantation because the net present value of this activity is the highest. Income on farm with fertile soils and capital is still higher than on farms with poor soil and capital because maize cultivation contributes towards the farm income on farms with fertile soils.

Palmheart is never a viable option according to the model. The low net present value per hour of the different palmheart options restrict its attractiveness for the farming systems. When palmheart is already present at a farm it influences the income negatively by reducing the amount of off farm work (farm VII-IX and farm III-IV). When no capital is present to pay wage laborers working in palmheart, the model opts for cultivating palmheart with family labor reducing the income even more by prohibiting off farm work (farm IV and V). Larger farms provide higher incomes, mainly by the expending amount of pasture. Maize cultivation does not increase in area on large fertile farms.

According to this model overall land-use remains very extensive. Pasture is dominating all farming systems. Maize will be incorporated in the farming system when soil fertility and capital allow maize cultivation. Palmheart is reducing the farm income by reducing the possibility of off farm work.

5.7.4 Relating to reality

The model reflects quite accurate the present situation in the Neguev. An extensive land-use with mainly pasture and some arable farming. It also demonstrates the dependency of the region on off farm work and especially the dependency on the large estates. Without off farm employment incomes are lowering somewhat on the fertile soils but dramatically on the poor soils. Although the extensive land-use in the settlement does not appear to provide the maximal income per area it does provide the highest income per family since it allows off farm work with its high return.

The model probably does approach the actual situation because the differences in gross margins between activities are in reality also large. It is yet unsuitable for private on farm planning because it does not specify and differentiate the cropping systems sufficiently to approach the actual situation at a farm. For example pasture is not related to the stock-ingrate and composition of the pasture.

The model also assumes variables to be homogenous. Part of the entrepreneurship of farmers is to exploit the relative differences of the variables. Cacao can be managed exactly the same and have the same gross margin but a different financing of the plantation can make the difference between a successful return or a negative return. Farmers are also considered to be homogenous with regard to their behavior. They have of course their preferences, limitations and unique possibilities which are not incorporated but vital for their farm strategy.

Labor demand of crops during the season is also not included in the model but an important factor in the possibility to combine crops. The model determines the combination with the highest net present value but labor is not always fully utilized. This labor can be used to starting cultivating crops like palmheart.

The model also does not take the informal sector in account which is an essential part of the economics of the settlement and becomes more important when "normal" ways of obtaining an income are excluded. But the model serves as an indication of the optimal mix of activities and provide more insight why certain options are valid under which circumstances. The obtained income of the model farms is not the actual yearly income but the net present value resulting from the different activities over a 4 year period.

5.7.5 Options for farmers

On poor soils
Farmers on poor soils are severely restricted in the number of feasible cropping systems. Basically they have 3 options:

1) Working off-farm and combining off farm work with extensive cropping systems such as pasture or silvo-pastoral systems.

2) Combining off-farm work with the development of palmheart. This means having a small income in the first 2 years and hopefully a better income afterwards if the market does not change. It is possible to cultivate cassava on a part of the Neguev soil[13] unit but cassava is very sensitive to market prices.

3) When a farmer is not able to work off-farm and not able to obtain capital to establish palmheart, leaving and selling the improvements remains the only option.

On fertile soils

Farmers on fertile soils have more possibilities than farmers on poor soils. They can still obtain a reasonable risk free income from maize cultivation when they are not able to work off-farm. They can also invest in perennial crops as plantain and palmheart but net present values are lower of these crops compared to maize since they have a longer non-productive period. Cassava can be cultivated but the eventual profits are very dependent on the market price as demonstrated in table 26.

5.8 Characteristics of farm economics

Gross margins vary between minus 94.000 and 290.000 colones (700 - 220 US $). Maize and pumpkin are important cash crops on fertile soils while palmheart serves as a cash crop on poor soils. Off-farm work is important at most farms but often not expressed in the presented gross margin. Most crops do provide an attractive gross margin although uncertain markets can reduce the benefits significantly. Farming remains an attractive activity despite low market prices.

The labor demand of crops and labor supply by the family is an important parameter explaining the present land-use. At nearly all farms supply of labor by the family is larger than the use of family labor at the farm. This does not take into account the division of labor over crops during their development. The possible cultivated area of crops with distinct labor peaks and distinct growing seasons such as maize is sharply reduced by these demands explaining partly the relative small maize area.

This labor shortage during periods is one reason explaining the extensive land-use. Another is the low net present value of many farming activities in relation to off-farm work. This is caused by the relative long unproductive period of crops as palmheart and plantain while they need a substantial labor input, unstable prices and the security of income provided by working at banana plantations.

[13] Cassava cultivation experienced a small boom due to high prices and was planted on quite a large scale on poor soils. Many of these parcels gave a very low yield and parcels were even returned into pasture without harvesting, since root growth of cassava was severely reduced.

CONCLUSIONS

General conclusions

The results of the study were initially surprising because farming systems were less involved in arable farming and much more in informal trading and off-farm work than was expected. The income of farmers was also higher than expected. Differences between farms are large. Figures used by official programs deviate often from the figures obtained at the investigated farms.
The researched farming systems can be characterized by three terms. **Extensive, off-farm work** and **heterogeneity**. Land-use is extensive. Off-farm work forms at all the farms an important component and there is a large heterogeneity between farms and in time.

Extensive land-use

Land-use of the sample farms is extensive although they were stratified towards more intensive arable farming. The majority of land is used for pasture.

The extensive land-use in the sample is caused by a combination of factors.
- Labor shortage because older sons tend to work nearly full-time off farm. This reduces the effective available labor at farms.
- The relative low profit of arable farming compared to off-farm work. Most crops have a lower net present value than off farm work. This is caused by the assumed security of off farm work, unstable markets and lower yields during the rainy seasons. Poor soils demand a large input use reducing the already low profits of arable farming and disabling commercial cultivation of most crops on poor soils.
- Availability of off farm work. Many farmers can find employment outside the farm. This ranges from wage labor to small enterprises. Farmers on fertile soil can still achieve a reasonable income without off farm work by cultivating maize or other crops. Farmers on poor soils can only obtain a reasonable income from palmheart cultivation but this option implies a negative income for at least two years combined with high labor use.

Land-use can be described by crops or more accurately by cropping systems. Factors determining the choice for a cropping system are:
- The possibility and willingness to work off farm.
- The available capital in the form of land (land quality, quantity and location), money and labor capacity.
- Social networks, entrepreneurship and objectives.

Assessing these choices is complicated by substitution and additivity. This substitution takes place between cropping systems but also within cropping systems. Different combinations of cropping systems can fulfil the same objectives on farm level. More capital input in the form of hired labor can substitute family labor on cropping system level. The additivity of activities is important. The possibility to combine and substitute activities and inputs is determining the crop and cropping system choice. Maize for instance has distinct labor peaks enabling to combine maize cultivation with off-farm work and obtaining a joint higher income.

Off farm work
Off farm work is vital at many farms. It provides a relatively secure income and is an important possibility to obtain income on the poor soils where arable cropping is hardly possible and palmheart is not planted or in production. Farms are linked into a regional network by the large amount of off-farm work and the informal sector. This increases the mobility of farmers and the number of options they have to obtain an income. The off farm component of farm systems can be so large that decisions concerning the farm are taken, with the maximization of off-farm activities as departing point.

Heterogeneity
Differences between farms are large although farms appear similar at first hand. This heterogeneity exits also in time. A sad example is the farm encountered during the stratification without any cattle and nearly bankrupt, who was studied as an intensive dairy farm only years before.
Differences within crop cultivation remain large although the variation is explained and as much as possible.

Land units, land-use types and economic returns
One of the main objectives of the study was to relate land units (soil types) with land-use. For some an obvious relationship because soil type is nearly by definition related towards agricultural production possibilities. By mapping soil types and combining them with potential land-uses a relative easy assessment can be made of the agricultural potential of the area. Using the full agricultural potential would provide the highest economic returns utilizing comparative advantages. Area's with a low potential should then remain or return to rainforest or forestry projects. The next paragraphs will outline why this argumentation is less obvious than it appears.

Land units, land-use type
Soil type is closely related to the physical agricultural production potential. This can be translated in yield levels of several crops at certain input levels. But production possibilities are not only limited by soil fertility. Labor, location and entrepreneurship are also influencing the production potential. Soil type is only a component determining the production potential as demonstrated for maize cultivation in La Lucha. Land-units defined by soil types are therefore only partly indicating the actual production potential. The less restrictive soil fertility becomes the less clear the relation between soil type and land-use[14] becomes. A more detailed description of land-units for example including factors as location and labor input would increase the relation between land-unit and land-use[15].

Redefining land-units[16] in such a way that farmers production choices are also reflected is complicated and subject to the rapid changes occurring in the area.

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[14] This relation becomes on farm level even more difficult when land units are consisting of various soil types.

[15] The same fertile soils at both sides of the Parismina could then be classified in different groups reflecting the difficult accesability of the parcels at the south side of the Parisimina river.

[16] Land price for instance is an interesting parameter reflecting partly the possibilities of a parcel.

Land-use
The definition of land-use by crops in this study is a very rough estimation. A definition of land-use by cropping systems would increase the relation between the redefined land unit and land-use system. Maize can be grown on fertile and poor soils but under totally different cropping systems.

Economic returns
Land-use can be predicted partly by land units. Land unit, predicted land-use and economic returns are closely related. This does imply that poor soils are more or less restricted towards pasture, palmheart and pineapple but does not imply that poor soils are related to low economic returns. The highest gross margin in the sample was obtained by a farm on poor soils.
It is easy to assume that the most suitable land-use is the land-use utilizing the potential production possibilities towards a maximum. Farmers however do not maximize towards the physical agricultural production potential but towards a maximum financial yield of their farming systems[17] including off-farm work and trading in the informal economy. Their farming systems are thereby linked in a regional network. They utilize the production possibilities of different land-unit by working off-farm in agricultural production but also use options not related to land units such as trading.
Surprisingly extensive land-use as pasture, sometimes combined with maize and off-farm work is the most profitable farming system and widely applied in the Neguev.

Many small farmers of the Neguev are therefore intertwined in a regional system with a mainly extensive land-use at small farms combined with intensive land-use at the agro-industrial farms. The large difference between these small farmers working at agro-industrial farms and landless laborers is that landless laborers do not have the additional income and security of a farm.

Relating land-units with land-uses and economic returns is possible but will not reflect the actual land-use because farmers optimize their farming system utilizing the possibilities of the different land units and options not related to land within and outside their farming systems.

Regional and subregional planning and research should take in account the heterogeneity, the amount of off-farm work and the difficulty to relate land-units (physical constraints) to land-use and economic returns. Social and economic needs, how unconnected, irksome and somehow immovable they may be, should be incorporated in order to approach reality better.

[17] As quite surprisingly found by relating the linear programming model with actual land use.

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APPENDIX I: BASIC STRATIFICATION LIST

Basic stratification list with the parcel numbers, the owners, the prevalent soil types, previous studies, development programs and present land use. The information of this list is based on the soil map of De Bruin (1990). The ICTO map (ICTO, 1981). Several internal studies and the archives of the Programma Zona Atlantica.

Parcel number	Enquesta General 1987	Specific studies. 1987	Van Uf-felen 1989	Jansen 1990	Janssen & Zuring 1990	De Haan 1990	Stoor-vogel 1990	Cruz Cacao 1990	Piña IDA	Palmito IDA si/no	Chile IDA 86-87
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47	1	3B12			1						
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50 A	1				1						
51					1						
51 A					1						
52					1						
53					1						
54	1	3B3,3B7,3B15			1						
55	1	4B4			1						
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Parcel number	Enquesta General 1987	Specific studies 1987	Van Uffelen 1989	Jansen 1990	Janssen & Zuring 1990	De Haan 1990	Stoorvogel 1990	Cruz Cacao 1990	Piña IDA	Palmito IDA si/no	Chile IDA 86-87
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50 A	1				1						
51					1						
51 A					1						
52					1						
53					1						
54	1	3B3,3B7,3B15			1						
55	1	4B4			1						
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58					1						
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Parcel number	Enquesta General 1987	Specific studies 1987	Van Uf-felen 1989	Jansen 1990	Janssen & Zuring 1990	De Haan 1990	Stoor-vogel 1990	Cruz Cacao 1990	Piña IDA	Palmito IDA si/no	Chile IDA 86-87
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91	1	3B5							1		
92	1	3B14									
93											
94	1	3B5	1	1							
94 A											
94 B								1			
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96	1	3B12	1	1					1	1	
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127	1	3B5, 4B4						1			
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133											
134			1								1

Parcel number	Enquesta General 1987	Specific studies 1987	Van Uffelen 1989	Jansen 1990	Janssen & Zuring 1990	De Haan 1990	Stoorvogel 1990	Cruz Cacao 1990	Piña IDA	Palmito IDA si/no	Chile IDA 86-87
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147	1	3B12, 3B14									1
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154	1	3B6, 3B11									
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156				1						1	
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159			1	1							
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163	1	3B10							1		
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194	1	3B12								1	
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198	1	3B12									
199				1							
200	1			1							1
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203 A											
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204	1	3B8, 3B10									
205											
206											
207											
208	1	3B6, 3B8							1		1
209											

Parcel number	Enquesta General 1987	Specific studies 1987	Van Uffelen 1989	Jansen 1990	Janssen & Zuring 1990	De Haan 1990	Stoor-vogel 1990	Cruz Cacao 1990	Piña IDA	Palmito IDA si/no	Chile IDA 86-87
210											
211											
212											
213											
214											
215											
216											
217											
218											
219											
220											
221											
222											
223											
224			1								
225											
226											1
227											
228											
229											1
230										1	
231											
232											
233									1		
234											
235	1								1		1
236										1	
237				1						1	1
238	1	3B14	1	1			1				
239	1			1							1
240											
241											
242	1	4B4								1	
243											
244											
245								1		1	
246				1					1		
247				1					1		1
248											
249											
250	1										
251											
252											
253											
254									1	1	
255											
256											
257	1	3B12	1			1			1	1	
258											
259											
260											
261										1	1
262	1	3B6									1
263	1										
264											1
265										1	
266								1		1	
267										1	
268	1	4B4									
269											
270	1		1	1							
271			1								
272											
273											
274	1	3B8, 4B4								1	
275											
276											
277											
278											
279	1	3B14, 4B4									
280											
281											
282											
283			1	1							
284											
285				1							
286											
287											

Parcel number	Enquesta General 1987	Specific studies 1987	Van Uf-felen 1989	Jansen 1990	Janssen & Zuring 1990	De Haan 1990	Stoor-vogel 1990	Cruz Cacao 1990	Piña IDA	Palmito IDA si/no	Chile IDA 86-87
288											
289											
290	1	4B4									
291											
292										1	1
293	1									1	
294										1	
295											
296											
297											
298				1							1
299			1								
300											
301											
302			1							1	
303											
304											
305											
306	1			1							
307											
308				1							
311											

Parcel number	Name	Area ha	Soil type	Prof-ile	classi ficat-ion	Producio chili ha^{-1}	pasture	Cacao	Coconut	Cassava*
1	Victor	15	LI/SI				1			
2	Alcides	15	PA/LI							1
3	Mario R	15	PA/DO				1			
4	Olivier	15	PA/LI				1			
5	Ovido S	15	PA/LI							1
6	Floribe	15	PA/LI							
7	Hernán	15	PA				1			
8	Damian	15	PA				1			
9	Gerardo	15	LI/SI				1			
10	Ricardo	15	LI				1			
11	Juan Ro	15	LI/SI				1			
12	uan Her	15	LI/NE				1			
13	Domingo	15	LI/NE				1			
14	Elodia	15	LI							
15	Heriber	15	LI/WI				1			
16	Victor	15	WI/LUIII							
17	Oliver	15	WI/LUIII							
18	Omar Ch	15	WI/LUIII				1			
19	Leocadi	15	WI/LUIII							
20	Gerardo	15	LU/WI				1			
21	Tito Ro	15	LU/NE				1			
22	Simón P	15	LU/NE							
23	Rosendo	15	LU/NE							
24	Hugo He	15	LU/U							
25	Ricardo	15	LU/NE							
26	Alexand	15	NE/BOIII							
27	Gerado	15	NE/LU							
28	Ruperto	15	NE/PA				1	1		1
29	Eladio	15	BOIII/PA							
30	Gibert	15	PA/BOIII							
31	Juan Va	15	PA/BOIII							
32	Raul Va	15	PA/BOIII				1			1
33	Aquiles	15	PA/NE							1
34	Centro	15	PA/BOIII							
35	José Sá	15	PA/BOIII							
36	Gonzalo	15	PA/NE							
37	Olman A	15	NE/BOIII							
38	Gerardo	15	NE							
38			NE							
39	Benito	15	NE/U							
40	Virgili	15	NE/U							
41	Elisio	15	U/NE							
42	Piedade	15	U/NE							
43	Miguel	15	U/NE							
44	Nantili	15	NE/U							
45	Estaban	15	NE/BO							

