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COFFEE CULTIVATION IN THE WATERSHED OF THE RIVER ARANJUEZ

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CENTRO AGRONOMICO TROPICAL DE
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GANADERIA DE COSTA RICA (MAG)

THE REPOSA PROJECT

The Research Program on Sustainability in Agriculture (REPOSA) is a cooperation between Wageningen Agricultural University (WAU), the Center for Research and Education in Tropical Agriculture (CATIE), and the Costa Rican Ministry of Agriculture and Livestock (MAG). In addition, REPOSA has signed memoranda of understanding with numerous academic, governmental, international and non-governmental organizations in Costa Rica.
The overall objective of REPOSA is the development of an interdisciplinary methodology for land use evaluation at various levels of aggregation. The methodology, based on a modular approach to the integration of different models and data bases, is denominated *USTED* (*Uso Sostenible de Tierras En el Desarrollo*; Sustainable Land Use in Development).
REPOSA provides research and practical training facilities for students from WAU as well as from other Dutch and regional educational institutions.
REPOSA's research results are actively disseminated through scientific publications, internal reports, students' thesis, and presentations at national and international conferences and symposia. Demonstrations are conducted regularly to familiarize interested researchers and organizations from both within and outside Costa Rica with the *USTED* methodology.
REPOSA is financed entirely by WAU under its Sustainable Land Use in the Tropics program, sub-program Sustainable Land Use in Central America. It operates mainly out of Guápiles where it is located on the experimental station *Los Diamantes* of MAG.

EL PROYECTO REPOSA

REPOSA (*Research Program on Sustainability in Agriculture*, o sea Programa de Investigación sobre la Sostenibilidad en la Agricultura) es una cooperación entre la Universidad Agrícola de Wageningen, Holanda (UAW), el Centro Agronómico Trópical de Investigación y Enseñanza (CATIE) y el Ministerio de Agricultura y Ganadería de Costa Rica (MAG). Además REPOSA ha firmado cartas de entendimiento con organizaciones académicas, gubernamentales, internacionales y non-gubernamentales en Costa Rica.
REPOSA ha desarollado una metodología cuantitativa para el análisis del uso sostenible de la tierra para apoyar la toma de decisiones a nivel regional. Esta metodología, llamada USTED (Uso Sostenible de Tierras En el Desarollo) involucra dimensiones económicas y ecológicas, incluyendo aspectos edafológicos y agronómicos.
REPOSA ofrece facilidades para investigaciones y enseñanza para estudiantes tanto de la UAW, como de otras institutiones educacionales holandesas y regionales.
REPOSA publica sus resultados en revistas científicas, tesis de grado, informes informales, y ponencias en conferencias y talleres. REPOSA regularmente organiza demostraciones para investigadores de Costa Rica y de otros países para familiarizarlos con la metodología USTED.
REPOSA es financiado por la UAW bajo su Programa del Uso Sostenible de la Tierra en los Areas Trópicos. La sede de REPOSA está ubicada en la Estación Experimental Los Diamantes del MAG en Guápiles.

Preface

During a period of 15 weeks, from July to Oktober 1997, I researched coffee cultivation. The studie has been carried out within the context of REPOSA (Research Programme on Sustainablility in Agriculture).
Research was done to describe and to quantify the cultivation operations of coffee. To obtain data, a survey was done to a group of coffee farmers who live in the watershed of the river Aranjuez. Almost all coffee farmers in the watershed are members of the coffee cooperative 'Montes de Oro R.L.'. The survey was done with help of the cooperative.

The work was supervised by Dr. Bas Bouman in Costa Rica and by Ir. Theo Guiking from the Department of Agronomy from the Agricultural University Wageningen. Also Ing. Carlos Aragon Ramírez, Dr. André Nieuwenhuyse and Ir. Huib Hengsdijk assisted with their advice. I would like to thank them all for their good advice. Furthermore I would like to thank all farmer members and employees of the cooperative who made possible I could do the survey. Especially I want to name Victor Julio Arce (manager of the cooperative), Alvaro Chaves Saborío (public relations), Johel (Technical expert) and Alvaro Porras (Administor of the beneficio). Last but not least I want to thank my collegue students and friends (Arja van de Valk, Kathryn Faulkner, Wendy Hesseling, Ytha Kempes, Harke Dijksterhuis, Jelger de Vriend and Karel van Riel) for their support, friendship and company.

Contents

Appendices

List of tables

List of figures

1 Introduction

The work presented in this report was carried out within the context of REPOSA (Research Programme on Sustainabilility in Agriculture). The overall objective of REPOSA is the development of an interdisciplinary methodology for land use evaluation. With this methodology the programme wants to explore alternative land use options while maximising regional added values. These maximisation's are restricted by sustainable, environmental and/or economical restrictions.

One part of the methodology is the input of data of land use systems into the model. The data is defined in LUSTs (Land use systems at a defined Technology). LUST is a description of a land use system (a crop cultivation or livestock type) at a certain level of technology (Jansen et al, 1995). Land use system can be executed at several levels of technology. That is why one land use system can also have several LUSTs.

First the model was made for the Atlantic Zone, a small area in the north-east of Costa Rica. The program of REPOSA will finish her task in the end of 1998. In future the developed methodology will be used by MAG, the Costa Rican Ministry of Agriculture and Livestock. During handing over the methodology, people of REPOSA will instruct the people of MAG about the methodology and accessory computer model. This will be done in another region of Costa Rica, the watershed of the river Aranjuez. One of the land use activities in the watershed is coffee cultivation.

Coffee cultivation in the watershed is more or less regulated by the coffee co-operative Coopemontes de Oro, R.L.. One of the objectives of the co-operative is to produce organic coffee. Many farmers of the co-operative want to transform their current (= chemical) cultivation into organic cultivation, without using chemicals. But transformation is not that easy. A few farmers are producing organic already and some are in a period of transforming their manner of current cultivation by decreasing their chemical use.

Till now there were no LUSTs about coffee cultivation. Objective of this student research was to obtain information about coffee cultivation in the watershed. The information shall be used to create LUSTs about coffee cultivation. In the watershed there are mainly two manners of cultivation: organic and chemical. To obtain information about the two manners of coffee cultivation a survey was done in a group of coffee cultivators, all members of the coffee cooperative.

Data about prices in this report are given in Colones (¢). These are the prices given in August 1997. Then the exchange rate was 238 Colones (¢) for 1 dollar ($).

2 Coffee

Coffee is an evergreen shrub or small tree, native to the tropical rain forest. The leaves are dark-green and glossy. Coffee is a perennial crop. The cultivated plant begins to bear fruits when it is 3 years old and may continue to do for many years. After some years the production decreases. Farmers in the watershed keep the plants for 15 to 20 years in production.

2.1 Taxonomy

Coffea is a member of the family Rubriaceae. The only economic genera are Coffea (coffee) and Cinchona (quinine). The genus Coffea includes about 60 species. Most of the world's produced coffee, 80%, comes from the species C. Arabica. Other species are C. Canephora and C. Liberia respectively responsible for about 20 and less than 1 percent of the world production.(Purseglove, 1987)
In the watershed they only grow varieties of the species C. Arabica. The varieties that are used are Caturra and Catuaí. Following data will all be specific about this species.

2.2 Origin

Arabica coffee is native of the highland, wet forests of Ethiopia where it grows wild as a constituent of understory of shrubby vegetation. It is a small tree which grows up to 5 m tall. In cultivation the form of the tree is controlled by pruning to produce a densely branched bush 2 to 3 m tall . (Purseglove,1987)

2.3 Morphology

The roots can grow 1,5 metre deep. It has been determined that the largest amount of the roots is located in the upper 30 centimetre of the soil.
The plant has two types of branches: orthotropic and plagiotropic. The main vertical branch is orthotropic. The side branches are plagiotropic. Flowers only will grow on the one year old plagiotropic branches. Each branch has a growing node. Every year the growth of the branch decreases. Due to pruning the farmer can stimulate the plant to form new branches. (Anonymous, 1988)
The leaves are 12-15 cm long and 5-6 cm broad. They grow both on orthotropic and plagiotropic branches. Typical to coffee the leaves don't have stomata's in the leave surface but have other organs situated close to the veins at the under-surface. These organs are named domatias.

