ATLANTIC ZONE PROGRAMME



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# THE PINEAPPLE IN THE ATLANTIC ZONE OF COSTA RICA

## A study on the sustainability of the cropping system of pineapple in the Atlantic Zone of Costa Rica

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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.

PREFACE

General description of the research programme on sustainable Landuse.

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

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

Combinations of crops and soils

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

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

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

CONTENTS

LIST OF FIGURES AND MAPS:

## PREFACE

This report presents the work done in a practical period within the context of the Atlantic Zone Programme, a 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 program was started in 1986. Its central theme is sustainable land use.

Field and laboratory work was carried out from February until April 1992. Analysis of the data and writing of the report was done in May and June of 1992 and January-April of 1993.

The work was supervised by Ir. Don Jansen in Costa Rica and by Dr. Louise Fresco and Ir. Theo Guiking from the Department of Tropical Crop Science from the Agricultural University Wageningen.

**SUMMARY**

This report describes the work and results of a practical period on the Atlantic Zone Program. Emphasis is put on pineapple cultivation in the Atlantic Zone and the nutrient balance of pineapple in the zone.
First a description of Costa Rica and the Atlantic Zone is given. After that pineapple cultivation is highlighted. In the next chapters data collection by literature study, farmer interviews, sampling of soils and plants and laboratory work, its results and conclusions, discussion and recommendations are dealt with.
Results in short are:

-Pineapple is of minor importance in the area.
-Farmers have very different ways of cultivating pineapple. Investments in the crop in money and time depend on the expected incomes and the relative importance of the crop on the farm.
-The biggest problems in cultivation are rot of the heart of the plant and weeds.
-Pineapple prices differ from farm to farm, even if salesmen are the same.
-P is the most limiting nutrient in the soils of the area. Other nutrient uptakes (including N) depend on its uptake and on N uptake.
-Highest losses (in kg/ha) during the harvest of the fruits are:
K (91.5), N (47.7), Ca (14.0), Mg (7.7), P (7.4) and S (6.7).
-If whole plants are removed losses are much higher (kg/ha):
K (323), N (210), Ca (99), Mg (48), S (41), P (24), Fe (11.6) and Mn (8.2).

Conclusions in short are:
Because of high losses fertilization is necessary. P fertilization has to be done first. N and K fertilization are also important because N determines the uptake of other nutrients and K and N are used in the highest amounts.
Farmers that leave crop residues on the field use their nutrients more ecomically than those who remove the whole plant after the harvest.

# 1. OBJECTIVES AND HYPOTHESES OF THE WORK.

## 1.1 Introduction.

The Atlantic Zone Programme carries out research in the Atlantic Zone of Costa Rica. The research on sustainable land use in this zone is the aim of the program. In this research a lot of disciplines of agricultural knowledge are integrated. One of them is crop science. The program focuses on the most important crops of the area they are working in. One of these is the pineapple (Ananas comosus (L.) Merr., syn. A. sativus Schult.).
The cropping system of the local farmers is one point of interest in this practical period. The other point of interest is the nutrient balance. The sustainability of the cropping system is related to the export and import of nutrients in that cropping system. This report tries to quantify export of nutrients in relation with absolute nutrient content of the soil and farmer management of small farmers in the northern part of the Atlantic Zone.

## 1.2 Objectives.

The objectives of this research were to describe the relation between soil, crop management and crop growth of pineapple in the Atlantic Zone and to become more familiar with agriculture in this part of Costa Rica especially concerning pineapple cultivation. Obtained pineapple data will be used in a linear programming model to give advises about crop choices and crop management.

## 1.3 Method.

The research consisted of farmer interviews during February 1992, sampling of soils and plants during march 1992 and the study of data from literature and the laboratory of CORBANA. CORBANA analyzed soil samples and plant samples that were taken on the fields of the farmers that were interviewed. Interviews were carried out in the pilot areas of the Atlantic Zone Programme. Finally the interviews, the laboratory data of the program and the CORBANA laboratory and data found in the literature were compared to find the relationship between soil fertility, production and crop management.

## 1.4 Hypothesis.

The hypothesis of this study is:

- -A positive relation exist between soil fertility, as characterized by pH, organic C and absolute contents of nutrients, and production of pineapple.
- -A higher production of pineapple is related to a higher uptake of nutrients.
- -Losses of nutrients from the soil can be counteracted by application of fertilizers.

## 2. THE ATLANTIC ZONE OF COSTA RICA.

### 2.1 General information.

Costa Rica (Figure 2.1.1) can be divided into three main regions (LUIJEKX & ZUNNENBERG 1992):
- The Central mountain range
- The Pacific coastal region
- The Atlantic lowland

The Atlantic lowland is the area where the study of the AZP (Atlantic Zone Programme) is carried out. The study area of the AZP is defined as the (planning region) Huetar Atlántica plus the Puerto Viejo district (VAN DER WEIDE 1986).
In this chapter some global information is given about the history, climate, soils and the agriculture of the Atlantic Zone. First some information is given about the AZP and its pilot areas in the zone.

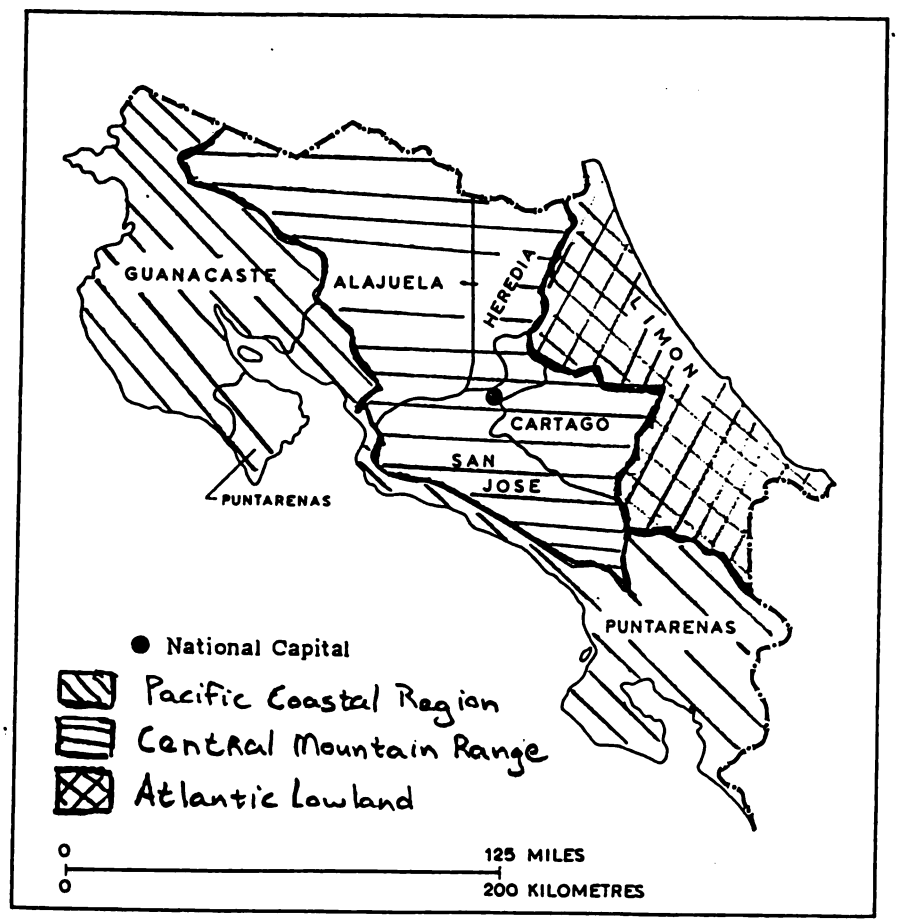



Figure 2.1.1: Map of Costa Rica

## 2.2 The Atlantic Zone Programme and its pilot areas.

The Atlantic Zone Programme is a result of an agreement for technical cooperation between the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, Turrialba), the Ministerio de Agricultura y Ganadería of Costa Rica (MAG) and the Agricultural University Wageningen, The Netherlands. The program was started in April 1986. It has a long-term objective multidisciplinary research aimed at rational use of the natural resources in the Atlantic Zone of Costa Rica (Figure 2.2.1) with emphasis on the small landowner. Because of its preference to areas that would involve the small landowner the AZP chose three pilot areas to concentrate on (SCHIPPER 1988):

- The Neguev
- The Rio Jimenez
- Cocori

In this chapter special attention will be given to this pilot areas. The area around Rio Frio and Horquetas is also important at this moment. The major part of this research was carried out there because of its suitability to pineapple cultivation.

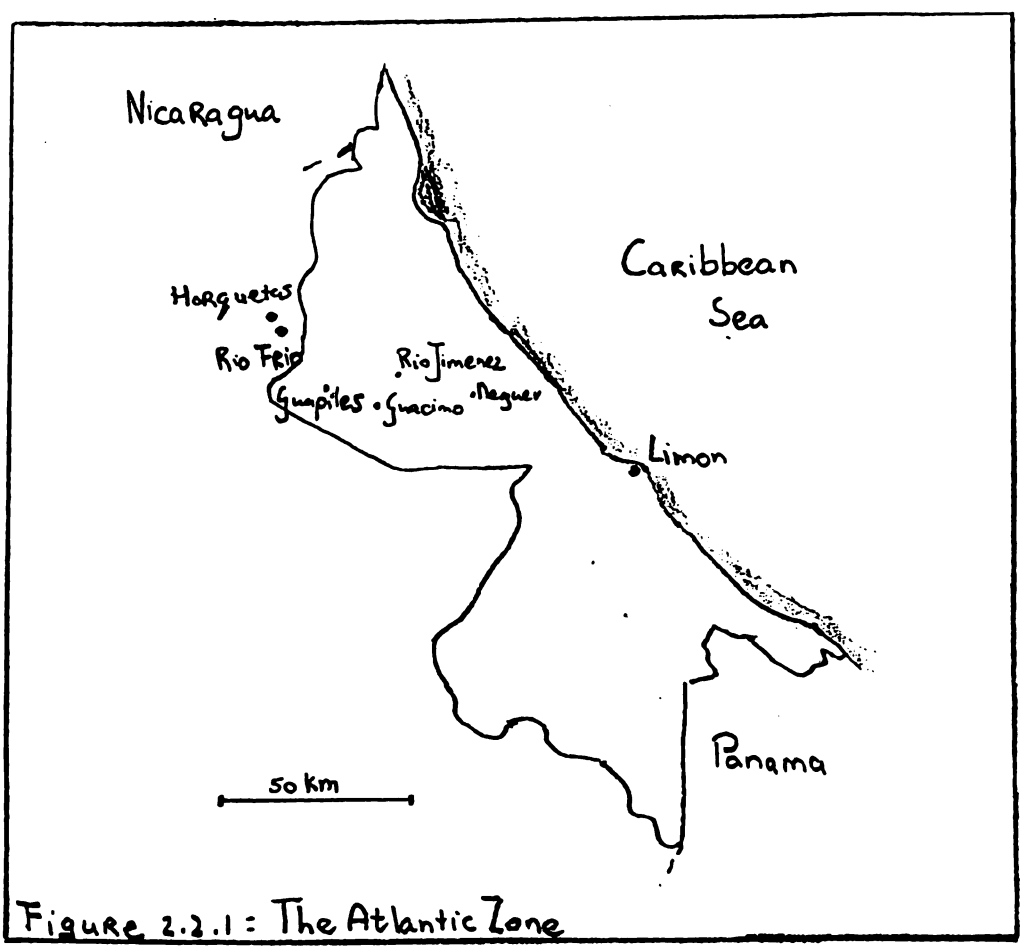



Figure 2.2.1 : The Atlantic Zone

## 2.3 History of the Atlantic Zone.

In colonial times the Atlantic Zone of Costa Rica didn't play an important role. It was not accessible and did not have any economic importance because of lack of natural resources. After the state of independence of Costa Rica in 1821 Costa Rica started to grow coffee in the Central Valley. To export the coffee a harbour was made in Puerto Limón and a railroad constructed. This railroad was used for the export of bananas in the end of the last century. The banana plantations kept on looking for better soil conditions in the area between Guápiles and Limón. The banana diseases Fusarium oxisporum (±1926) and Micosphaerella musicola (1937) reduced the area under production drastically and the banana production moved to the Pacific Coast. The Costa Rican government started to legalize land invaders.
In the period between 1950 and 1960 cocoa became the most important export crop. In these years also a banana variety resistant to Fusarium oxisporum was introduced by the Standard Fruit Company. A new invasion of the Atlantic Zone followed. Bananas and coffee became again the major export products of the region. The government restrained the banana companies a little bit more than before by taxes and restrictions in the possibilities to get more land. The State started settlement programs and collective services like schools and clinics.
In the 70's and 80's new roads were opened from Limón to Siquirres and later to Guápiles. From Guápiles a new road was constructed to Rio Frio and Puerto Viejo. The road from San José to Guápiles through the National Park Braulio Carrillo made the Atlantic Zone accessible from San José within an hour and a half.(VAN DER WEIDE 1986, DE VRIES 1986).
At this moment the land in the Atlantic Zone is owned by the government, the banana companies and farmers. The land in the pilot areas of this research is distributed by IDA (Instituto de Desarrollo Agrario, Institute of Agricultural Development of Costa Rica).

## 2.4 Climate.

The climate of the Atlantic Zone can be characterized by high temperatures and a abundance of precipitation during the whole year (OñORO, 1990). To give an indication of temperature, precipitation, evapotranspiration and sunshine an example that is representative for the area of the pilot areas is given (WAAIJENBERG, 1990). These information is given by COBAL, canton Guácimo, Costa Rica.
Mean temperatures in Guácimo (Figure 2.2.1) during the whole year are about 24.4 °C with a mean maximum of 30.9 °C and a mean minimum of 20.2 °C. The mean total precipitation is 3934 mm in a year. Rainfall is well distributed over the year with a relative dry period during February, March and April. There are 266 days with rain during a year. Mean evapotranspiration in a year is 1086 mm, resulting in a rainfall surplus of about 3000 milimeters. The mean duration of sunshine is 4.3 hours in one day. The mean global radiation is 15 $MJ/m^2/day$.

## 2.5 Soils.

The soils of the Atlantic Zone are in general of volcanic origin. The AZP uses a classification based on fertility and drainage. Three groups of soils are important to the research of the program (ATLANTIC ZONE PROGRAMME, 1991):
- Young Holocene soil deposits with good drainage properties
- Young Holocene soil deposits with poor drainage properties
- Old Pleistocene soil deposits with reduced fertility and good drainage.

For the cultivation of pineapple a well drained soil is necessary. In this research only well drained acid soils in the Neguev and near Rio Frio and Horquetas are used because only there pineapple was found.

## 2.6 Agriculture.

Huetar Atlantica is about 10000 km² large and had in 1986 a population of 180000 persons and a population growth of more than 3% per year (WAAIJENBERG, 1986). In that year about 58000 persons belonged to the labour force, of which 26000 persons worked in agriculture. Approximately 6500 of these were farmers, most of the others labourers.
The major crops of the Atlantic Zone are banana, plantain, cocoa, coconut, coffee, pejibaye, macadamia, maize, rice and cassava. In the pilot areas of the AZP these crops are important as well as pineapple. The program selected some crops to concentrate on and two other land use types. The crops are maize, cassava, plantain, pineapple and palmito de pejibaye (palm heart). Other subjects of research are pasture and forests. More about the agriculture in the Atlantic Zone can be found in a survey by Waaijenberg (1986).

# 3. PINEAPPLE.

## 3.1 General information.

Pineapple (Ananas comosus (L.) Merr., syn. A. sativus Schult.) is a member of the Bromeliaceae. It was cultivated in pre-Columbian times in South America. The centre of its origin was most probable the Paraná-Paraguay river watershed (15-30° southern latitude, 40-60° western longitude). Pineapples were widely distributed throughout most of tropical America at the time of the discovery (1592). After a mutation for seedlessness indians had made selections for increased fruit size, juiciness, sweetness and improved flavour. Many writers of that time described the fruit as the most delicious they had ever tasted. The remarkable way it grows many times is a subject of their writing.
A mature fruiting pineapple consists of the following major parts and organs (figure 3.1.1):

- Stem or main axis to which other organs are attached.
- Peduncle: The slender leaf bearing stalk supporting the fruit and connecting it with the stem.
- Leaves attached to the peduncle and to the stem throughout its above ground part.
- Fruit at the upper end of the peduncle.
- Crown as a short stem with small leaves at the apex of the fruit.
- Slips: Leafy branches developed from axillary buds below the fruit.
- Hapas: Leafy branches developed from axillary buds at the point of junction of peduncle and stem.
- Shoots: Leafy branches developed from axillary buds on the stem: Just below the fruit (hijo intermedio, chupón aéreo), or as 'suckers'produced in leaf axils lower down the stem (hijo de pie, hijo bastajo). Slips, hapas and shoots can be used for propagation as well as the whole corona (COBLY, 1976).
- Roots can be found as axillary roots growing in the axils of basal leaves or as soil roots from the underground part of the stem (COLLINS, 1960).