Parcel number	Name	Area ha	Soil type	Prof-ile	classi ficat-ion	Producio chili ha^{-1}	pasture	Cacao	Coconut	Cassava
46	Ulises	15	NE							
46			NE/FL							
47	Carlos	15	NE/U							
48	Marvin	15	NE/U							
49	Onesimo	15	NE/U				1	1		
50	Damian	15	PA/NE							
50			PA/Fl							
51	Melvin	15	PA/BOIII							
51			PA							
52	Emilio	15	PA/BOIII							
53	Juan Ca	15	PA/BOIII				1	1	1	1
54	Manuel	15	PA/BOIII							
55	Carlos	15	PA/BOIII				1	1		1
56	Rafael	15	PA/BO							
57	Juan Al	15	PA/BO							
58	Germah	15	PA/BO							
59	José Zu	15	PA/BOIII							
60	Victor	17	PA	1	Grisaceo					
61	Rigober	17	PA							
62	José Hi	17	BO/PA							
63	Carlos	17	BO/PA							
64	José Va	17	BO/SI							
65	José Ar	17	BO/SI							
66	Emilian	17	U/PA					1		1
67	Alejand	17	U/PA				1	1		-
68	Marceli	17	SI/BO						1	
69	Eric Mé	17	SI/U							
70	Víctor	17	SI/U			9284	1		1	
71	Francis	17	NE/DE				1			
72	Antonio	17	NE/DE				1			
73	Carlos	17	NE/SI				1			
74	Rafael	17	SI/U							
75	Modesto	17	NE/SI							1
76	Emilio	17	NE/SI							
77	Olger v	17	NE/DE							
78	Abdenag	17	NE/DE			27700	1			1
79	Fulvio	17	NE/DE							1
80	Juan Ob	17	SI/NE				1			
81	Juan He	17	NE/U							1
82	Miguel	17	NE/DE				1			
83	Pedro A	17	SI/NE							
84	Rodrigo	17	SI/NE							
85	Jorge S	17	NE				1			
86	Rafael	17	SI/NE			38594				
87	Bienven	17	SI/NE				1			
88	Juan Ru	17	SI/U				1			
89	Roque t	17	SI/NE				1			
90	Santiag	17	U/NE							1
91	Fillemo	17	NE/SI				1	1		
92	Edelber	17	SI/NE				1			
93	Ricardo	17	SI/NE				1			
94	Johel P	17	NE/U							
94			NE							
94	Abraham		SI/NE				1	1		1
95	Narciso	17	SI/NE				1			
96	Dalay A	17	SI/NE				1			
97	Novelio	17	SI/NE				1			
98	Placido	17	SI/NE				1			
99	Dagober	17	SI/NE				1			
100	Hernán	17	SI/NE	1	Lansu		1			
101	Miguel	17	SI/NE				1			
102	Victor	17	SI/NE				1			
103	José Fr	17	SI/NE				1			
104	José Fr	17	SI/NE				1			
105	Ulises	17	SI/NE							
106	Elías B	17	SI/NE				1			
107	Francis	17	SI/U							
108	Abdenag	17	SI/U							
109	Ronulfo	17	SI/U							
110	Juan Ru	17	SI/U	1	Lansu					
111	Reinald	17	SI/NE							
112	José Co	17	SI/NE							
113	Alexis	17	SI/NE							
114	Gerardo	17	SI/NE							
115	Alvaro	17	SI/NE							
116	Rodrigo	17	SI/NE							
117	Alvaro	17	SI/NE							
118	Juan Vi	17	SI/NE							

Parcel number	Name	Area ha	Soil type	Prof-ile	classi ficat-ion	Producio chili ha^{-1}	pasture	Cacao	Coconut	Cassava
119	Tobias	17	SI/NE				1			
120	José Je	17	SI/NE				1			
121	Elpidio	17	SI/NE				1			
122	Rigober	17	SI/NE					1		
123	Antonio	17	SI/NE							
124	Segundo	17	SI/DE							1
125	Guiller	17	SI/DE				1			
126	Carlos	10	DE/NE							
127	Rolando	10	NE							
128	Pedro	10	NE/DE			30910				
129	Pedro V	10	DE/NE							
130	Alexis	10	NE/DE							
131	Juan An	10	NE/DE							
132	José Go	10	NE/DE							
133	Luis Lo	10	NE/DE							
134	Vicente	10	NE/DE			19996				
135	Antonio	10	NE/DE			43250				
136	Manuel	10	NE/WI				1			1
137	Javier	10	DE/NE							
138	Isabel	10	DE/NE			19325				
139	Pedro C	10	DE/NE				1			
140	Sr. Jua	10	NE/DE				1			1
141	Elias C	10	NE/DE				1			1
142	Jorge P	10	NE/DE							1
143	Carlos	10	DE/NE							
144	Juana T	10	NE/DE							
145	Manuel	10	NE/U							
146	Ricardo	10	NE/U					1		1•
147	Jorge F	10	NE/DE			35586	1			
148	Eudoro	10	NE/DE				1			
149	José Ro	10	NE/DE				1			
150	Enid Al	10	DE				1			
151	Jesús A	10	DE/MI				1			
152	Isidro	10	MI/NE			36277	1			
153	Carlos	10	DE				1			
154	Elias A	10	DE/MI				1			
155	Elian Q	10	DE/MI	1	DE		1			1
156	Adria H	10	MI/WI	1	MI		1			
157	Jorge V	10	MI				1			
158	Rigober	10	MI							1
159	Anibal	10	MI/WI				1			
160	Ovidio	10	WI/MI							
161	Carlos	10	WI/MI			28572				
162	Norma M	10	WI/DE				1			
163	Fernand	10	NE/WI	1	NE		1			1
164	Angel A	10	DE/NE				1			1
165	Sergio	10	NE/DE				1			
166	Santos	17	DE/NE				1			
167	Reiner	17	WI/NE							
168	Ramón V	17	WI/NE				1			
169	Eraquio	10	NE/TU				1			
170	Luia Hi	10	NE/WI			18315	1			
171	Edwin F	10	NE							
172	Misael	10	NE/WI							
173	Carmeli	10	NE/DE				1			
174	Eulalio	10	NE/DE				1			
175	Hermidr	10	NE/DE				1			
176	Jorge C	10	NE							1
177	Ronald	10	NE/WI							
178	Luz Ari	10	NE							1
179	Quirós	10	NE/WI				1			
180	Tomás L	10	NE				1			
181	Laurean	10	NE/WI			25534	1			
182	Fernado	10	NE				1			
183	Emilce	10	NE/WI				1			1
184	Nelson	10	NE							1
185	Ramon L	10	NE				1			
186	Gerardo	10	NE							
186	Ma. Del Pilar		NE			37818				
187	Rafael	10	NE				1			
188	Israel	10	NE							
189	Ovidio	10	NE/WI							
190	Miguel	10	NE							
191	Emilce	10	NE/U							
192	Nelson	10	NE/WI							
193	Saúl Vi	10	NE							
194	Juan Vi	10	NE							

Parcel number	Name	Area ha	Soil type	Profile	classification	Producio chili ha^{-1}	pasture	Cacao	Coconut	Cassava
195	Delia Q	10	NE/MI							
196	Mariano	10	NE/WI							
197	Leonara	10	MI/WI				1			
198	Rosalía	10	MI/DE				1			
199	Ronulfo	10	MI/DE							
200	Olman A	10	MI			55108	1			
201	Rafael	10	MI			40196	1			
202	Juan R.	10	MI				1			
203	Abelard	10	MI							
203	Abelard	10	DE							
203	Lino Ga		DE				1		1	
204	Gilbert	10	DE/MI				1			
205	Gilbert	10	DE/MI				1	1 A		
206	Willian	10	DE/MI				1			
207	Miguel	10	DE/MI				1			
208	José Fa	10	DE/MI			33636	1			1
209	Marco P	10	DE/MI				1			
210	José Vi	10	DE/MI				1			
211	Alvaro	10	DO/MI							
212	Norbert	10	DE/MI				1			
213	Alberto	10	DO/MI							
214	Elísd A	10	DE/MI				1			
215	Jesús C	10	MI/DO							
216	Efrain	10	DE/MI				1			
217	José Ch	10	DO/MI							
218	Adelia	10	DE				1			
219	Jesús S	10	MI/DO							
220	Angela	10	MI/DO							
221	Fernand	10	MI/DO							
222	Leandro	10	MI/DO							
223	Manuel	17	NE/WI				1			1
224	Sibrife	17	NE/WI	1	Lansu		1			
225	José Le	17	MI/WI				1			
226	Benjamí	10	NE/WI			21144				
227	José An	10	SI/NE				1			
228	Rafael	10	NE							
229	Mariano	10	NE			11006				
230	Elgar S	10	NE				1		1	
231	Hermes	10	NE							
232	Oscar L	10	NE							
233	Carlos	10	NE							
234	Carlos	10	NE							
235	Vidal S	10	NE			35733	1			
236	Orlando	10	NE/WI				1			
237	Porfilo	10	NE/MI			38488	1	1		
238	Mario A	10	NE/MI	1	MI					1
239	Narciso	10	NE/MI			23704	1			
240	Marco M	10	SI/NE				1			
241	Jorge M	10	NE/SI							
242	Gerardo	10	NE							
243	Alcides	10	NE							
244	Gonzalo	10	NE							
245	Israel	10	NE							
246	Carlos	10	NE	1	Lansu					
247	Victor	10	NE/MI			13188				
248	Rodrigo	17	NE/DE	1	Lansu					
249	Bolivar	17	NE/DE							
250	Miguel	17	NE/DE				1			
251	Fabio S	17	NE/DE							
252	Franckl	17	NE/DE							
253	Jorge P	17	NE/DE							
254	Delio Z	17	NE/DE				1	1		1
255	José Ca	10	NE							
256	Omar Je	10	NE/DE							
257	Orlando	10	NE/DE	1			1			
258	Rafael	10	NE/WI				1			
259	Ramón M	10	NE				1			
260	Jesús F	10	NE/WI							
261	Gerardo	10	NE/DE			43292	1			1
262	Egar Mo	10	SI/WI			34192				
263	Guiller	10	NE/DE				1			
264	Claudio	10	SI/WI			29080				
265	Edwin V	10	NE/DE							
266	Juvenal	10	NE/SI					1		
267	Rafael	10	NE/DE					1		
268	Alberto	10	NE/SI							
269	Victor	10	NE/DE				1	1		
270	Joaquin	10	NE/WI				1			

Parcel number	Name	Area ha	Soil type	Profile	classification	Producio chili ha^{-1}	pasture	Cacao	Coconut	Cassava
271	Gilbert	10	NE				1			
272	Gilbert	10	NE/WI				1			
273	Wilser	10	NE							
274	Gerardo	10	NE/DE							
275	Frankli	10	SI/WI							
276	Gerardo	10	NE/DE							
277	Fransis	10	SI/WI							
278	Luis Ma	10	NE/DE							
279	Rodrigo	10	SI/WI							
280	Eliecer	10	SI/WI							
281	Lidia C	10	NE/DE				1			
282	Marco T	10	NE/DE				1			
283	Rafael	10	MI/DE				1			
284	José Um	10	MI/DE	1	MI		1			
285	Victor	10	NE/MI				1			
286	Ivonne	10	NE/DE							
287	Teresa	10	NE					1		
288	Nelsón	10	NE							
289	Elizabe	10	NE							
290	Beatriz	10	NE/DE							
291	Carlos	10	NE/DE							
292	Luis Pa	10	NE			27150				
293	Rodrigo	10	NE							
294	Marcial	10	NE/DE							1
295	Luz Mar	10	DE/NE				1			
296	Gerardo	10	NE				1			
297	José A,	10	NE				1		1	
298	Daniel	10	NE			18325	1			
299	Danilo	10	NE/DE				1			
300	Javier	10	NE						1	
301	Frederi	10	DE/NE				1		1	
302	Danilo	10	NE				1		1	
303	Amancio	10	NE				1		1	
304	José Ca	10	NE				1	1 A	1 A	
305	Fernado	10	NE/DE				1			
306	Jose Jo	10	NE/DE				1			
307	Albino	10	NE/DE				1			
308	Gonzalo	10	NE/DE				1			
311	?		NE							

Parcel number	Passion fruit	Peijbaye	Palmheart	Cassava sust.	Plantain	Coffee	Rice	Maize sust.	Maize	Forest	Pineapple	Beans	Citrus	Collocassia
1														
2														
3														
4														
5														
6														1
7														
8														
9														
10														
11														1
12														
13														
14					1									1
15														
16														
17			1											
18														
19					1									
20					1									
21														
22														
23														
24														
25														
26														
27														
28					1				1					
29														
30														

Parcel number	Passion fruit	Peijbaye	Palmheart	Cassava sust.	Plantain	Coffee	Rice	Maize sust.	Maize	Forest	Pineapple	Beans	Citrus	Collocassia
31														
32														
33														
34														
35														
36														
37														
38														
38														
39														
40														
41														
42									1					
43														
44														
45														
46														
46														
47														
48														
49				1					1			1		
50														
50														
51														
51														
52														
53					1				1					
54														
55			1		1				1					
56														
57									1					
58														
59														
60														
61														
62														
63														
64														
65														
66			1		1				1	1		1		
67									1					
68				1	1									
69											1			
70	1		1								1		1	
71										1				
72														
73														
74										1				
75														
76														
77														
78											1			
79											1			
80														
81														
82										1				
83														
84														
85														
86											1			
87														
88														
89											1			
90														
91														
92														
93														
94														
94														
94					1									
95														
96			1											
97														
98				1										
99														
100	1													
101														

Parcel number	Passion fruit	Peijbaye	Palmheart	Cassava sust.	Plantain	Coffee	Rice	Maize sust.	Maize	Forest	Pineapple	Beans	Citrus	Collocassia
102														
103														
104														
105														
106														
107			1											
108														
109														
110														
111														
112														
113														
114														
115														
116														
117														
118														
119														
120														
121														
122														
123														
124	1													
125														
126														
127														
128														
129														
130														
131														
132														
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135														
136														
137														
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140														
141														
142									1					
143														
144														
145														
146														1
147														
148														
149														
150														
151														
152														
153														
154														
155									1		1		1	
156														
157														
158					1									
159														
160														
161														
162														
163											1			
164									1					
165										1				
166			1											
167														
168										1				
169			1											
170										1				
171														
172														
173														
174														
175														
176										1				
177														
178														

Parcel number	Passion fruit	Peijbaye	Palmheart	Cassava sust.	Plantain	Coffee	Rice	Maize sust.	Maize	Forest	Pineapple	Beans	Citrus	Collocassia
179														
180										1				
181														
182														
183											1			
184			1		1				1			1		
185											1			
186														
186														
187											1			
188														
189														
190														
191														
192														
193														
194														
195														
196														
197														
198														
199														
200														
201											1			
202														
203														
203														
203														
204														
205					1						1			
206			1	1	1									
207														
208											1			
209														
210														
211														
212														
213														
214														
215														
216														
217														
218														
219														
220														
221														
222														
223		1												
224					1	1								
225	1			1										
226														
227														
228														
229														
230			1					1						
231														
232														
233														
234														
235														
236			1											
237			1									1		
238			1											
239														
240														
241	1		1											
242														
243														
244														
245														
246														
247														
248														
249														
250														
251														
252														
253														

Parcel number	Passion fruit	Peij-baye	Palm-heart	Cass-ava sust.	Plan-tain	Cof-fee	Rice	Maize sust.	Maize	For-est	Pine-apple	Beans	Citrus	Collo-cassia
254														
255														
256														
257														
258														
259														
260														
261			1						1					
262														
263														
264														
265														
266			1											
267														
268														
269			1							1				
270														
271														
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290														
291														
292														
293			1	1										
294							1					1		
295														
296				1	1		1							
297		1		1										
298										1				
299										1				
300		1						1						
301				1	1			1						
302			1	1										
303		1			1									
304														
305														
306														
307														
308														
311					1									

Legend:

3B1	Farm case studies 1.
3B2	Farm case studies 2.
3B3	Household: decision making, labour and consumption
3B4	Cropping systems: banana (also 2B6, 4B5)
3B5	Cropping systems: cocoa (also 4B3)
3B6	Cropping systems: maize (also 2B5)
3B7	Cropping systems: root and tuber crops
3B8	Cropping systems: fruits
3B9	Cropping systems: comparative study of economics
3B10	Intensive livestock systems: dairy
3B11	Extensive livestock systems: beef
3B12	Dual purpose livestock systems
3B13	Livestock systems: comparative study of economics
3B14	Agro-forestry systems
3B15	Weather, production and workability
4B4	Technology and extension: IDA and MAG in the Neguev

A = Association

APPENDIX II: STOCK TAKING INTERVIEW

PROGRAM CATIE/ UAW/ MAG

ESTUDIO DE LA RELACION TIERRA-CULTIVOS Y DE SISTEMAS DE FINCA EN NEGUEV.

Encuesta diciembre 1990
Inventario de tierras, mano de obra y bienes de capital.

Encuestador	
Fecha	
Duración	

Nombre de productor	
Edad	
Educación	
Origen	
Numero de finca	

¿ Cual cultivos tiene Ud. ?					
Maíz	Palmito	Yuca	Cacao	Chamol	Pasto
Otro cultivo					

MAPA DE FINCA Completar con el productor.
Numero de finca

Información por cultivo.		
¿Cual es la edad del cultivo ?		
¿Cuando es la cosecha ?		
En caso de una perenne		
¿Cuántas cosechas tiene Ud. de ese cultivo por año?		
¿Cual era el uso de esta parcela antes este.......?		
¿ Y antes de este uso, por favor?		
¿ Y antes de este uso, por favor?		
¿ Superficie aproximada de esta parte?	ha	
¿ Hubo cambios en la superficie en el pasado ?		

tipo de tierra	
tierra negra	
tierra bermeja	
tierra café	
tierra colorada	
tierra muy roja	
tierra suamposa	

En una siguiente encuesta se preguntará por que es este tipo de tierra. ¿Cuales son las características?

¿ Tiene Ud. mas parcelas un otro lugar ?

¿ Ud. trabaja solo o con otras personas ?

¿ Tiene Ud. Ganado ?	Si	No	

Familia			
	edad	vive en casa	actividad

Estas preguntas son parte de lo encuesta inventario pero esta información va obtener gradualmente durante la investigación semanal.

Silvicultura		
¿ Tiene Vd árboles maderables en su finca ?		
¿ De cuál tipo y cuantos, por favor ?	numero	
Expectación de vender para los próximos años		

Ganado					
Categoría	Número	Leche	Cría	Desarrollo	engor
Hembras <1 año					
Hembras 1-2 años					
Hembras >2 años					
Total hembras					
Vacas en lactancia					
Machos <1 año					
Machos 1-2 años					
Machos > 2 años					
Toros reproductivos					
Bueyes					
Superficie aproximada de pastos			ha		m
¿ Cuál tipo de pastos tiene Ud.?					