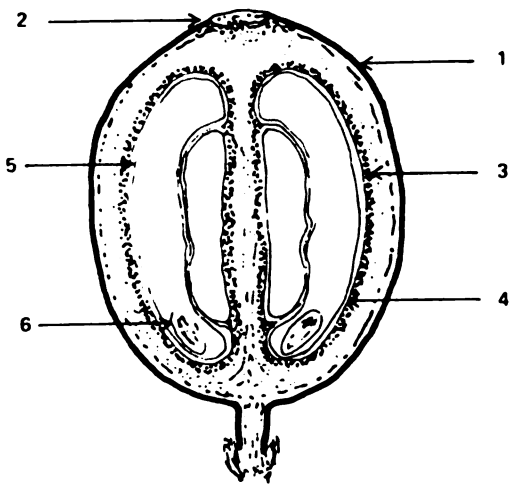

Fig. 2.1 Longitudinal section of a coffee berry: 1. epicarp; 2. navel; 3. mesocarp; 4. endocarp (coffee hull); 5, spermoderm (silver skin); 6. embryo. (Bressani et al., 1979)

(Anonymous, 1988)
The flowers are hermaphrodites, which means they contain both male and female organs. The flowers are placed in clusters in the axils of leaves and branches. The flowers are white and heavily scented.
The fruits are ellipsoidal in shaped. They develop over a period of 7-9 months from green to yellow (yellow varieties) or through yellow to crimson (red). The ripe fruits are called 'berries'. In cross section the coffee berry shows four anatomical fractions: the pulp or esocarp, a layer of mucilage or the mesocarp, the endocarp or coffee hull and the heart of the berry consists of two (sometimes three) grey-green beans of about 12-15 mm long. One kilo fresh coffee berries consists of 432 g coffee pulp, 118 g mucilage and free sugars (estimated), 61 g coffee hull and 389 of coffee bean. Dry weight percentage of the final coffee bean from one kilo fresh beans is 19.1 per cent (Table 2.1). (Bressani et al., 1979)

Table 2.1: Material balance of coffee beans (bressani et al., 1979)

berry component	fresh weight (g)	moisture (%)	dry weight (g)
berry	1000	65.5	345
pulp (esocarp)	432	77.0	99
mucilage (mesocarp)	118	85.5	17
hull (endocarp)	61	32.0	41
beans	389	51.0	191

2.4 Climatical and geographical conditions

Coffee can be grown from sea level till 1500 metre. Best conditions can be found between 800 and 1300 metre. The minimum precipitation needs to be 1400 mm. The temperature for normal development of the crop should be between 17 and 24 ^{o}C. Seasonal short periods with little rainfall and cool temperature restrict vegetative growth. When the climate is warm and wet all year and there is no seasonal check to growth, excessive fruits production may deplete food reserves that young shoots die. (Cobley, 1986)
From origin coffee is a shadow crop. However according to experiences the cultivated plants have a higher production of dry matter when the plant is in full-sun condition. Wind is an important aspect of the cultivation. Wind harms the production. Wind causes mechanical damage to young leaves which give rise to diseases like 'Derrite' (Anonymous, 1991)
All species grow best on a deep, fertile, well drained, loamy soil (Cobley, 1986). The plant requires soils with a depth of 1.5 metre which permits a normal development of the roots. The soil should be open and well drained. Soil that are very clayey or sandy are not recommended.
The pH of the soil should be 6 to 6.5. But also with a lower pH the plant obtains a good production. A minimum pH level for coffee is not known. In soils with a pH lower than 4 aluminium (Al) dissolves which has a poisoning effect on the roots and fixates other nutrients. A high pH over 7.5 causes insolubility of other elements like Iron (Fe).

2.5 Pests and diseases

Coffee has a lot of enemies. First are mentioned pests of soil organism:
- Nematodes (Meloidogyne sp.): they attack the roots and can be detected by presence of nodules in the roots and general chlorosis and premature downfall of leaves and fruits.
- Piojito de la raiz (Neorhizoecus coffeae): They settle in the rind of the roots and suck juice out the roots. Symptoms can be confounded with other diseases. The stem stays slim, short and fragile and has just a few leaves.

Other problems, diseases, are caused by the fungi:
- Ojo de gallo is caused by the fungus Mycena citricolor which develops in coffee fields with excessive shade, bad ventilation, low temperatures and a cloudy or humid climate. The disease manifests as round spots on the leave surface that cause decrease in photosynthesis. But also fruits and young branches are affected. Weed can be the host of the fungus. Ojo de Gallo could be avoided or reduced by regulation of shade, weed control, sanitarial pruning and fertilisation. There are preventive and curative chemicals. In the watershed Ojo de Gallo can be found especially in the higher parts like in the surroundings of Cedral, Palmital and San Rafael. Farmers with a lot of shadow in their field also have risk to Ojo de Gallo. (Anonymous, 1990).
- Roya is a disease of rainy and warm regions at places with a lack of direct light. Roya is caused by the fungus Hemileia vastratix. The fungus first affects the under-surface of the leave. It causes yellow spots at the upper surface and finally are developed brown spots and holes. The spots reduce photosynthesis and production. Chemical control is done by products that contain cupre like Cardo borales and Cobre Sandoz. Surroundings of San Buenaventura, Bajo Caliente and villages more north-east of Bajo Caliente have more problems with Roya. Probably Roya is the most destructive disease of coffee. (Anonymous, 1988)
- Derrite is caused by the fungus Phoma costarricensis and affect mostly in coffee field at high altitude with a cloudy humid climate and low temperatures and cold winds. Derrite can be detected by the dark borders of young leaves. Also young branches and fruits can be affected. (Anonymous, 1990)
- Chasparria is caused by the fungus Cercóspora coffeicola during cold, humid and periods with less light. The control of the diseases is preventive only.

2.6 Cultivation

Coffee cultivation depends on local climate. Information about cultivation operations is based on the watershed location.

2.6.1 Tree nursery

The coffee plants are propagated form seed (can also be propagated vegetatively). The seeds are sown in the beginning of the rain season (April, May). After a few months they are transplanted per pair in a small field or into bags. These are the operations of a tree nursery. But also many farmers have personal coffee nursery.

2.6.2 Transplanting

Transplantation into the field is executed in the following year. The field preparation consists of weed control, ploughing and measures to control soil conservation like construction of ditches and/or barriers. Ditches and barriers are more or less the same. In both measures the field is transformed in contours with barriers and ditches. The plants are planted on the higher places. Field preparation is done during the summer (March-April) so the field will be ready for planting when the rain season starts in April or May. Mostly the fields are not plain. Plants needs to be planted on contour. Spacing of the plants depends on altitude and cultivation manner of the farmer. Plant density varies between 3,000 and 5,000 per hectare. Operations during planting are digging holes and putting down broza (remainder of pulped coffee fruits) in it. Coffee plants are always transplanted per pair, but a pair of plants must be seen as one plant.

2.6.3 Weed control

Weed has to be controlled because weeds reduce the coffee production and can be host of pests and diseases. Weed control can be done in chemical, manual and mechanical (motor mower) manner depending on the type cultivation type.
Every farmer has his own schedule of weed control. All farmers control the weed before fertilising. Mostly the first control is in May, followed by one or two times during winter (May-September) and the last control is at the beginning of the harvest period (September till February). Organic farmers only have manual or mechanical weed control. In general the chemical farmers have manual weed control during the winter when they have enough time. Their last weed control at the beginning of the harvest is chemical. The chemicals they use are Paraquat and Round-up. The effect of the products is different. Round-up works slowly but is very effective for a long period. Paraquat works very fast (within a few hours after application) but is twice as expensive as Round-up.

2.6.4 Manure/Fertilisers

The sort of use of fertilisers depends on the type of farmer. Organic farmers only use gallinaza (chicken manure) and broza (remainder of the pulped coffee fruits). Current farmers only use synthetic fertilisers.

2.6.5 Pests and diseases

Chemical farmers control pests and diseases preventive and curative with chemical products. Organic farmers do not use chemicals and can only execute a preventive cultivation.

2.6.6 Harvest

Coffee bushes begin to bear fruit when they are 3 years old and may continue to do so for many years. The fruits ripe within 7 to 9 months.
There is no clear difference between the harvest period of organic and current coffee. The harvest starts in September, October and ends in February. The harvest peak is in December. Only in the area around the village Laguna the harvest starts later, in December and ends in February.