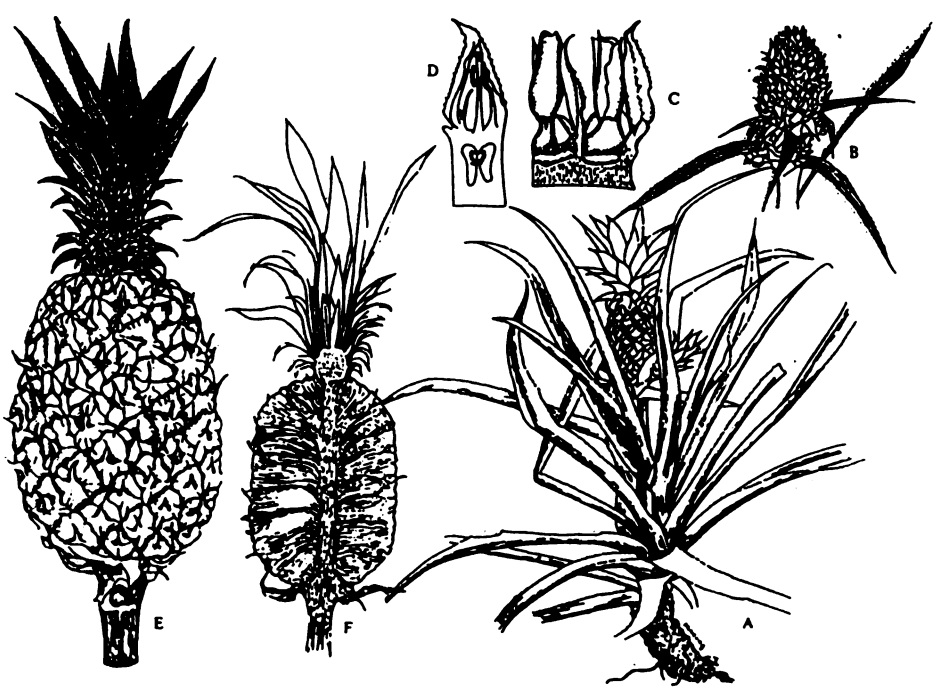



Figure 3.1.1: The pineapple

A classification in cultivar groups can be made based on the colour of the flesh of the fruits and other differences in appearance, like spiny leaves, fruit size or taste. Maritza (1983) mentioned four groups: 'Cayenne', with yellow flesh and good industrial processing and transport properties, 'Queen', also with yellow flesh, 'Spanish', with white flesh and high sugar content and 'Abracaxi', with yellow flesh and very high sugar content. In Central America the following cultivars are grown:

- From the 'Cayenne' group 'Cayena Lisa'
- From the 'Spanish' group 'Española Roja' and 'Montelirio' or 'Guatemala Lisa'.
- From the 'Abracaxi' group 'Pan de Azúcar' (also known as 'Sugar Loaf' and 'Azucarona').

In this study the cultivars 'Montelirio' and in a small amount 'Cayena Lisa' are used. On world scale the 'Cayenne' group is most spread because of its excellent properties for industrial processing (canning and juice production).

Best mean temperatures for pineapple production are between 24 and 26 °C. It does not survive frost. Temperatures below 8 °C reduce yield severely. The combination of temperatures above 40 °C and drought damages the leaves. On the other hand an excess of water is bad (DIRECCCION GENERAL DE AGRICULTURA, 19??).

Pineapple needs a well drained soil. That is the single most important soil property that is needed. It will produce on an acid soil and under low soil fertility conditions.

## 3.2 Crop treatment.

In some parts of the tropics pineapple is grown on large scale by big companies. Hawaii is the major producer at this moment. Industrial methods of agriculture are used by the large companies. The pineapple plants are planted on a mulch paper or plastic in densities of 40000-80000 per hectare. High inputs of fertilizer and pesticides are used. Hormones to induce early flowering are applied. Under natural conditions 'suckers' bear fruit after 17 months (ARRIOLA et al., 1976). When a hormone is applied plants bear fruit after 12 months or even earlier. A hormone also guaranties a homogenous ripened field and can be applied to plan a constant production. The transport of a product of a constant quality and the immediate industrial processing are part of this advanced system. Although this efficient system can provide a large part of the world of pineapples, small farmers still produce pineapple. In many cases they can use modern inputs as well, but on a less industrial way. Soils are not fumigated and mulch paper and big machinery are not used.

Before the crop is planted some chemical and/or mechanical treatments of the soil can be done. Pineapple prefers a loose top soil. When the crop is planted it needs some fertilizer, and pests and diseases must be controlled. Some publications give advises for the application of nitrogen, phosphate, potassium and in case of deficiencies zinc, iron and other spore elements. The pests and diseases of pineapple are some nematodes, insects, fungi, rats and bacterium diseases. Every area of the world where pineapple is cultivated has its own major pests and diseases. In the next chapter a more local view on pineapple cultivation in the Atlantic Zone of Costa Rica is given.

# 4. PINEAPPLE RESEARCH BY THE ATLANTIC ZONE PROGRAMME.

## 4.1 Pineapple in the Atlantic Zone Programme.

The atlantic Zone Programme selected crops on the basis of their typical occurrence in the study region and on their perspectives for future development (ATLANTIC ZONE PROGRAMME, 1992)'. Pineapple was selected as one of them.

The program has its own approach of the research:

'To develop scenarios for sustainable and economically feasible land use, three hierarchical levels of analysis can be distinguished:

1. The Land Use System (LUS) analyses the relations between soil type and crops as well as technology and yield.
2. The Farm System (FS) analyses the decisions made at the farm household regarding the generation of income and on farm activities.
3. The Regional System (RS) analyses the agro-ecological and socio-economic boundary conditions and the incentives presented by development oriented activities.' (ATLANTIC ZONE PROGRAM, 1992)'

This report handles mainly with the first level and some aspects of the second. It looks at the pineapple cultivation of farmers in settlement projects in the Atlantic Zone and at the use of mineral resources of the soil by the crop to come to a quantitative description that can be used in advises (for example about fertilization). This aspect of the pineapple cultivation was not studied by the programme until 1992. After this study about nutrient balances and cropping systems, more research on pineapple marketing will be done.

## 4.2 Sustainability.

The information the program collected from 87-90 formes the basis of the work plan for the second phase: A methodology for analysis and planning of sustainable land use. This is an ecological and economical sustainability. For this research it means that it shout focus on ways to maintain production in the area and to preserve the soil of the small farmers.

## 5. DATA COLLECTION.

### 5.1 Literature study.

Literature study results in general in information about the industrial way of pineapple cultivation as described above. The small farmers of the pilot areas do not cultivate pine apple in that way. Some more local information is given by Central American institutes and studies. CONITTA (1991) gives some information about pineapple cultivation in Costa Rica in a publication of the Ministry of Agriculture (MAG). Van Ee and Helmer (1989) gave some attention to pineapple cultivation in the north of the Atlantic Zone based on four farmer interviews.
This study quantifies the amount of nutrients in the different plant parts. About the chemical composition of the plant parts not much is known. Some data about the fruits and the plants per hectare is available and one study about mineral nutrition of pineapple by Romero (1973). Romero only uses analyzes of the leaves. A more complete analysis is necessary to say more about total uptake of nutrients and distribution of nutrients within the plant. The relation between soil and crop also needs some attention.
To get a more complete view on pineapple cultivation in the Atlantic Zone a combination of interviewing farmers, sampling of whole plants, sampling of soils and laboratory analysis was carried out.

### 5.2 Farmer interviews.

In the interviews (APPENDIX 1) farmers were asked about several aspects of the work on their own farm and pineapple field. Interviews contained questions about the preparation of the field, the information sources of the farmer, the cultivars used, planting material and its treatments, planting densities, fertilizers, application of hormones, weeds, pests and diseases, harvesting, yields and marketing, rotations, future plans, the time they needed for the work on the pineapple fields they own and the soils that they use for pineapple.
Three farmers in the Neguev and 17 farmers in the area around Rio Frio and Horquetas were interviewed during February 1992. Appendix 2 gives a summary of their answers to the questions. In chapter 6 results of the interviews are discussed. At the same farms of the interviews soil samples and plant samples were taken.

### 5.3 Sampling of plants and soil.

Only plants with a ripe or almost ripe fruit (as indicated by the farmer) were selected for sampling. At four different places in the field the whole aerial part of one plant was extracted. At the same places soil samples were taken of the first 20-30 centimetres. The rooting depth of the plants is restricted to the first decimeters of the soil. Concurrently planting densities were measured and some observations about the field and the plants in the field were made. At this moment attention was given to pests and diseases, weeds and the general condition of the plants. This information was used to give an estimation of the production per hectare. The percentage of

plants that reached maturity and beared a marketable fruit was determined by counting in a representable part of the field. Plants and soil samples were brought to the laboratory of the AZP immediately. Plants were processed at the laboratory directly after their arrival. Soil samples were dried after all samples were taken and send to the CORBANA laboratory.

## 5.4 Laboratory work.

In the laboratory plants were divided in parts:

- The fruit
- The crown
- Leaves
- The stem
- Shoots (spanish = hijos)

The number of sprouts was counted and the different parts were weighted separately. Random samples of these parts were taken to dry in a oven at 70 °C. The samples stayed in the oven for 48 hours and were send to the CORBANA laboratory for chemical analysis. The juicy fruit needed a different treatment. Of every one of the four fruits a part was taken (20-25%) by cutting out a part from the edge to the centre. The rind and the fibrous heart were dried like the other parts of the plant. The juicy fruit flesh was processed in a blender. The resulting liquid was send to the laboratory of CORBANA, where it was filtered and analyzed.

# 6. RESULTS.

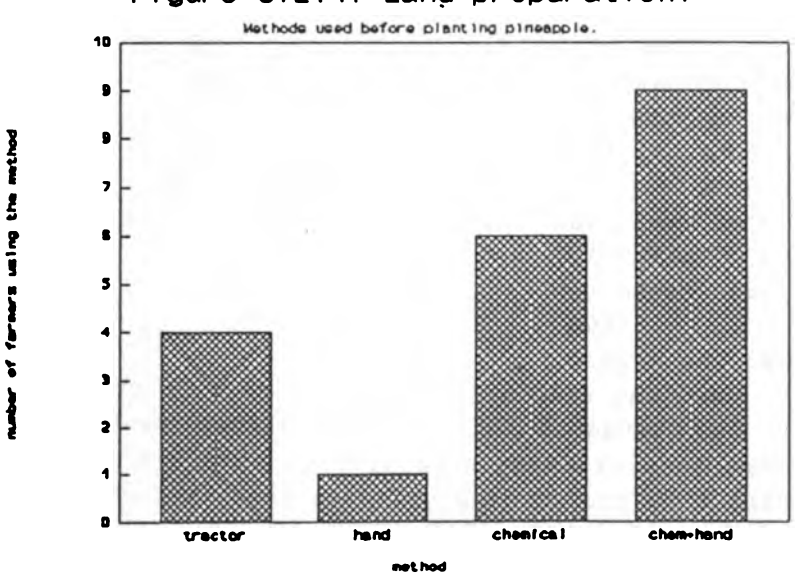
## 6.1 The importance of pineapple in the Atlantic Zone.

Because of its need for a well drained soil and the occupation of the best soils by bananeras, pineapple in the Atlantic Zone is restricted to some parts of the zone. At the moment of the interviews pineapple was not an important crop in the pilot areas. It can only be found in a limited amount in the Neguev. Near Rio Frio and Horquetas a lot more farmers cultivate it. To the farmers that cultivate it pineapple is an important cash crop. The cultivation of the crop is the first or second source of income. This is reflected in the area and the work they put in its cultivation. The mean area planted by the interviewed farmers was 0.762 hectare (0.25-2). The work invested in the crop varies between 456 and 1446 hours per hectare per copping season (mean value 842 hours).
The 'Cayenne' cultivar is used for the export market and the 'Montelirio' cultivar for the local market. The production for the local market is farout the most important. Three of the farmers planted a 'Cayenne' cultivar. They called it 'Hawaiana Lisa'. The other 17 planted the cultivar 'Montelirio', that also has got the local name 'Criolla'. One of them called his cultivar 'San Carlena', because of its origin. The fruits and the plants had the appearance of the 'Montelirio' cultivar. Also because he had bought planting material from a neighbour and neighbours all had 'Montelirio', it is assumed that this 'San Carlena' is similar to 'Montelirio'.

## 6.2 Crop management in the Atlantic Zone.

Farmers more or less gave a description of their crop management during the interviews, which contained many aspects from preparing the land until harvesting. Interview abstracts of every farmer are given in appendix 2.
Figure 6.2.1 shows the methods of land preparation of the 20 farmers. Four of the 20 farmers used a tractor. One did this work by hand using a 'machete', a local tool that can be described as a long knife. In general chemicals were used to spray against weeds before sowing, or a combination of 'machete' and

Figure 6.2.1: Land preparation.



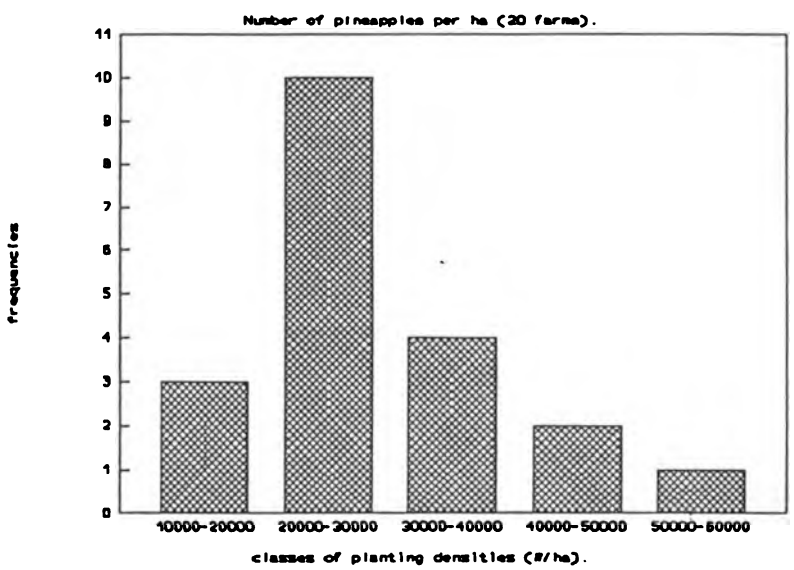
chemicals. When the soil was ploughed by a tractor no chemicals were applied. Six farmers only applied chemicals. Nine combined chemicals and hand work with a 'machete'. The chemicals Karmex, Diuron, Polydiuron, Roundup and Gramoxone were applied using a knapsack sprayer. One farmer also applied calcium on his field before planting. He considered that this treatment was stimulating early growth.

The planting material 19 farmers used consisted in general of the shoots just below the fruit. It can be picked together with the fruit. One farmer also used the shoots of the crown (but these are few). Three farmers also used the shoots from leaf axils. Only one farmer did not use the shoots below the fruit. He used only shoots from leaf axils, because they produce fruit in the shortest time. Another farmer was experimenting with regrowth of the stubble from axillary buds. He cut a part of the plants after the harvest at five to ten centimetres above the ground.

The planting material that is used for the next generations of crops consists of parts of the harvested plants. Pests and diseases can spread easily when planting material is not cured. Planting material was not cured in 15 of this 20 cases. Planting material can be dipped in or sprayed with a solution of chemicals. Three farmers used chemicals to cure the shoots. One used Decis, one a combination of Diazinon and Benlate, and one Fusillade. One farmer kept shoots from ill plants apart. Another left the shoots a few days lying on the field before planting. One farmer had started drying shoots on top of the plants when sampling of plants and soil was done on his field. He also removed the lowest leaflets to stimulate rooting.

Distances of planting differ from farm to farm. Planting densities of 14 to 53 thousand plants per hectare were used with an average of 26.5 thousand. Figure 6.2.2 shows the plant densities used by the 20 farmers. Six farmers used beds of two rows with a slightly bigger distance between two beds. The others only used one spacing between all rows. Farmers mentioned reasons for this planting distances and densities. Sixteen mentioned that it improved working. Eleven used planting densities to obtain a good fruit size. For the local market they preferred big fruits and planted in lower densities. One farmer used a high density to obtain a fruit of about 2 kilograms for the export market. One farmer mentioned the closing of the crop and another the utilization of sun light.

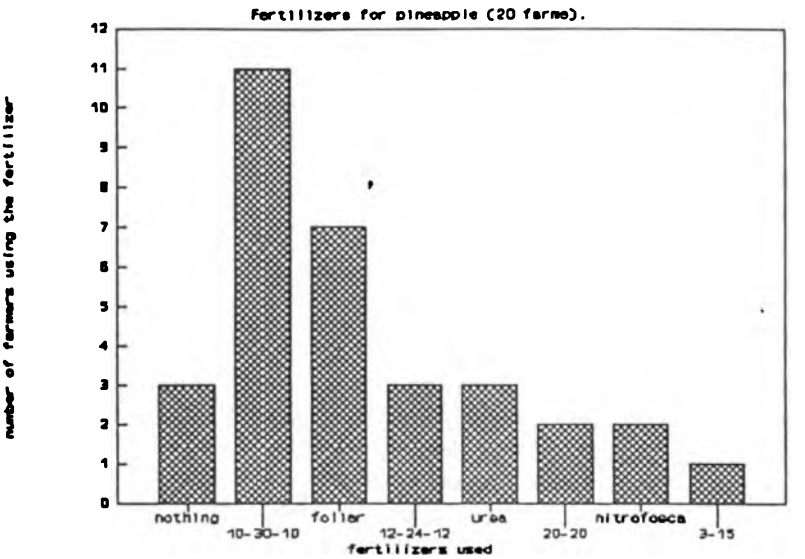
Figure 6.2.2: Plant densities.