¿ Qué otros animales tiene Usted ?
Cerdos para reproducción
Cerdos para carne
Caballos
Yeguas
Mulas
Pollos/gallos/gallinas
Patos/gansos
Chompipes
Peces
Otros

¿ Cuál maquinaria tiene Ud.?			
	Número	edad	valor original
- bombas de espalda			
manual			
motor			
- motosierras			
- vehículos			
- chapulines			
- arados y/o rastros			
- motores de combustión			
- machetes			
- cuchillo			
- macanas			

APPENDIX III: FLOW SCHEDULE

PROGRAMA CATIE/UAW/MAG

Estudio de relaciones tierras-cultivos a nivel de finca en Neguev
- Encuesta de costos de producción agropecuaria, 1990/91

Finca:____________ Parcela:____________ Fragmento:____________

Parte:____________ Cultivo(s) o pasto(s) ____________ ____________

Uso de insumos y producción, operaciones, y el uso de mano de obra y de bienes de capital

Insumo/Producto					
tipo	cantidad	unidad	precio/ valor	código precio/ valor	venta/ propio gasto
------	----	------	------	------	------
------	----	------	------	------	------
------	----	------	------	------	------
------	----	------	------	------	------
------	----	------	------	------	------
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------	----	------	------	------	------
------	----	------	------	------	------
------	----	------	------	------	------
------	----	------	------	------	------

Tipo de operación	Mano de obra / Bienes de capital				
	tipo	horas/ dias/ ha	código horas/ dias/ha	precio/ valor	código precio/ valor
------	------	------	------	------	------
------	------	------	------	------	------
------	------	------	------	------	------
------	------	------	------	------	------
------	------	------	------	------	------
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------	------	------	------	------	------
------	------	------	------	------	------
------	------	------	------	------	------

APPENDIX IV : DATA BASE STRUCTURE

This appendix presents the structure of the database. Each recorded activity was described by 22 characteristics. The list with the different fields and field types is presented below. An output of a part of the data base is presented at page two. The complete database exists of 952 records. An example of a data record is presented to demonstrate how the data base functions. A manual explaining the use of the data base is currently being prepared at the Programa Zona Atlantica.

Structure for database: C:SORT10.dbf
Number of data records: 08/01/91

Field	Field Name	Type	Width	Dec
1	FECHA	Date	8	
2	PARCELA	Numeric	1	
3	AREA_NO	Numeric	1	
4	CULTIVO_1	Character	3	
5	CULTIVO_2	Character	3	
6	CULTIVO_3	Character	1	
7	CULTIVO_4	Character	1	
8	OPERACION	Character	34	
9	COD_OPER	Character	4	
10	TIPO_M_MAQ	Character	15	
11	COD_MAQ	Numeric	4	
12	DURACION	Numeric	5	1
13	COD_HDJH	Numeric	1	
14	PV_OPER	Numeric	7	
15	COD_PV_OP	Numeric	7	
16	INSUM_PROD	Character	20	
17	COD_INSPRO	Numeric	4	
18	CANTIDAD	Numeric	8	2
19	COD_UNIDAD	Numeric	2	
20	PV_INSPRO	Numeric	9	2
21	COD_PV_IP	Numeric	1	
22	MEMO	Memo	10	
TOTAL			146	

#Record	FECHA	PARCELA	AREA_NO	CULTIVO_1	OPERACION
10	01/12/91	****	0	AYO	APLICAR PESTICIDAS
11	01/12/91	****	0	MAI	PREPARAR TERRENO (CHAPULIN)
12	01/18/91	****	0	MAI	SEMBRAR

COD_OPERA	TIPO_M_MAQ	COD_M_MAQ	DURACION	COD_HDJH
40	FAMILIAR	1	9.0	1
10	CHAPULIN	2	17.0	1
50	FAMILIAR	1	32.0	1

PV_OPER	COD_PV_OP	INSUM_PRO	COD_INSPRO	CANTIDAD
0	1	GRAMOXONE	41	2.00
2000	1	-	0	0.00
0	1	SEMILLA DE MAIZ	20	32.00

COD_UNIDAD	PV_INSPRO	COD_PV_IP
3	806	2
0	0	0
2	0	1

Record number 12 was recorded on the eighteenth of January 1991 at parcel ****. Maize was sown (code 50) by the family (code 1) which took 32 hours (hour = code 1). They used 32 kg (code 2) of maize seed obtained from the previous harvest. Therefore no price was included.

APPENDIX V: TRANSLATE MACRO

Macro to convert the dbase flow information towards the program PEPE IV. Important assumptions in this macro are the number of hours in a day (8 hours) and the number of hours in a jornal (6 hours).

```
copy a9 till a300 to ba9 till ba300     /Ca9..a100~ba9..ba100~
go to bb 9                              {goto}bb9~
calculate the month & day sum           @IF(BA9>19910000,(BA9-19910000),(BA9-19900000))~
copy of bb9 to bb10 till bb300          /cbb9~bb10..bb100~
go to bc 9                              {goto}bc9~
formulation of the month number         @choose(bb9/100,0,1,2,3,4,5,6,7,8,9,10,11,12)~
copy from bc9 to bc10 till Bc300        /cbc9~bc10..bc100~
copy month to a 325 till a616           /rvbc9..bc100~a325..a416~
go to bd 9                              {goto}bd9~
day number in month 1 and 2             @IF(Bb9<200,(Bb9-100),(Bb9-200))~
copy from bd 9 to bd 10 till bd 300     /cbd9~bd10..bd100~
go to be 9                              {goto}be9~
day number in month 1,2, and 3          @if(bb9>300,(bb9-300),(bd9))~
copy from be9 to be10 till be300        /cbe9~be10..be100~
goto bf 9                               {goto}bf9~
day number in month 1,2,3 and 4         @if(bb9>400,(bb9-400),(be9))~
copy from bf9 to bf10 till 300          /cbf9~bf10..bf100~
go to bG9                               {goto}BG9~
day number in month 1,2,3,4 and 5       @if(bb9>500,(bb9-500),(bF9))~
copy from bG9 to bG10 till bG300        /cbG9~bG10..bG100~
go to bH9                               {goto}bH9~
day number, month 1...6                 @if(bb9>600,(bb9-600),(bG9))~
copy command                            /cbH9~bH10..bH100~
go to bI9                               {goto}bI9~
day number, month 1...7                 @if(bb9>700,(bb9-700),(bH9))~
copy command                            /cbI9~bI10..bI100~
GO TO BJ9                               {goto}bj9~
month 8                                 @if(bb9>800,(bb9-800),(bi9))~
copy                                    /cbj9~bj10..bj100~
GO TO Bk9                               {goto}bk9~
month 9                                 @if(bb9>900,(bb9-900),(bj9))~
copy                                    /cbk9~bk10..bk100~
GO TO Bl9                               {goto}bl9~
month 10                                @if(bb9>1000,(bb9-1000),(bk9))~
copy                                    /cbl9~bl10..bl100~
GO TO Bm9                               {goto}bm9~
month 11                                @if(bb9>1100,(bb9-1100),(bl9))~
copy                                    /cbm9~bm10..bm100~
GO TO Bn9                               {goto}bn9~
month 12                                @if(bb9>1200,(bb9-1200),(bm9))~
copy                                    /cbn9~bn10..bn100~
go to bo 9                              {goto}bo9~
number of days in month 1+2             @if(bc9=1,bn9,(31+bn9))~
copy from bo9 to bo10 to bo300          /cbo9~bo10..bo100~
go to bp9                               {goto}bp9~
number of days in month 3               @if(bc9=3,59+bn9,bo9)~
copy of bp9 to bp10 till bp300          /cbp9~bp10..bp100~
go to bq9                               {goto}bq9~
number of days in month 4               @if(bc9=4,90+bn9,bp9)~
copy of bq9 to bq10 till bq300          /cbq9~bq10..bq100~
go to br9                               {goto}br9~
number of days in month 5               @if(bc9=5,120+bn9,bq9)~
copy of br9 to br10 till br300          /cbr9~br10..br100~
go to bs9                               {goto}bs9~
number of days in month 6               @if(bc9=6,151+bn9,br9)~
copy of bs9 to bs10 till bs300          /cbs9~bs10..bs100~
go to bt9                               {goto}bt9~
number of days in month 7               @if(bc9=7,181+bn9,bs9)~
copy of bt9 to bt10 till bt300          /cbt9~bt10..bt100~
go to bu9                               {goto}bu9~
number of days in month 8               @if(bc9=8,212+bn9,bt9)~
copy of bu9 to bu10 till bu300          /cbu9~bu10..bu100~
go to bv9                               {goto}bv9~
number of days in month 9               @if(bc9=9,243+bn9,bu9)~
copy of bv9 to bv10 till bv300          /cbv9~bv10..bv100~
go to bw9                               {goto}bw9~
number of days in month 10              @if(bc9=10,273+bn9,bv9)~
copy of bw9 to bw10 till bw300          /cbw9~bw10..bw100~
go to bx9                               {goto}bx9~
number of days in month 11              @if(bc9=11,304+bn9,bw9)~
```

```
copy of bx9 to bx10 till bx300               /cbx9~bx10..bx100~
go to by9                                    {goto}by9~
number of days in month 12                   @if(bc9=12,334+bn9,bx9)~
copy of by9 to by10 till by300               /cby9~by10..by100~
goto ca 9                                    {goto}ca9~
calculating the week number                  (((by9+2)/7))~
copy from ca9 to ca10 till ca300             /cca9~ca10..ca100~
copy week number to b325 to b616             /rvca9..ca100~b325..b416~
copy cultivo                                 /cd9..d100~c325..c416~
copy activitynumber to worksheet             /rvi9..i100~d325..d416~
copy activity                                /ch9..h100~e325..e416~
goto cc9                                     {goto}cc9~
if fam.labour then hours                     @if(k9=1,19,0)~
copy from cc9 to cc10 till cc300             /ccc9~cc10..cc100~
go to cd9                                    {goto}cd9~
If hours than copying                        @if(M9=1,cc9,0)~
copy from cd9 to cd10 till cd300             /ccd9~cd10..cd100~
go to ce9                                    {goto}ce9~
transforming days to hours                   @if(m9=2,(cc9*8),cd9)~
copy from ce9 to ce10 till ce300             /cce9~ce10..ce100~
go to cf9                                    {goto}cf9~
transforming jornales to hours               @if(m9=3,(cc9*6),ce9)~
copy from cf9 to cf10 till cf300             /ccf9~cf10..cf100~
copy to f325 till f616                       /rvcf9..cf100~f325..f416~
go to cg9                                    {goto}cg9~
calculating peones to hours                  @if(k9=2,19,0)~
copy cg9 to cg10 till cg300                  /ccg9~cg10..cg100~
go to ch9                                    {goto}ch9~
If hours than mentioning hours               @if(m9=1,cg9,0)~
copy to ch9 till ch300                       /cch9~ch10..ch100~
go to ci9                                    {goto}ci9~
transforming days to hours                   @if(m9=2,(cg9*8),ch9)~
copy to ci9 to ci300                         /cci9~ci10..ci100~
go to cj9                                    {goto}cj9~
transforming jornales to hours               @if(m9=3,(cg9*6),ci9)~
copy cj9 to cj10 till cj300                  /ccj9~cj10..cj100~
copy value to worksheet                      /RVcj9..cj100~g325..g416~
copy value to da9 till da300                 /RVcj9..cj100~da9..da100~
copy value from dc9 to i325 till i616        /RVdc9..dc100~i325..i416~
go to ck9                                    {goto}ck9~
costs per hour                               @If(o9=0,0,0)~
copy from ck9 to ck300                       /cck9~ck10..ck100~
go to cl9                                    {goto}cl9~
If o9 = precio than mention n9               @If(o9=1,(n9),ck9)~
copy from cl9 to cl10 till cl300             /ccl9~cl10..cl100~
go to cm9                                    {goto}cm9~
converting a value to a price                @If(o9=2,(N9/19),cl9)~
copy cm9 to cm10 till cm300                  /ccm9~cm10..cm100~
goto cn9                                     {goto}cn9~
calculating price of not hours to hours@If(m9<>1,(n9/g325),n9)~
copy to cn9 to cn300                         /ccn9~cn10..cn100~
go to co9                                    {goto}co9~
avoiding an error by dividing by 0           @If(f325<>0,0,cn9)~
copy to co9 till co300                       /cco9~co10..co100~
copy to h325 till h616                       /rvco9..co100~h325..h416~
copy a number of                             /cP9..p100~j325..j416~
unchanged rows to the                        /cr9..r100~k325..k416~
worksheet                                    /cs9..s100~l325..l416~
goto cp9                                     {goto}cp9~
Converting a value to a price                @if(u9=2,(T9/s9),t9)~
copy from cp9 till cp300                     /ccp9~cp10..cp100~
copy to worksheet                            /rvcp9..cp100~m325..m416~
go to a315                                   {goto}a315~
```

APPENDIX VI: DIFFERENT SOILTYPES IN THE NEGUEV SETTLEMENT (De Bruin, 1990).

Silencio	- Oxic Humitropept
Milano	- Andic Humitropept
Dos Novillos	- Typic Udivitrand
Rio Parismina	- Fluventic Eutropept
Destierra	- Andic Eutropept
Ligia	- Andic Eutropept
La Lucha	- Andic Acquic Dystropept
Bosque	- Andic Aquic Humitropept
Williamsburg	- Aquic Dystropept

APPENDIX VII: GONIOMETRIC CALCULATION PROGRAM
Printout of the Lotus values.

```
El calculo de superficie, angulos y lados de un triangulo.
==================================================================
La hoja calcula el lado a, y los angulos betha y gamma de un triangu
y la superficie S, en base de los lados b y c y el angulo alfa.

Entra los datos y presiona la tecla F9 para calcularse.
==================================================================
Entrada de datos:            Resultados:
b (m):       84.15           betha (grados):          85
c (m):          36           gamma (grados):          25
alfa:           70           a (m):                79.40
(grados)                     S (m cuadratos):       1423
==================================================================
Parte de la hoja para control

La suma de los angulos debe ser igual a pi (en rad.) o a 180 grados:

                             Suma de los angulos:
                             (grados)  (rad.)    pi:
                                180.00 3.1415926 3.1415926
==================================================================
Parte de la hoja para los calculos

==================================================================
                             alfa      betha     gamma
                             (grados)  (grados)  (grados)
                                 70.00     84.78     25.22
   a        b        c       alfa      betha     gamma       Superficie
  (m)      (m)      (m)      (rad.)    (rad.)    (rad.)       (m cuad.)
==================================================================
   79.40    84.15    36.00     1.2217 1.4797557 0.4401064     1423.35


==================================================================
    S                        sin alfa  sin betha sin gamma
1423.352                     0.9396926 0.9958586 0.4260357
    a                        cos alfa  cos betha cos gamma
79.40397                     0.3420201 0.0909149 0.9047063
                             alfa      betha     gamma
                             (rad.)    (rad.)    (rad.)
                             1.2217304 1.4797557 0.4401064

sin alfa/a                   3.1415926             pi:
0.011834                     3.1415926           3.1415926
```

APPENDIX VII: GONIOMETRIC CALCULATION PROGRAM
Printout of the Lotus formulas.

```
A1: 'El calculo de superficie, angulos y lados de un triangulo.
A2: '=================================================================
A3: 'La hoja calcula el lado a, y los angulos betha y gamma de un triangu-
lo,
A4: 'y la superficie S, en base de los lados b y c y el angulo alfa.
A6: 'Entra los datos y presiona la tecla F9 para calcularse.
A7: '=================================================================
A8: 'Entrada de datos:
D8: [W10] 'Resultados:
A9: 'b (m):
B9: 84.15
D9: [W10] 'betha (grados):
F9: (F0) [W10] +E27
A10: 'c (m):
B10: 36
D10: [W10] 'gamma (grados):
F10: (F0) [W10] +F27
A11: 'alfa:
B11: 70
D11: [W10] 'a (m):
F11: (F2) [W10] +A31
A12: '(grados)
D12: [W10] 'S (m cuadratos):
F12: (F0) [W10] +G31
A13: '=================================================================
A14: 'Parte de la hoja para control
A16: 'La suma de los angulos debe ser igual a pi (en rad.) o a 180 grados:
D18: [W10] 'Suma de los angulos:
D19: [W10] '(grados)
E19: [W10] '(rad.)
F19: [W10] 'pi:
D20: (F2) [W10] @SUM(D27..F27)
E20: [W10] @SUM(D41..F41)
F20: [W10] @PI
A21: '=================================================================
A22: 'Parte de la hoja para los calculos
A24: '=================================================================
D25: [W10] 'alfa
E25: [W10] 'betha
F25: [W10] 'gamma
D26: [W10] '(grados)
E26: [W10] '(grados)
F26: [W10] '(grados)
D27: (F2) [W10] +B11
E27: (F2) [W10] (E31*180)/@PI
F27: (F2) [W10] (F31*180)/@PI
A28: ^a
B28: ^b
C28: ^c
D28: [W10] 'alfa
E28: [W10] 'betha
F28: [W10] 'gamma
G28: [W11] 'Superficie
A29: ^(m)
B29: ^(m)
C29: ^(m)
```

```
D29: [W10] '(rad.)
E29: [W10] '(rad.)
F29: [W10] '(rad.)
G29: [W11] ^(m cuad.)
A30: '=================================================================
A31: (F2) +A38
B31: (F2) +B9
C31: (F2) +B10
D31: (F4) [W10] (D27*@PI)/180
E31: [W10] +E41
F31: [W10] +F41
G31: (F2) [W11] +A36
A34: '=================================================================
A35: ^S
D35: [W10] 'sin alfa
E35: [W10] 'sin betha
F35: [W10] 'sin gamma
A36: 0.5*B31*C31*D36
D36: [W10] @SIN(D31)
E36: [W10] +B31*A44
F36: [W10] +C31*A44
A37: ^a
D37: [W10] 'cos alfa
E37: [W10] 'cos betha
F37: [W10] 'cos gamma
A38: ((B31^2)+(C31^2)-2*B31*C31*D38)^0.5
D38: [W10] @COS(D31)
E38: [W10] ((A38^2)+(C31^2)-(B31^2))/(2*A38*C31)
F38: [W10] (A38^2+B31^2-C31^2)/(2*A38*B31)
D39: [W10] 'alfa
E39: [W10] 'betha
F39: [W10] 'gamma
D40: [W10] '(rad.)
E40: [W10] '(rad.)
F40: [W10] '(rad.)
D41: [W10] @ACOS(D38)
E41: [W10] @ACOS(E38)
F41: [W10] @ACOS(F38)
A43: 'sin alfa/a
D43: [W10] @SUM(D31..F31)
F43: [W10] ^pi:
A44: +D36/A38
D44: [W10] @SUM(D41..F41)
F44: [W10] @PI
```

APPENDIX VIII: LAND USE, FAMILY COMPOSITION, FARM EQUIPMENT, CATTLE, INPUT AND OUTPUT DATA PER FARM.