2.6.7 Pruning

Coffee farmers need to prune their plants to maintain production and to decrease incidences of diseases (anonymous, 1989).
First pruning of a coffee field is after five or six years. Mostly the next pruning is after every four years. Maximum age of the plants is 15 to 20 years what means that the plants mostly are pruned 3 or 4 times. There are different types of pruning: selective and total pruning. Selective pruning means that a part of the field is pruned every year: a third, a fourth or a fifth part. It depends on the pruning-cycle: respectively a three, four or five year cycle. Selective pruning can be executed in lines or per parts. Total pruning means that the field is pruned totally every three to five years.

2.7 Shade

Coffee, native to the tropical rain forests, is common to be shaded by forest trees (Cobley, 1986). Traditional coffee cultivators grow shade trees. Sometimes they use a lot of different species. This traditional overstory of shade trees often includes fruit trees, hard-wood species and herbaceous plants that create an agro-forestry system in which the coffee grows. Different sorts of trees give a structural diversity and provides niches for innumerable organisms. But the agro-forestry profile of traditional shade coffee in many areas has given way to full-sun or near-sun coffee. Although the production will be higher there is a negative effects on environment. This negative effect is caused by new fertiliser-responsive coffee cultivars and the higher use of other agro-chemicals. The latter because increased sun in the field provides prime habitat for weeds. (Rice, 1996)

In a favourable environment and with intensive cultivation, coffee grows satisfactorily without shade. Mostly unshaded coffee has a higher yield, but gives some troubles to cultivation: over-bearing, die-back, erosion, biannual bearing, disease and short productive life (Purseglove, 1987). Shade has a lot of benefits besides disadvantage. According to Pursglove shade trees prevent the crop to above-mentioned problems. Other advantages are: a more even annual cropping , providing a favourable micro-climate, reduction of evaporation and transpiration, production and protection against a fast breakdown of organic material. Shade trees also should reduce costs of weeding and helps to keep out grass and may provide useful products like fruits, firewood, timber.
The disadvantage is the compatibility of shade tree and crop for water, light and nutrients. A disadvantage that is not mentioned could be the extra labour to manage shade trees.

2.8 Postharvest

After picking, the pulp must be removed from the coffee fruit. One method, the wet pulping, is done as follows: The mesocarp is removed in a pulping machine, after which the washed fruits, still within the hull, are left to ferment for one day. Then the seeds are washed and dried in the sun or by machine. The hull must be removed before roasting.
Dry pulping: the fruits are dried in the sun for 2-3 weeks, stirred every day. The dry pulp is then removed mechanically.
The pulp may be returned to the soil because it contains nutrients (Cobley, 1986).

3 Materials and Methods

3.1 Introduction

To obtain data about the two types of coffee cultivation a survey was done in a group of coffee cultivators, all members of the coffee cooperative. First a questionnaire (Appendix IV) had to be developed. With the help of data collected from literature and first conversations with coffee cultivators in the watershed a concept questionnaire was made. After a field test of seven farmers the questionnaire was revised. Finally 26 farmers were interrogated. The first seven questionnaires are handled the same as the other 19 questionnaires.
Besides this survey of 26 farmers, six farmers were interrogated with in a reduced survey. The 26 questionnaires and the six reduced questionnaires have been put in a database, Excel. This file can be asked for at the office of REPOSA. The name of the file is: DBCOFFEE.EXL. The codebook accessory of the database has file name:

This chapter contains a description of the area and a description of the coffee cooperative 'Coopemontes de Oro, R.L.'.

3.2 Survey area

A watershed (Cuenca in Spanish) is the zone that is drained by one river. The watershed of the river Aranjuez canton Puntarenas, both part of the province Puntarenas, located near the city Puntarenas. Miramar is situated in the centre of the area at an altitude of 340 metre. Other small towns are Cedral (1100 m), Corazón de Jesús (1100 m), Bajo Caliente (600 m) and Unión (600 m). The population in the watershed is 11,000 (1987). Altitude of the watershed is varies from sea level to 1700 metre. (Chinchilla, 1987)
The name 'Montes de Oro' points to the material that the hills should conceal: gold. In early days gold minery was a good provision of work. Now there is only one gold mine in the village Unión. There are plans to start open-minery what means dig-away-of-hills. People in the is formed by the canton Montes de Oro (244 km^2) the district Pitahaya (271 km^2) of region oppose the idea.

The climatical circumstances are as follows: average temperature is 22°C and the precipitation varies between 2,000 and 3,000 mm per year.
Landuse is diverse. In the lower part of the watershed are sugar cane plantations. In the upper parts (the area with an altitude of 700 to 1,300 metres) are coffee fields. Seventy five per cent of the coffee is grown above the altitude of 1,000 metres. The land of the watershed between the sugar cane area and the coffee area is used for pasture and livestock. Many people also have small fields to grow vegetable like maize and beans. Tomatoes are cultivated for sale.
In 1944 the first activities of coffee cultivation in the watershed started. It was just in the 80's that the extension office of the department of agriculture in Miramar did a research into the agro-ecological potentials of the region. Coffee was mentioned as a product with positive perspectives. (Anonymous, 1996)

3.3 Coffee cooperative 'Coopemontes de Oro R.L.'

Coopemontes de Oro R.L. is cooperative of 430 coffee farmers (1995). All members of the cooperative have their coffee fields in the watershed. The office of the cooperative is situated in Miramar just like the 'coffee solar drying place'. The beneficio, the factory were the fresh coffee beans are pulped, is located in Cedral.
This year 'Coopemontes de Oro R.L.' celebrates her 10th anniversary. The cooperative of coffee cultivators was born at the moment that the coffee enterprises were exploiting the farmers by paying low prices and because of the bad services these enterprises rendered. In 1981 started the initiations to form the cooperative. In 1984, the cooperative was registered in the ministry of labour and social security, as group of 160 partner founders. Just in 1986 started the first processing of harvest, 155 tons of coffee. Following years the amount for processing increased. On the 23rd of 1988, hurricane Juana destroyed the complete processing plant. By national and international help a new plant was installed . In 1991 the processing was resumed. During the harvest of '95-'96 the cooperative consisted of 430 partners and processed 5.5 Mltr (=3.5 Kton) of coffee.
One of the objectives of the cooperative is to produce organic coffee. At this moment just 20 coffee farmers produce organic coffee. Others want to transform or are transforming their farm to organic cultivation. But many farmers still stay producing chemical. Next year will be the first time that organic coffee can be processed separate from current coffee. Now the organic farmers don't receive a extra price for their organic product. This is one of the reasons some farmers still not have started to change.

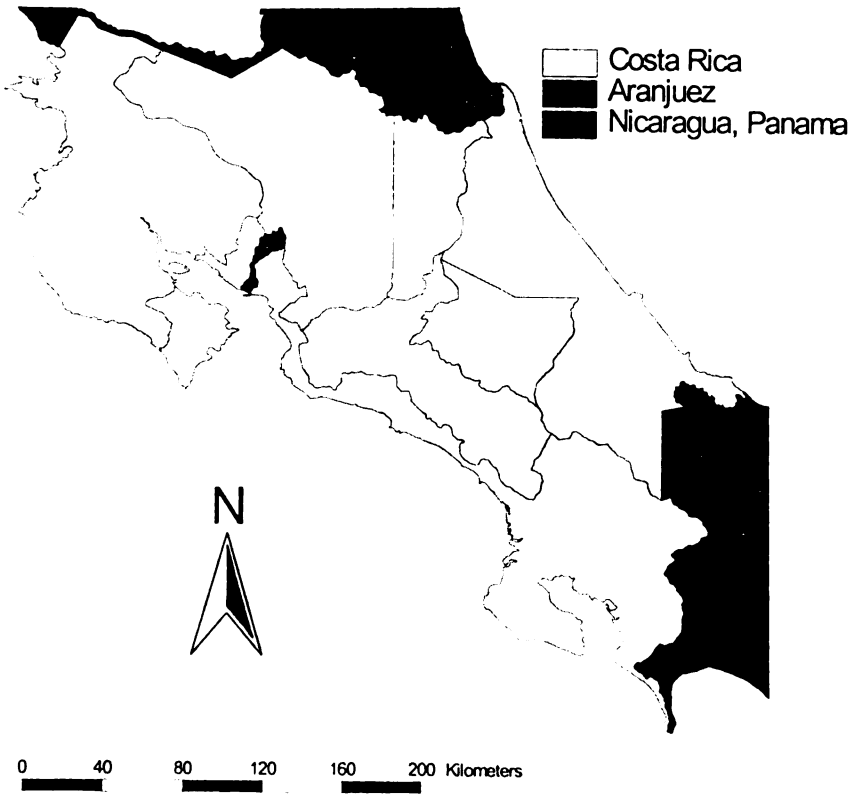

Fig. 3.1 Location of the watershed of the river Aranjuez.