The use of fertilizer is quite common for the farmers (figure 6.2.3).

Seventeen farmers use one, two or three different grades. Eleven were using 10-30-10 and seven 'foliar' (Urea or Nitrofosca), a fertilizer that is applied as a liquid on the leaves. Other formulas mentioned were urea, 12-24-12, 20-20-0, Nitrofosca, and 3-15-0. Only three farmers did not use any fertilizer. They said that the reason for not using fertilizer was the high price.

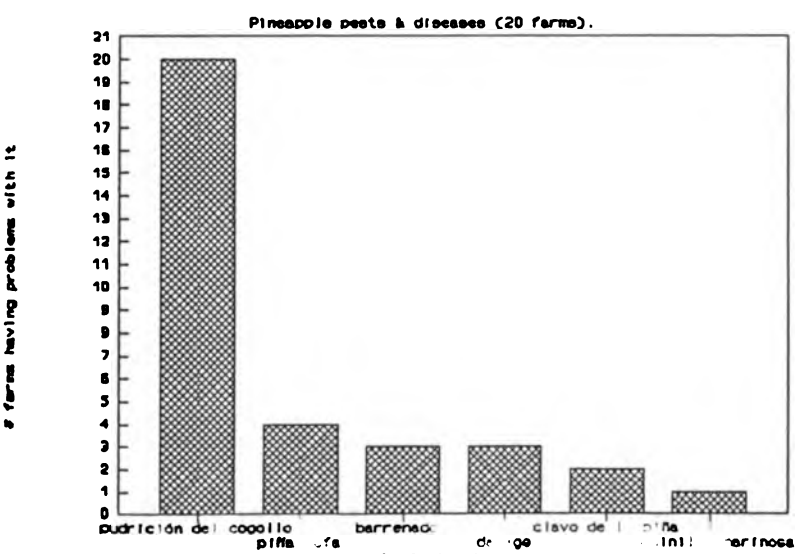
Figure 6.2.3: Use of fertilizers.




Eighteen farmers applied hormone to induce flowering. They applied it early in the morning or late in the afternoon. The best results are obtained when it is applied late in the afternoon (COLLINS, 1960). Farmers use hormone when they think the plant is at that size it can produce a large fruit. In general they used it after eight to ten months.

Pests and diseases cause a considerable reduction of the yield (15-70%, estimated in during the second visit of the farms). Figure 6.2.4 gives the most important pests and diseases and their frequencies at the 20 farms. All farmers mentioned the disease 'pudrición del cogollo' (rot of the heart of the plant) caused by a fungus (Erwinia sp.). This is a big problem in the 'Montelirio' cultivar (CONITTA, 1991). Ten farmers applied Counter. Others used Decis, Furadan or Gramoxone. Two did not combat the fungus. Three farmers cured the plants with Carbolina. This is also recommended by

Figure 6.2.4: Pests & diseases.



CONITTA (1991). One of them also mentioned Farmolina. One farmer chose a broader plant distance and one tried to avoid spread of the fungus during the work by not touching the plants. Humid circumstances work in favour of the fungus. Bad drainage of the soils may be an important reason of its widespread appearance.

Three farmers mentioned 'barrenador' (Tecla basalides, Lepidoptera: Lycaenidae). The larvas of this insect cause holes and caves in the fruit' which can easily be attacked by other pests and diseases. Only one farmer combatted the pest. He applied Diazol and Diazinon.

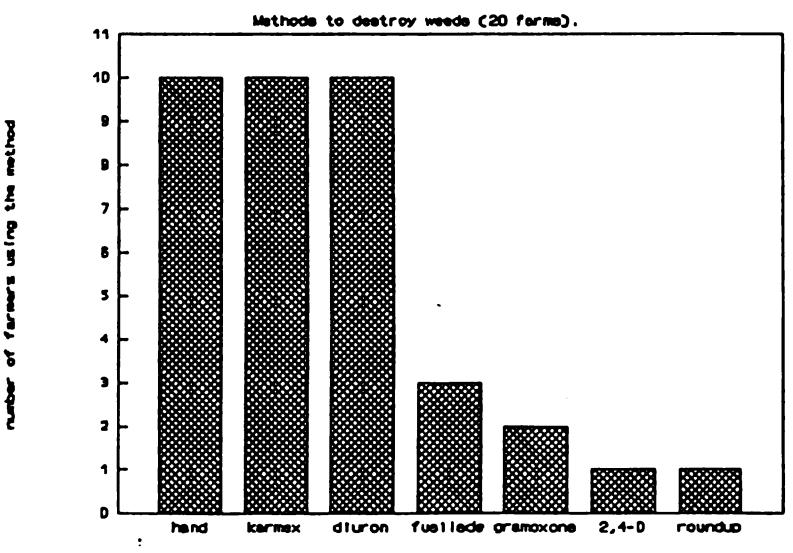
Four farmers had problems with 'piña bofa' a physiological disease of the fruit, which causes that the fruit turns into a sweet smelling and juicy mass within a few hours after the harvest. The best way to avoid this is not to harvest in humid and warm periods (CONITTA,1991). This is a problem in the very humid climate of this area.

Two farmers had problems with 'clavo de la piña' (Penicillium funiculosum and Fusarium moniliforme). Some parts of the fruit get a black colouring when they are ripe. They lose their commercial value. To combat these diseases a good control of weeds and insects is necessary (CONITTA, 1991).

One farmer mentioned the insect pest 'cochinilla harinosa' (Dysmicoccus brevipes, Homoptera: Coccidae). It lives in symbiosis with ants. It feeds on roots and stem of the pineapple. This farmer used a mixture of Gramoxone and Aldrin to combat the insect. CONITTA (1991) mentions a list of methods and chemicals to combat it.

The most persistent weeds were some grasses (monocotyledons) and in the second place some dicotyledons. Figure 6.2.5 shows the methods to destroy the weeds. Three farmers did not often use chemicals. They cut the weeds with a 'machete'. Seven others used the 'machete' frequently. Karmex and Diuron were the most common used chemicals. Farmers also mentioned Fusillade, Gramoxone, Roundup,and 2,4-D. On three farms damage by rats occurred. This problem can not be avoided easily.

Figure 6.2.5: Weed treatment.



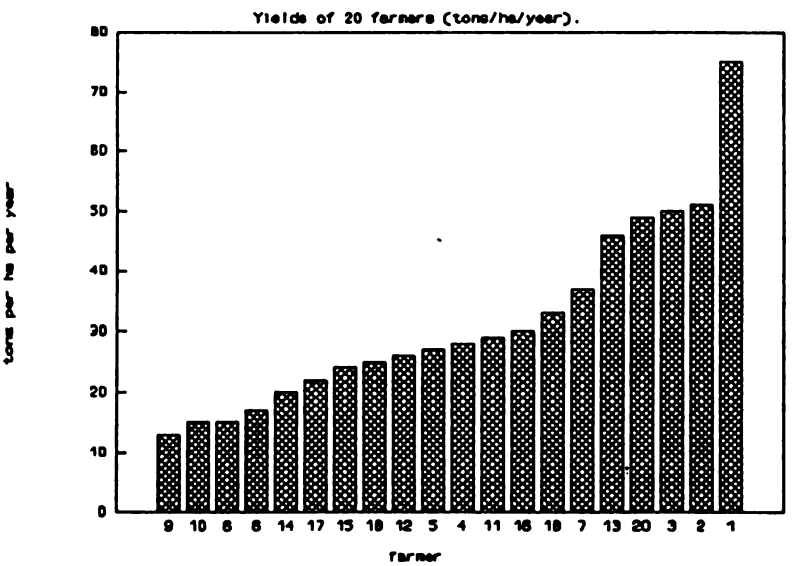

After 12-18 months the fruits can be harvested for the first time. When the same plants are used for a second or a third harvest this can be done after 10-12 months. Most farmers (14) harvested twice. Four only had one harvest. One harvested three times from the same plants and one was trying a system of ratoon cropping, with regrowth from axillary buds. The first harvest gives

the biggest fruits (2-3 kilograms). The second and third harvest fruits are smaller (1-2 kilograms or even less). The advantage of more harvests is the reduction of the work, the disadvantage is the lower price compared to the first harvest.
After the last harvest of the field the plants are destroyed or transported from the field. Eleven farmers destroy the plants mechanically or by 'machete'. One of these farmers first plants new pineapple shoots between the rows and destroys the old ones. Four farmers spray dead the old plants and leave them on the field. Five farmers transport the plants from the field.
Farmers know the differences in their soils. They distinguish soils by colour, structure, stoniness, drainage, slope or weeds growing on it. Two farmers treated pineapple different on different soils. One had two types of soil. On the one with better drainage properties he sprayed less against pests and diseases. The other used more fertilizer on the hardest soil types. They also mentioned differences in yield from different soil types.
All investments in the crop in money and time depend on the expected incomes and the relative importance of the crop on the farm.

## 6.3 Production.

Using the interviews, the laboratory data and the observations in the field an estimation of the total yield per hectare of every farmer was made. The fruit weight was multiplied by the plant density and the losses caused by pests and diseases were subtracted. The mean yield of the 20 farms was estimated at 32 tons fresh fruit (with crown) per hectare, which is high compared to Hawaii were a yield of 30 tons per hectare is realized with high inputs (PURSEGLOVE, 1985). Figure 6.3.1 shows the yields as estimated for the 20 interviewed farmers. The farmers 1, 2, 3 and 20 cultivate pineapple as their most important crop. Fields are well weeded and don't show much pests and diseases. The other farmers seem to have more regular yields of about twenty tons per hectare per year.

Figure 6.3.1: Pineapple yields.



## 6.4 Marketing.

Figure 6.4.1: Pineapple prices.

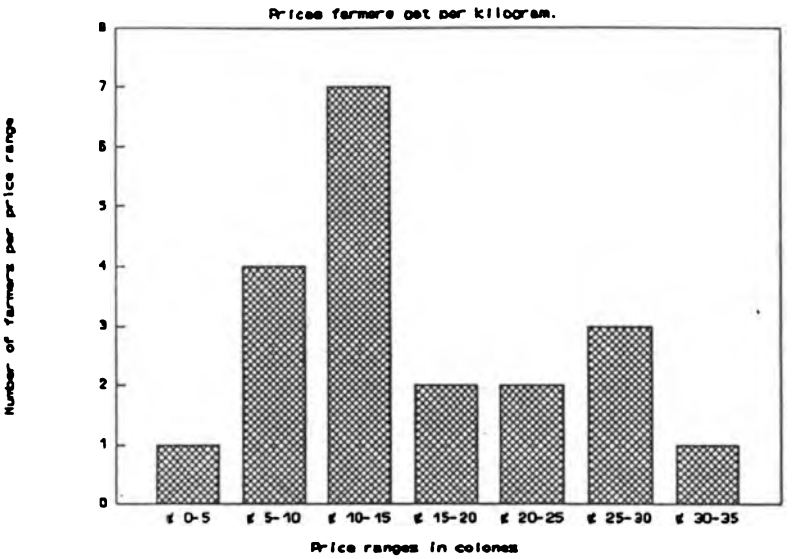
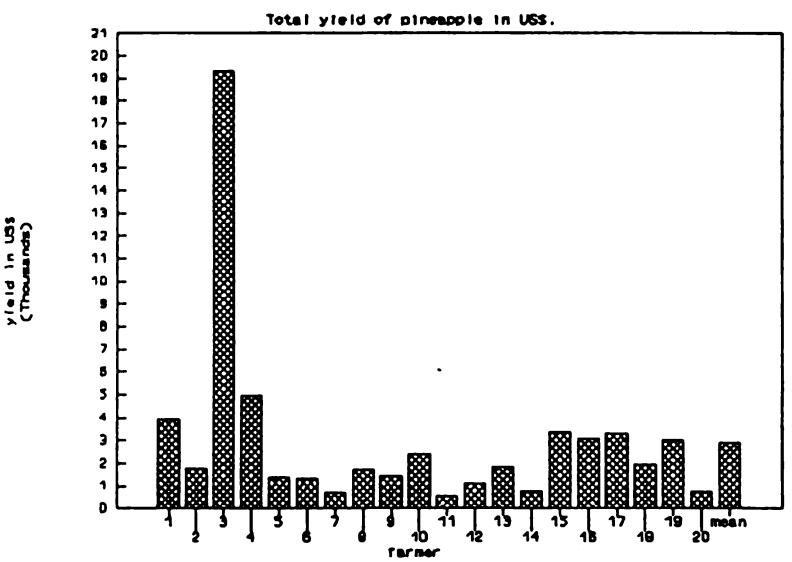



Figure 6.4.2: Farmer Incomes.




Farmers sell their fruits to salesmen that pass now and then at the farm. Two farmers sell also fruits to Hortifruti a company that buys and sells agricultural products in Costa Rica. Only one farmer sells the fruits himself on markets. Prices vary between ¢4-30 per kilogram (mean price ¢15.2, ¢120 = 1 US $, 1991). Figure 6.4.1 shows how much farmers get per kilogram. Prices of the fruits differ from farm to farm even if the same salesman buys them. Sale of the fruits gives farmers a mean income of ¢380000 (1991). Figure 6.4.2 shows farmer incomes due to selling pineapple. Costs of inputs are not included. The income of the farmer depends on the yield of the pineapple per ha, the area of the crop and above all the price. Farmer 3 gets a very high price (30-35 colones per kg). His income due to the selling of pineapple fruits is much higher than for example that of farmer 1, although farmer 1 produces per hectare 1.5 times as much as he does. The difference is that farmer 1 has only 0.75 hectare instead of the two hectares of farmer 3 and farmer 3 gets a much higher price for his product. In this way all the differences between figure 6.3.1 and 6.4.2. can be explained.

## 6.5 Soil chemical analyses.

The CORBANA laboratory analyzed the soil samples, that were taken in the fields of the twenty farmers. Results of the analyses are given in appendix 3. Soils are rather acid (pH between 3.74 and 4.73). The mean organic matter content of the soils is 8.6% (4.68-20.9). Soil chemical data were used to compare them to the uptake of nutrients by the plants that were analyzed. The low pH of the soils can influence the uptake of nutrients by the plant.

## 6.6 Nutrient uptake.

The data of the analyses of the plants were used to make an estimation of the total uptake of nutrients per hectare in case the whole crop would reach maturity like the sampled plants. Of course this is not the field situation, but a few farmers showed to come close to this result in case of good management. These farmers often used much more fertilizer, chemicals and above all work to keep the condition of the crop high. A crop like that uses a lot of nutrients. The total uptake of nitrogen of the best crop reaches almost 500 kg per hectare. The mean nitrogen

Figure 6.6.1.a

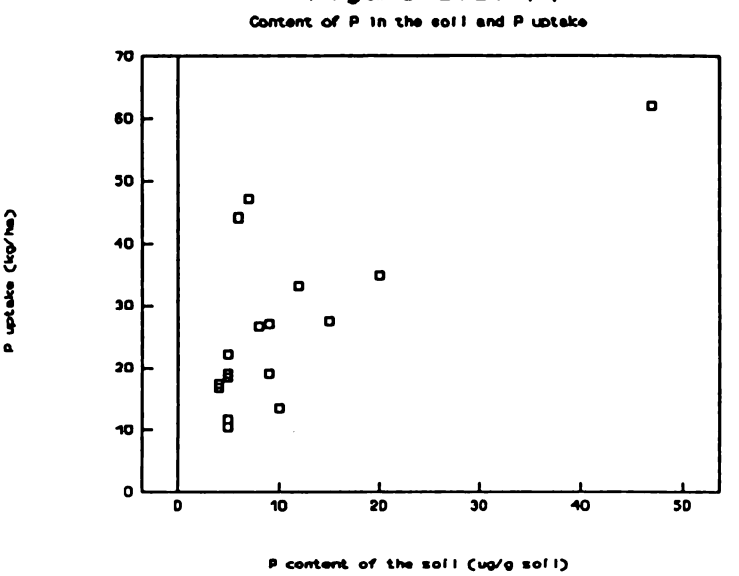
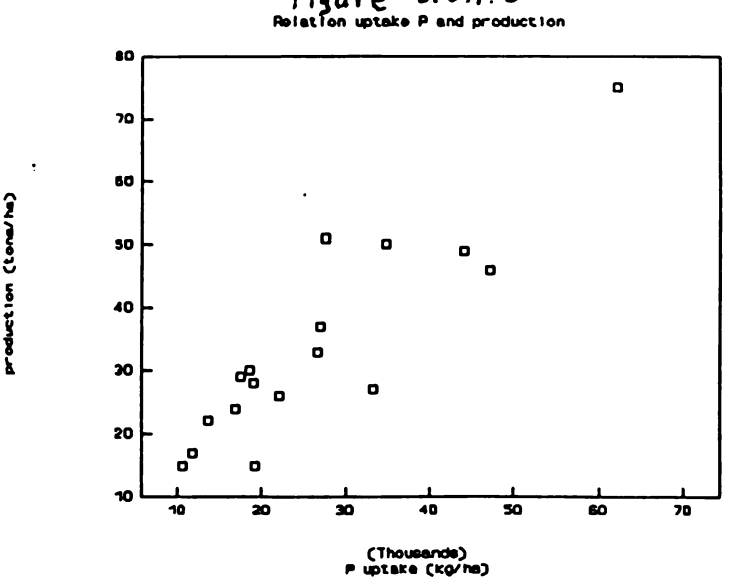



Figure 6.6.1.b



uptake per hectare of the crops of the 17 farmers of which data is available was 210 kg. De Geus (1973) mentions an uptake of 205 kg N per hectare of which 43 is found in the fruits. This result comes close to his data. Mean crop uptake of P was 24 kg. De Geus mentions 25 kg/ha (7 kg in the fruits), which is comparable to the means of the 17 farms. The uptake of P was related to the P content of the soils (R squared 0.51). Figure 6.6.1.a shows this relation. No relation was found between the uptake of other elements and their contents in the soil, but there is a relation between the P uptake and the uptake of N (Rsq 0.72), K (Rsq 0.61), Mg (Rsq 0.59), Ca (Rsq 0.50), Cu (Rsq 0.50), Zn (Rsq 0.72) and Mn (Rsq 0.67). An explanation of this phenomenon is that in the first place phosphate is limiting and the restrictions in P uptake determine the uptake of the other elements. If this is true, the strongest relation between production and P uptake has to be found compared to other nutrient uptakes and crop production. This is found indeed (Figure 6.6.1.b, R squared 0.80). P removals may be small, but the soil has to be well supplied with phosphate (Finck, 1982).