This appendix provides the condensend information from the stocktaking interview and the data base. No in and output data of farm V are included since these data were incomplete.

Several area indications are provided of each farm. The area indications of ICTO (Institute de Tierras y Colonizacion) are the official area indications used by the IDA. The measured area is the area measured by making a lay-over of mm paper from the areal photographs and soilmap. Finally the area mentioned by the farmer during the stocktaking interview is also provided. Differences between the area's are therefore caused by: interview bias, measurement errors partly caused by not correcting for tilt and height of the areal photographs and erosion by the Parismina river.

Farm number : I
Total acreage: 11.5 + 3.5 ha (ICTO)

Soiltype: (ha)		Crops	Measured acreage (ha)	Acreage according to farmer(ha)
Neguev	4.64	pasture & sec. forest	5.68	-
La Lucha	2.56	pasture	1.32	-
Bosque III	1.44	cacao	1.25	2
Parismina	5.82	cacao		
		maiz with cassava	1.93 1.26	4 0.25
		pumpkin	1.46	-
		compound	0.30	-
		wasteland	0.12	
Swampo	1.44	wasteland	1.44	-
Total	16.42		14.84	15

Family situation

	age	living at farm	working at farm
farmer	66	yes	yes
wife	58	yes	no
son	22	yes	yes/ bananera
son	32	now and then	bananera
wife	17	yes	no

Equipment

	age (years)	original value (colones)
Sprayer	2	5800
Machetes	0.3	380
Motor bike	0.6	100.000
Total		106.180

Cattle

	Number	Age
Heifer	1	1 - 2
Cow	1	> 2
Horse	1	> 3
Stockingrate		1.97

Farm number I
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product (colones)	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
pumpkin	9.800	1.46	6.712	feb - may	98.000	57	54	12.700	1.342	83.958	57.505	756
cassava	8.025	1.26	6.369	dec	26.165	55	206	15.450	1.458	10.715	8.503	41
cassava	-	3.19	-	feb - may	-	100	66	4.360	0	-4.360	-3.460	-26
maize	12.060		3.780	feb - may	150.900	469	127	44.450	46.267	60.183	18.866	101
cacao	-	1.25	-	jan - may	-	50	15	2.200	0	-2.200	-2.750	-34
total		7.16			275.065	731	368	79.160	49.067	146.838	20.508	134

Farm number : II
Total acreage: 14.5 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer(ha)
Parismina	0.36	maiz	0.90	-
Swampo	2.96	wasteland & sec.forest	0.46* 12*	-
		yuca	0.12	-
Neguev	1.44	cacao	1.52	2
Total	15.36		14.5	

Borders covered by forest, forest area estimated by substracting of the ICTO area.

Family situation

	age	living at farm	working at farm
farmer	55	yes	yes, parttime
wife	46	yes	no
son	8 - 12	yes	no

Equipment

	age (years)	original value (colones)
Sprayer	2	4.000
Machete	1	300
Total		4.300

Farm number II
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product (colones)	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
maize	-	0.90	0	feb - may	-	206	0	0	17.116	-17.116	-19.018	-92
cacao	69	1.52	45	feb - may	6356	46	0	0	400	5.956	3.918	129
cassava	-	0.12	-	feb - may	0	68	0	0	0	0	0	-
off-farm				may	41.400	278	0	0	0	41.400	0	-
total	-	2.54			47.756	598	0	0	17.516	30.240	-	-

Farm number : III
Total acreage: 12.4 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer (ha)
Bosque	2.16			
Bosque III	2.56	maize	4.96	8
Parismina	6.84	cacao & coco	1.73	2
		cacao & plantain & orange & coco	0.56	1
		yuca	-	1
		pasture & wasteland	1.80	1
Floris	0.28			
Swampo	2.08	wasteland	2.65	-
Neguev	1.44			
Total	15.36		11.70	

Family situation:

	age	living at farm	working at farm
farmer	30 - 40	yes	yes, parttime
wife	30 - 40	yes	no
son	15 - 20	yes	yes

Equipment

	age (years)	original value (colones)
Sprayer	2	4.000
Machete	1	300
Machete	2	280
Truck	10	?
Total		

Cattle

	Number	Age
cows	2	>2
Stockingrate		1.11

Farm number III
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product (colones)	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
green maize		1			90.000	261	458	34.270	45.861	248.569	62.770	-
	12500	3.96	12500	march	37.500							
maize	16080		4061	may 91	201.200							
coconut	4040	1.73	2618	jan - mar.	26.640	61	222	12.720	0	13.920	8046	132
cacao	167		96	feb - may	15.318	142	190	15.136	1.380	-1.189	-687	-5
plantain	-	0.56	-	jan - may	-	36	8	640	-	-	-	-
cassava	-	1	-	jan - may	-	48	96	7.680	-	-	-	-
total		8.25			370.658	548	974	70.446	47.241	261.300	31.672	477

Farm number : IV
Total acreage : 16.2 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer(ha)
		wasteland		
Bosque	2.80	maize & palmheart	2.27	1.50
Bosque III	1.48	beans	0.10	-
Parismina	10.80	palmheart & plantain & laurel	1.50	1.50
		pasture	6.70	_
		cassava	0.80	_
		cacao	1.63	-
Swampo	1.24	wasteland	1.24	_
Floris	0.72	wasteland	0.72	_
Total	17.04		14.96	15

Family situation

	age	living at farm	working at farm
farmer	30	no	yes

Equipment

	age (years)	original value (colones)
Sprayer (2)	2	8.000
Machete (3)	1	900
Motor bike	5	125.000
Total		133.900

Cattle

	Number	Age
bulls 1-2	15	1-2 years
Stockingrate		1.34

Farm number IV
Yields and yield level:

Crop	yield level (kg)	total area (ha)	yield level kg/ha	growing season	value product	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
maize	13.330	2.27	5.877	may 91	145.870	176	403	32.962	40.437	73.399	32.334	127
palmito	-	3	-	jan - may	-	90	218	15.060	15.446	-30.506	-10.168	- 140
plantain	510	1.5	-	jan - may	50.100	150	115	13.360	20.450	16.289	10.859	61
cacao	262	1.63	160	jan - may	24.559	94	51	3.900	-	20.569	12.619	142
cassava	5.520	0.80	6.900	jan - may	51.500	66	224	18.819	7.109	31.964	39.955	110
total		9.2			272.029	576	1011	84.101	83.442	111.715	12.143	70

Farm number : V
Total acreage: 15.7 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer (ha)
Swampo	1.04	wasteland	2.53	_
Bosque	8.40	plantain & soursack	0.25	-
		pasture	1.9	3
		compound	1.38	-
Parismina	6.04	maiz	3.94	2.50
		cassava	0.81	1.50
		pasture	0.84	3.00
		plantain*	1.78	-
		maiz *	0.61	-
		forest	0.96	-
Floris	0.68	pasture	0.55	-
Total	16.16		15.00	7.25

* rented out

Family situation

	age	living at farm	working at farm
farmer	40	yes	yes/ bananera
wife	33	yes	no
girls	7,9,13	yes	no

Cattle

	Number	Age
Cows	2	> 2
Horse	1	> 3
Stockingrate		0.72

Equipment

	age (years)	original value (colones)
Sprayer (2)	5	7.000
Chain saw	1	25.000
Machete (2)	0.1/2	280
Motor bike	0.3	200.000
Total		232.460

* second hand

Farm number : VI
Total acreage: 18 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer(ha)
Bosque	2.92	pumpkin	0.85	1
Parismina	5.84	pumpkin & maize	0.52	-
		yam	0.01	-
		cacao	0.69	1
		pasture	1.50	-
		cassava	0.16	0.75
Silencio	4.12	sec.forest	14.27*	
Swampo	3.84			
Neguev	0.44			
Total	17.16		18	

* estimated by subtracting the cultivated area from the total ICTO area.

Family situation

	age	living at farm	working at farm
farmer	30 - 40	yes	parttime
wife	30 - 40	yes	no
son	15 - 20	yes	parttime
son	20 - 25	yes	parttime
wife	15 - 20	yes	parttime
daughter	< 1	yes	no

Equipment

	age (years)	original value (colones)
Sprayer	2	4.000
Machete	1	300
Total		4.300

Cattle

	Number	Age
Cows	1	> 2
Horse	1	> 3
Stockingrate		1.33

Farm number VI
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
pumpkin	10.350	1.37	7554	jan - may	114.500	168	58	17.500	8.058	88.941	64.920	393
cacao	-	0.69	-	jan - may	-	100	0	0	1.306	-1.306	1.892	-13
pepper	-	-	-	march-may	-	28	0		1.508	-	-	-
culantro	-	0.01	-	march	760	-	-	-	-	760	-	-
off-farm	-	-	-	jan - may	5.700	76	0	0	0	5.700	-	75
cassava	-	1	-	jan - may	-	98	0	0	1.458	-1.458	-	-
beans	-	-	-	jan - may	-	24	0	0	0	-	-	-
maize	-	0.52	-	feb - may	-	4.5	0	0	0	-	-	-
total		3.06			120.960	499	58	19.008	10.872	91.080	27.901*	-

* not including off farm work

Farm number : VII
Total acreage: 10 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer(ha)
Williamsburg	2.76	pasture & wasteland	5.1	
Destierro	1.76			
Neguev	6.52	pineapple	0.75	
		cassava	1.70	2
Total	11.04			10

Family situation

	age	living at farm	working at farm
farmer	30 - 40	yes	parttime
wife	30 - 40	yes	now and then
daughter	10	yes	no
son	13	yes	no
son	8	yes	parttime

Equipment

	age (years)	original value (colones)
Sprayer	2	4.000
Machete	1	300
Machete	1	300
Total		4.600

Cattle

	Number	Age
milk cows	6	>2
calfs	6	<1
cows	9	>2
bull	1	> 3
horse	1	> 3
stockingrate		2.38

Farm number VII
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product (colones)	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
beans		0.1	-	march- may	-	6	0	0	200	-	-	-
pasture	-	5.1	-	jan - may	-	30	55	28.940	-	-28.940	-	-
pineapple	2580	0.8	3440	jan - may	28.950	66	0	0	92.508	-63.558	-	-
cassava	-	1.7	-	jan - may	-	98	0	0	1.992	-1.992	-	-
total		7.7			28.950	200	55	28.940	94.700	-94.490	-	-

Farm number :VIII
Total acreage :10 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer (ha)
Neguev	10.08	palmheart	0.97	1
		palmheart	0.12	-
		pasture	3.98	4
		compound	0.30	-
		secundary forest	4.63*	-
Total	10.08		10	10

* Estimated by substration, borders not visible.

Family situation:

	age	living at farm	working at farm
farmer	36	yes	yes
wife	30	yes	no
son	9	yes	no
son	6	yes	no
son	4	yes	parttime
brother	20-25	now and then	parttime
father	50-60	now and then	parttime

Equipment

	age (years)	original value (colones)
Sprayer Machete (2)	2 1	4.000 300
Total		40.600

Cattle

	Number	Age
cows	2	> 2
calf	1	1 -2
calf	1	< 1
horse	1	> 3
stockingrate		1.63

Farm number VIII
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product (colones)	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
carbon	136*	4.63	-	jan - may	35.850	439	4	400	20.400	15.450	-	-
palmheart	1660	0.97	1711	jan - may	46.800	274	0	0	5.667	41.134	42.406	150
pasture	-	3.98	-	jan - may	17.000	25	0	0	0	17.000	4.293	-
off farm	-	-	-	jan - may	560	7	0	0	0	560	0	-
total	-	9.58			100.210	745	4	400	26.067	74.143	46.699	63

* bags (old fertiliser bags)

Farm number : IX
Total acreage: 10 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer(ha)
Milano	2.04	palmheart	2	2
Neguev	8.12	palmheart	1	1
		palmheart & beans	0.9 0.1	1
		pasture	6	6
Total	10.76		10	10

* 2 addicionally ha cassava on Neguev soil are rented.

Family situation

	age	living at farm	working at farm
farmer	40 - 50	yes	parttime
wife	30 - 40	yes	no
daughter	> 15	yes	no
daughter	> 15	no	no
son	12- 15	yes	parttime
son	8 - 12	yes	parttime
son	8 - 12	yes	parttime

Equipment

	age (years)	original value (colones)
Sprayer Machete (2)	2 1	4.000 600
Total		4.600

Cattle

	Number	Age
cows	4	>2
stockingrate		0.83

Farm number IX
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product (colones)	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hour
						fam	hired					
off-farm				jan - may	192.841	617	0	0	65.630	127.211	-	206
palmito	9182	3	3.060	jan - may	205.026	570	118	7.860	24.731	172.434	57.478	381
pasture	-	6	-	jan - may	-	189	0	0	6.440	-	-	-
cassava	-	2	-	jan - may	-	42	0	0	2.131	-	-	-
total		11			398.047	1418	118	7.860	98.932	299.115	27.192	195

Farm number X
Total acreage: 10 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer(ha)
Neguev	8.28	palmheart & yuca	0.65	1
		palmheart & maize		1
		palmheart & beans	1.37	-
		secundary forest	5.03*	-
		pasture	2.95	4
Total	9.24		10	10

* Estimated by substration, borders not visible.

Family situation

	age	living at farm	working at farm
farmer	30 - 40	yes	parttime
wife	21	yes	no
son	< 2	yes	no
daughter	< 1	yes	no
brother	15-20	yes	parttime
brother	20-25	yes	parttime
father	50-60	yes	parttime
mother	50-60	yes	parttime

Equipment

	age (years)	original value (colones)
Sprayer	2	4.000
Machete	1	300
Machete	1	300
Chainsaw	1	40.000
Total		44.600

Farm number X
Yields and yield level:

Crop	yield level (kg)	ha	level ha/kg	growing season	value product	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hora
						fam	hired					
palmito	835	2.02	-	jan - may	22.225	122	65	2.025	7.260	9.285	4.596	-
maize	121			jan -april								
beans	112			feb -april								
cassava	960			may								
total												

Farm number XI
Total acreage: 10 ha (ICTO)

Soiltype: (ha)		Crops (ha)	Measured acreage (ha)	Acreage according to farmer (ha)
Swampo	0.80	wasteland	0.80	
Neguev	8.28	palmheart & maize cassava pineapple	0.33 0.03 0.006 0.006	0.75 - -
Destierro	1.68	pasture	8.78 *	7.5
Total	10.76		10	10

* estimated by subtracting the other areas from the total given by ICTO.

Family situation

	age	living at farm	working at farm
farmer	30 - 40	yes	yes
wife	30 - 40	yes	no
son	< 7	yes	no
son	< 7	yes	no
son	< 7	yes	no
daughter	< 7	yes	no

Equipment

	age (years)	original value (colones)
Sprayer Machete	2 1	4.000 300
Total		4.300

Cattle

	Number	Age
milk cows	3	>2
cows	18	>2
bulls	2	1 -2
bull	1	> 3
pigs	13	< 0.4
horse	1	> 3
stockingrate		3.25

Farm number XI
Yields and yield level

Crop	yield level (kg)	ha	level ha/kg	month	value product	labor input		labor costs	other input costs	gross margin	gross margin ha	gross margin hora
						fam	hired					
palmito		0.33	-	jan - may		220			7600			-
pasture		8.78	-	jan - may	75.000	291	-	-				
off-farm					1.800*	42	-	-				
total					76.800	552						

* partly in exchange for labor by neighbours (farm outside the settlement belonging to the same owner)

APPENDIX IX: LAND-USE RELATED TO SOIL TYPE.

These tables are specifying the simple but rather rough indication of land-use per soil type as provided in chapter III.
Table 1 characterizes the cropping pattern per soil type for the whole sample, based upon the information of table 1. Table 2 and 3 are demonstrating the land-use per soil type in the stratum with mainly poor soils and the stratum with mainly fertile soils. Differences between the summation of the separate land use types and the total area of a crop are caused by rounding off the figures.

Table 1. Land use in hectares per soil type of the total sample.

soil type	pasture & forest	cacao	maize	cas-sava	pump-kin	waste-land	coco-nut	plan-tain	orange	palmheart	beans	pine-apple	Total
Neguev	38	2	1	4		1				5	0	1	66
Bosque	1	1	11		1	3		0		2	0		18
La Lucha	3												3
Parismina	10	5	5	5	1	0	2	4	1	2			35
Swampo						11				0			12
Floris	1					1							4
Silencio	3												3
Williamsburg	3					4							4
Destierro	3												3
Milano													0
Total	63	9	17	9	1	19	2	4	1	9	0	1	147

Table 2. Land use in hectares per soil type of the sample farms on fertile soils.

Soil type	pasture & forest	cacao	maize	cas-sava	pump-kin	waste-land	coco-nut	plan-tain	orange	palm-heart	beans	Total
Neguev	4.5	1.5				1.4						7
Bosque	1.4	1.1	9.1		0.9	3		0.3		2.3		18
La Lucha	2.5											2
Parismina	11.5	4.6	7	5	2	0.1	2.3	3.8	0.6	1.5	0.1	38
Suampo						10.2						10
Floris	0.8					0.7						2
Silencio	4.0											4
Total	25	7	16	5	3	15	2	4	1	4	0	81

Table 3. Landuse in hectares per soiltype of the sample farms on poor soils.