4 Analysis of data

4.1 Introduction

The survey has been held under 26 coffee farmers. A second group of six coffee farmers have co-operated in a reduced survey. Both groups of coffee farmers have been put in a database. For reason of anonymity, all farmers were given a number, and these numbers will be used in the text throughout.

To define the method of cultivation the farmers are devided in four groups (Table 4.1): 3 organic farmers which don't use chemical fertilisers and pesticides, 20 chemical farmers, using chemical fertilisers and pesticides, 5 transforming farmers which try to decrease their use of chemical products and four mixed-farmers, which have both organic and chemical cultivated coffee fields. To use the data of the last group, the data of organic and chemical fields have been put separately in Table 4.3. Data of transforming farmers is not used in the analysis. These farmers don't have a constant management. LUSTs can only be built on data of farms with stable management.

Table 4.1 also shows the origin of the data of organic and chemical fields. Organic farmers only have organic fields and chemical farmers only have chemical fields. The mixed-farmers have both organic and chemical fields.

Table 4.1: Composition of group of interrogated farmers and origin of organic and chemical field data.

	number of farmers	origin of type of field data	
		organic	chemical
1. Organic farmers	3	3	0
2. Chemical farmers	18	0	18
3. mixed-farmers	4	4	4
4. Transforming farmers	7	-	-

To give an indication of the coffee cultivation in the watershed first will be presented data about the field size (Table 4.2). This is directly the first problem. The coffee farmers gave data about field size but many times it became obvious they don't know or make the difference between a hectare or manzana (=0.7 ha). It is almost impossible to measure the fields because of the field form and density of plants. Two field measurements have been executed. The farmer of the first measurement said he had three hectares or three manzanas (2.1 ha). Finally the measured size was 1.7 hectare. The farmer of the field of the second measurement said he had four manzanas (2.8 ha). After measuring a field size of 2.5 hectares was calculated. In consequence of this measurement and doubt of farmers, data about area size can't be taken too secure.

Table 4.2 gives the data of interrogated farmers about their total farm area, total area of coffee fields and the area of the coffee fields that is not in production. Further, it shows data about the mean plant density of the coffee fields and the coffee production. There are two sorts of data about the coffee production. 'Coffee production '96-'97 A' is the data

given by the farmers themselves. 'Coffee production '96-'97 B' is the data released by the office of the cooperative.

Table 4.2: General overview of interrogated farmers: total farm area (ha), total coffee area (ha), coffee area not in production (ha), mean plant density of coffee fields (plants / ha), coffee production '96-'97 A (ltr) (according to the farmer) and coffee production'96-'97 B (ltr) (according to the cooperative office).

name	total farm area	total coffee area	coffee area not in prod.	plant density	coffee production (x 1000) A	coffee production (x 1000) B
organic farmers						
1	30.8	1	1	3200	-	0.6
2	48	3	1.5	5000	4.3	3.5
11	26	2	0	5000	6.8	-
mixed farmers (* = organic field)						
5 *	6	0.25	0	4500	-	-
5		1.75	0	4500	3.3	-
8 *	2.8	0.75	0	5000	22.9	34.0
8		1.35	0	5700	-	-
12 *	20	0.75	0	3000	3.7	12.0
12		0.25	0	3000	-	-
19 *	20	1	1	3000	9.1	10.7
19		1.5	0	5000	-	-
chemical farmers						
4	4	2	0	4300/5600	8.8	10.0
7	1	1	0	3000	10.0	9.1
9	6	1.5	1	5000	27.2	26.0
10	2	0.5	0	2000	22.4	21.9
14	2	1	0	5000	14.0	13.0
15	2.1	2.1	0	5000	9.5	5.6
16	8	4	1.5	5000	-	-
17	2	2	0	4000	16.0	16.0
18	4.2	1.4	0.9	4000	-	-
22	13.3	1.1	0	5000	19.9	21.9
24	35	2.1	0.7	5000	28.6	20.5
26	3	2	1	3000	8.0	8.1
27	2	2	1	4500	20.0	13.5
28	-	1.5	0.5	-	11.4	-
29	-	-	2	-	0.4	-
30	-	1	0.7	-	13.1	-
32	-	2	1	-	21.3	-
33	-	1	-	-	24.2	-

The coffee cultivators don't have large fields of coffee. The average size of the coffee area per coffee farmers is 1.7 hectares. Of the interrogated farmers 26 % of the coffee area was out of production. This was caused by pruning (9 %) and new planting (17 %) (Table 4.3).

Table 4.3: Condition of coffee area in %.

	%
Coffee area in production	74
Coffee area out of production	
- new transplanted field	17
- pruned field	9

4.2 Cultivation operations

4.2.1 Soil conservation

Without soil prevention erosion is inevitable on the (steep) sloops of the watershed. Soil conservation is part of organic coffee cultivation.
The organic farmers mostly prevent erosion by constructing ditches and barriers in the field, a layer of organic material and manual weed control. The latter means that the weed is only chopped off and roots stay intact that give higher soil resistance to erosion. One farmer had planted the grass 'Vetiveria Zicanoides' in a line through his field, on contour. The roots of this grass go three metre deep.
All chemical farmers except one said they prevented soil erosion. They also have ditches and barriers and they plant on contour. When they spoke about making terraces they intended ditches. Chemical farmers which use herbicides have an extra problem in erosion. Due to herbicides the soil becomes more or less sterile and bare. There is also less organic matter in the field. These circumstances cause a higher risk to soil erosion .
The survey only has data about maintenance of ditches or living barriers. On average, 7 hours per year per hectare are needed to maintain the ditches and barriers. Data about construction of ditches and living barriers is part of the field preparation operation, paragraph 4.2.3. Other data about contour planting and manual weed control can be found in the paragraphs 4.2.4 and 4.2.5. Data about terraces (construction and maintenance) are missing.

4.2.2 Tree nursery

Farmers can buy plants in nurseries or grow the plants themselves in a their own nursery. The cooperative has two nurseries. In the watershed, a lot of farmers have a small nursery for personal use and for sale. Table 4.4 shows the prices of pairs of coffee plants of different origin. The price of the cooperative for a pair of coffee plants is ¢ 80 (colones). The price of plants from personal tree nurseries is ¢ 66. This is an average calculated for eight farmers, excluding two farmers which said the price should be ¢ 10 or ¢ 25 which was found to be unrealistically low. (All prices are of the year 1997)
A personal nursery requires time but demands area to a lesser extent. Farmer '8' had a personal nursery using chemical fertilisers and pesticides in 1991 and 1992. He calculated

an average price per pair of plants of ¢ 30. A farmer that had a organic nursery said the average price of his plants would be ¢ 12.5.

Table 4.4: Price (¢) of a pair of coffee plants of different origin.

origin	price
nursery of the cooperative	80
nursery in countryside	66
personal nursery	
- chemical	30
- organic	12.5

4.2.3 Field preparation

Labour use of field preparation consists of weed control and the construction of ditches and barriers. Labour used for field preparation depends on the vegetation before on the same field. When the field was a coffee field before, the old coffee plants have to be lifted (= renovation). Farmer '25' said he used 137 hours per hectare to renovate. Farmer '14' prepared a field that was natural vegetation before: 360 hours per hectare. On average farmers spend 150 hours per hectare (average of four farmers) to transform pasture to coffee field. Fields with an annual crop before is very easy to transform to coffee field. According to four farmers on average it requires 143 hours. Data about labour use for field preparation can be found in Table 4.5.