De Geus (1973) writes that N uptake determines the amount of uptake of the other nutrients. The uptakes of K, Mg, Ca and Mn are stronger related to N uptake than to P uptake. Especially Mg and Ca uptake are strongly determined by N uptake (Rsq 0.76 instead of 0.59 and 0.82 instead of 0.50).

K uptake is very high. This is logical, because pineapple needs a high amount of potassium like many fruits. The K uptake by the crop is higher than N uptake (De Geus, 1973). All mean nutrient uptakes are shown in figure 6.6.2.a and b. Uptake and distribution of nutrients is shown more detailed in appendix 4.

Figure 6.6.2.a

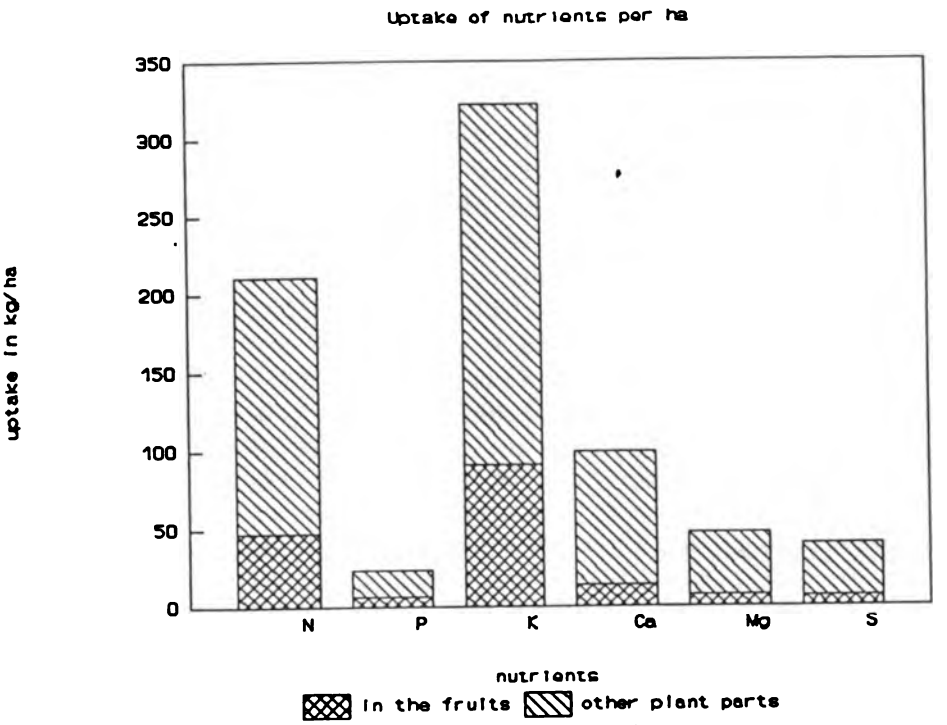
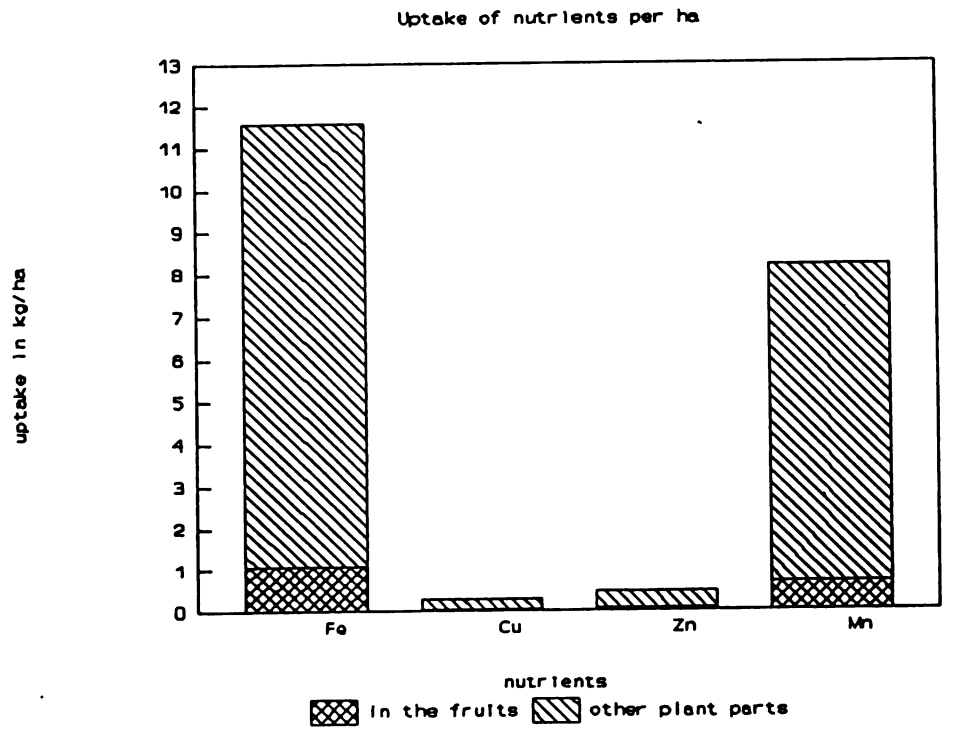



Figure 6.6.2.b



## 6.7 Fresh and dry matter production and partitioning.

The mean dry matter production per hectare of the farmers was 23.6 tons. The fruits contented 30% of the dry matter. The fresh matter production of the crop was 116 tons. Of this fresh matter 36% was fruit. If all plants in the field reach the harvestable age 42 tons of fruit can be harvested. Figure 6.3.1 shows the mean fruit production is about 30 tons per hectare.
The distribution of nutrients in the plant is important. If a farmer leaves the crop residues in the field losses of nutrients can be lowered. The question is: What quantity of nutrients is removed during the harvest and what quantity is removed when crop residues are removed?
The nitrogen and potassium content of the fruits is high. Fruits are always removed from the field. Losses of N and K need to be replenished. If plants are removed as a whole, calcium, magnesium and sulphur losses are high.
Spore elements are mainly found in the green parts of the plant (Appendix 4). Plants content relatively much of the nutrients Fe and Mn.

## 6.8 Integration of all results.

The results of the interviews and the laboratory data show great differences between farmers. The importance of pineapple cultivation in the pilot areas was not high during the period of the field work. However, some farmers depend upon the pineapple production. For those farmers a good price is important. Those who are cultivating pineapple for the export market mentioned higher prices than those who produced for the local market. Crop quality is determined by the management of the farmer. Farmers had their own ways of managing the crop. Different treatments of pests and diseases, different ways of preparing the land, different planting densities and different fertilizer use were seen.
Farmers have also things in common. Two problems appear on all farms. The fungus (Erwinia sp.) that causes rot in the heart of the plants was found throughout the area. The bad drainage of the soils may be the most important reason for its appearance. Weeds are the other problem on the farms.
Unfortunately laboratory data was missing. The data of the juice of the fruits missed completely. This contains only a small part of the nutrients. Because of this not much differences would be found if data were complete.
Phosphor is the most limiting nutrient in the area. The uptake of other nutrients depends on the P content of the soil. If losses of nutrients are not compensated by fertilizers, soil fertility will decrease rapidly. This means that a high gift of nitrogen and potassium is necessary. More than 200 kg of nitrogen more than 300 kg of potassium have to compensated per hectare if plants are removed from the field. If fruits are removed less than 50 kg N and less than 100 kg K per hectare are exported per hectare from the field during the harvest. Demands of the crop are mainly nitrogen and potassium, but other nutrients are removed in high quantities with the crop. Advices for fertilization mention N gifts of up to 550 kg/ha and K gifts of up to 315 kg/ha. These are high gifts, but because of the high uptakes they are realistic in the farmer situation in the Atlantic Zone.
For those who are interested in the nutrient contents of the separate plant parts and the uptakes per hectare appendix 4 gives more details for all nutrient contents that were determined in the CORBANA laboratory.

# 7. CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

## 7.1 Conclusions.

The hypotheses of chapter 1.4 have been studied during the field work, the laboratory work and the analysis of the CORBANA data. In short the conclusions are mentioned in this paragraph.
Only a positive relation is found between phosphorus content of the soil and P uptake by the plants. The P uptake determines the production and the uptake of the nutrients N, K, Mg, Ca, Cu, Zn and Mn (directly and indirectly via N uptake). The balance between nutrients in the plant is kept stable in this way.
A higher production of pineapple means a higher uptake of nutrients. A crop of 30 tons fresh fruit contains about 50 kg N and 100 kg K in the fruits. If whole plants are removed from the field after the harvest more than 200 kg N and more than 300 kg K are removed per hectare. If this losses are not counteracted by fertilizers the absolute amount of nutrients will decrease rapidly. Losses of the other elements have to be counteracted also.
Losses that have to be compensated are (table 7.1.1):

| Nutrient: | Total uptake (kg/ha): | Uptake in fruit (kg/ha): |
|---|---|---|
| N | 210 | 47.7 |
| P | 24 | 7.4 |
| K | 323 | 91.5 |
| Ca | 99 | 14.0 |
| Mg | 48 | 7.7 |
| S | 41 | 6.7 |
| Fe | 11.6 | 1.1 |
| Cu | 0.3 | 0.05 |
| Zn | 0.5 | 0.06 |
| Mn | 8.2 | 0.7 |

Table 7.1.1: Uptake of nutrients by pineapple (kg/ha, means of 17 farms in the Atlantic Zone of Costa Rica).

In the first place P fertilization has to be done and after that also K and N fertilization. N determines the uptake of other elements and the production and K is used in the highest amounts (also in the fruits).

## 7.2 Discussion.

Because of the restricted number of farmers (20 farmers) and the loss of some data this research has to be used as an indication for the pineapple-soil relations in the Atlantic Zone. However, results are interesting and show similarities. The missing juice data may be analyzed, but will not bring much new information, because juice does not contain much nutrients comparing it to the other parts of the fruit and to the whole plant.
Losses of nutrients are not a result of removal of the fruits and the plant only. The slow closing of crop may cause a loss of nutrients in the wet climate of the Atlantic Zone.

Because of the bad drainage of the soils of the pineapple fields rot of the heart of the plants is widespread. The Zone is not very suitable for the pineapple looking at this soil property. The high price of pineapple comparing it to other local crops is an important reason for the farmers to cultivate the crop. If too many farmers start cultivating pineapple, prices may lower and the area of cultivation may decrease.

### 7.3 Recommendations.

This study tried to quantify nutrient contents of plants. It would be interesting to quantify those losses of nutrients that are caused by other reasons than removal of harvested products and plants. This would be a better basis, together with the results of this research, to give an advice for application of fertilizers. Other ways of protecting the soil against loss of fertility may be part of this research. The aim of the project (sustainable land use) contains more than fertilizer gifts after losses of nutrients. It may also be preventing this losses.

## 8. PERSONAL.

### 8.1 Practical period at the Atlantic Zone Programme.

In october 1991 I made my first entry in a tropical country. Costa Rica seemed to be a nice start. The Atlantic Zone Programme offered the opportunity to have a practical period or a thesis. I decided to do both. At the AZP I continued the experiment at the Agropalmito plantation started by Raymond Jongschaap. This report describes my other 'job' in Costa Rica: A practical period in pineapple cultivation in the Atlantic Zone of Costa Rica. Of course my interest did not only reach to the pineapple and palmito cultivation in the Atlantic Zone but also to other crops and parts of this beautiful country. In the eight months of my stay I travelled across the country and saw in this way a diversified country. The Atlantic Zone is a very humid zone and has a totally different land use as the Central Valley and the Pacific Coastal Area. In the Central Valley I saw the coffee and the export crops strawberries, flowers, ornamental plants, and other horticulture crops. In january I saw the harvest of the coffee. I have to admit that Costa Rica has got a beautiful harvest of big orange/red coffee berries. At the Pacific Coast the oilpalm fruits were harvested in the end of january. In the western part of Costa Rica large plantations of oil palm can be seen. In the south western part of the country in the mountains near San Isidro the cows looked more like the Swiss type. Sisal and sugar cane were cultivated there on the lower parts of the slopes. In the north western part livestock is important. In the wet period rice is cultivated there. When I visited the area the dry period had lasted for six months. This is extremely long. Farmers were burning the pasture near Liberia. The 'Peninsula' Nicoya had turned into a yellow land. Rivers were dry.
Of course I spend most of my time in the environment of Guápiles were the program is located. I enjoyed living with a family near 'Los Diamantes'. The work in the field, in the laboratory, and in the buildings of the program in combination with the totally new environment made this stay a useful experience.

### 8.2 Field work.

The field work part of the practical period I enjoyed most. The interviews gave the opportunity to talk with the farmers. Before I started interviewing I met with some farmers by going to the Neguev and the Rio Jimenez together with other students that were doing their thesis or practical period at the program. For more than two months I worked together with my assistant Mario Solano. He is a good car driver and knows lots about agriculture and people of this area. Thanks to him I learned more about this things but also about the nature of the area (example: curative plants). The Neguev, the Rio Jimenez, and the area around Rio Frio and Horquetas are beautiful and farmers liked to talk to us even if they were interviewed before. The month after the interviews they followed with interest the sampling of plants and soil. They are eager to hear the results.

## 8.3 Laboratory work.

The laboratory of the AZP is suitable for dividing and drying of the plants and for drying of the soil samples. Analysis has to be done at the CORBANA laboratory. Disadvantage of this laboratory is the long time they need to do the analyses. This is why the report of the palmito experiment has to be finished in Holland. The analyses however will be good enough. They showed the laboratory and the equipment is modern and they treat the samples careful. Unfortunately a part of the lab-data of this practical period was lost in the laboratory.

## 8.4 The report.

Computers were invented to produce a higher quality report, to make calculations more easy and to work quicker. This resulted in higher demands on the quality of the report, more calculations and more work. Computers can ruin my day. I'm glad the report is ready.

## 8.5 Personal opinions.

The program has a well structured organization. Sometimes the rules are against you. This makes working more difficult. Perhaps the first rule has to be: Work first. The second rule should be: You have to work together. When all the members of this project remembered that annoyance would have been less. However, in general to me working with the people of the program has been pleasant.
I didn't have a drivers license. My assistant is a good driver. Without him working would have been difficult. Getting a drivers license in Holland is expensive. It's not self-evident students have one.

## 8.6 Salsa, meringue and cumbia.

The people of Costa Rica like to dance. They swing their hips to the rhythm of the salsa. They dance their troubles away by the sound of the meringue. They keep moving to the cumbia, even if they're too drunk to walk. One evening the Dutch students had the opportunity to use discotheque 'Dynastia' for their own music. A successful cultural exchange. Keep movin'.....

## 8.7 Time to leave....

After eight months it's time to leave. Time to see my friends and family. I climbed the Chirripo, I saw the crater of the Poas, I was in Puerto Viejo, Manuel Antonio, Montezuma, Santa Rosa, the Braulio Carrillo forest, national park Rincon de la Vieja, saw the most of San José, felt the cold mist on the Irazu and the sun in Cahuita, and travelled around by bus, car and motorcycle. It would be nice to walk the forests of Baarn and smell the sea on Schiermonnikoog. I will return to the tropics, but now it's time to leave...

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# APPENDIX 1: THE FARMER INTERVIEW

The questions that were used during every interview. Original spanish version.