Soiltype	pasture & forest	cacao	maize	cas-sava	waste-land	palm-ito	pine-apple	Total
Neguev	45.4	1.5		1.8		5.4	1	55
Parismina			1					1
Milano						2.0		2
Suampo					0.8			1
Destierro	1.8							2
Williamsburg					2.8			3
Total	47	2	1	2	4	7		62

APPENDIX X: WEEKLY IN- AND OUTPUT DATA FOR MAIZE

Farm number I.
Costs and hours for maize intercropped with cassava.
Area 3.19 ha.

Operations	labor (hours) family	hired	total	costs	inputs prod.	quantity	unit	input costs	output value
landpreparation	0	17	17	34000					
weeding	50	0	50	0					
(cassava)	70	22	92	1960					
fertilisation	48	5	53	400	nutran	552	kg	11922	
fumigation	91	0	91	0	gramoxone	21	l	8291	
sowing	150	0	150	0	seed	82	kg	0	
doblar	35	0	35	0					
harvesting	55	140	195	13450	grain	12060	kg	10260	150900
harvesting	0	5	5	0	maize cob	900	cobs		2700
Total	499	189	688	49810				30473	153600

Farm number I
Costs and hours for maize intercropped with cassava:
Area 1.00 ha

Operation	family labour	hired labour	total labour	labour costs	inputs prod.	quantity	unit	input costs	output value
landpreparation	0	5	5	10658					
weeding	16	0	16	0					
(cassava)	22	7	29	614					
fertilisation	15	2	17	125	nutran	173	kg	3737	
fumigation	29	0	29	0	gramoxone	7	l	2599	
sowing	47	0	47	0	seed	26	kg	0	
doblar	11	0	11	0					
harvesting	17	44	61	4216	grain	3781	kg	3216	47304
	0	2	2	0	maize cob	282	cobs	0	846
Total	156	59	216	15614				9553	47304

Farm number I
Use of inputs and labor by week.
Area 3.19 ha

Week	prod.	quant.	unit	prod.	quant.	unit	land-prep.	fumiga-tion	sow-ing	ferti-lisat.	weed-ing	harvest	doblar	Total
1							0	0	0	0	0	0	0	0
2							17	0	0	0	0	0	0	17
3	gramox.	5.5	l				0	24	96	0	0	0	0	120
4	gramox.	2.0	l				0	11	30	0	0	0	0	41
5	nutran	138.0	kg	gramox.	3.0	l	0	18	24	18	0	0	0	60
6	gramox.	0.7	l				0	5	0	15	0	0	0	20
7	gramox.	3.7	l				0	8	0	0	0	0	0	8
8	nutran	138.0	kg				0	0	0	10	0	0	0	10
9	nutran	138.0	kg	gramox.	2.0	l	0	10	0	10	0	0	0	20
10							0	0	0	0	0	0	0	0
11							0	0	0	0	12	0	0	12
12							0	0	0	0	0	0	0	0
13							0	0	0	0	0	0	0	0
14							0	0	0	0	50	5	0	55
15							0	0	0	0	30	0	0	30
16							0	0	0	0	25	0	10	35
17	gramox.	3.7	l				0	15	0	0	0	0	20	35
18							0	0	0	0	0	0	0	0
19							0	0	0	0	0	0	5	5
20							0	0	0	0	0	60	0	60
21							0	0	0	0	0	25	0	25
22							0	0	0	0	25	110	0	135
23							0	0	0	0	0	0	0	0
Total							17	91	150	53	142	200	35	688

Farm number I
Use of inputs and labour use by week.
Area 1 ha.

Week number	Inputs 1 prod.	Inputs 1 quant.	Inputs 1 unit	Input 2 prod.	Input 2 quant.	Input 2 unit	week number	land prep.	fumigation	sowing	fertilisation	weed-	harvest	doblar	Total
1		0.0			0.0		1	0	0	0	0	0	0	0	0
2		0.0			0.0		2	5	0	0	0	0	0	0	5
3	gramox.	1.7	1		0.0		3	0	8	30	0	0	0	0	38
4	gramox.	0.6	1		0.0		4	0	3	9	0	0	0	0	13
5	nutran	43.3	kg	gramox.	0.9	1	5	0	6	8	6	0	0	0	19
6	gramox.	0.2	1		0.0		6	0	2	0	5	0	0	0	6
7	gramox.	1.2	1		0.0		7	0	3	0	0	0	0	0	3
8	nutran	43.3	kg		0.0		8	0	0	0	3	0	0	0	3
9	nutran	43.3	kg	gramox.	0.6	1	9	0	3	0	3	0	0	0	6
10		0.0			0.0		10	0	0	0	0	0	0	0	0
11		0.0			0.0		11	0	0	0	0	4	0	0	4
12		0.0			0.0		12	0	0	0	0	0	0	0	0
13		0.0			0.0		13	0	0	0	0	0	0	0	0
14		0.0			0.0		14	0	0	0	0	16	2	0	17
15		0.0			0.0		15	0	0	0	0	9	0	0	9
16		0.0			0.0		16	0	0	0	0	8	0	3	11
17	gramox.	1.2	1		0.0		17	0	5	0	0	0	0	6	11
18		0.0			0.0		18	0	0	0	0	0	0	0	0
19		0.0			0.0		19	0	0	0	0	0	0	2	2
20		0.0			0.0		20	0	0	0	0	0	19	0	19
21		0.0			0.0		21	0	0	0	0	0	8	0	8
22		0.0			0.0		22	0	0	0	0	8	34	0	42
23		0.0			0.0		23	0	0	0	0	0	0	0	0
Total								5	29	47	17	45	63	11	216

Farm number II
Costs and hours for maize, mono cropped.
Area 0.9 ha.

	family labor	hired labor	total labor	labor costs	product	quantity
landpreparation	40	0	40	0		
fertilisation	11	0	11	0		
weeding	4	0	4	0		
fumigation	85	0	85	0	gram/karmex	7.52 l
					gramoxone	7.28 l
sowing	21	0	21	0	maize	16 kg
resowing	21	0	21			
doblar	12	0	12			
harvesting	0	0	0			
Total	194	0	194	0		

Farm number II.
Costs and hours for maize, mono cropped.
Area 1 ha.

	family labor	hired labor	total labor	labor costs	product	quantity	*
landpreparation	44	0	44	0			
fertilisation	12	0	12	0			
weeding	4	0	4	0			
fumigation	94	0	94	0	gram/karmex	8.35 l	
	0	0	0	0	gramoxone	8.08 l	
sowing	23	0	23	0	maize	17.7 kg	
resowing	23	0	23	0			
doblar	13	0	13	0			
harvesting	0	0	0	0			
Total	216	0	216	0			

* assuming that sowing takes as much time as resowing

Farm number II
Use of inputs and labor by week.
Area 0.9 ha.

Week number	prod.	Inputs quant.	unit	prod.	Input 2 quant.	unit	Week number	Land prep.	fumigation	sowing	fertilisation	weeding	harvedoblar		Total
1							1	0	0	0	0	0	0	0	0
2							2	0	0	0	0	0	0	0	0
3							3	0	0	0	0	0	0	0	0
4	gramoxone	5.6	1				4	40	40	0	0	0	0	0	80
5	& karmex						5	0	0	0	0	0	0	0	0
6							6	0	0	0	0	0	0	0	0
7							7	0	0	21	0	0	0	0	21
8	gramoxone	2	1				8	0	8	6	0	0	0	0	14
9	& karmex						9	0	0	5	0	0	0	0	5
10	fertiliser	-					10	0	0	5	11	4	0	0	20
11							11	0	0	0	0	0	0	0	0
12	gramoxone	6	1				12	0	23	0	0	0	0	0	23
13							13	0	0	0	0	0	0	0	0
14							14	0	0	5	0	0	0	0	5
15							15	0	0	0	0	0	0	0	0
16							16	0	0	0	0	0	0	0	0
17							17	0	0	0	0	0	0	0	0
18							18	0	0	0	0	0	0	0	0
19							19	0	0	0	0	0	0	0	0
20							20	0	0	0	0	0	0	0	0
21							21	0	0	0	0	0	0	0	0
22	gramoxone	2	1				22	0	14	0	0	0	0	12	26
23							23	0	0	0	0	0	0	0	0
Total								40	85	42	11	4	0	12	194

Farm number II
Use of inputs and labor by week.
Area 1 ha.

Week number	prod.	Inputs quant.	unit	prod.	Input 2 quant.	unit	Week number	Land prep.	fumiga-tion	sowing	fertili-sation	weeding	harvedoblar		Total
1							1	0	0	0	0	0	0	0	0
2							2	0	0	0	0	0	0	0	0
3							3	0	0	0	0	0	0	0	0
4	gramoxone	6.2	1				4	44	44	0	0	0	0	0	89
5	& karmex						5	0	0	0	0	0	0	0	0
6							6	0	0	0	0	0	0	0	0
7							7	0	0	23	0	0	0	0	23
8	gramoxone	2.1	1				8	0	9	7	0	0	0	0	16
9	& karmex						9	0	0	6	0	0	0	0	6
10	fertiliser	-					10	0	0	6	12	4	0	0	22
11							11	0	0	0	0	0	0	0	0
12	gramoxone	6.2	1				12	0	26	0	0	0	0	0	26
13							13	0	0	0	0	0	0	0	0
14							14	0	0	6	0	0	0	0	6
15							15	0	0	0	0	0	0	0	0
16							16	0	0	0	0	0	0	0	0
17							17	0	0	0	0	0	0	0	0
18							18	0	0	0	0	0	0	0	0
19							19	0	0	0	0	0	0	0	0
20							20	0	0	0	0	0	0	0	0
21							21	0	0	0	0	0	0	0	0
22	gramoxone	1.9	1				22	0	16	0	0	0	0	13	29
23							23	0	0	0	0	0	0	0	0
Total								44	94	47	12	4	0	13	216

Farm number III.
Costs and hours for maize, mono cropped.
Area 3.96 ha.

Operation	family labour	hired labour	total labour	labour costs	inputs/ products	quantity	unit	input costs	output value
landpreparation	60	210	270	15750					
(including sowing)					seed	116.00	kg	0	
(incl. fumigation)					gramoxone	18.60	l	7290	
weeding									
fertilisation	16	36	52	2700	nutran	1334.00	kg	29551	
fumigation	0	4	4	320	gramoxone	16.00	onza	181	
doblar (*)			0						
harvesting grain	0	0 *		21816	maize grain	16080.00	kg	1680	201200
harvesting cobs	20	4	24	320	maize cobs	12500.00	cob		37500
selling stand. maize					maize ha	1.00	ha		90000
Total	96	254	350	40906				38702	328700

* not mentioned
* 10 laborers together with the farmer harvested 400 bags, for 60 colones a bag
* selling of 1 ha cobs for 90.000 colones not included.

Farm number III
Costs and hours for pure maize:
Area: 1.00 ha

Operation	family labour	hired labour	total labour	labour costs	inputs prod.	quantity	unit	input costs	output value
landpreparation	15	53	68	3977		0.00		0	0
(including sowing)	0	0	0	0	seed	29.29	kg	0	0
(incl. fumigation)	0	0	0	0	gramoxone	4.70	l	1841	0
weeding	0	0	0	0		0.00		0	0
fertilisation	4	9	13	682	nutran	336.87	kg	7462	0
fumigation	0	1	1	81	gramoxone	4.04	onzas	46	0
doblar (*)		0	0	0		0.00		0	0
harvesting grain	0	0 *		5509	maize grain	4060.61	kg	424	50808
harvesting cobs	5	1	6	81	maize cobs	3156.57	cob	0	9470
selling stand. maize	0	0	0	0	maize ha	0.25	ha	0	22727
Total	24	64	88	10330				9773	83005

* not mentioned
* 10 laborers together with the farmer harvested 400 bags, for 60 colones a bag
* selling of 1 ha cobs for 90.000 colones not included.

Farm number III
Use of inputs and labour use by week.
Area 3.96 ha

Week number	Inputs 1 prod.	quant.	unit	Input 2 prod.	quant.	unit	week number	land prepar.	fumiga- tion	sowing	fertili- sation	weeding	harvest.	doblar
1							1	0	0	0	0	0	0	0
2	gramox.	18.60	l				2	270	0	0	0	0	0	0
3							3	0	0	0	0	0	0	0
4	seed	116.00	kg				4	0	0	0	0	0	0	0
5	nutran	920.00	kg				5	0	0	0	28	0	0	0
6	nutran	414.00	kg				6	0	0	0	0	0	0	0
7	gramox.	0.45	l				7	0	0	0	0	0	0	0
8							8	0	0	0	24	0	0	0
9							9	0	0	0	0	0	0	0
10							10	0	0	0	0	0	0	0
11							11	0	0	0	0	0	8	0
12							12	0	0	0	0	0	8	0
13							13	0	0	0	0	0	0	0
14							14	0	0	0	0	0	8	0
15							15	0	0	0	0	0	0	0
16							16	0	0	0	0	0	0	0
17							17	0	4	0	0	0	0	0
18							18	0	0	0	0	0	0	0
19							19	0	0	0	0	0	0	0
20							20	0	0	0	0	0	0	0
21							21	0	0	0	0	0	0	0
22							22	0	0	0	0	0	0	0
23							23	0	0	0	0	0	0	0
Total								270	4	0	52	0	24	0

Farm number III
Use of inputs and labour use by week.
Area 1. ha

Week number	prod.	Inputs 1 quant.	unit	prod.	Input 2 quant.	unit	week number	land prepar.	fumiga-tion	sowing	fertili-sation	weeding	harvest.	doblar
1		0			0		1	0	0	0	0	0	0	0
2	gramox.	5	1		0		2	68	0	0	0	0	0	0
3		0.			0		3	0	0	0	0	0	0	0
4	seed	29	kg		0		4	0	0	0	0	0	0	0
5	nutran	232	kg		0		5	0	0	0	7	0	0	0
6	nutran	105	kg		0		6	0	0	0	0	0	0	0
7	gramox.	0	1		0		7	0	0	0	0	0	0	0
8		0			0		8	0	0	0	6	0	0	0
9		0			0		9	0	0	0	0	0	0	0
10		0			0		10	0	0	0	0	0	0	0
11		0			0		11	0	0	0	0	0	2	0
12		0			0		12	0	0	0	0	0	2	0
13		0			0		13	0	0	0	0	0	0	0
14		0			0		14	0	0	0	0	0	2	0
15		0			0		15	0	0	0	0	0	0	0
16		0			0		16	0	0	0	0	0	0	0
17		0			0		17	0	1	0	0	0	0	0
18		0			0		18	0	0	0	0	0	0	0
19		0			0		19	0	0	0	0	0	0	0
20		0			0		20	0	0	0	0	0	0	0
21		0			0		21	0	0	0	0	0	0	0
22		0			0		22	0	0	0	0	0	0	0
23		0			0		23	0	0	0	0	0	0	0
Total								68	1	0	13	0	6	0

Farm number IV
Cost and hours for maize, intercropped with young palmito.
Area 2.27 ha

Operation	family labour	hired labour	total labour	labour costs	inputs prod.	quantity	unit	input costs	output value
land prep. (sowing)		160	160	12800					
(incl. fumigation)					carmix	2.00	kg	400	
do					2,4 D	0.50	l	264	
fertilisation	36	20	56	1600	12-24-12	276.00	kg	7909	
do					nutran	414.00	kg	12763	
weeding	20	78	98	6280					
fumigation		19	19	1520	gram/karmex	3.72	l	2525	
do	9	9	18	720	roundup	1.78	l	1860	
do		13	13	1040	fusilade	2.53	l	3796	
do		9	9	720	gramoxone	5.30	l	2466	
doblar	17	39	56	3120					
perrot chasing	16	4	20	320					
harvesting	19	134	153	1298	maize	11658.00	kg	9900	
Total	117	485	601	29418				41883	0

Farm number IV
Cost and hours for maize, intercropped with young palmito.
Area 1.00 ha

Operation	family labour	hired labour	total labour	labour costs	inputs prod.	quantity	unit	input costs	output value
land preparation	0	70	70	5639		0.00		0	0
(incl. fumigation)	0	0	0	0	carmix	0.88	kg	176	0
do	0	0	0	0	2,4 D	0.22	l	116	0
fertilisation	16	9	24	705	12-24-12	121.59	kg	3484	0
do	0	0	0	0	nutran	182.38	kg	5622	0
weeding	9	34	43	2767		0.00		0	0
fumigation	0	8	8	670	gram/karmex	1.64	l	1112	0
do	4	4	8	317	roundup	0.78	l	819	0
do	0	6	6	458	fusilade	1.11	l	1672	0
do	0	4	4	317	gramoxone	2.33	l	1086	0
doblar	7	17	25	1374		0.00		0	0
perrot chasing	7	2	9	141		0.00		0	0
harvesting	8	59	67	572	maize	5135.68	kg	4361	0
Total	51	213	265	12959				18450	0