Table 4.5: Labour use (hrs / ha) for field preparation for coffee cultivation dependent on the vegetation before.

	labour
natural vegetation	360
annual crop	143
pasture	150
coffee	137

4.2.4 Planting and plant density

Labour use for transplanting depends on the amount of plants per hectare. This amount depends on the altitude of the field and the way of cultivation. Chemical farmers with fields at high altitude have a plant density of 4000 plants. At lower level the plant density is 5000 plants. Organic farmers put less plants per hectare than chemical farmers. They prefer a plant density of 3000 to 4000 plants per hectare also depending on the altitude (Table 4.6) (data of the technical expert of the cooperative).
Transplanting operations of chemical and organic farmers are the same. Farmers needed 42 hours on average (of 15 farmers within a range of 15 to 96 hours) to transplant 1000 pairs of coffee plants (Table 4.6).
Transplanting is done before the rain season starts. The beginning of the rain season varies but in general farmers transplant in April-May.

Table 4.6: Plant density (plants / ha) and labour use (hrs / 1000 plants) of both organic and chemical farmers.

	organic farmers	chemical farmers
plant density -coffee field on low altitude -coffee field on high altitude	 3000 4000	 4000 5000
labour use	42	

4.2.5 Weeds

In general, farmers control the weed 3.6 times a year, an average of twenty organic, chemical and transforming farmers.

Organic farmers manually control the weed with a machete/cutlass or mechanical weed control with a motor mower. On average they control the weed three times a year. Manual weed control requires much time. According to the technical expert of the cooperative farmers spend 45 hours to control one hectare one time. According to the inquiry it should take 48 hours to control. This is calculated with figures in a range from 12 to 103 hours per hectare. This difference in figures is possible because some farmers only have coffee fields with large plants that prevent weed grow. And some farmers only have young small or just pruned plants which bring along many weeds.

Chemical farmers control the weed chemical, manual and mechanical. On average they spend 3.6 times to control: 2.3 times manually and 1.3 times chemically. Data about mechanical weed control are not included because this is a new manner. Also chemical farmers control the weed many times manually because chemicals are very expensive. Second reason is that they have enough time for manual control. The chemicals they use are Paraquat and Round-up. Average application amount of Paraquat is 1.7 litre per hectare and of Round-up is 2.0 litre per hectare, both per application. Paraquat is applied 0.5 times a year and Round-up 0.8 times a year. Farmers don't make much difference in use of both herbicides. They said they use them alternately.
On average application takes 20 hours per hectare. Application is done with a back-spayer. The herbicides are aggressive chemicals. Application needs to done very secure and with low pressure of the sprayer. The use of a motor-sprayer is inefficient when using with low pressure.

New in weed control is the mechanical way, using a motor mower. Such a machine saves time and back-ache. The buying and upkeep of a motor mower (gasoline, broken accessories and blunt blades) is more expensive than buying a machete. Coffee farmer '26' gave information about it. Since three months he works with it. The price of the machine is ¢ 110.000. Gasoline use is more or less a half gallon per 6 hours. The price of the special gasoline is ¢ 500 per gallon. An extra costs is the string for cutting. The price is about ¢ 2000 per 60 m on roll. The mower is very efficient in time. The farmer used six hours to mow one manzana dependent on the accessiblility of the field. Weed control in

this way is executed as many times it should be done manual or chemical. Data of this paragraph is summarised in Table 4.7.

Table 4.7: Manual and chemical weed control in application amount of used chemical (ltr / ha / appl.), labour use (hrs / ex.) and frequency (ex. / yr.) of organic and chemical farmers per execution or application.

	organic farmers			chemical farmers		
	amount	labour	frequency	amount	labour	frequency
manual	-	48	3	-	48	2.3
chemical					(20)	(1.3)
- Paraquat	-	-	-	1.7	20	0.5
- Round-up	-	-	-	2.0	20	0.8
	both organic and chemical farmers					
	amount	labour	frequency			
mechanical	-	9	3.6			

4.2.6 Manure/Fertilisers

Organic farmers use gallinaza and broza. Six organic farmers used gallinaza while four of them also used broza. Farmers which use both sorts of manure mix them before application. The average amount of gallinaza application is 6.9 tons per hectare per year (with a range between 3.3 and 13.8 tons). The average amount of broza application is 6.1 tons per hectare per year (with a range between 2.9 and 13.8 tons).
Application of gallinaza and broza is same. Therefore the figures about labour for distribution of both gallinaza and broza were combined. Labour of manure distribution is expressed in hours used to distribute one ton of manure per hectare. The labour figures obtained of the farmers are homogeneous with exception to the labour figures of farmer '8'. This exception differs totally from the other data and seems to be unreal so it was not used in the calculation of the average. The average labour of manure distribution is seven hours per ton. Application of gallinaza and/or broza is done in the winter.

Chemical farmers don't use manure or broza. The relative nutrient content of manure and broza is very low, in contrast with chemical fertilisers. Two synthetic fertilisers are used by almost all chemical farmers. They use the synthetic fertilisers Nutran and the fertiliser with the formula 18-5-15. According to the data, usually formula 18-5-15 is used two times a year. The average amount per application is 301 kg per hectare (calculated with figures differing from 230 to 460 kg). Time needed to apply the fertiliser differs per field, depending on the accessibility. On average, farmers need 14 hours per application per hectare.
Generally Nutran is used one time per year with an average amount per application of 309 kg per hectare (calculated with figures differing from 230 to 460 kg). This is almost the same as the average amount of 18-5-15. This is caused by the fact that almost all farmers that use 18-5-15 also use Nutran, in the same amount. Also this application needs 14 hours per hectare. Data about fertilizer use in this chapter is summarised in Table 4.8.
Many chemical farmers apply also a few other products. There can't be given a good overview of what is used of these products in general. Eight of the 18 used a foliar

fertilizer (one or more times), one farmer used another complete formula fertilizer and one used chicken manure. Appendix I contains a list of names, prices and recommendations of manure and fertilisers, used in the watershed.

Table 4.8: Fertilizer use in amount (kg / ha / appl.), labour use (hrs / appl.) and frequency (appl. / yr.) per application of organic and chemical farmers.

	organic farmers			chemical farmers		
fertilisers	amount	labour	frequency	amount	labour	frequency
gallinaza	6900	48	1	0	0	0
broza	6100	43	1	0	0	0
18-5-15	0	0	0	301	14	2
Nutran	0	0	0	309	14	1

4.2.7 Pests and diseases

In both organic and current coffee fields there are pests and diseases. The organic farmers seem to neglect the pests and diseases. In their vision of organic farming, diseases and pests should be tolerated, to a certain level. For now, the existing level is acceptable. The organic farmers don't use chemical products. Two of them said their shadow trees had a preventive effect. According to the technical expert, organic farmers are permitted to use Fytosan. This fungicide contains cupre.

Chemical farmers use different sorts of chemicals preventively and curatively:

-Atemi has a preventive effect to Chasparria, Rosada disease, Ojo de Gallo and Roya. On average the chemical farmers applied Atemi one time a year in an amount of 0.9 litre per hectare.

-Coopecide (cupre) is preventive to all four diseases, mentioned in paragraph 2.5. This product on average was applied 1.5 times per year in an amount of 1.5 kg per hectare per application. Twelve farmers used Coopecide and/or Atemi. Eight farmers used both chemicals, two only used Atemi and two only used Coopecide. Farmers that used both chemicals applied 2.5 times per year, on average.

-Bayletón is used by four of the seventeen chemical farmers. Bayletón is a curative chemical to Roya and Chasparria. The average application amount was 1.1 litre per hectare and the average application rate was one time a year. Bayletón was used by farmers that already applied Coopecide and Atemi.

- Vydate: farmers have problems with plagues: Piojito and to a lesser extent with nematodes (Meloidogyne exigua). Vydate can be used to control both Piojito and nematodes. Three of the 22 chemical farmers used Vydate. One farmer had unrealistic data. Average use of Vydate was 1.5 kg per hectare per application. They only applied once a year.

Table 4.9 shows the data about the application of the biocides, mentioned in this paragraph. Some farmers used also other biocides. However these biocides were just a small part of total biocide use. Appendix II contains the list of names, prices and recommendations of biocides, used in the watershed.

The chemicals are applied by a back-sprayer or a motor-sprayer. Which one they use depend on the time and money they have. A motor-sprayer is more expensive because it will be executed by a hired labourer. Application on one hectare can be done within one

or two hours. Application by back-sprayer needs one day of six hours. Application time depends on accessibility of the field. Accessibility depends on level of weed control and steepness of the field. Prices of sprayers can be found in Appendix III.