# CONVENIO CATIE/UAW/MAG
# Entrevista sobre el cultivo de piña
# Jorg-Johan Tönjes
# (Universidad Agricola Wageningen Holanda)

1. Información general:

a. Región:

b. Fecha:

c. Encuestador:

d. Localización del terreno:

e. Nombre del campesino:

f. Nombre de la finca y lugar:

g. Número de la percela o número de cadaster:

h. Area total: _____Ha

i. Area de piña: _____Ha

2. Piña:

a. Preparación del terreno:

Cómo ha preparado su terreno?

Químico: -cuales medidas usaba Ud.
-gramoxone / paraquat
-round up
-karmex / diuron
-gesapax
-fusilade II / fluazifop-butil
-

Mecanico: -método

Mecanico y químico

b. De dónde resibía usted la informaciá sobre el cultivo?

c. Qué variedad de piña usaba / usa Ud.?
-Cayena Lisa
-Montelirio (la criolla)
-

d. Que usaba Ud. para plantar? (Puede Ud. indicar?)

brote del tallo/hijo de pie o bastago/chupón del suelo

hijo intermedio/chupón aéreo

bulbillo/esqueje basal

corona / esqueje de corona

Cómo trataba Ud. la semilla?

Cómo plantaba Ud. la semilla?

De dónde recibia Ud. la semilla?

e. Densidad

____ m * ____ m

hileras? camas?

Porque usaba Ud. estas distancias?

f. Abonamiento:

Qué clase de fertilizante usaba Ud. y cuando lo utilizaba?

| classe | cuantidad | tiempo |
|---|---|---|
| | | |

| |
|---|
| |

g. Usaba Ud. un compusto químico para inducir la floración?

Cuál?

Cuándo?

Por qué?

h. Cómo combatia Ud. las malezas y cúal malezas son las más importante?

| maleza: | combatir con: |
|---|---|
| | |

i. Hay plagas?

| plaga: | combatir con: |
| --- | --- |
| Cochinilla harinosa | |
| Jobotos | |
| Barrenador | |
| Nematodos | |

j. Hay enfermedades?

| Enfermedad: | combatir con: |
| --- | --- |
| Pudrición del cogollo | |
| Podredumbre del corazon | |
| Clavo de la piña | |
| Podredumbre blanda del fruto | |
| Enfermedad de Wilt | |
| Podredumbre suave de la fruta o piña bofa | |

k. La cosecha:

A qué edad cosechaba Ud. la piña?

El cultivo tenía solamente una cosecha?

Cuantos kilogrammas por héctarea piensa Ud. riendía el cultivo?

Qué hacía Ud. con las hojas, los tallos y las raíces depués de la cosecha?

Quién compraba las frutas? Es con contrato?

Cuanto dan por las frutas?

l. Hay una rotación?

Cultivo antes de la piña _____

Cultivo después de la piña _____

m. Cuáles son las perspectivas para el futuro? Más / menos piña? Cuánto? Por qué?

Ha Ud. tenido más / menos piña?

Va Ud. de cambiar la manera de producción?

n. Cuándo Ud. ha comenzado a trabajar con piña?

o. Tiempo:

| Cuánto tiempo para: | en 1 dia (horas) | la percela (___ha) | por ha |
|---|---|---|---|
| preparar su terreno | | | |
| plantar | | | |
| aplicar abono | | | |
| aplicar hormones | | | |
| aplicar *-cides | | | |
| deshijar | | | |
| cosechar | | | |
| ..... | | | |

p. Suelos:

Ud. tiene diferencias en los suelos de la piña?

Como distingue Ud. las diferencias?

Ud. trataba la piña en diferentes suelos de una otra manera?

Se nota diferencias en cantidad y / o calidad de producción en los suelos diferentes?

Cuál será la razon?

q. Quiere Ud. decir algo más sobre el cultivo de piña?

# APPENDIX 2: SUMMARIZED ANSWERS OF THE FARMER INTERVIEW

A short summary of the interview of every farmer.

| | | | | |
|---|---|---|---|---|
| FARMER NR. | 1 | TOTAL AREA | 10 | ha |
| FARMER NAME | Victor Valesgues Solano | | | |
| LOCALIZATION OF THE LOT | Neguev | | | |
| LOT NR. | 247 | PINEAPPLE AREA | 0.75 | ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Tractor | |
| INFORMATION FROM | IDA | |
| CULTIVAR USED | Hawaiana Lisa | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | Decis | |
| PLANTING DISTANCES | IN THE ROW | 25 cm |
| | BETWEEN THE ROWS | 50 cm |
| | BETWEEN DOUBLE ROWS | 100 cm |
| REASON FOR DISTANCES | work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , 20-20 , urea | | |
| USED HORMONES | Ethrel | | |
| WEEDS | grasses & dicot. | | |
| USED HERBICIDES | Fusilade & machette | | |
| PESTS & DISEASES | Pudrición del cogollo | Barrenador | |
| USED PESTICIDES | Decis | | |

| | |
|---|---|
| HARVEST AFTER 15 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Transported from the field |
| BUYER | Salesman or Hortifruti |
| PRICE IN COLONES PER KILOGRAM | 9 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Less |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Casava |
| CHANGES IN CROPPING SYSTEM | no |
| EXPERIENCE IN YEARS | 3 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS 1251 (TOTAL) | |
|---|---|
| PREPARE FIELD | 8 |
| PLANTING | 120 |
| FERTILIZING | 120 |
| APPLY HORMONE | 43 |
| APPLY *-CIDES | 320 |
| HARVESTING & PICKING SHOOTS | 640 |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Colour |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 2 | TOTAL AREA | 13 ha |
| FARMER NAME | Delio Samora | | |
| LOCALIZATION OF THE LOT | Neguev | | |
| LOT NR. | 254 | PINEAPPLE AREA | 0.5 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Tractor | |
| INFORMATION FROM | IDA | |
| CULTIVAR USED | Hawaiiana Lisa | |
| PLANTING MATERIAL | Below fruit & crown | |
| CURE PLANTINGMATERIAL? | Diazinon & Benlate | |
| PLANTING DISTANCES | IN THE ROW | 30 cm |
| | BETWEEN THE ROWS | 60 cm |
| | BETWEEN DOUBLE ROWS | 90 cm |
| REASON FOR DISTANCES | Work | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | No | | |
| USED HORMONES | Yes | | |
| WEEDS | Dicots | | |
| USED HERBICIDES | Karmex | | |
| PESTS & DISEASES | Pudrición del cogollo | Barrenador | |
| USED PESTICIDES | (Carbolina) | Diazinon + Diazol | |

| | |
|---|---|
| HARVEST AFTER 14 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman & Hortifruti |
| PRICE IN COLONES PER KILOGRAM | 9 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Cacao |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | Broader planting |
| EXPERIENCE IN YEARS | 2 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS 872 (TOTAL) | |
|---|---|
| PREPARE FIELD | 6 |
| PLANTING | 533 |
| FERTILIZING | 0 |
| APPLY HORMONE | 38 |
| APPLY *-CIDES | 28 |
| HARVESTING & PICKING SHOOTS | 267 |

| SOIL DIFFERENCES? | No |
|---|---|
| WAY OF DISTINGUISHING THEM | - |
| OTHER TREATMENT | - |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | |

| | | | |
|---|---|---|---|
| FARMER NR. | 3 | TOTAL AREA | 30 ha |
| FARMER NAME | Romilva Loria Lopez | | |
| LOCALIZATION OF THE LOT | Colonia Villalobos (Rio Frio) | | |
| LOT NR. | ? | PINEAPPLE AREA | 2 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Tractor | |
| INFORMATION FROM | IDA | |
| CULTIVAR USED | San Carlena (= Montelirio) | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 50 cm |
| | BETWEEN THE ROWS | 50 cm |
| | BETWEEN DOUBLE ROWS | 90 cm |
| REASON FOR DISTANCES | Work | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 | | |
| USED HORMONES | Yes | | |
| WEEDS | Grasses and dicots | | |
| USED HERBICIDES | Carmex & Gramoxone | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | | | |

| | |
|---|---|
| HARVEST AFTER 13 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 25 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 3 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS 1446 (TOTAL) | |
|---|---|
| PREPARE FIELD | 10 |
| PLANTING | 343 |
| FERTILIZING | 24 |
| APPLY HORMONE | 6 |
| APPLY *-CIDES | 720 |
| HARVESTING & PICKING SHOOTS | 343 |

| SOIL DIFFERENCES? | No |
|---|---|
| WAY OF DISTINGUISHING THEM | - |
| OTHER TREATMENT | - |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | - |

| | | | | |
|---|---|---|---|---|
| FARMER NR. | 4 | TOTAL AREA | 2 | ha |
| FARMER NAME | Freddy Chaves | | | |
| LOCALIZATION OF THE LOT | La Victoria (Rio Frio) | | | |
| LOT NR. | 185 | PINEAPPLE AREA | 1 | ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 60 cm |
| | BETWEEN THE ROWS | 100 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , foliar | | |
| USED HORMONES | Ethrel | | |
| WEEDS | Gras | | |
| USED HERBICIDES | Diuron | | |
| PESTS & DISEASES | Pudrición del cogollo | Piña bofa | |
| USED PESTICIDES | Counter | | |

| | |
|---|---|
| HARVEST AFTER 13 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 28 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Casava |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | ? |
| EXPERIENCE IN YEARS | 1.5 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 1435 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 100 | |
| PLANTING | 484 | |
| FERTILIZING | 360 | |
| APPLY HORMONE | 120 | |
| APPLY *-CIDES | 80 | |
| HARVESTING & PICKING SHOOTS | 290 | |

| | | |
|---|---|---|
| SOIL DIFFERENCES? | Yes | |
| WAY OF DISTINGUISHING THEM | Heigh / low | |
| OTHER TREATMENT | No | |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 5 | TOTAL AREA | 6 ha |
| FARMER NAME | Nelson Obando | | |
| LOCALIZATION OF THE LOT | Colonia Colegio (Rio Frio) | | |
| LOT NR. | ? | PINEAPPLE AREA | 0.25 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 42 cm |
| | BETWEEN THE ROWS | 92 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , 3-15 , 20-20 | | |
| USED HORMONES | Yes | | |
| WEEDS | Grass | | |
| USED HERBICIDES | Karmex & Diuron | | |
| PESTS & DISEASES | Pudrición del cogollo | Cochinilla | Piña bofa |
| USED PESTICIDES | (Counter) | Gromoxone+Aldrin | |

| | |
|---|---|
| HARVEST AFTER 13 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Transport from the field |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 26.7 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Less |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | ñame |
| CHANGES IN CROPPING SYSTEM | Less spraying |
| EXPERIENCE IN YEARS | 15 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 1067 (TOTAL) |
|---|---|
| PREPARE FIELD | 276 |
| PLANTING | 259 |
| FERTILIZING | 12 |
| APPLY HORMONE | 6 |
| APPLY *-CIDES | 48 |
| HARVESTING & PICKING SHOOTS | 466 |

| SOIL DIFFERENCES? | No |
|---|---|
| WAY OF DISTINGUISHING THEM | - |
| OTHER TREATMENT | - |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | - |

| | | | |
|---|---|---|---|
| FARMER NR. | 6 | TOTAL AREA | 14 ha |
| FARMER NAME | Pedro Mendez | | |
| LOCALIZATION OF THE LOT | Finca Melincia (Rio Frio) | | |
| LOT NR. | ? | PINEAPPLE AREA | 0.75 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 67 cm |
| | BETWEEN THE ROWS | 108 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , nutran | | |
| USED HORMONES | Yes | | |
| WEEDS | Grasses | | |
| USED HERBICIDES | Machete , Diuron | | |
| PESTS & DISEASES | Pudricion del cogollo | Clavo de la pina | |
| USED PESTICIDES | (Counter) | - | |

| | |
|---|---|
| HARVEST AFTER 13 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Spray dead |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 13.3 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Less |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pejibaye |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 1 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 845 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 48 | |
| PLANTING | 240 | |
| FERTILIZING | 16 | |
| APPLY HORMONE | 32 | |
| APPLY *-CIDES | 288 | |
| HARVESTING & PICKING SHOOTS | 221 | |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Dry / wet |
| OTHER TREATMENT | Caused by less pests & diseases on dry part |

| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |
|---|---|

| | | | |
|---|---|---|---|
| FARMER NR. | 7 | TOTAL AREA | 15 ha |
| FARMER NAME | Rosendo Jimenez | | |
| LOCALIZATION OF THE LOT | La Lucha | | |
| LOT NR. | 23 | PINEAPPLE AREA | 0.25 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit & leaf axils | |
| CURE PLANTINGMATERIAL? | Fusilade | |
| PLANTING DISTANCES | IN THE ROW | 50 cm |
| | BETWEEN THE ROWS | 50 cm |
| | BETWEEN DOUBLE ROWS | 70 cm |
| REASON FOR DISTANCES | Fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , 12-24-12 | | |
| USED HORMONES | No | | |
| WEEDS | Mono- & dicots | | |
| USED HERBICIDES | Machete (or Karmex or Fusilade) | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | | | |

| | |
|---|---|
| HARVEST AFTER 18 MONTHS | |
| NR. OF HARVESTS | 1 |
| STUBBLE TREATMENT | Transport from the field |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 10 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Same |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pineapple |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | Experiments |
| EXPERIENCE IN YEARS | 5 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 560 (TOTAL) |
|---|---|
| PREPARE FIELD | 64 |
| PLANTING | 64 |
| FERTILIZING | 0 |
| APPLY HORMONE | 0 |
| APPLY *-CIDES | 240 |
| HARVESTING & PICKING SHOOTS | 192 |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Colour |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 8 | TOTAL AREA | 7.5 ha |
| FARMER NAME | Juan Jose Chavez | | |
| LOCALIZATION OF THE LOT | Colonia Huetar (Rio Frio) | | |
| LOT NR. | 21 | PINEAPPLE AREA | 1 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 50 cm |
| | BETWEEN THE ROWS | 100 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , urea | | |
| USED HORMONES | No | | |
| WEEDS | Grasses | | |
| USED HERBICIDES | Diuron | | |
| PESTS & DISEASES | Pudricion del cogollo | Clavo de la pina | Damage |
| USED PESTICIDES | (Counter) | | |

| | |
|---|---|
| HARVEST AFTER 18 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 18.3 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Same |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 4 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 470 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 24 | |
| PLANTING | 120 | |
| FERTILIZING | 14 | |
| APPLY HORMONE | 0 | |
| APPLY *-CIDES | 71 | |
| HARVESTING & PICKING SHOOTS | 240 | |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Wet / dry |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | | |
|---|---|---|---|---|
| FARMER NR. | 9 | TOTAL AREA | 11 | ha |
| FARMER NAME | Rafael Angel Montero Sanches | | | |
| LOCALIZATION OF THE LOT | Rio Frio | | | |
| LOT NR. | 20 | PINEAPPLE AREA | 0.50 | ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Chemical | |
| INFORMATION FROM | MAG | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 40 cm |
| | BETWEEN THE ROWS | 80 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , Nitrofosca | | |
| USED HORMONES | Yes | | |
| WEEDS | Grass | | |
| USED HERBICIDES | Machete , Diuron | | |
| PESTS & DISEASES | Pudricion del cogollo | Pina bofa | |
| USED PESTICIDES | (Counter) | | |

| | |
|---|---|
| HARVEST AFTER 15 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 30 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Same |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Maracuia |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | Perhaps |
| EXPERIENCE IN YEARS | 6.5 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 877 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 48 | |
| PLANTING | 288 | |
| FERTILIZING | 144 | |
| APPLY HORMONE | 12 | |
| APPLY *-CIDES | 72 | |
| HARVESTING & PICKING SHOOTS | 313 | |

| | |
|---|---|
| SOIL DIFFERENCES? | Yes |
| WAY OF DISTINGUISHING THEM | High / low , soil structure |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 10 | TOTAL AREA | 6.5 ha |
| FARMER NAME | Pedro Vega | | |
| LOCALIZATION OF THE LOT | Rio Frio | | |
| LOT NR. | 38 | PINEAPPLE AREA | 1 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 55 cm |
| | BETWEEN THE ROWS | 100 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | (10-30-10 , foliar) | | |
| USED HORMONES | Piomone | | |
| WEEDS | Grass | | |
| USED HERBICIDES | Diuron , Karmex | | |
| PESTS & DISEASES | Pudricion del cogollo | Pina bofa | Barrenador |
| USED PESTICIDES | (Clean working) | | |

| | |
|---|---|
| HARVEST AFTER 15 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 20 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Same |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No second harvest & experimenting |
| EXPERIENCE IN YEARS | 10 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 549 (TOTAL) |
|---|---|
| PREPARE FIELD | 90 |
| PLANTING | 109 |
| FERTILIZING | 0 |
| APPLY HORMONE | 60 |
| APPLY *-CIDES | 72 |
| HARVESTING & PICKING SHOOTS | 218 |

| SOIL DIFFERENCES? | No |
|---|---|
| WAY OF DISTINGUISHING THEM | - |
| OTHER TREATMENT | - |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | - |

| | | | |
|---|---|---|---|
| FARMER NR. | 11 | TOTAL AREA | 9.8 ha |
| FARMER NAME | Rafael Alfares Cortez | | |
| LOCALIZATION OF THE LOT | Horquetas | | |
| LOT NR. | 18 | PINEAPPLE AREA | 0.25 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 50 cm |
| | BETWEEN THE ROWS | 100 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Use of sunlight | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , 12-24-12 , urea | | |
| USED HORMONES | Ethrel | | |
| WEEDS | Grasses | | |
| USED HERBICIDES | Machete , Karmex , Diuron | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | - | | |

| | |
|---|---|
| HARVEST AFTER 12 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Spray dead |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 10 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Less |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Platano & casava |
| CROP AFTER PINEAPPLE | Palmito de pejibaye & pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 10 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 456 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 60 | |
| PLANTING | 96 | |
| FERTILIZING | 60 | |
| APPLY HORMONE | 20 | |
| APPLY *-CIDES | 60 | |
| HARVESTING & PICKING SHOOTS | 160 | |

| | | |
|---|---|---|
| SOIL DIFFERENCES? | Yes | |
| WAY OF DISTINGUISHING THEM | Looking at plants | |
| OTHER TREATMENT | No | |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 12 | TOTAL AREA | 8 ha |
| FARMER NAME | Ronny from the ppulperia in Ticarri | | |
| LOCALIZATION OF THE LOT | Ticarri (Rio Frio) | | |
| LOT NR. | 48 | PINEAPPLE AREA | 0.8 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below the fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 32 cm |
| | BETWEEN THE ROWS | 75 cm |
| | BETWEEN DOUBLE ROWS | 150 cm |
| REASON FOR DISTANCES | Work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | (Foliar) | | |
| USED HORMONES | Ethrel | | |
| WEEDS | Grasses | | |
| USED HERBICIDES | Gramoxone , 2,4-D | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | (Row distances) | Furadan | |

| | |
|---|---|
| HARVEST AFTER 12 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Transport from the field |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 6.7 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Less |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Some other crops |
| CROP AFTER PINEAPPLE | Forest |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 6 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS 732 (TOTAL) | |
|---|---|
| PREPARE FIELD | 56 |
| PLANTING | 56 |
| FERTILIZING | 15 |
| APPLY HORMONE | 23 |
| APPLY *-CIDES | 75 |
| HARVESTING & PICKING SHOOTS | 507 |

| SOIL DIFFERENCES? | No |
|---|---|
| WAY OF DISTINGUISHING THEM | - |
| OTHER TREATMENT | - |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | - |

| | | | |
|---|---|---|---|
| FARMER NR. | 13 | TOTAL AREA | 10 ha |
| FARMER NAME | Bernardino Sanches | | |
| LOCALIZATION OF THE LOT | Horquetas | | |
| LOT NR. | 10 | PINEAPPLE AREA | 0.8 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Tractor | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Leaf axils | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 30 cm |
| | BETWEEN THE ROWS | 100 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | Nutran , Nitrofosca | | |
| USED HORMONES | Yes | | |
| WEEDS | Grass | | |
| USED HERBICIDES | Karmex | | |
| PESTS & DISEASES | Pudricion del cogollo | Damage | |
| USED PESTICIDES | Gramoxone | | |

| | |
|---|---|
| HARVEST AFTER 12 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 6.7 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Same |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Platano / banana |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 15 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 761 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 8 | |
| PLANTING | 158 | |
| FERTILIZING | 66 | |
| APPLY HORMONE | 8 | |
| APPLY *-CIDES | 23 | |
| HARVESTING & PICKING SHOOTS | 500 | |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Soil structure |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 14 | TOTAL AREA | 7 ha |
| FARMER NAME | Michael Loria Ramirez | | |
| LOCALIZATION OF THE LOT | Colonia Chavez (Horquetas) | | |
| LOT NR. | 54 | PINEAPPLE AREA | 0.5 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit & leaf axils | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 45 cm |
| | BETWEEN THE ROWS | 100 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | Nutran , foliar | | |
| USED HORMONES | Hormonil | | |
| WEEDS | Grass and dicots | | |
| USED HERBICIDES | Roundup | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | Gramoxone | | |

| | |
|---|---|
| HARVEST AFTER 12 MONTHS | |
| NR. OF HARVESTS | 1 |
| STUBBLE TREATMENT | Sowing between and destroy old crop |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 10 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | Less |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pineapple + other |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 3 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 696 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 180 | |
| PLANTING | 121 | |
| FERTILIZING | 96 | |
| APPLY HORMONE | 20 | |
| APPLY *-CIDES | 36 | |
| HARVESTING & PICKING SHOOTS | 242 | |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Soil structure |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 15 | TOTAL AREA | 13 ha |
| FARMER NAME | Victor Gerero Ulatte | | |
| LOCALIZATION OF THE LOT | Finca Huetares | | |
| LOT NR. | 22 | PINEAPPLE AREA | 1 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 50 cm |
| | BETWEEN THE ROWS | 100 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 10-30-10 , foliar | | |
| USED HORMONES | Yes | | |
| WEEDS | Grasses | | |
| USED HERBICIDES | Machete , (Fusilade) | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | Counter | | |

| | |
|---|---|
| HARVEST AFTER 15 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Spray dead |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 18.3 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 12 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS 522 (TOTAL) | |
|---|---|
| PREPARE FIELD | 30 |
| PLANTING | 72 |
| FERTILIZING | 72 |
| APPLY HORMONE | 18 |
| APPLY *-CIDES | 30 |
| HARVESTING & PICKING SHOOTS | 300 |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Soil structure & colour |
| OTHER TREATMENT | More fertilizer on harsh ground |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 16 | TOTAL AREA | 16.75 ha |
| FARMER NAME | Leondro Vega | | |
| LOCALIZATION OF THE LOT | Uataris Colonia (Rio Frio) | | |
| LOT NR. | 7 | PINEAPPLE AREA | 1 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit & leaf axils | |
| CURE PLANTINGMATERIAL? | Diseased apart | |
| PLANTING DISTANCES | IN THE ROW | 50 cm |
| | BETWEEN THE ROWS | 60 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work & fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | Foliar | | |
| USED HORMONES | Piamone | | |
| WEEDS | Grass | | |
| USED HERBICIDES | Diuron , pull out | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | Counter | | |

| | |
|---|---|
| HARVEST AFTER 16 MONTHS | |
| NR. OF HARVESTS | 2 |
| STUBBLE TREATMENT | Spray dead |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 13.3 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | ? |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Frigoles |
| CROP AFTER PINEAPPLE | ? |
| CHANGES IN CROPPING SYSTEM | Land preparation only by hand |
| EXPERIENCE IN YEARS | 7 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 584 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 12 | |
| PLANTING | 90 | |
| FERTILIZING | 30 | |
| APPLY HORMONE | 42 | |
| APPLY *-CIDES | 90 | |
| HARVESTING & PICKING SHOOTS | 320 | |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Looking at the plants |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 17 | TOTAL AREA | 17 ha |
| FARMER NAME | Ananias Villalobos Castro | | |
| LOCALIZATION OF THE LOT | La Esperanza (Rio Frio) | | |
| LOT NR. | 2 | PINEAPPLE AREA | 1 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 45 cm |
| | BETWEEN THE ROWS | 125 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Work & closing crop | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | 12-24-12 | | |
| USED HORMONES | Yes | | |
| WEEDS | Grass | | |
| USED HERBICIDES | Machete , (Diuron) | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | Counter | | |

| | |
|---|---|
| HARVEST AFTER 15 MONTHS | |
| NR. OF HARVESTS | 1 |
| STUBBLE TREATMENT | Transport of the field |
| BUYER | Farmer brings products to the market and sells them |
| PRICE IN COLONES PER KILOGRAM | 20 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Platano |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 10 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 663 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 90 | |
| PLANTING | 288 | |
| FERTILIZING | 18 | |
| APPLY HORMONE | 18 | |
| APPLY *-CIDES | 36 | |
| HARVESTING & PICKING SHOOTS | 213 | |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Stonyness & colour |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | |
|---|---|---|---|
| FARMER NR. | 18 | TOTAL AREA | 5 ha |
| FARMER NAME | Solano Rojelio | | |
| LOCALIZATION OF THE LOT | Finca Chaves (Horquetas) | | |
| LOT NR. | | PINEAPPLE AREA | 0.75 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self & workers | |
| CULTIVAR USED | Hawaiana Lisa | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 35 cm |
| | BETWEEN THE ROWS | 110 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | No | | |
| USED HORMONES | Yes | | |
| WEEDS | Grasses | | |
| USED HERBICIDES | Karmex | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | Counter | | |

| | |
|---|---|
| HARVEST AFTER 12 MONTHS | |
| NR. OF HARVESTS | 1 (or 2) |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 12 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Banana |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 5 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 1093 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 24 | |
| PLANTING | 156 | |
| FERTILIZING | 0 | |
| APPLY HORMONE | 26 | |
| APPLY *-CIDES | 264 | |
| HARVESTING & PICKING SHOOTS | 623 | |

| SOIL DIFFERENCES? | Yes |
|---|---|
| WAY OF DISTINGUISHING THEM | Soil structure |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

| | | | | |
|---|---|---|---|---|
| FARMER NR. | 19 | TOTAL AREA | 4.9 | ha |
| FARMER NAME | Antonio Mora Sisneros | | | |
| LOCALIZATION OF THE LOT | Horquetas | | | |
| LOT NR. | 33 | PINEAPPLE AREA | 1 | ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand , chemical , calcium | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | No | |
| PLANTING DISTANCES | IN THE ROW | 35 cm |
| | BETWEEN THE ROWS | 120 cm |
| | BETWEEN DOUBLE ROWS | - |
| REASON FOR DISTANCES | Fruitsize | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | Foliar | | |
| USED HORMONES | Ethrel | | |
| WEEDS | Pasture | | |
| USED HERBICIDES | Karmex , Diuron , machete | | |
| PESTS & DISEASES | Pudricion del cogollo | Damage | |
| USED PESTICIDES | Counter | | |

| | | |
|---|---|---|
| HARVEST AFTER 12 MONTHS | | |
| NR. OF HARVESTS | More (ratoon) | |
| STUBBLE TREATMENT | Destroy | |
| BUYER | Salesman | |
| PRICE IN COLONES PER KILOGRAM | | 12 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | Depends on prices |
| EXPERIENCE IN YEARS | 3 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 805 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 24 | |
| PLANTING | 180 | |
| FERTILIZING | 72 | |
| APPLY HORMONE | 71 | |
| APPLY *-CIDES | 186 | |
| HARVESTING & PICKING SHOOTS | 272 | |

| | |
|---|---|
| SOIL DIFFERENCES? | No |
| WAY OF DISTINGUISHING THEM | - |
| OTHER TREATMENT | - |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | - |

| | | | |
|---|---|---|---|
| FARMER NR. | 20 | TOTAL AREA | 7 ha |
| FARMER NAME | Jose Dimas Solis | | |
| LOCALIZATION OF THE LOT | Horquetas | | |
| LOT NR. | 27 | PINEAPPLE AREA | 0.5 ha |

| | | |
|---|---|---|
| FIELD PREPARATION | Hand & chemical | |
| INFORMATION FROM | Self | |
| CULTIVAR USED | Montelirio | |
| PLANTING MATERIAL | Below fruit | |
| CURE PLANTINGMATERIAL? | Leaf shoots some days on the field | |
| PLANTING DISTANCES | IN THE ROW | 30 cm |
| | BETWEEN THE ROWS | 40 cm |
| | BETWEEN DOUBLE ROWS | 60 cm |
| REASON FOR DISTANCES | Work | |

| | | | |
|---|---|---|---|
| USED FERTILIZER(S) | No | | |
| USED HORMONES | Maduron | | |
| WEEDS | Grass | | |
| USED HERBICIDES | Karmex , pull out | | |
| PESTS & DISEASES | Pudricion del cogollo | | |
| USED PESTICIDES | Counter | | |

| | |
|---|---|
| HARVEST AFTER 12 MONTHS | |
| NR. OF HARVESTS | 3 |
| STUBBLE TREATMENT | Destroy |
| BUYER | Salesman |
| PRICE IN COLONES PER KILOGRAM | 4.2 |
| MORE OR LESS PINEAPPLE IN THE FUTURE | More |

| | |
|---|---|
| CROP BEFORE PINEAPPLE | Pasture |
| CROP AFTER PINEAPPLE | Pineapple |
| CHANGES IN CROPPING SYSTEM | No |
| EXPERIENCE IN YEARS | 1 |

| WORKING TIME PER HECTARE PER YEAR IN MAN HOURS | 1157 | (TOTAL) |
|---|---|---|
| PREPARE FIELD | 108 | |
| PLANTING | 286 | |
| FERTILIZING | 18 | |
| APPLY HORMONE | 24 | |
| APPLY *-CIDES | 168 | |
| HARVESTING & PICKING SHOOTS | 571 | |

| | |
|---|---|
| SOIL DIFFERENCES? | Yes |
| WAY OF DISTINGUISHING THEM | Slope |
| OTHER TREATMENT | No |
| DIFFERENCES IN QUANTITY & QUALITY OF FRUITS ON DIFFERENT SOILS | Yes |

# APPENDIX 3

Data of the analyses of soils and plants of the twenty pineapple farmers.

| farmer nr. | % organic matter | CEC meq/100g soil | pH | extractable acids meq/100g soil | meq/100g soil K | Ca | ug/g soil Mg |
|---|---|---|---|---|---|---|---|
| 1 | 5.3 | 20 | 4.17 | 3.92 | 0.13 | 0.87 | 0.1 |
| 2 | 5.23 | 21 | 3.92 | 5.6 | 0.16 | 0.51 | 0.17 |
| 3 | 8.74 | 28 | 4.31 | 4.54 | 0.13 | 1.24 | 0.14 |
| 4 | 11.7 | 38 | 4.26 | 3.34 | 0.2 | 0.97 | 0.22 |
| 5 | 8.58 | 29 | 4.01 | 4.6 | 0.16 | 0.34 | 0.12 |
| 6 | 11.62 | 45 | 4.24 | 2.56 | 0.14 | 0.38 | 0.17 |
| 7 | 6.08 | 22 | 3.95 | 5.5 | 0.1 | 0.31 | 0.07 |
| 8 | 6.86 | 32 | 3.89 | 5.54 | 0.3 | 0.49 | 0.18 |
| 9 | 11.08 | 29 | 3.98 | 4.96 | 0.69 | 1.39 | 0.49 |
| 10 | 8.47 | 28 | 3.87 | 5.76 | 0.3 | 0.63 | 0.2 |
| 11 | 11.54 | 38 | 4.38 | 1.62 | 0.12 | 0.58 | 0.2 |
| 12 | 9.83 | 45 | 4.73 | 0.52 | 0.4 | 4.4 | 1.66 |
| 13 | 10.3 | 32 | 3.85 | 7.6 | 0.24 | 0.39 | 0.2 |
| 14 | 4.84 | 29 | 4.03 | 7.06 | 0.21 | 0.73 | 0.25 |
| 15 | 6.24 | 29 | 4.14 | 4.04 | 0.13 | 0.96 | 0.17 |
| 16 | 7.02 | 29 | 3.95 | 6.06 | 0.34 | 0.77 | 0.23 |
| 17 | 20.9 | 50 | 3.93 | 3.86 | 0.29 | 0.21 | 0.23 |
| 18 | 5.46 | 26 | 3.8 | 9.8 | 0.15 | 0.35 | 0.12 |
| 19 | 4.68 | 22 | 3.79 | 7.1 | 0.2 | 0.38 | 0.13 |
| 20 | 7.18 | 23 | 3.74 | 7.84 | 0.45 | 0.46 | 0.17 |
| mean | 8.5825 | 30.75 | 4.047 | 5.091 | 0.242 | 0.818 | 0.261 |