Farm number IV
Use of inputs and labor by week
Area 2.27 ha

Week number	Inputs 1 prod.	Inputs 1 quant.	Inputs 1 unit	Input 2 prod.	Input 2 quant.	Input 2 unit	week number	land prepar.	fumiga-tion	sowing	fertili-sation	weeding +perrots	harvest.	doblar
1							1	0	0	0	0	0	0	0
2							2	0	0	0	0	0	0	0
3							3	0	0	0	0	0	0	0
4	2,4 D	0.63	l	carmix	0.50	l	4	0	80	80	20	3	0	0
5	nutran *	104.00	kg	12-24-12*	104.00	kg	5	0	0	0	0	0	0	0
6	nutran	92.00	kg	12-24-12	92.00	kg	6	0	0	0	24	22	0	0
7	gram.karm	3.72	l				7	0	19	0	0	21	0	0
8	nutran	92.00	kg	gramox.	0.45	l	8	0	5	0	9	0	0	0
9	gramox.	0.38	l				9	0	4	0	0	3	0	0
10							10	0	0	0	0	0	0	0
11							11	0	0	0	0	0	0	0
12							12	0	0	0	0	0	0	0
13							13	0	0	0	0	0	0	0
14							14	0	0	0	0	0	0	0
15	roundup	1.80	l				15	0	18	0	0	10	0	0
16							16	0	13	0	0	10	0	27
17	nutran	92.00	kg	12-24-12	92.00	kg	17	0	0	0	3	0	0	18
18							18	0	0	0	0	0	0	8
19							19	0	0	0	0	3	0	3
20							20	0	0	0	0	38	0	0
21							21	0	0	0	0	0	132	0
22							22	0	0	0	0	8	21	0
23							23	0	0	0	0	0	0	0
Total								0	139	80	56	117	153	56

* in fact in week 4

Farm number IV
Use of inputs and labour use by week
Area 1 ha

Week number	Inputs 1 prod.	quant.	unit	prod.	Input 2 quant.	unit	week number	land prepar.	fumiga-tion	sowing	fertili-sation	weeding	harvest.	doblar	Total
1		0.00			0.00		1	0	0	0	0	0	0	0	0
2		0.00			0.00		2	0	0	0	0	0	0	0	0
3		0.00			0.00		3	0	0	0	0	0	0	0	0
4	2,4 D	0.28	l	carmix	0.22	l	4	0	35	35	9	1	0	0	80
5	nutran *	45.81	kg	12-24-12*	45.81	kg	5	0	0	0	0	0	0	0	0
6	nutran	40.53	kg	12-24-12	40.53	kg	6	0	0	0	11	10	0	0	20
7	gram.karm	1.64	l		0.00		7	0	8	0	0	9	0	0	18
8	nutran	40.53	kg	gramox.	0.20	l	8	0	2	0	4	0	0	0	6
9	gramox.	0.17	l		0.00		9	0	2	0	0	1	0	0	3
10		0.00			0.00		10	0	0	0	0	0	0	0	0
11		0.00			0.00		11	0	0	0	0	0	0	0	0
12		0.00			0.00		12	0	0	0	0	0	0	0	0
13		0.00			0.00		13	0	0	0	0	0	0	0	0
14		0.00			0.00		14	0	0	0	0	0	0	0	0
15	roundup	0.79	l		0.00		15	0	8	0	0	4	0	0	12
16		0.00			0.00		16	0	6	0	0	4	0	12	22
17	nutran	40.53	kg	12-24-12	40.53	kg	17	0	0	0	1	0	0	8	9
18		0.00			0.00		18	0	0	0	0	0	0	4	4
19		0.00			0.00		19	0	0	0	0	1	0	1	3
20		0.00			0.00		20	0	0	0	0	17	0	0	17
21		0.00			0.00		21	0	0	0	0	0	58	0	58
22		0.00			0.00		22	0	0	0	0	4	9	0	13
23		0.00			0.00		23	0	0	0	0	0	0	0	0
Total								0	61	35	24	52	67	25	265

* in fact in week 4

Farm number V
Costs and hours for maize, mono cropped.
Area 4 ha.

	family labor	hired labor	total labor	labor costs	product	quantity	costs	value produkt
landpreparation	40	0	40	0	-	-	-	-
fertilisation	32	0	32	0	nutran	184 kg	4060	-
					10-30-10	828 kg	22500	-
fumigation	76	0	76	0	gramoxone	5.7 l	2231	
					2.4 D	1 l	260	
					kasagrin	3.72 l	1750	
					71 LS	2 l	875	
sowing	48	29	77	1840	-			
doblar	-	-	0					
harvesting	-	-	0					
Total	196	29	225	1840			31676	0

Farm number V
Costs and hours for maize, mono cropped.
Area 1 ha.

	family labor	hired labor	total labor	labor costs	product	quantity	costs	value produkt
landpreparation	10	0	10	0	-	-	-	-
fertilisation	8	0	8	0	nutran	47 kg	1030	-
					10-30-10	210 kg	5711	-
fumigation	19	0	19	0	gramoxone	1.4 l	566	
	0				2.4 D	0.25 l	66	
	0				kasagrin	0.94 l	444	
	0				71 LS	0.51 l	222	
sowing	12	7	20	467	-			
doblar	-	-	0					
harvesting	-	-	0					
Total	50	7	57	467			8040	0

Farm number V.
Use of inputs and labor in maize cultivation.
Area 4 ha.

Week number	prod.	Inputs quant.	unit	prod.	Input 2 quant.	unit	prod.	Input 3 quant.	unit	Week number	Land prep.	fumiga-tion	sow-ing	fertili-sation	weed-ing	harvest-ing	doblar	Total
1										1	0	0	0	0	0	0	0	0
2										2	0	0	0	0	0	0	0	0
3	2,4 D	1.0	l	gramox.	2.0	l	71 LS	2.0	l	3	16	16	16	0	0	0	0	48
4	2,4 D	1.0	l	gramox.	3.7	l	Kasagrin	3.7	l	4	0	0	29	8	0	0	0	37
5							* 10-30-10	460	kg	5	0	0	0	8	0	0	0	8
6	10-30-10	186	kg							6	8	0	32	8	0	0	0	48
7										7	0	0	0	0	0	0	0	0
8	10-30-10	186	kg	nutran	186	kg	gramoxone	4.0	l	8	0	24	0	8	0	0	0	32
9										9	0	0	0	0	0	0	0	0
10	gramoxone	3.7	l	mesumas	3.7	l				10	0	48	0	0	16	0	0	64
11										11	0	0	0	0	0	0	0	0
12										12	0	0	0	0	0	0	0	0
13										13	0	0	0	0	0	0	0	0
14										14	0	0	0	0	0	0	0	0
15										15	0	0	0	0	0	0	0	0
16										16	0	0	0	0	0	0	0	0
17										17	0	0	0	0	0	0	0	0
18										18	0	0	0	0	0	0	0	0
19										19	0	0	0	0	0	0	0	0
20										20	0	0	0	0	0	0	0	0
21										21	0	0	0	0	0	0	0	0
22										22	0	0	0	0	0	0	0	0
23										23	0	0	0	0	0	0	0	0
Total											24	88	77	32	16	0	0	237

Farm number V
Use of inputs and labor by week.
Area 1 ha.

Week number	prod.	Inputs 1 quant.	unit	prod.	Input 2 quant.	unit	prod.	Input 3 quant.	unit	Week number	Land prep.	fumiga-tion	sowin	fertili-sation	weedin	harvesti	doblar	Total
1										1	0	0	0	0	0	0	0	0
2										2	0	0	0	0	0	0	0	0
3	2,4 D	0.2	l	gramox.	0.5	l	71 LS	0.5	l	3	4	4	4	0	0	0	0	12
4	2,4 D	0.2	l	gramox.	0.9	l	Kasagrin	0.9	l	4	0	0	7	2	0	0	0	9
5							* 10-30-10	115.0	kg	5	0	0	0	2	0	0	0	2
6	10-30-10	46.5	kg							6	2	0	8	2	0	0	0	12
7										7	0	0	0	0	0	0	0	0
8	10-30-10	46.5	kg	nutran	46.5	kg	gramoxone	1.0	l	8	0	6	0	2	0	0	0	8
9										9	0	0	0	0	0	0	0	0
10	gramoxone	0.9	l	mesumas	0.9	l				10	0	12	0	0	4	0	0	16
11										11	0	0	0	0	0	0	0	0
12										12	0	0	0	0	0	0	0	0
13										13	0	0	0	0	0	0	0	0
14										14	0	0	0	0	0	0	0	0
15										15	0	0	0	0	0	0	0	0
16										16	0	0	0	0	0	0	0	0
17										17	0	0	0	0	0	0	0	0
18										18	0	0	0	0	0	0	0	0
19										19	0	0	0	0	0	0	0	0
20										20	0	0	0	0	0	0	0	0
21										21	0	0	0	0	0	0	0	0
22										22	0	0	0	0	0	0	0	0
23										23	0	0	0	0	0	0	0	0
Total											6	22	19	8	4	0	0	59

APPENDIX XI: WEEKLY IN- AND OUTPUT DATA FOR PALMHEART

farm number IV
palmheart — Activity in hours — Use of inputs
area: 3 ha
Use of inputs and labour use by week

Week Number	Harveing	Removin Suckers	Fumiga-tion	Re-sowing	Fertili-sation	Limpi	Deshierba Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant	unit	product	Inputs 3 quant	unit	product
1								0									
2								0									
3								0									
4						5		5									
5								0									
6							44	44	65	kg	nutran	65	kg	12-24-12			
7					18			18									
8								0									
9				12		6		18									
10								0									
11								0									
12							11	11									
13								0									
14								0									
15								0									
16			26					26	2	1	Fusilade						
17		5			11			16	86	kg	12-24-12	172	kg	nutran	30	onzas	gramoxone
18						3		3									
19						3		3									
20						35		35									
21								0									
22			4			44		48	24	onzas	gramoxone						
23	5					26	10	41	125		palmitos						
24						21	3	24									
25					13		4	17	172	kg	12-242-12	172	kg	nutran			
26							0	0									
27							0	0									
Total	5	5	30	12	42	143	72	309									

farm number IV
palmheart — Activity in hours — Use of inputs
area: 1 ha
Use of inputs and labour use by week

Week Number	Harveing	Removin Suckers	Fumigation	Re-sowing	Fertilisation	Limpi	Deshierba Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant	unit	product	Inputs 3 quant	unit	product
1	0	0	0	0	0	0	0	0	0								
2	0	0	0	0	0	0	0	0	0								
3	0	0	0	0	0	0	0	0	0								
4	0	0	0	0	0	2	0	2	0								
5	0	0	0	0	0	0	0	0	0								
6	0	0	0	0	0	0	15	15	22	kg	nutran	22	kg	12-24-12	0		
7	0	0	0	0	6	0	0	6	0			0			0		
8	0	0	0	0	0	0	0	0	0			0			0		
9	0	0	0	4	0	2	0	6	0			0			0		
10	0	0	0	0	0	0	0	0	0			0			0		
11	0	0	0	0	0	0	0	0	0			0			0		
12	0	0	0	0	0	0	4	4	0			0			0		
13	0	0	0	0	0	0	0	0	0			0			0		
14	0	0	0	0	0	0	0	0	0			0			0		
15	0	0	0	0	0	0	0	0	0			0			0		
16	0	0	9	0	0	0	0	9	1	1	Fusilade	0			0		
17	0	2	0	0	4	0	0	5	29	kg	12-24-12	57	kg	nutran	10	onza	gramoxone
18	0	0	0	0	0	1	0	1	0			0			0		
19	0	0	0	0	0	1	0	1	0			0			0		
20	0	0	0	0	0	12	0	12	0			0			0		
21	0	0	0	0	0	0	0	0	0			0			0		
22	0	0	1	0	0	15	0	16	8	onzas	gramoxone	0			0		
23	2	0	0	0	0	9	3	14	42		palmitos	0			0		
24	0	0	0	0	0	7	1	8	0			0			0		
25	0	0	0	0	4	0	1	6	57	kg	12-242-12	57	kg	nutran	0		
26	0	0	0	0	0	0	0	0	0			0			0		
27	0	0	0	0	0	0	0	0	0			0			0		
Total	2	2	10	4	14	48	24	103									

APPENDIX XI: WEEKLY IN- AND OUTPUT DATA FOR PALMHEART

farm number IV
palmheart
area: 3 ha
Use of inputs and labour use by week

Week Number	Harvesting	Removing Suckers	Fumigation	Re-sowing	Fertilisation	Limpi	Deshierba Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant	unit	product	Inputs 3 quant	unit	product
	Activity in hours								Use of inputs								
1								0									
2								0									
3								0									
4						5		5									
5								0									
6							44	44	65	kg	nutran	65	kg	12-24-12			
7					18			18									
8								0									
9				12		6		18									
10								0									
11								0									
12							11	11									
13								0									
14								0									
15								0									
16			26					26	2	1	Fusilade						
17		5			11			16	86	kg	12-24-12	172	kg	nutran	30	onzas	gramoxone
18						3		3									
19						3		3									
20						35		35									
21								0									
22			4			44		48	24	onzas	gramoxone						
23	5					26	10	41	125		palmitos						
24						21	3	24									
25					13		4	17	172	kg	12-242-12	172	kg	nutran			
26							0	0									
27							0	0									
Total	5	5	30	12	42	143	72	309									

farm number IV
palmheart Activity in hours Use of inputs
area: 1 ha
Use of inputs and labour use by week

Week Number	Harveing	Removin Suckers	Fumiga-tion	Re-sowing	Fertili-sation	Limpi	Deshierba Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant	unit	product	Inputs 3 quant	unit	product
1	0	0	0	0	0	0	0	0	0								
2	0	0	0	0	0	0	0	0	0								
3	0	0	0	0	0	0	0	0	0								
4	0	0	0	0	0	2	0	2	0								
5	0	0	0	0	0	0	0	0	0								
6	0	0	0	0	0	0	15	15	22	kg	nutran	22	kg	12-24-12	0		
7	0	0	0	0	6	0	0	6	0			0			0		
8	0	0	0	0	0	0	0	0	0			0			0		
9	0	0	0	4	0	2	0	6	0			0			0		
10	0	0	0	0	0	0	0	0	0			0			0		
11	0	0	0	0	0	0	0	0	0			0			0		
12	0	0	0	0	0	0	4	4	0			0			0		
13	0	0	0	0	0	0	0	0	0			0			0		
14	0	0	0	0	0	0	0	0	0			0			0		
15	0	0	0	0	0	0	0	0	0			0			0		
16	0	0	9	0	0	0	0	9	1	1	Fusilade	0			0		
17	0	2	0	0	4	0	0	5	29	kg	12-24-12	57	kg	nutran	10	onza	gramoxone
18	0	0	0	0	0	1	0	1	0			0			0		
19	0	0	0	0	0	1	0	1	0			0			0		
20	0	0	0	0	0	12	0	12	0			0			0		
21	0	0	0	0	0	0	0	0	0			0			0		
22	0	0	1	0	0	15	0	16	8	onzas	gramoxone	0			0		
23	2	0	0	0	0	9	3	14	42		palmitos	0			0		
24	0	0	0	0	0	7	1	8	0			0			0		
25	0	0	0	0	4	0	1	6	57	kg	12-242-12	57	kg	nutran	0		
26	0	0	0	0	0	0	0	0	0			0			0		
27	0	0	0	0	0	0	0	0	0			0			0		
Total	2	2	10	4	14	48	24	103									

farm number VIII
palmito
area: 0.97 ha
Use of inputs and labour use by week

Activity in hours / Use of inputs

Week Number	Acor-donar	Sowing	Harvest-ing	Removing Suckers	Fumi-gation	Ord-enar	Fertili-sation	Limpiar	Deshierbar Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant.	unit	product	Inputs 3 quant.	unit	product
1										0									
2										0									
3						20				20									
4				24				18		42									
5					8				16	24	1.5	1	gramoxone						
6										0									
7		2		16						18									
8	18									18									
9	19				5					24	0.5	1	gramoxone						
10		5								5	2700.0	sacs	plastic bags						
11		12								12									
12		7								7									
13		12	5							17	660.0		palmitos						
14	12									12									
15	8	8				4				20									
16	6									6									
17	10				5					15	1.0	1	gramoxone						
18	10									10									
19										0									
20					5					5	1.0	1	gramoxone						
21					3					3	0.5	1	gramoxone						
22										0									
23										0									
24			10		4					14	328.0		palmitos				8.0	onza	gramoxone
25	4		16		4					24	550.0		palmitos				14.0	onza	gramoxone
26			4	6	3					13	200.0		palmitos				12.0	onza	gramoxone
27	9		6				1			16	200.0		palmitos				1.0	1	foliar
Total	96	46	41	46	37	24	1	18	16	325									

Farm number VIII
palmheart — Activity in hours — Use of inputs
area: 1 ha
Use of inputs and labour use by week