Table 4.9: Biocides: application amount (kg or ltr / ha / appl.), labour use per application with different sprayers (hrs / ha) and frequency of application (appl. / yr.).

product	amount	labour		frequency
		back-sprayer	motor-sprayer	
Fungicides				
-Atemi	0.9 (ltr)	1-2	6	1
-Coopecide	1.5 (kg)	1-2	6	1.5
-Bayletón	1.1 (ltr)	1-2	6	1
Nematicides				
-Vydate	1.5	1-2	6	1

The chemicals are applied by a back-sprayer or a motor-sprayer. Which one they use depend on the time and money they have. A motor-sprayer is more expensive because it will be executed by a hired labourer. Application on one hectare can be done within one or two hours. Application by back-sprayer needs one day of six hours. Application time depends on accessibility of the field. Accessibility depends on level of weed control and steepness of the field. Prices of sprayers can be found in Appendix III.

4.2.8 Shadow trees

Almost all organic farmers use shadow trees in their field. Only one farmer said he didn't need shadow trees in his field because of the local sub climate which means just a little sun. The average density of shadow trees used by this group was 93 trees per hectare. This average is calculated without the information of one farmer which said he had 1000 shadow trees in his field. Thousand shadow trees per hectare means a density of 3 x 3 metre. According to the technical expert, recommendations for organic farmers is 100 trees per hectare.

Half of the group of current coffee cultivators don't use shadow trees. Most of them say they don't need shadow because of the local sub climate which means just a little sun. The average tree density in the field of current farmers was 83 trees per hectare (Table 4.10).

Table 4.10: Average number of shadow tree per hectare of organic and chemical coffee farmers.

	number
organic farmer	93
chemical farmer	83

There are different sorts of trees they use. Farmers gave me some names of the trees: Poró, Inga and Gavilancillo.

Farmers couldn't give a clear answer on the question how much time they spend on pruning shadow trees. It is not needed to prune and maintain the trees every year. Some farmers combine the pruning with the pruning of the coffee.

4.2.9 Harvest

There is no clear difference between the harvest period of organic and current coffee. The harvest starts in September, October and ends in February. The harvest peak is in December. Only in the area around the village Laguna, the harvest starts later, in December and ends in February.
Farmers are helped by their family members. During the harvest peak the help of family members is not enough. During this period the farmers hire labourers. Labourers are paid per unity of harvest; per basket of 20 ltr. The average price farmers pay for a basket is 230 colones. This average is calculated with the figures differing from 200 to 300 colones per basket. Labour need to harvest a basket depends on the moment during harvest. During the harvest peak a basket can be filled within 12 hours because branches are full of red fruits. Before and after the harvest peak it takes more time to harvest a basket because there are relatively less mature coffee fruits on the branches. On average it will take 23 hours (out of a range between 12 and 48 hours) to harvest a basket. According to the technical expert it would take 24 hours.

4.2.10 Pruning

Eight of 15 chemical farmers who gave information about pruning, prune selectively. This means they chop every year a third, a quarter or a fifth of their field depending on their pruning-cycle. Seven of this farmers execute a four-year-cycle.
Three of five interrogated organic farmers pruned their field once in total. Two farmers pruned selectively. One of these two farmers pruned per line and in a four-year-cycle. All pruning is done manual.
Time used for pruning depends on the manner of pruning. Selective pruning takes more time than a total field pruning. A total field pruning (independent of how-many-years-cycle) requires on average 58 hours per hectare, executed once in four year. This means a labour use of 15 hours a year. Selective pruning, lasting four years to prune the field in total and takes 82 hours per hectare (= 20 hours per year). Selective pruning with a six-year-cycle requires 180 hours per pruning cycle (30 hours per year), according to the executing farmer. Table 4.11 shows the labour use for pruning per cycle and per year.

Table 4.11: Labour use for pruning per cycle (hrs / ha / cycle) and per year (hrs / ha / yr.).

	labour	
	per cycle	per year
-total field pruning	58	15
-selective field pruning	82	20
- 4-year-cycle	180	30
- 6-year-cycle		

4.3 Production level

It is difficult to analyse the data about production level of the farmers. The data given by the farmers have been compared to the figures released by the cooperative office. Often it turned out there was a difference between the data of the different sources (Table 4.2). This is caused by at least two reasons. First sometimes it was not clear in what unity farmers had given the production figure: double hectolitre[1] for fanega[2]. Secondly it was not very clear which part of the coffee area had been used to produce the coffee amount. This because of pruned or new planted fields.
Determination of a figure about production per hectare meets also another problem. Farmers just gave a general estimation of the size of the coffee fields.
For these reasons it is also difficult to make a secure distinction between the production level between organic and current farmers.
The average production level of the chemical farmers, calculated with the production figures (with a range between 3.0 and 28.5 m^3) given by the farmers, is 14.7 m^3 (36.8 fanegas) fresh coffee beans per hectare. Calculated with the figures (with a range between 3.5 and 26 m^3) released by the cooperative office the production should be 13.0 m^3 (32.5 fanegas) per hectare.

4.4 Cultivation calendars

The cultivation calendars of organic and chemical coffee farmers are the summaries of the data of this chapter. Both calendars give a view about the coffee cultivation per year, except the information about field preparation and transplanting. These operations are only executed in the first year of cultivation. The data about labour and costs are expressed in hours and Colones per year. The prices of shovels, saws and machetes are not mentioned.

[1] double hectolitre = 200 litre
[2] fanega = 400 litre

4.4.1 Organic coffee farmers

Summary of cultivation operations of organic coffee farmers

operations	material/equipment	labour (hrs)	costs (¢)	month(s)
- **Field preparation** depends on the field vegetation before:				Mar.-Apr.
- natural vegetation		360		
- annual crop		143		
- pasture		150		
- coffee		137		
- **Transplanting** (per 1000 pairs of plants)		42		Apr.-May
	plants		80000	
	shovel			
- **Soil conservation** (*maintenance of ditches and living barriers)*	shovel	7		
- **Weed control**	machete, 3 times	144		May-Nov.
- **Fertilising**	shovel			July-Aug.
	- gallinaza, 6900 kg / ha	48	10000[3]	
	- broza 6100 kg / ha	43	8840	
- **Pest and disease control**	-	-	-	-
- **Harvest** *(per cajuela, basket of 20 ltr)*				Sept.-Jan.
	- personal	23		
	- peon	23	230[4]	Nov.-Dec.
- **Pruning**	machete/saw			Feb.-Mar.
- selective pruning (4-year-cycle)		20		
- total field pruning (4-year-cycle)		15		

[3] farmer only has to pay transport costs

[4] on average a labourer is paid ¢ 230 per 20 litre of collected coffee beans

4.4.2 Chemical coffee farmers

Summary of cultivation operations of chemical coffee farmers

operations	material / equipment	labour (hrs)	costs (¢)	month(s) (/ yr.)
- **Field preparation**				Mar.-Apr.
depends on the field vegetation before:				
- natural vegetation		360		
- annual crop		143		
- pasture		150		
- coffee		137		
- **Transplanting** (per 1000 pairs of plants)		42		Apr.-May
	plants		80000	
	shovel			
- **Soil conservation**	shovel	7		
(maintenance of ditches and living barriers)				
- **Weed control**				May-Sept.
- manual:	- machete, 2.3 times	110		
- chemical:	- herbicides, (1.3 times)			
	- Paraquat, 0.5 times			Oct.-Nov.
	0.85 ltr / ha	10		
	- Round-up, 0.8 times			
	1.6 ltr / ha	16		
- **Fertilising**	- 18-5-15	28		May-Sept.
	(602 kg in 2 applications)		40395	
	- Nutran	14		Oct.-Nov.
	(309 kg in 1 application)		17270	
- **Pest and disease control**	- Atemi			
	0.9 ltr / ha, 1 application		6210	
	- Coopecide			
	2.25 kg / ha, 1.5 applications		2907	
	- Bayletón			
	1.1 ltr / ha, 1 application		12572	
	- Vydate			
	1.5 ltr / ha , 1 application		7470	
- **Harvest** *(per cajuela, basket of 20 ltr)*				Sept.-Jan
	- personal	23		
	- peon	23	230	Nov.-Dec.
- **Pruning**	machete/saw			Feb.-Mar
- selective pruning (4-year-cycle)		20		
- total field pruning (4-year-cycle)		15		

5 Concluding remarks

5.1 Reliability of the data

After executing the survey it became clear that not all data were reliable. Some remarks about the reliability of the obtained data have to be made.
First problem was language. The interviewer was not master of Spanish very well. Extra information beside of what was questioned by the standard questions was difficult to get clear. A second problem was the small group of farmers that has been interrogated. For some subjects the collected data had a rather large variation. So it was difficult to make sound averages. Another problem was inaccuracy and inconstancy of the interviewer. This caused some missing in data. It had be better to check the data in the field. Just a few times the field of the interrogated farmers was visited. Further, coffee is not a annual crop. The age of a coffee field can be almost two decades. To some farmers, questions in the questionnaire were difficult to answer. For example, farmers with an old coffee field couldn't answer to questions about transplanting. But also when a farmer had a new field for 4 or 5 years the farmer had to remember this from years before. Last point to remark is the estimation of area size of the coffee fields. During the inquiries it became clear that farmers don't know or make difference between hectares and Manzanas. So it was difficult to determine precisely the size of their coffee area. For them, precise information is not very interesting and it is hard to measure the fields that are not square and flat. But for estimations of production per hectare precise information is needed.