| farmer nr | nutrient uptake kg/ha | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P | Fe | Cu | Zn | Mn | | N | P | K | Ca | Mg | Fe |
| 1 | 47 | 513 | 28 | 7.2 | 69 | | 488521.2 | 62177.27 | 494347.5 | 200076.4 | 115077.9 | 14786.57 |
| 2 | 15 | 613 | 34 | 12 | 54 | | 192025.2 | 27557 | 553035.5 | 51882.67 | 40941.44 | 2720.659 |
| 3 | 20 | 660 | 22 | 5.9 | 35 | | 477843.4 | 34845.17 | 524122.9 | 237548.8 | 108130.2 | 5132.537 |
| 4 | 9 | 488 | 24 | 6.3 | 12 | | 182932.3 | 19031.32 | 246077 | 106332.3 | 37937.34 | 7411.011 |
| 5 | 12 | 1042 | 23 | 2.6 | 13 | | 115457.6 | 33235.28 | 268944.5 | 49217.78 | 34823.53 | 14325.02 |
| 6 | 5 | 306 | 18 | 3.6 | 25 | | 162345.2 | 11733.44 | 133710.4 | 62378.3 | 26693.41 | 25158.09 |
| 7 | 9 | 1200 | 24 | 3.3 | 15 | | 238975.1 | 27041.88 | 315814 | 81091.77 | 40935.58 | 6436.114 |
| 8 | 5 | 759 | 31 | 6.4 | 76 | | 122548.8 | 10544.03 | 261867.7 | 43204.05 | 31160.54 | 41652.29 |
| 9 | 9 | 806 | 24 | 9.7 | 112 | | ? | ? | ? | ? | ? | ? |
| 10 | 5 | 1095 | 25 | 7.4 | 27 | | 139338.8 | 19137.96 | 211403.3 | 87407.84 | 32907.23 | 4639.394 |
| 11 | 4 | 285 | 14 | 4 | 22 | | 177174 | 17542.86 | 207718.4 | 160974.7 | 78440.62 | 8908.073 |
| 12 | 5 | 203 | 22 | 5.5 | 28 | | 133576.8 | 22112.83 | 296519.3 | 55945.02 | 41600.56 | 4145.051 |
| 13 | 7 | 402 | 22 | 7.1 | 19 | | 439408.5 | 47201.28 | 723766.5 | 179071.3 | 78218.01 | 3163.589 |
| 14 | 8 | 726 | 28 | 3.2 | 41 | | ? | ? | ? | ? | ? | ? |
| 15 | 4 | 417 | 27 | 10.5 | 180 | | 136236.6 | 16865.63 | 197670.3 | 77661.14 | 54750.6 | 22846.13 |
| 16 | 5 | 699 | 32 | 13.5 | 67 | | 138821 | 18566.23 | 284603.7 | 69428.44 | 28935.34 | 9243.835 |
| 17 | 10 | 580 | 20 | 4.6 | 17 | | 151382.7 | 13586.79 | 118605.8 | 49660.58 | 16473.13 | 4743.267 |
| 18 | 6 | 1300 | 21 | 4 | 8 | | ? | ? | ? | ? | ? | ? |
| 19 | 8 | 900 | 26 | 5.4 | 19 | | 226388.8 | 26738.12 | 454157.7 | 99874.8 | 46640.9 | 9706.97 |
| 20 | 6 | 1320 | 26 | 5.3 | 24 | | 418828 | 44188.96 | 750597 | 217536.1 | 80494.62 | 6060.709 |
| mean | 9.95 | 715.7 | 24.55 | 6.375 | 43.15 | | 211065.3 | 24034.19 | 322644 | 99486.51 | 47832.06 | 11588.52 |

| farmer nr | Cu | Zn | Mn | | pl/ha | hours/ha | tons/ha |
|---|---|---|---|---|---|---|---|
| 1 | 586.4165 | 1498.399 | 34065.36 | 62.17727 | 53333 | 1251 | 75 |
| 2 | 152.5168 | 474.024 | 11816.39 | 27.557 | 44444 | 872 | 51 |
| 3 | 367.406 | 924.8866 | 21378.67 | 34.84517 | 28571 | 1446 | 50 |
| 4 | 128.5373 | 318.2091 | 6133.543 | 19.03132 | 24206 | 1435 | 28 |
| 5 | 456.7948 | 350.5763 | 5756.818 | 33.23528 | 25888 | 1067 | 27 |
| 6 | 192.3622 | 300.5327 | 3342.89 | 11.73344 | 13820 | 845 | 17 |
| 7 | 327.9482 | 692.2256 | 6284.85 | 27.04188 | 32000 | 560 | 37 |
| 8 | 380.537 | 358.8446 | 5064.869 | 10.54403 | 20000 | 470 | 15 |
| 9 | ? | ? | ? | 0 | 31250 | 876 | 13 |
| 10 | 175.3556 | 287.8947 | 1972.11 | 19.13796 | 18182 | 549 | 15 |
| 11 | 311.9062 | 144.7941 | 6343.847 | 17.54286 | 20000 | 456 | 29 |
| 12 | 164.798 | 362.2385 | 1076.055 | 22.11283 | 27778 | 732 | 26 |
| 13 | 444.8223 | 652.3719 | 10804.69 | 47.20128 | 33333 | 760 | 46 |
| 14 | ? | ? | ? | 0 | 20202 | 696 | 20 |
| 15 | 398.2321 | 431.5844 | 9642.45 | 16.86563 | 20000 | 522 | 24 |
| 16 | 199.1439 | 396.1782 | 8785.936 | 18.56623 | 33333 | 584 | 30 |
| 17 | 147.2889 | 152.9111 | 5086.908 | 13.58679 | 17778 | 663 | 22 |
| 18 | ? | ? | ? | 0 | 25974 | 1093 | 25 |
| 19 | 272.2621 | 810.5191 | 7415.942 | 26.73812 | 23810 | 805 | 33 |
| 20 | 394.8071 | 792.4512 | 22626.87 | 44.18896 | 47619 | 1157 | 49 |
| mean | 289.3341 | 466.2052 | 8200.818 | total | 561513 | 16839 | 632 |
| | | | | mean | 28075.65 | 841.95 | 31.6 |

| Dry matter pineapple | | % of dry matter | | | | | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data CORBANA | | N | P | K | Ca | Mg | S | Fe | Cu | Zn | Mn |
| COR | 1 | 1.04 | 0.09 | 1.61 | 0.33 | 0.28 | 0.23 | 140 | 12 | 36 | 1000 |
| HIJ | 1 | 1.1 | 0.13 | 1.17 | 0.29 | 0.18 | 0.21 | 83 | 15 | 24 | 710 |
| HOJ | 1 | 1.13 | 0.1 | 0.83 | 0.36 | 0.3 | 0.16 | 403 | 13 | 35 | 974 |
| PUL | 1 | 0.82 | 0.13 | 1.17 | 0.11 | 0.06 | 0.12 | 78 | 11 | 12 | 203 |
| TAL | 1 | 0.98 | 0.16 | 0.55 | 1.21 | 0.27 | 0.38 | 541 | 22 | 64 | 630 |
| SAP | 1 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | | | 0.3 |
| total | | | | | | | | | | | |
| COR | 2 | 1.13 | 0.26 | 2.11 | 0.34 | 0.27 | 0.2 | 96 | 9 | 20 | 525 |
| HIJ | 2 | | | | | | | | | | |
| HOJ | 2 | 0.95 | 0.11 | 3.19 | 0.28 | 0.23 | 0.16 | 163 | 9 | 32 | 815 |
| PUL | 2 | 0.52 | 0.11 | 1.31 | 0.08 | 0.07 | 0.06 | 63 | 6 | 8 | 150 |
| TAL | 2 | 0.81 | 0.1 | 0.82 | 0.64 | 0.13 | 0.21 | 324 | 11 | 21 | 295 |
| SAP | 2 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 3 | 1.18 | 0.15 | 1.4 | 0.6 | 0.22 | 0.11 | 53 | 13 | 31 | 449 |
| HIJ | 3 | 0.95 | 0.09 | 1.5 | 0.33 | 0.15 | 0.06 | 60 | 9 | 18 | 410 |
| HOJ | 3 | 1.47 | 0.07 | 1.23 | 0.7 | 0.39 | 0.09 | 207 | 6 | 26 | 910 |
| PUL | 3 | 1.32 | 0.09 | 1.5 | 0.33 | 0.08 | 0.09 | 42 | 43 | 14 | 1.39 |
| TAL | 3 | 1.01 | 0.09 | 0.78 | 1.25 | 0.33 | 0.68 | 130 | 11 | 44 | 193 |
| SAP | 3 | 0.03 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 4 | 1.65 | 0.25 | 2.13 | 0.84 | 0.21 | 0.11 | 118 | 19 | 39 | 520 |
| HIJ | 4 | 1.1 | 0.15 | 1.52 | 0.83 | 0.22 | 0.23 | 139 | 14 | 19 | 410 |
| HOJ | 4 | 0.9 | 0.05 | 0.97 | 0.47 | 0.21 | 0.09 | 600 | 5 | 13 | 510 |
| PUL | 4 | 0.41 | 0.12 | 1.49 | 0.25 | 0.08 | 0.08 | 92 | 5 | 8 | 130 |
| TAL | 4 | 0.64 | 0.06 | 0.71 | 0.53 | 0.15 | 0.25 | 221 | 9 | 14 | 33 |
| SAP | 4 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 5 | 0.98 | 0.07 | 1.07 | 0.3 | 0.17 | 0.08 | 810 | 53 | 14 | 381 |
| HIJ | 5 | 1.11 | 0.09 | 1.65 | 0.21 | 0.16 | 0.08 | 760 | 24 | 17 | 440 |
| HOJ | 5 | 0.44 | 0.3 | 1.08 | 0.32 | 0.2 | 0.06 | 1109 | 24 | 27 | 412 |
| PUL | 5 | 0.46 | 0.06 | 1.05 | 0.19 | 0.1 | 0.06 | 90 | 10 | 9 | 135 |
| TAL | 5 | 0.82 | 0.04 | 1.48 | 0.18 | 0.17 | 0.08 | 585 | 23 | 13 | 212 |
| SAP | 5 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 6 | 1.04 | 0.18 | 2.05 | 0.54 | 0.25 | 0.13 | 544 | 9 | 24 | 392 |
| HIJ | 6 | 1.14 | 0.14 | 1.82 | 0.3 | 0.19 | 0.1 | 453 | 9 | 16 | 290 |
| HOJ | 6 | 1.09 | 0.04 | 0.78 | 0.41 | 0.23 | 0.11 | 405 | 13 | 24 | 351 |
| PUL | 6 | 0.84 | 0.14 | 1.31 | 0.24 | 0.15 | 0.1 | 106 | 5 | 13 | 128 |
| TAL | 6 | 1.21 | 0.1 | 0.54 | 0.82 | 0.21 | 0.43 | 6100 | 28 | 35 | 203 |
| SAP | 6 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 7 | 0.58 | 0.16 | 1.41 | 0.21 | 0.08 | 0.19 | 57 | 7 | 1 | 72 |
| HIJ | 7 | 1.1 | 0.17 | 1.72 | 0.38 | 0.15 | 0.18 | 84 | 9 | 18 | 366 |
| HOJ | 7 | 0.78 | 0.06 | 0.83 | 0.18 | 0.12 | 0.27 | 81 | 16 | 30 | 278 |
| PUL | 7 | 1.15 | 0.11 | 0.9 | 1.09 | 0.34 | 0.54 | 1675 | 15 | 63 | 157 |
| TAL | 7 | 0.89 | 0.14 | 1.47 | 0.35 | 0.16 | 0.2 | 119 | 7 | 11 | 303 |
| SAP | 7 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 8 | 1.24 | 0.11 | 1.93 | 0.32 | 0.16 | 0.09 | 524 | 11 | 23 | 522 |
| HIJ | 8 | 0.9 | 0.08 | 1.78 | 0.16 | 0.11 | 0.07 | 34 | 42 | 15 | 406 |
| HOJ | 8 | 0.61 | 0.04 | 1.22 | 0.28 | 0.21 | 0.05 | 710 | 17 | 22 | 547 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FUL | 8 | 0.81 | 0.1 | 1.01 | 0.37 | 0.18 | 0.08 | 171 | 17 | 11 | 311 |
| TAL | 8 | 0.61 | 0.05 | 1.04 | 0.2 | 0.12 | 0.1 | 103 | 14 | 21 | 98 |
| SAP | 8 | 0.01 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 9 | | | | | | | | | | |
| MIJ | 9 | | | | | | | | | | |
| HOJ | 9 | 1.73 | 0.04 | 2.09 | 0.39 | 0.21 | 0.07 | 277 | 11 | 9 | 581 |
| FUL | 9 | | | | | | | | | | |
| TAL | 9 | | | | | | | | | | |
| SAP | 9 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 10 | 1.39 | 0.19 | 2.52 | 0.58 | 0.17 | 0.1 | 82 | 11 | 23 | 290 |
| MIJ | 10 | 0.9 | 0.15 | 2.2 | 0.3 | 0.18 | 0.11 | 105 | 10 | 12 | 158 |
| HOJ | 10 | 0.72 | 0.11 | 1.46 | 0.48 | 0.25 | 0.22 | 197 | 9 | 17 | 288 |
| FUL | 10 | 0.73 | 0.12 | 1.69 | 0.21 | 0.13 | 0.12 | 287 | 11 | 14 | 97 |
| TAL | 10 | 0.98 | 0.12 | 1.04 | 0.77 | 0.23 | 0.26 | 432 | 15 | 24 | 44 |
| SAP | 10 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 11 | 1.15 | 0.13 | 1.5 | 0.42 | 0.24 | 0.1 | 403 | 10 | 5 | 252 |
| MIJ | 11 | 0.39 | 0.14 | 1 | 0.47 | 0.2 | 0.14 | 201 | 17 | 13 | 144 |
| HOJ | 11 | 0.92 | 0.07 | 0.96 | 1.05 | 0.59 | 0.16 | 577 | 17 | 5 | 564 |
| FUL | 11 | 0.46 | 0.08 | 1.27 | 0.15 | 0.04 | 0.05 | 85 | 27 | 16 | 32 |
| TAL | 11 | 0.89 | 0.07 | 0.87 | 1.03 | 0.28 | 0.54 | 586 | 16 | 12 | 66 |
| SAP | 11 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 12 | 0.69 | 0.12 | 1.23 | 0.5 | 0.29 | 0.57 | 1359 | 19 | 29 | 50 |
| MIJ | 12 | 1.3 | 0.2 | 2.13 | 0.65 | 0.38 | 0.17 | 187 | 16 | 10 | 110 |
| HOJ | 12 | 0.59 | 0.15 | 1.92 | 0.4 | 0.3 | 0.15 | 282 | 11 | 31 | 85 |
| FUL | 12 | 0.52 | 0.09 | 1.35 | 0.18 | 0.12 | 0.12 | 71 | 9 | 11 | 35 |
| TAL | 12 | 0.61 | 0.09 | 1.62 | 0.37 | 0.28 | 0.18 | 229 | 14 | 23 | 75 |
| SAP | 12 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 13 | 0.81 | 0.1 | 1.57 | 0.35 | 0.09 | 0.14 | 46 | 14 | 7 | 90 |
| MIJ | 13 | 1.21 | 0.12 | 2.43 | 0.61 | 0.21 | 0.13 | 199 | 20 | 21 | 330 |
| HOJ | 13 | 1.93 | 0.21 | 2.48 | 0.75 | 0.3 | 0.22 | 79 | 15 | 22 | 494 |
| FUL | 13 | 1.13 | 0.1 | 2.17 | 0.7 | 0.33 | 0.33 | 92 | 17 | 60 | 100 |
| TAL | 13 | 0.81 | 0.06 | 2.41 | 0.49 | 0.22 | 0.13 | 161 | 11 | 17 | 350 |
| SAP | 13 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 14 | | | | | | | | | | |
| MIJ | 14 | | | | | | | | | | |
| HOJ | 14 | | | | | | | | | | |
| FUL | 14 | | | | | | | | | | |
| TAL | 14 | | | | | | | | | | |
| SAP | 14 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | |
| COR | 15 | 1.33 | 0.2 | 2.55 | 0.37 | 0.3 | 0.09 | 792 | 6 | 20 | 650 |
| MIJ | 15 | 1.13 | 0.18 | 2.31 | 0.35 | 0.29 | 0.12 | 620 | 8 | 35 | 570 |
| HOJ | 15 | 1.01 | 0.1 | 1.13 | 0.69 | 0.46 | 0.16 | 2500 | 37 | 33 | 1038 |
| FUL | 15 | 0.52 | 0.1 | 1.34 | 0.14 | 0.15 | 0.07 | 109 | 50 | 8 | 142 |