Week	Acord-	Sowing	Harvest-	Removing	Fumiga-	Orden-	Fertili-		Deshierbar	Total	Inputs 1			Inputs 2			Inputs 3		
Number	ar		ing	Suckers	tion	ar	sation	Limpiar	Deshojar		quant.	unit	product	quant.	unit	product	quant.	unit	product
1	0	0	0	0	0	0	0	0	0	0	0.0						0.0		
2	0	0	0	0	0	0	0	0	0	0	0.0						0.0		
3	0	0	0	0	0	21	0	0	0	21	0.0						0.0		
4	0	0	0	25	0	0	0	19	0	43	0.0						0.0		
5	0	0	0	0	8	0	0	0	16	25	1.5	1	gramoxone				0.0		
6	0	0	0	0	0	0	0	0	0	0	0.0						0.0		
7	0	2	0	16	0	0	0	0	0	19	0.0						0.0		
8	19	0	0	0	0	0	0	0	0	19	0.0						0.0		
9	20	0	0	0	5	0	0	0	0	25	0.5	1	gramoxone				0.0		
10	0	5	0	0	0	0	0	0	0	5	2783.5	sacs	plastic bags				0.0		
11	0	12	0	0	0	0	0	0	0	12	0.0						0.0		
12	0	7	0	0	0	0	0	0	0	7	0.0						0.0		
13	0	12	5	0	0	0	0	0	0	18	680.4		palmitos				0.0		
14	12	0	0	0	0	0	0	0	0	12	0.0						0.0		
15	8	8	0	0	0	4	0	0	0	21	0.0						0.0		
16	6	0	0	0	0	0	0	0	0	6	0.0						0.0		
17	10	0	0	0	5	0	0	0	0	15	1.0	1	gramoxone				0.0		
18	10	0	8	0	0	0	0	0	0	10	0.0						0.0		
19	0	0	0	0	0	0	0	0	0	0	0.0						0.0		
20	0	0	0	0	5	0	0	0	0	5	1.0	1	gramoxone				0.0		
21	0	0	0	0	3	0	0	0	0	3	0.5	1	gramoxone				0.0		
22	0	0	0	0	0	0	0	0	0	0	0.0						0.0		
23	0	0	0	0	0	0	0	0	0	0	0.0						0.0		
24	0	0	10	0	4	0	0	0	0	14	338.1		palmitos				8.2	onza	gramoxone
25	4	0	16	0	4	0	0	0	0	25	567.0		palmitos				14.4	onza	gramoxone
26	0	0	4	6	3	0	0	0	0	13	206.2		palmitos				12.4	onza	gramoxone
27	9	0	6	0	0	0	1	0	0	16	206.2		palmitos				1.0	1	foliar
Total	99	47	42	47	38	25	1	19	16	335									

farm number IX
palmheart
area: 4 ha

Activity in hours — Use of inputs

Use of inputs and labour use by week

Week Number	Acordar	Sowing	Harvesting	Removing Suckers	Fumigation	Ordenar	Fertilisation	Limpiar	Deshierbar Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant.	unit	product	Inputs 3 quant.	unit	product	Inputs 4 quant.	unit	product
1			6		32						0.7	gallo	gramoxone				150.0		palmitos			
2			38														1148.0		palmitos			
3			6		0												150.0		palmitos			
4																						
5		13	6		16						1.0	1	gramoxone				160.0		palmitos			
6		30	6		10	6	16				258.0	kg	nutran	164.0		palmitos	1.0	kg	plastic bags	0.5	1	gramoxone
7			74		28		20				344.0	kg	nutran	0.5	gallo	gramoxone	2350.0		palmitos			
8		6	6		42						1.5	1	gramoxone	220.0		palmitos						
9	6		0				32				172.0	kg	nutran									
10																						
11			10					0			150.0		palmitos									
12			6					25			140.0		palmitos									
13			6					20			150.0		palmitos									
14			11		18						2.0	1	gramoxone	290.0		palmitos						
15																						
16			6		34						1.0	gallo	gramoxone	170.0		palmitos						
17			6								100.0		palmitos									
18			10								120.0		palmitos									
19	10		5	6	6						1.0	1	gramoxone	120.0		palmitos						
20			4	12	10						150.0		palmitos	1.0	1	gramoxone						
21			24								3200.0		palmitos									
22																						
23	55		14	6	3						240.0		palmitos	1.5	1	gramoxone						
24	38		8				6				150.0		palmitos	129.0	kg	urea						
25																						
26																						
27	13		2								150.0		palmitos									
Total	122	49	254	24	199	6	74	45	0	0												

Farm number IX
palmito
area: 1 ha
Use of inputs and labour use by week

Week Number	Acordar	Sowing	Harvest-ing	Removing Suckers	Fumiga-tion	Ordenar	Fertili-sation	Limpiar	Deshierbar Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant.	unit	product	Inputs 3 quant.	unit	product	Inputs 4 quant.	unit	product
1	0	0	2	0	8	0	0	0	0	0	0.2	gallo	gramoxone	0.0			37.5		palmitos	0		
2	0	0	10	0	0	0	0	0	0	0	0.0			0.0			287.0		palmitos	0		
3	0	0	2	0	0	0	0	0	0	0	0.0			0.0			37.5		palmitos	0		
4	0	0	0	0	0	0	0	0	0	0	0.0			0.0			0.0			0		
5	0	3	2	0	4	0	0	0	0	0	0.3	l	gramoxone	0.0			40.0		palmitos	0		
6	0	8	2	0	3	2	4	0	0	0	64.5	kg	nutran	41.0		palmitos	0.3	kg	plastic bags	0	l	gramoxone
7	0	0	19	0	7	0	5	0	0	0	86.0	kg	nutran	0.1	gallo	gramoxone	587.5		palmitos	0		
8	0	2	2	0	11	0	0	0	0	0	0.4	l	gramoxone	55.0		palmitos	0.0			0		
9	2	0	0	0	0	0	8	0	0	0	43.0	kg	nutran	0.0			0.0			0		
10	0	0	0	0	0	0	0	0	0	0	0.0			0.0			0.0			0		
11	0	0	3	0	0	0	0	0	0	0	37.5		palmitos	0.0			0.0			0		
12	0	0	2	0	0	0	0	6	0	0	35.0		palmitos	0.0			0.0			0		
13	0	0	2	0	0	0	0	5	0	0	37.5		palmitos	0.0			0.0			0		
14	0	0	3	0	5	0	0	0	0	0	0.5	l	gramoxone	72.5		palmitos	0.0			0		
15	0	0	0	0	0	0	0	0	0	0	0.0			0.0			0.0			0		
16	0	0	2	0	9	0	0	0	0	0	0.3	gallo	gramoxone	42.5		palmitos	0.0			0		
17	0	0	2	0	0	0	0	0	0	0	25.0		palmitos	0.0			0.0			0		
18	0	0	3	0	0	0	0	0	0	0	30.0		palmitos	0.0			0.0			0		
19	3	0	1	2	2	0	0	0	0	0	0.3	l	gramoxone	30.0		palmitos	0.0			0		
20	0	0	1	3	3	0	0	0	0	0	37.5		palmitos	0.3	l	gramoxone	0.0			0		
21	0	0	6	0	0	0	0	0	0	0	800.0		palmitos	0.0			0.0			0		
22	0	0	0	0	0	0	0	0	0	0	0.0			0.0			0.0			0		
23	14	0	4	2	1	0	0	0	0	0	60.0		palmitos	0.4	l	gramoxone	0.0			0		
24	10	0	2	0	0	0	2	0	0	0	37.5		palmitos	32.3	kg	urea	0.0			0		
25	0	0	0	0	0	0	0	0	0	0	0.0			0.0			0.0			0		
26	0	0	0	0	0	0	0	0	0	0	0.0			0.0			0.0			0		
27	3	0	1	0	0	0	0	0	0	0	37.5		palmitos	0.0			0.0			0		
Total	31	12	64	6	50	2	19	11	0	0												

farm number X
palmheart
area: 2 ha
Use of inputs and labour use by week

Week Number	Activity in hours: Acordar	Sowing	Harvesting	Removing Suckers	Fumigation	Ordenar	Fertilisation	Limpiar	Deshierbar Deshojar	Total	Use of inputs: Inputs 1 quant.	unit	product	Inputs 2 quant.	unit	product	Inputs 3 quant.	unit	product	Inputs 4 quant.	unit	product
1					16						3.0	1	gramoxone									
2																						
3																						
4			12		16						300.0		palmitos	3.0	1	gramoxone						
5				5	5						18.0	onzas	gramoxone									
6		60									3.0	kg	plastic bags									
7																						
8					7						1.0	1	gramoxone									
9																						
10																						
11			5								200.0		palmitos									
12								15														
13			12		2						1.0	1	gramoxone	300.0		palmitos						
14																						
15	0																					
16					15						1.0	gallo	gramoxone									
17			2		15						1.0	1	gramoxone	35.0		palmitos						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
25																						
26																						
27																						
Total	0	60	31	5	76	0	0	15	0	0												

farm number X
palmheart
area: 1 ha
Use of inputs and labour use by week

Activity in hours — Use of inputs

Week Number	Acordar	Sowing	Harvesting product	Removing Suckers	Fumigation	Ordenar	Fertilisation	Limpiar	Deshierbar Deshojar	Total	Inputs 1 quant.	unit	product	Inputs 2 quant.	unit	product	Inputs 3 quant.	unit	product	Inputs 4 quant.	unit	product
1	0	0	0	0	6	0	0	0	0	0	1.5	1	gramoxone	0.0								
2	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
3	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
4	0	0	6	0	8	0	0	0	0	0	150.0		palmitos	1.5	1	gramoxone						
5	0	0	0	3	3	0	0	0	0	0	9.0	onzas	gramoxone	0.0								
6	0	30	0	0	0	0	0	0	0	0	1.5	kg	plastic bag	0.0								
7	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
8	0	0	0	0	4	0	0	0	0	0	0.5	1	gramoxone	0.0								
9	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
10	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
11	0	0	3	0	0	0	0	0	0	0	100.0		palmitos	0.0								
12	0	0	0	0	0	0	0	8	0	0	0.0			0.0								
13	0	0	6	0	1	0	0	0	0	0	0.5	1	gramoxone	150.0		palmitos						
14	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
15	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
16	0	0	0	0	8	0	0	0	0	0	0.5	gallo	gramoxone	0.0								
17	0	0	1	0	8	0	0	0	0	0	0.5	1	gramoxone	17.5		palmitos						
18	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
19	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
20	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
21	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
22	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
23	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
24	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
25	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
26	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
27	0	0	0	0	0	0	0	0	0	0	0.0			0.0								
Total	0	30	16	3	38	0	0	8	0	0												

Farm number XI
palmheart
area: 0.33 ha
Use of inputs and labour use by week

Activity in hours | Use of inputs

Week Number	Acordar	Sowing	Harvest-ing	Removing Suckers	Fumiga-tion	Orden-ar	Fertili-sation	Limpiar	Deshierbar	Total Deshojar	Inputs 1 quant.	Inputs 1 unit	Inputs 1 product	Inputs 2 quant.	Inputs 2 unit	Inputs 2 product	Inputs 3 quant.	Inputs 3 unit	Inputs 3 product	Inputs 4 Number quant.	Inputs 4 unit
1	0			13	13		4				107.5	kg	nutran	75.0	onzas	gramoxone	25.0	onza	karmex		
2																					
3																					
4																					
5								18													
6								6													
7																					
8								26													
9								12													
10							6	42			43.0	kg	10-30-10								
11							6				43.0	kg	10-30-10								
12																					
13					12						66.0	onzas	gramoxone								
14					6			6			36.0	onzas	gramoxone								
15					12						42.0	onzas	gramoxone								
16																					
17																					
18																					
19																					
20																					
21																					
22																					
23																					
24																					
25																					
26																					
27																					
Total	0	0	0	13	43	0	16	110	0	0											

* 1 workday calculated as 6 hours since feeding the cattle has also to be included.

Farm number XI
palmheart
area: 1 ha
Use of inputs and labour use by week

Activity in hours / **Use of inputs**

Week Number	Acordar	Sowing	Harvesting	Removing Suckers	Fumigation	Ordenar	Fertilisation	Limpiar	Deshierbar Deshojar	Total	Inputs 1 quant.	Inputs 1 unit	Inputs 1 product	Inputs 2 quant.	Inputs 2 unit	Inputs 2 product	Inputs 3 quant.	Inputs 3 unit	Inputs 3 product	Inputs product
4																				
quant.																				
1	0	0	0	4	4	0	1	0	0	0		kg	nutran	25	onzas	gramoxone		onza	karmex	
2	0	0	0	0	0	0	0	0	0	0	0			0						
3	0	0	0	0	0	0	0	0	0	0	0			0						
4	0	0	0	0	0	0	0	0	0	0	0			0						
5	0	0	0	0	0	0	0	6	0	0	0			0						
6	0	0	0	0	0	0	0	2	0	0	0			0						
7	0	0	0	0	0	0	0	0	0	0	0			0						
8	0	0	0	0	0	0	0	9	0	0	0			0						
9	0	0	0	0	0	0	0	4	0	0	0			0						
10	0	0	0	0	0	0	2	14	0	0	14	kg	10-30-10	0						
11	0	0	0	0	0	0	2	0	0	0	14	kg	10-30-10	0						
12	0	0	0	0	0	0	0	0	0	0	0			0						
13	0	0	0	0	4	0	0	0	0	0	22	onzas	gramoxone	0						
14	0	0	0	0	2	0	0	2	0	0	12	onzas	gramoxone	0						
15	0	0	0	0	4	0	0	0	0	0	14	onzas	gramoxone	0						
16	0	0	0	0	0	0	0	0	0	0	0			0						
17	0	0	0	0	0	0	0	0	0	0	0			0						
18	0	0	0	0	0	0	0	0	0	0	0			0						
19	0	0	0	0	0	0	0	0	0	0	0			0						
20	0	0	0	0	0	0	0	0	0	0	0			0						
21	0	0	0	0	0	0	0	0	0	0	0			0						
22	0	0	0	0	0	0	0	0	0	0	0			0						
23	0	0	0	0	0	0	0	0	0	0	0			0						
24	0	0	0	0	0	0	0	0	0	0	0			0						
25	0	0	0	0	0	0	0	0	0	0	0			0						
26	0	0	0	0	0	0	0	0	0	0	0			0						
27	0	0	0	0	0	0	0	0	0	0	0			0						
Total	0	0	0	4	14	0	5	36	0	0										

* 1 workday calculated as 6 hours since feeding the cattle has also to be included.

APPENDIX XII: NET PRESENT VALUE CALCULATIONS.

This appendix provides the estimated net return of the different crop combinations over a 4 year period and the resulting net present value. The labor use during the first year and the capital use is also indicated .

Crop combination	Years 0.5	1	1.5	2	2.5	3
Maize, mono cropped	57024	37024	57024	37024	57024	37024
With 80 % hired labor	41344	22624	41344	22624	41344	22624
With 40 % hired labor	49184	29824	49184	29824	49184	29824
Maize - cassava	32800	63500	32800	500	32800	63500
With 80 % hired labor	17760	34540	17760	-28460	17760	34540
With 40 % hired labor	25280	49020	25280	-13980	25280	49020
Maize with palmheart	41317	41317	16466	43500	81750	81750
With 80 % hired labor	12757	12757	-12094	22700	60950	60950
With 40 % hired labor	27037	27037	2186	33100	71350	71350
Pumpkin	61213	61213	61213	61213	61213	61213
With 80 % hired labor	42013	42013	42013	42013	42013	42013
With 40 % hired labor	51613	51613	51613	51613	51613	51613
Pasture	20000	20000	20000	20000	20000	20000
Palmheart	49942	49942	49942	49942	49942	49942
With 80 % hired labor	29542	29542	29542	29542	29542	29542
With 40 % hired labor	39742	39742	39742	39742	39742	39742
Palmheart new poor soil	-28500	-28500	-28500	19500	49942	57750
Palmheart new fertile soil	-28500	-28500	-28500	43500	81750	81750
Carbon	74	74	74	74	74	74
Off farm work	100	100	100	100	100	100
Bananera	156	156	156	156	156	156
Plantain	0	57640	0	57640	0	57640
With 80 % hired labor	-29440	28200	-29440	28200	-29440	28200
With 40 % hired labor	-14720	42920	-14720	42920	-14720	42920

Crop combination	Years 3.5	4	NPV 4 %	Labor 1 year hours	Capital (colones)
Maize, mono cropped	57024	37024	317921	376	1470
With 80 % hired labor	41344	22624	216576	75	15680
With 40 % hired labor	49184	29824	267248	226	9310
Maize - cassava	32800	500	222269	550	11470
With 80 % hired labor	17760	-28460	75068	110	26510
With 40 % hired labor	25280	-13980	148668	330	18990
Maize with palmheart	81750	81750	383408	715	1470
With 80 % hired labor	60950	60950	221832	143	30030
With 40 % hired labor	71350	71350	302620	429	15750
Pumpkin	61213	61213	412132	480	13000
With 80 % hired labor	42013	42013	282863	96	32200
With 40 % hired labor	51613	51613	347497	288	22600
Pasture	20000	20000	134655	40	0
Palmheart	49942	49942	336247	510	0
With 80 % hired labor	29542	29542	198899	102	20400
With 40 % hired labor	39742	39742	267573	306	10200
Palmheart new poor soil	57750	57750	110351	752	25000
Palmheart new fertile soil	81750	81750	211752	752	25000
Carbon	74	74	498	1	0
Off farm work	100	100	673	1	0
Bananera	156	156	1050	1	0
Plantain	0	57640	190233	735	20000
With 80 % hired labor	-29440	28200	-7979	147	49440
With 40 % hired labor	-14720	42920	91127	441	34720

Maize,
Source, table 24 maize (green maize)
Maize second harvest 2000 kg less * 20 colones & less labour = 16 hours in order to compensate for the lower yield during the second half of the year.

Maize - cassava,
Source, table 24.
Good cassava price --- > 9 colones/kg, 9000 kg/ha
Bad cassava price --- > 3 colones/kg, 9000 kg/ha
Capital costs: 1 ploughing = 10.000 colones
Other inputs 17.500 colones/ha/crop.
It is assummed that good and low cassava prices occur with the same frequency

Maize - palmheart
Yield of maize minus the input costs of palmheart
Yield decline of 1500 kg * 20 colones in the third harvest
Palmheart between 2 and 2.5 year
Output: 3000*24 = 72.000 colones = financial yield
10 l gramoxone * 600 = 6000
15 * 46 kg fertiliser = 15 * 1500 =22500
Total input costs palmheart = 28.500 colones
(from the second year onwards)
From the third year onwards --> 6000 palmitos/ ha
6000*24 =144000 colones
Gross Margin 144.000 - 28500 =115500 /2
Capital costs pumpkin = 10.000 (ploughing) + 3.000 (seed)

Palmheart new poor soil
Palmheart between 2 and 2.5 year
Output: 2000*24 = 48.000 colones = financial yield
Input costs 28.500 colones, plantingmaterial
Labordata from the Programa Nacional
Capital estimated with 5 colones per plant * 5000 plants per ha.

Plantain
5*5 m --> 400 plantains * 150 colones/bunch = 60000 * (9/12)
= 80.000 colones bunch yield
Costs: 4.8 l herbicides * 700 colones and 4000 colones nematicides
460 kg fertiliser ==> 10 * 1500 = 15.000
Total costs 22360 colones
Capital costs: seeds ---> 400 plants * 50 colones.

Carbon
74 colones/hour (table 24)

Off- farm work
100 colones /hour.

Off- farm work/ bananera
Based upon 56 hours/week and 15.000 colones every 14 days (table 24). This is a rather low estimation. It is possible to earn 20.000-22.000 colones every 14 days depending on the work and work availability at the banana plantations.

Overall assumptions:
Costs of labor 100 colones/ hour
Costs of inputs do not change over time.