5.2 Difference between organic and chemical farmers

Definition of an organic farmer is he don't use agro-chemicals. This definition is the main key to make difference between the two groups of farmers. Almost all cultivation operations that differ between these groups are based on chemical use. Now weed control of organic farmers is totally manual. Chemical farmers control weed both chemically and manually. In the near future mechanical weed control is an opportunity for both organic and chemical farmers. In pest and disease control of chemical coffee cultivation are mainly used chemicals. Organic farmers said they don't have products to combat pests and diseases. Pests and diseases are related to lightness and weeds can be a host of diseases so the organic farmers can prevent pests and diseases more or less by shadow management and weed control.
Also the manner of soil fertility maintenance is a good indicator of the type of farmer. Chemical farmers use synthetic fertilisers and foliars[5]. Organic farmers use manure and broza. Plant density is also an indicator of cultivation manner. Organic farmers have a lower plant density in comparison with chemical farmers, related to the altitude. Most of the organic farmers in the watershed just have changed their manner of cultivation and use the coffee fields they had before transforming from chemical to organic. This means they have the same plant density as the chemical farmers. But in future, when they renovate their fields, they will plant in lower density.

[5] foliars are fertilizers that are directly applied on the leaves.

5.3 State of organic coffee cultivation in the watershed

One of the objectives of the coffee cooperative is to reduce the negative impact of chemical and synthetic fertilisers and pesticides by producing organic coffee. Since four years some farmers have changed their chemical coffee cultivation into organic cultivation. Organic coffee cultivation means a decrease in production because of less fertilisation and no pesticide use. This decrease in production should be compensated by an extra price for organic coffee. Till now there was no possibility to process their coffee fruits separately. So they didn't receive an extra price for their product. From harvest period of 1998-1999, the organic coffee fruits will be processed separately.
Processing of the coffee includes drying of the coffee bean. Normally coffee is dried in oven. This method is done by burning wood that harms the environment by deforestation and needless energy demand. From the harvest period of 1997-1998 the cooperative starts with solar drying. They expect to dry 80 % of harvest by sun energy. 20 % should be drying in oven during periods of under capacity of the solar drying place or on cloudy days. By solar drying the processed organic coffee of next harvest period will be totally organic.

5.4 Fertilizer use in organic coffee cultivation

Organic farmers are not permitted to use chemical and synthetic products. These products harm the environment because of their toxic components. Also synthetic fertilisers are forbidden. Organic farmers have to use manure and compost. The farmers that want to transform to organic coffee cultivation said there will be a lack of organic fertilisers. Are the organic fertilisers better for the environment than synthetic ones. Or in other words, which fertilizer does harm the environment less.
Fertilisers are used to keep the soil fertile. The soil fertility decreases due to export of nutrients during harvest. Fertilisers need to fill up the caused gap. Manure relatively contains a low level of nitrogen, phosphorus and potassium. Organic farmers need a large amount of organic fertilisers to keep soil fertility on same level. Coffee farmers in the watershed have to transport organic fertilisers like chicken manure and broza. Transport of these needs gasoline which is harmful to the environment.
Contrary to organic fertilisers synthetic fertilisers have a relatively high content of nutrients. Transport of these fertilisers costs less gasoline. Problem of the synthetic fertilisers is that they don't contain organic matter. This can be compensated by the fact that applied fertilisers do increase the growth of weeds. These extra grown weeds could be supplement to the organic matter. Another problem is that synthetic fertilisers are more susceptible to leaching. Both problems could be eliminated by good husbandry: split application. Problem of split application is labour need. However when the number of organic farmers increases there will be a lack of organic fertilisers. To maintain the soils of organic farmers fertile there should be found other possibilities

6 Personal

In 'Personal' wil ik beschrijven hoe ik deze stageperiode heb ervaren. Disculpe, maar dit hoofdstuk schrijf ik in het nederlands, omdat dit hoofdstuk de wetenschap niet dient én omdat ik mij in moe'rs taal wat genuanceerder kan uitdrukken.

Ik had mij al geruime tijd voorbereid op de stage; een half jaar om precies te zijn: genoeg tijd om te wennen aan het idee, om voor langere tijd buiten bereik van familie en vrienden te zijn, lichamelijk wel te verstaan en niet geestelijk. Na een druk studiejaar had ik mijn stage ook maar direkt in de vakantie gepland. Maar gelukkig kwam ik van het stressy Nederland zo het 'vida tranquila' van Costa Rica binnen. Reeds bij aankomst op de luchthaven te Alajuela was er een tico, Marra, die zorgde voor persoonlijke opvang en vervoer naar het projekt te Guápiles. Net zoals veel andere studenten sprak ik niet goed spaans en was het dus een hele klus om een gesprek in het spaans te houden. Goed ontvangst, maar wel jammer dat de finishing touch ontbrak: korte maar goede nederlandse introductie omtrent de ins en outs van het gastenverblijf te Guapi.

Mijn stage zou te maken hebben met IPM (Integral Pest Management) en met de bananenteelt. Maar uiteindelijk is het iets met koffie geworden. Mijn opdracht was om informatie over teelthandelingen van chemische en organische koffieboeren te verzamelen. De koffieboeren die ik moest interviewen waren allemaal woonachtig in het stroomgebied van de rivier Aranjuez in het westen van Costa Rica. Omdat dit onderzoeksgebied ver verwijderd was van het projekt, had ik de mogelijkheid om ook tijdens werktijden meer van het Costa Rica te zien dan alleen de omgeving van Guápiles.

Het projekt Reposa was een stageplaats waar ik veel geleerd heb. Het is moeilijk om een één-regel-mening te geven, dus wordt het een alinea. Ik heb het als goed ervaren dat ik grote vrijheid kreeg om mijn onderzoek uit te voeren. In een relaxte samenspraak met mijn begeleider heb ik een rapport over koffieteelt kunnen produceren. Vele diensten stonden mij bij om dit te bereiken: collega's die meegingen in het veld, vervoer, computers en electronische post. Dat er niet altijd vervoer was als ik het nodig had, de computer wat slakkerig was en de e-mail-procedure vaak tot irritaties leidde, vond ik soms wat minder. Als advies voor iedereen die ik hier achter laat en als punt van kritiek, ook naar mijzelf toe: er zou meer mét elkaar dan óver elkaar 'gepraat' moet worden.

Het onderzoek doen onder boeren in de watershed was een leerzamer en leuke tijd. Ik zag daar hoe mensen, naar mijn idee, gelukkig leefden, terwijl we hun omstandigheden naar nederlandse maatstaven niet altijd als puik zouden bestempelen: één telefoon per dorp, tweemaal daags een busverbinding met de eerste volgende grote stad, etc. De gastvrijheid en de vrijgevigheid (van informatie, fruit en 'koffie met wat erbij') die ik ervaren heb, was te gek. Door het afnemen van interviews heb ik mijn spaans goed kunnen verbeteren. Nu, na vier maanden Costa Rica spreek ik het nog steeds niet fantastisch, maar die tijd in de watershed heeft mij voor erger bewaard.
Al met al een leerzame tijd met écht tropen weer, regen en warmte.