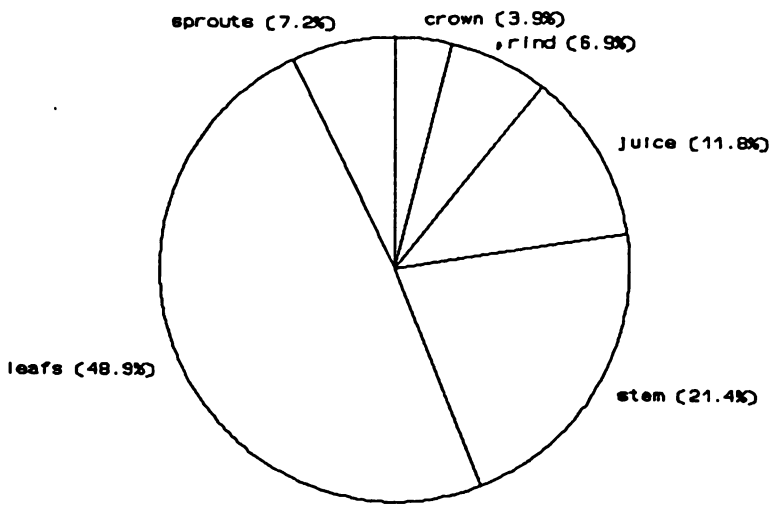
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TAL | 15 | 1.69 | 0.23 | 3.33 | 0.5 | 0.37 | 1.06 | . | 1350 | 33 | 41 | 503 |
| SAP | 15 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | . | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | | |
| COR | 16 | 1.41 | 0.18 | 1.88 | 0.97 | 0.21 | 0.15 | . | 140 | 11 | 37 | 698 |
| HIJ | 16 | 1.24 | 0.16 | 2.27 | 0.52 | 0.19 | 0.11 | . | 262 | 17 | 21 | 334 |
| HOJ | 16 | 0.72 | 0.08 | 1.39 | 0.41 | 0.16 | 0.11 | . | 413 | 8 | 24 | 742 |
| PUL | 16 | 0.61 | 0.08 | 1.02 | 0.57 | 0.19 | 0.39 | . | 1597 | 46 | 52 | 309 |
| TAL | 16 | 0.52 | 0.09 | 1.71 | 0.23 | 0.08 | 0.06 | . | 63 | 6 | 11 | 225 |
| SAP | 16 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | . | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | | |
| COR | 17 | 1.65 | 0.18 | 1.27 | 0.33 | 0.14 | 0.22 | . | 250 | 13 | 40 | 433 |
| HIJ | 17 | 0.89 | 0.13 | 0.96 | 0.28 | 0.1 | 0.17 | . | 100 | 12 | 9 | 400 |
| HOJ | 17 | 1.41 | 0.07 | 0.5 | 0.38 | 0.12 | 0.14 | . | 477 | 14 | 10 | 646 |
| PUL | 17 | 0.75 | 0.15 | 0.54 | 0.15 | 0.03 | 0.14 | . | 100 | 13 | 4 | 77 |
| TAL | 17 | 1.04 | 0.07 | 1.19 | 0.99 | 0.26 | 0.96 | . | 865 | 13 | 33 | 256 |
| SAP | 17 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | . | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | | |
| COR | 18 | | | | | | | . | | | | |
| HIJ | 18 | | | | | | | . | | | | |
| HOJ | 18 | | | | | | | . | | | | |
| PUL | 18 | | | | | | | . | | | | |
| TAL | 18 | | | | | | | . | | | | |
| SAP | 18 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | . | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | | |
| COR | 19 | 0.66 | 0.12 | 1.64 | 0.29 | 0.07 | 0.12 | . | 47 | 7 | 6 | 165 |
| HIJ | 19 | 1.47 | 0.18 | 1.98 | 0.57 | 0.21 | 0.2 | . | 185 | 20 | 54 | 950 |
| HOJ | 19 | 0.78 | 0.1 | 1.6 | 0.51 | 0.21 | 0.57 | . | 526 | 12 | 44 | 192 |
| PUL | 19 | 0.72 | 0.05 | 1.82 | 0.44 | 0.22 | 0.15 | . | 572 | 13 | 26 | 722 |
| TAL | 19 | 1.04 | 0.1 | 2.03 | 0.24 | 0.15 | 0.11 | . | 251 | 10 | 21 | 351 |
| SAP | 19 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | . | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | | |
| COR | 20 | 0.87 | 0.04 | 0.48 | 0.59 | 0.3 | 0.16 | . | 272 | 17 | 26 | 860 |
| HIJ | 20 | 0.52 | 0.05 | 1.83 | 0.39 | 0.19 | 0.08 | . | 64 | 32 | 14 | 342 |
| HOJ | 20 | 1.24 | 0.12 | 2.03 | 0.66 | 0.2 | 0.16 | . | 56 | 12 | 22 | 706 |
| PUL | 20 | 0.81 | 0.04 | 0.65 | 0.34 | 0.31 | 0.36 | . | 1085 | 12 | 34 | 225 |
| TAL | 20 | 0.69 | 0.09 | 1.95 | 0.34 | 0.13 | 0.14 | . | 61 | 7 | 19 | 639 |
| SAP | 20 | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | . | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | | |
| means | | | | | | | | | | | | |
| COR | | 1.119411 | 0.158235 | 1.498588 | 0.444705 | 0.201176 | 0.165882 | . | 326.1176 | 14.17647 | 22.35294 | 442.1176 |
| HIJ | | 1.079375 | 0.138125 | 1.745625 | 0.4025 | 0.193125 | 0.135 | . | 221 | 17.25 | 20.1875 | 395.125 |
| HOJ | | 1.057777 | 0.101666 | 1.424444 | 0.479444 | 0.261666 | 0.163888 | . | 514.5555 | 13.88888 | 24.32352 | 563 |
| PUL | | 0.737058 | 0.098235 | 1.313529 | 0.356470 | 0.15 | 0.168235 | . | 371.6470 | 18.94117 | 21.64705 | 180.1405 |
| TAL | | 0.921764 | 0.088823 | 1.234705 | 0.602941 | 0.214117 | 0.298235 | . | 948.1176 | 14.94117 | 26.94117 | 268 |
| SAP | | 0.08 | 0.0135 | 0.1705 | 0.0115 | 0.011 | 0.007 | . | 3 | 0 | 0 | 0.3 |
| total | | | | | | | | | | | | |

# APPENDIX 4

Distribution of nutrients over pineapple plants

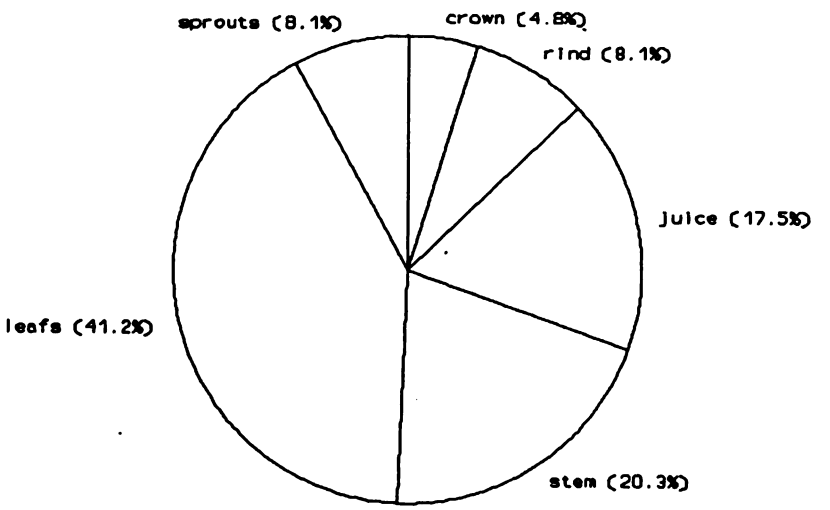
# Distribution nitrogen

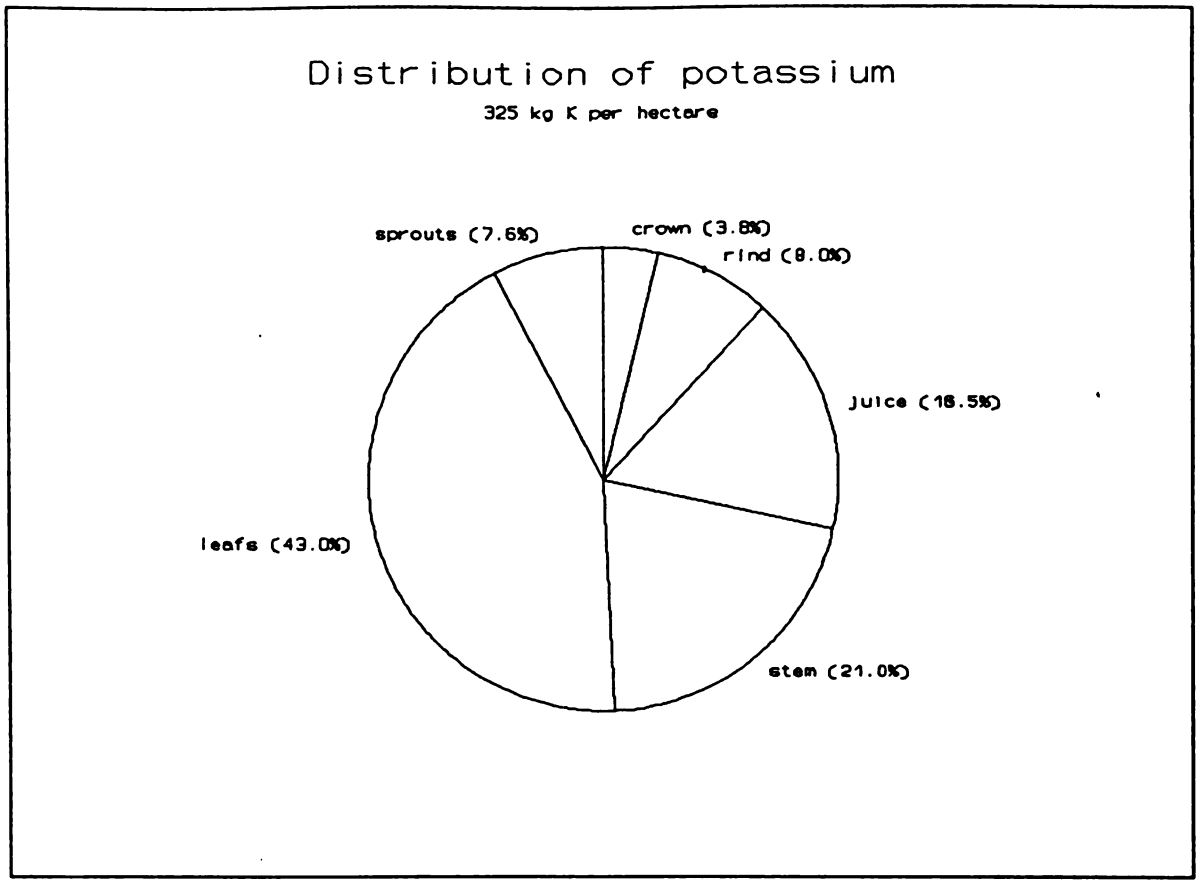
210 kg N per hectare

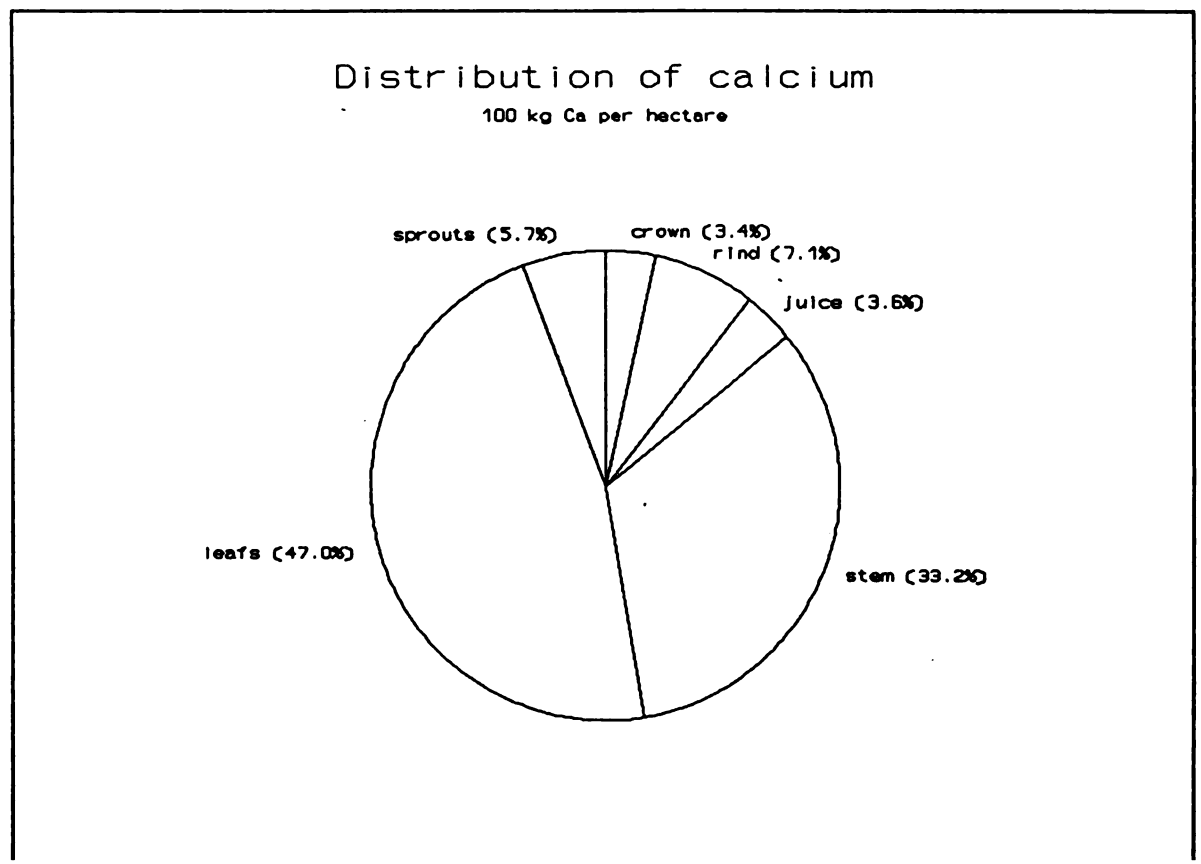



# Distribution phosphorus

24 kg P per hectare

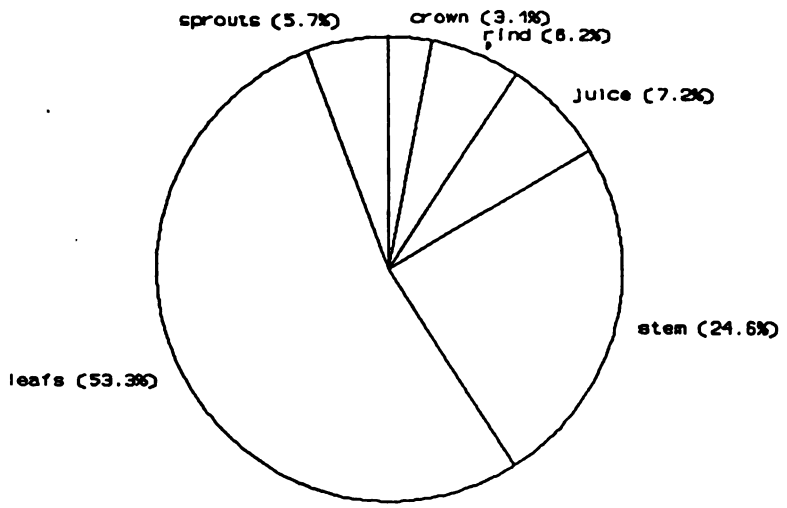



Distribution of potassium
325 kg K per hectare
sprouts (7.6%)
crown (3.8%)
rind (8.0%)
juice (16.5%)
leafs (43.0%)
stem (21.0%)


Distribution of calcium
100 kg Ca per hectare
sprouts (5.7%)
crown (3.4%)
rind (7.1%)
juice (3.6%)
leafs (47.0%)
stem (33.2%)

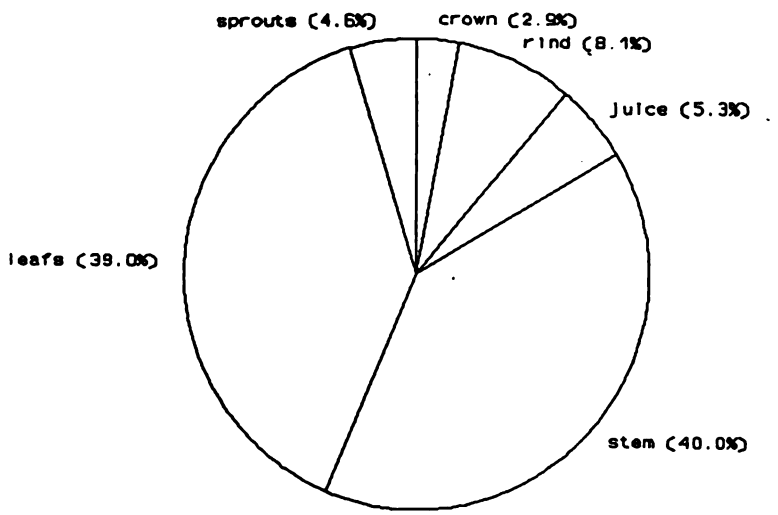
## Distribution of magnesium

48 kg Mg per hectare



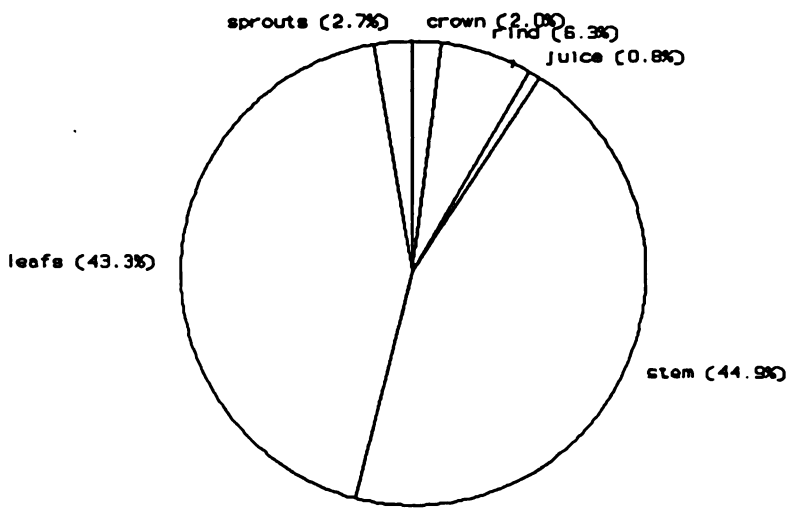

## Distribution of sulphur

41 kg S per hectare



## Distribution of Fe

12 kg Fe per hectare




## Distribution of manganese

8 kg Mn per hectare