APPENDIX XIII: THE FARM MODEL

The linear programming tableau is portrayed below. The different values of the variables and constraints are incorporated in the matrix. The Right-hand side (RHS) shows the fixed resource supplies. Some of the algebraic functions of the model are presented on page two. The condensed results of the primal and dual solution of the different farm models are presented from page two onwards.

NEGUEV	OBJECTIVE: MAX	VARIABLES: 24	DATE 01-05-1992
BASIS: NONE	CONSTRAINTS: 11	SLACKS: 8	TIME 16:09:08

	MAI00	MAI08	MAI04	MAC00	MAC08	MAC04	MAP00	
RETURN	317.90	216.60	267.20	222.70	75.070	148.70	383.40	RETURN
LABOR	376.00	76.000	226.00	550.00	110.00	330.00	715.00	LABOR
LAND	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	LAND
CAPITAL	1.4700	15.680	9.3100	11.470	26.510	18.990	1.4700	CAPITAL
FERTILITY	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	FERTILITY
LOCATION	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	LOCATION
PASTURE								PASTURE
CARBON								CARBON
PUMPKIN								PUMPKIN
PAL AREA								PAL AREA
OF1								OF1
OF2								OF2

	MAP08	MAP04	PUM00	PUM08	PUM04	PAS	PAL00	
RETURN	221.80	302.60	412.10	282.80	347.50	134.60	336.20	RETURN
LABOR	143.00	429.00	480.00	96.000	288.00	40.000	510.00	LABOR
LAND	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	LAND
CAPITAL	30.030	15.750	13.000	32.200	22.600			CAPITAL
FERTILITY	1.0000	1.0000	1.0000	1.0000	1.0000			FERTILITY
LOCATION	1.0000	1.0000	1.0000	1.0000	1.0000			LOCATION
PASTURE								PASTURE
CARBON								CARBON
PUMPKIN			1.0000	1.0000	1.0000			PUMPKIN
PAL AREA							1.0000	PAL AREA
OF1								OF1
OF2								OF2

	PAL08	PAL04	PNP	PNF	CAR	OF1	OF2	
RETURN	198.90	267.60	110.40	211.80	.49800	.67300	1.0500	RETURN
LABOR	102.00	306.00	752.00	752.00	1.0000	1.0000	1.0000	LABOR
LAND	1.0000	1.0000	1.0000	1.0000				LAND
CAPITAL	20.400	10.200	25.000	25.000				CAPITAL
FERTILITY				1.0000				FERTILITY
LOCATION								LOCATION
PASTURE								PASTURE
CARBON					1.0000			CARBON
PUMPKIN								PUMPKIN
PAL AREA	1.0000	1.0000						PAL AREA
OF1						1.0000		OF1
OF2							1.0000	OF2

	PLA00	PLA08	PLA04		RHS	
RETURN	190.20	-7.7980	91.130		.0000000	RETURN
LABOR	735.00	147.00	441.00	<=	1800.000	LABOR
LAND	1.0000	1.0000	1.0000	=	15.00000	LAND
CAPITAL	20.000	49.400	34.720	<=	.0000000	CAPITAL
FERTILITY	1.0000	1.0000	1.0000	<=	15.00000	FERTILITY
LOCATION	2.0000	2.0000	2.0000	<=	30.00000	LOCATION
PASTURE				>=	.0000000	PASTURE
CARBON				=	.0000000	CARBON
PUMPKIN				<=	2.000000	PUMPKIN
PAL AREA				=	1.000000	PAL AREA
OF1				<=	500.0000	OF1
OF2				>=	.0000000	OF2
	PLA00	PLA08	PLA04		RHS	

A part of the algebraic version of the model is presented below.

The objective function which has to be maximised.

```
RETURN      +317.9*MAI00+216.6*MAI08+267.2*MAI04+222.7*MAC00+75.07*MAC08+148.7*
            MAC04+383.4*MAP00+221.8*MAP08+302.6*MAP04+412.1*PUM00+282.8*PUM08+
            347.5*PUM04+134.6*PAS+336.2*PAL00+198.9*PAL08+267.6*PAL04+110.4*PNP+
            211.8*PNF+.498*CAR+.673*OF1+1.05*OF2+190.2*PLAO0-7.798*PLAO8+91.13*
            PLA04 = MAXIMAL
```

The resourche function for labor which describes the the utilisation of labor by the various variables and limits labor to a maximum of 1800 hours.

```
LABOR       376*MAI00+76*MAI08+226*MAI04+550*MAC00+110*MAC08+330*MAC04+715*
            MAP00+143*MAP08+429*MAP04+480*PUM00+96*PUM08+288*PUM04+40*PAS+510*
            PAL00+102*PAL08+306*PAL04+752*PNP+752*PNF+(CAR+..+OF2)+735*PLAO0+
            147*PLAO8+441*PLA04<=1800
```

The resourche function for land, indicating to what extent variables are utilising land.

```
LAND        (MAI00+..+PNF)+(PLAO0+..+PLA04)=15
```

The resourche function for capital, indicating to what extent variables are utilising land.

```
CAPITAL     1.47*MAI00+15.68*MAI08+9.31*MAI04+11.47*MAC00+26.51*MAC08+18.99*
            MAC04+1.47*MAP00+30.03*MAP08+15.75*MAP04+13*PUM00+32.2*PUM08+22.6*
            PUM04+20.4*PAL08+10.2*PAL04+25*PNP+25*PNF+20*PLAO0+49.4*PLAO8+34.72*
            PLA04<=0
```

The resourche function for soil fertility, indicating to what extent variables are utilising/ need soil fertility.

```
FERTILITY   (MAI00+..+PUM04)+PNF+(PLAO0+..+PLA04)<=15
```

The resourche function for location, indicating to what extent variables are utilising location parameters.

```
LOCATION    (MAI00+..+PUM04)+2*(PLAO0+..+PLA04)<=30
```

Other resourche functions which are varied in the model:

```
PASTURE
CARBON
PUMPKIN     (PUM00+..+PUM04)<=2
PAL AREA    (PAL00+..+PAL04)=1
OF1
OF2
```

Summerised results of LP 88 for farm 1. Only the main results are presented here. The primary solution provides the resulting farming system and return. The dual solution indicates if a constraint is binding. The schaduw price of that constraint (dual value). The right-hand value of the constraints which is different for each model the use of the constraint and the unused amount of constraint (slack).

FARM1 — SOLUTION IS MAXIMUM — RETURN 2019.000000 — DATE 31-12-1991
PRIMAL PROBLEM SOLUTION — TIME 17:25:55

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	15.000000	134.60000	134.60000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	NONBINDING	.00000000	1800.0000	600.00000	1200.0000
LAND	BINDING	134.60000	15.000000	15.000000	.00000000
CAPITAL	BINDING	169.25170	.00000000	.00000000	.00000000
FERTILITY	NONBINDING	.00000000	.00000000	.00000000	.00000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	.49800000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	201.60000	.00000000	.00000000	.00000000
OF1	BINDING	.67300000	.00000000	.00000000	.00000000
OF2	BINDING	1.0500000	.00000000	.00000000	.00000000

FARM2 — SOLUTION IS MAXIMUM — RETURN 2019.000000 — DATE 31-12-1991
PRIMAL PROBLEM SOLUTION — TIME 17:30:37

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	15.000000	134.60000	134.60000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	NONBINDING	.00000000	1800.0000	600.00000	1200.0000
LAND	BINDING	134.60000	15.000000	15.000000	.00000000
CAPITAL	NONBINDING	100.00000	100.00000	.00000000	100.00000
FERTILITY	BINDING	277.50000	.00000000	.00000000	.00000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	.49800000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	201.60000	.00000000	.00000000	.00000000
OF1	BINDING	.67300000	.00000000	.00000000	.00000000
OF2	BINDING	1.0500000	.00000000	.00000000	.00000000

FARM3 — SOLUTION IS MAXIMUM — RETURN 3279.000000 — DATE 31-12-1991
PRIMAL PROBLEM SOLUTION — TIME 17:35:22

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	15.000000	134.60000	134.60000	.00000000
OF2	BASIS	1200.0000	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	15.000000	15.000000	.00000000
CAPITAL	NONBINDING	.00000000	100.00000	.00000000	100.00000
FERTILITY	BINDING	89.400000	.00000000	.00000000	.00000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	NONBINDING	.00000000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-.80000000	.00000000	.00000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	1200.0000	600.00000

FARM4 SOLUTION IS MAXIMUM RETURN 3278.200000 DATE 31-12-1991
PRIMAL PROBLEM SOLUTION TIME 17:37:54

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	14.000000	134.60000	134.60000	.00000000
PAL08	BASIS	1.0000000	198.90000	198.90000	.00000000
OF2	BASIS	1138.0000	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	15.000000	15.000000	.00000000
CAPITAL	NONBINDING	.00000000	100.00000	20.400000	79.600000
FERTILITY	BINDING	89.400000	.00000000	.00000000	.00000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	NONBINDING	.00000000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-.80000000	1.0000000	1.0000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	1138.0000	662.00000

FARM5 SOLUTION IS MAXIMUM RETURN 2987.100000 DATE 31-12-1991
PRIMAL PROBLEM SOLUTION TIME 17:39:52

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	14.000000	134.60000	134.60000	.00000000
PALOO	BASIS	1.0000000	336.20000	336.20000	.00000000
OF2	BASIS	730.00000	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	15.000000	15.000000	.00000000
CAPITAL	BINDING	14.274510	.00000000	.00000000	.00000000
FERTILITY	NONBINDING	.00000000	.00000000	.00000000	.00000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	NONBINDING	.00000000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-291.90000	1.0000000	1.0000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	730.00000	1070.0000

FARM6 SOLUTION IS MAXIMUM RETURN 2019.000000 DATE 31-12-1992
PRIMAL PROBLEM SOLUTION TIME 17:47:31

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	15.000000	134.60000	134.60000	.00000000
S.1	BASIS	1200.0000	.00000000	.00000000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	NONBINDING	.00000000	1800.0000	600.00000	1200.0000
LAND	BINDING	134.60000	15.000000	15.000000	.00000000
CAPITAL	BINDING	169.25170	.00000000	.00000000	.00000000
FERTILITY	NONBINDING	.00000000	15.000000	.00000000	15.000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	.49800000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	201.60000	.00000000	.00000000	.00000000
OF1	BINDING	.67300000	.00000000	.00000000	.00000000
OF2	BINDING	1.0500000	.00000000	.00000000	.00000000

FARM7	SOLUTION IS MAXIMUM		RETURN	3054.295309	DATE	31-12-1992
	PRIMAL PROBLEM SOLUTION				TIME	17:46:19

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
MAI00	BASIS	2.9174240	317.90000	317.90000	.00000000
MAI08	BASIS	6.1040425	216.60000	216.60000	.00000000
PAS	BASIS	5.9785335	134.60000	134.60000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	.52795941	1800.0000	1800.0000	.00000000
LAND	BINDING	113.48162	15.000000	15.000000	.00000000
CAPITAL	BINDING	4.0174401	100.00000	100.00000	.00000000
FERTILITY	NONBINDING	.00000000	15.000000	9.0214665	5.9785335
LOCATION	NONBINDING	.00000000	30.000000	9.0214665	20.978533
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	-.02995941	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-46.540924	.00000000	.00000000	.00000000
OF1	BINDING	.14504059	.00000000	.00000000	.00000000
OF2	BINDING	.52204059	.00000000	.00000000	.00000000

FARM8	SOLUTION IS MAXIMUM		RETURN	3560.887755	DATE	31-12-1992
	PRIMAL PROBLEM SOLUTION				TIME	17:49:27

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
MAI08	BASIS	6.3775510	216.60000	216.60000	.00000000
PAS	BASIS	8.6224490	134.60000	134.60000	.00000000
OF2	BASIS	970.40816	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	15.000000	15.000000	.00000000
CAPITAL	BINDING	2.8188776	100.00000	100.00000	.00000000
FERTILITY	NONBINDING	.00000000	15.000000	6.3775510	8.6224490
LOCATION	NONBINDING	.00000000	30.000000	6.3775510	23.622449
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	-.55200000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-58.305102	.00000000	.00000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	970.40816	829.59184

FARM9	SOLUTION IS MAXIMUM		RETURN	3502.582653	DATE	31-12-1991
	PRIMAL PROBLEM SOLUTION				TIME	17:51:11

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
MAI08	BASIS	5.0765306	216.60000	216.60000	.00000000
PAS	BASIS	8.9234694	134.60000	134.60000	.00000000
PAL08	BASIS	1.0000000	198.90000	198.90000	.00000000
OF2	BASIS	955.24490	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	15.000000	15.000000	.00000000
CAPITAL	BINDING	2.8188776	100.00000	100.00000	.00000000
FERTILITY	NONBINDING	.00000000	15.000000	5.0765306	9.9234694
LOCATION	NONBINDING	.00000000	30.000000	5.0765306	24.923469
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	-.55200000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-58.305102	1.0000000	1.0000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	955.24490	844.75510

FARM10 SOLUTION IS MAXIMUM RETURN 2987.100000 DATE 31-12-1991
PRIMAL PROBLEM SOLUTION TIME 17:52:46

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	14.000000	134.60000	134.60000	.00000000
PALOO	BASIS	1.0000000	336.20000	336.20000	.00000000
OF2	BASIS	730.00000	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	15.000000	15.000000	.00000000
CAPITAL	BINDING	14.274510	.00000000	.00000000	.00000000
FERTILITY	NONBINDING	.00000000	15.000000	.00000000	15.000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	NONBINDING	.00000000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-291.90000	1.0000000	1.0000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	730.00000	1070.0000

FARM11 SOLUTION IS MAXIMUM RETURN 4949.887755 DATE 31-12-1991
PRIMAL PROBLEM SOLUTION TIME 17:56:29

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
MAI08	BASIS	6.3775510	216.60000	216.60000	.00000000
PAS	BASIS	23.622449	134.60000	134.60000	.00000000
OF2	BASIS	370.40816	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	30.000000	30.000000	.00000000
CAPITAL	BINDING	2.8188776	100.00000	100.000000	.00000000
FERTILITY	NONBINDING	.00000000	30.000000	6.3775510	23.622449
LOCATION	NONBINDING	.00000000	30.000000	6.3775510	23.622449
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	-.55200000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-58.305102	.00000000	.00000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	370.40816	1429.5918

FARM12 SOLUTION IS MAXIMUM RETURN 4756.519660 DATE 31-12-1991
PRIMAL PROBLEM SOLUTION TIME 17:57:52

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
MAI00	BASIS	1.1135909	317.90000	317.90000	.00000000
MAI08	BASIS	6.2731519	216.60000	216.60000	.00000000
PAS	BASIS	22.613257	134.60000	134.60000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	.52795941	1800.0000	1800.0000	.00000000
LAND	BINDING	113.48162	30.000000	30.000000	.00000000
CAPITAL	BINDING	4.0174401	100.00000	100.00000	.00000000
FERTILITY	NONBINDING	.00000000	30.000000	7.3867427	22.613257
LOCATION	NONBINDING	.00000000	30.000000	7.3867427	22.613257
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	BINDING	-.02995941	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-46.540924	.00000000	.00000000	.00000000
OF1	BINDING	.14504059	.00000000	.00000000	.00000000
OF2	BINDING	.52204059	.00000000	.00000000	.00000000

FARM13	SOLUTION IS MAXIMUM		RETURN	4668.000000	DATE 31-12-1991
	PRIMAL PROBLEM SOLUTION				TIME 17:59:22

VARIABLE	STATUS	VALUE	RETURN/UNIT	VALUE/UNIT	NET RETURN
PAS	BASIS	30.000000	134.60000	134.60000	.00000000
OF2	BASIS	600.00000	1.0500000	1.0500000	.00000000

DUAL SOLUTION

CONSTRAINT	STATUS	DUAL VALUE	RHS VALUE	USAGE	SLACK
LABOR	BINDING	1.0500000	1800.0000	1800.0000	.00000000
LAND	BINDING	92.600000	30.000000	30.000000	.00000000
CAPITAL	NONBINDING	.00000000	100.00000	.00000000	100.00000
FERTILITY	BINDING	89.400000	.00000000	.00000000	.00000000
LOCATION	NONBINDING	.00000000	30.000000	.00000000	30.000000
PASTURE	NONBINDING	.00000000	.00000000	.00000000	.00000000
CARBON	NONBINDING	.00000000	.00000000	.00000000	.00000000
PUMPKIN	NONBINDING	.00000000	2.0000000	.00000000	2.0000000
PAL AREA	BINDING	-.80000000	.00000000	.00000000	.00000000
OF1	NONBINDING	.00000000	1800.0000	.00000000	1800.0000
OF2	NONBINDING	.00000000	1800.0000	600.00000	1200.0000

APPENDIX XIV: CULTIVATION TERMS

The different terms as used by farmers during the research are presented below.

Acordonar,
Putting the dead leafs and debris in the middle of the alley.

Rodagar,
Cleaning around the base of the palmheart. If this is done with a pole it is called palear.

Limpiar,
Removing weeds with an machete, cutting them and leaving only naked earth.

Chapear,
Removing weeds with an machete but not as thorough as with limpiar.

Deshogar,
Removing old leaves or leaves which are hindering the throughway.

Deshijgar,
Removing the suckers. Normal practice is to leave 4 suckers of a different age per plant hole. This is done manually or by touching the plant with herbicide (gramoxone).

Fumigation,
Is labor consuming, since it has to be often with small doses. Since palmheart has a very superficious root system concurrence with weeds is high. A small experiment, introducing Arachis as mulch crop failed because it experienced too much concurrence during establishment.

The difference between several activities is minimal and not always differentiated by the farmers themselves. Limpiar might include rodagar or chapear, ignoring the small differences. Differences are in practice small and activities often combined in practice with for instance deshijgar with deshojar or limpiar. Activities are however connected. Fertilizer gifts can be lower if more time is spend removing suckers and weeds thereby diminizing the sinks.