7 References

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Appendix I : List of names, prices and recommendations of manure and fertilisers

Name	**price (¢ / kilo or litre)**	**recommendation**	
		amount	frequency
Manure			
-gallinaza			
-broza			
Synthetical fertilizers (price per 50 kg)			
Nutran	2515		
Abono18-5-15	3355		
Abono12-24-12	3276		
Abono 18-3-24	3667		
Abono 15-3-31	2853		
Abono 10-30-10	3300		
Foliars			
-Zn-Br-Asufre	1415/kg		
-boron	342/kg		
-Calcium	430/kg		
-Bayfolán	953/ltr	1.4-2 ltr/ha	3
-Multiminerales	4054/ltr	0.5-0.6 ltr/ha	2
-Manzate	1460/ltr		
-Zincalsado	578/ltr		
-Fosforo			
-Magnesio-zinc-boro			

Appendix II : List of names, prices and recommendations of biocides

Name	**price (¢ / kilo or litre)**	**recommandation** amount	frequence
nematicides			
-Vydate	4980/ ltr	2-3 ltr/ha	
Fungicides			
-Atemi	15833/ltr	0.4-0.5 ltr/ha	2-3
-Anvil	6900/ltr	0.7-1.0 ltr/ha	
-Trimiltox	2584/kg		
-Cupravit verde	927/kg		
-Benlate	3103/kg		
-Coopecide	1292/kg		
-Cobre Sandoz	1202/kg		
-Dithane	1169/kg		
-Bayletón	11429/ltr	0.75-1.0 ltr/ha	2-3
-Caldo bordeles	1203/kg		
-Silbacur	11590/ltr		
-Antracol	1771/kg		
-Ferban-contenaz			
herbicides			
-Paraquat/Gamoxone	1295/ltr		
-Randup	2363/ltr	1.5-4 ltr/ha (depends on the weed sort)	

Appendix III: List of prices of biocide-sprayers and motor mower

Prices of:
1. Back-sprayer : 15750¢
2. Motor-sprayer : 120000¢
3. Motor mower : 110000¢

Appendix VI: Questionnaire 'encuesta sobre cultivo de cafe'

REPOSA

REsearch Programme On Sustainablility in Agriculture

Encuesta dirigada a agricultores que están trabajando o quizás trabajarán en el cultivo orgánico de café.

Fecha: - - 1997 **Encuesta No.:**

1. Información personal

1.1 Nombre del agricultor: .....

1.2 Pueblo: .....

1.3 Coordenada: **Grado de logitudo: .....**

Grado de latitud : .....

2. Information de la finca

2.1 Superficie (área) de la finca : ..... (Hectareas /Manzanas)

2.2 Superficie de café en producción : ..... (ha / mz)

2.3 Superficie de café no está en producción : ..... (ha / mz)

2.4 Producción total de cosecha 1996 - 1997 : ..... (fanegas / .....)

2.5 ¿Cuál tipo de agricultor de café esta usted ?

orgánico / químico / transformando / mezcla / otro .....

2.6 ¿Cómo usted define su cultivo de café?

.....

.....

.....

3. Características generales de la plantación

3.1 ¿Cuál(es) Cultiv(os) cultiva usted?

1. ..... 3.....

2. ..... 4. pastos.....

3.2 ¿Usted intercultiva otras plantas en su campo de café?

.....

3.3 ¿Cuál(es) es/son la(s) variedad(es) que cultiva?
(Typica o Criollo, Hibrido, Bourbón, Caturra, Catuaí, Villa Sarchi, Mundo Novo, Catimor o Otras) (orgánico o corriente)

Variedad (orgánico, corriente, transformando	area (.....)	número de plantas	número de años
1.			
2.			
3.			
4.			

4. Suelo y conservación del suelo

4.1 Tipo de terreno (plano/quebrado): .....

4.2 Tipo de suelo: .....

4.3 Color : .....

4.4 Textura : arcilloso - limoso - arenoso

4.5 ¿Hay problemas con erosión? si / no ¿Porque (no) hay?

.....

.....

4.6 ¿Qué lo hace para prevenir erosión?

.....

4.7 ¿Usted siembra a contorno? si / no

4.8 ¿Hay otras medidas para prevenir erosión? Mano de obra (Jornales) Equipo

-Zanjas y desagues: ....

-Terrasas: ....

-Otro medidas o practicas: ....

4.9 ¿Riega usted sus campos? Si/no : ..... jornales

5. Preparación del terreno

5.1 ¿Cómo prepara usted su terreno antes de sembrar?

acción: limpiando / nivelando / arando / fertilizar / ..... / total

jornales: ..... / ..... / ..... / ..... / ..... / .....

producto de fertilizar: ..... **y la cantidad** .....**kg**

6. La siembra

6.1 ¿Usted ha usado semillas/plantas orgánicas?

.....

6.2 ¿De donde obtiene sus plantas de café? ¿Compra en el vivero? *sigue a 6.3*

¿Hace su vivero? *sigue a 6.4*

6.3 ¿En cuál vivero compra su plantas?.....

6.4 ¿Que es el precio de las plantas? .....

6.5 ¿Cómo hace su vivero?

- Equipo: .....

- Materiales: .....

- Area de sembrar: .....

- Mano de obra (jornales/ ..... plantas)

mes: ..... **sembrar:** ..... **cultivo:** .....

6.6 Plantación

mes: ..... **jornales:** ..... **equipo:** .....

7. Fertilización

7.1 ¿Tiene su plantas deficiencias de nutrientes?

nitrógeno / fósforo / potasio / calcio / magnesio / azufre / hierro / boro / zinc

.....

7.2 ¿Qué tipos de abonos usted utiliza? (Químicos, minerales, abono verde, gallinaza, compos, basura verde, abono foliar, otro)

nombre de abono	en cuál variedad	frecuencia	cantidad	precio	Mes(es)	Jornales	Area
1.							
2.							
3.							
4.							
5.							

7.3 ¿Cómo sabe usted si hay deficiencias de nutrientes (Ha hecho muestra de suelo)?

.....

.....

8. Malezas, plagas y enfermedades

8.1 ¿Hay problemas con plagas, enfermedades o nemátodos?

.....

.....

8.2 ¿Hay problemas con malezas?.....

.....

8.3 ¿Comó labra usted las malezas?.....

8.4a ¿Puede usted prevenir las plagas y enfermedades?

.....

8.4b ¿ Cuáles productos o medidades usa para atacar o prevenir enfermedades y plagas?

.....

.....

9. Combate

9.1 ¿Aplica usted agroquímicos si es necesario? Si/no

9.2 ¿Cuándo lo hace? .....

9.3 ¿ Contra cuál plaga? .....

9.4 ¿Cómo controla plagas, enfermedades o malezas, cuál?

Cuál plaga, maleza o enfermedad	en cuál variedad	Manual, Mecanico Químico	cantidad	jornales	Equipo	Mes	Area
1.							
2.							
3.							
4.							
5.							
6.							

9.5 ¿ Compra usted todo los materiales/productos a la cooperativa?

.....

10. Manejo especifico del cultivo café

10.1 ¿Necesita usted sombra en su campo? Si (sigue a 10.2)/ No

10.2 ¿Usted tiene árboles para sombra? ..... plantas/ .....

10.3 ¿Cuánto tiempo emplea en sembrar/podar los árboles para sombra?

***mes sembrar/plantar: ..... jornales: .....**

*** mes de podar: ..... jornales: .....**

10.4 ¿Usted le da mantenimiento a las cercas y caminos? Si/no

*** jornales: ..... * equipo : .....**

10.5 ¿ Comó poda sus plantas?

todo el campo en una vez / cada vez una parte del campo

10.6 ¿ Cuándo poda usted las plantas de café?

*** mes: ..... *jornales: .....**

*** equipo: .....**

11. La cosecha

11.1 ¿Cuándo usted cosecha el cultivo y hay el punto culminante? ..... - ..... , ...

11.2 ¿ Cuánto produce promedio en total? ..... fan / .....

11.3 ¿ Cuánto produce despues un año de podar? ..... fan / .....

11.4 ¿ Cuánto es un producción culminante? ..... fan / .....

11.5 ¿Cuánto paga por cajuela? ..... Colones

11.6 ¿Cuánto tiempo necesita para cosechar una fanega? ..... jornales

12. Mano de obra

¿Cuántos personas trabajan en esta finca?

	número	cuales actividades	cuales meses
agricultor	.	.	.
familiares	.	.	.
peones	.	.	.