ATLANTIC ZONE PROGRAMME

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PALMITO (*Bactris gasipaes H.B.K.*) GROWTH AND MANAGEMENT IN THE HUMID LOWLANDS OF THE ATLANTIC ZONE OF COSTA RICA

Raymond Jongschaap

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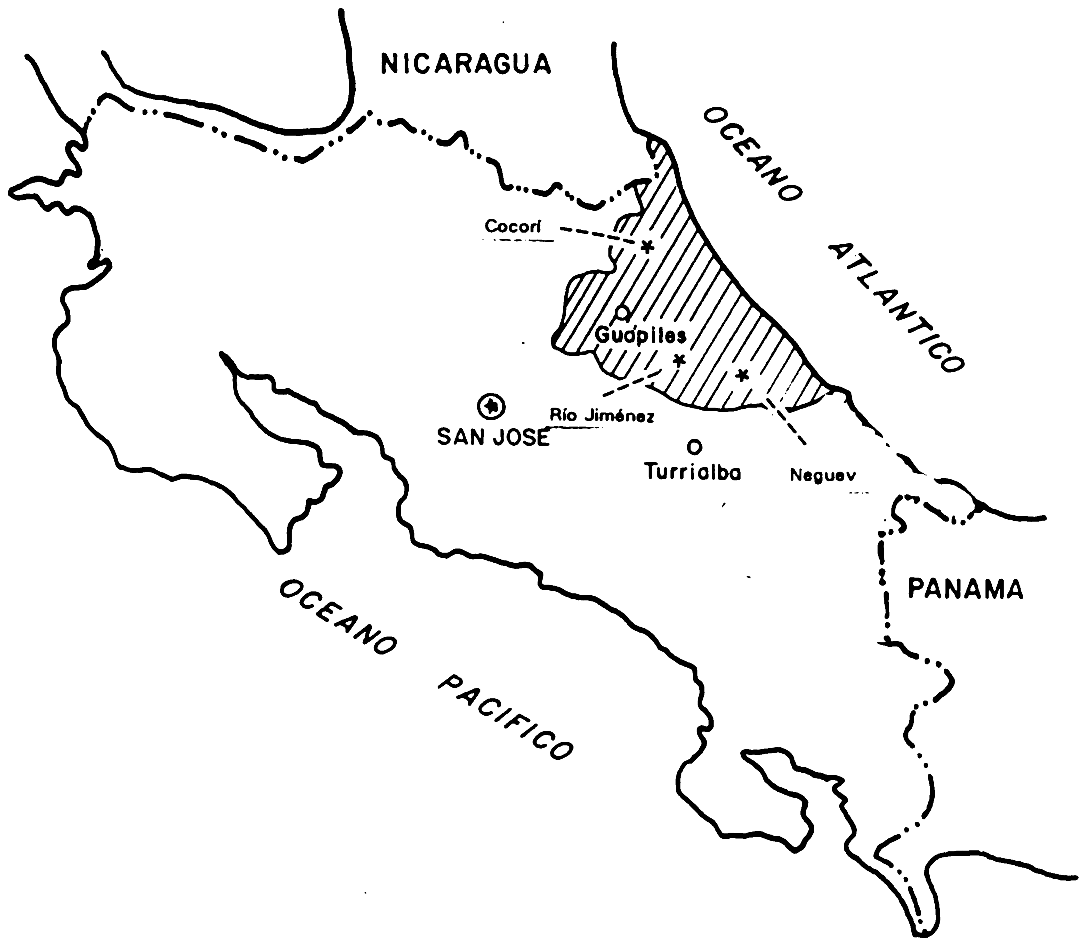

Figure 1. Location of the study area.

PREFACE

General description of the research programme on sustainable Landuse.

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

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

Combinations of crops and soils

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

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

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

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

ACKNOWLEDGEMENTS

During the period I worked in Costa Rica, many people crossed my way, and each of them contributed in smaller or bigger amount to the realization of this report. I would like to thank them all, as they were indispensable in many ways.

I am grateful for the guidence I received from the Wageningen Agricultural University by prof. dr ir L.O Fresco, prof. dr ir J. Bouma and ir D. Jansen who supervized me in Costa Rica. His fields of interests and continuous flow of questions nearly drove me mad, but as he might assent to, we managed some interesting issues. During their short visit, the profs vividly stimulated me for the root study, in an exploring field trip. More aid I received from dipl. geogr. Antje Weitz, for whom nothing seemed too much in order to help me, arguing, explaining and stimulating me. She openend my eyes many times.

The possibilities offered by *Agropalmito S.A.* were tremendous, not the least by the person of ing. Luis Angulo Jauberth, who made that I encountered no constraints in the organization of the trials or whatsoever. He provided me with his knowledge of the crop and treated me like a real friend. I could rely on the people of *Agropalmito* whenever I needed them. In this case I would also like to mention ing. Manuel Amador. They both showed great interest, not only in the research and results, but also in the used methods and techniques.

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CONTENTS

SUMMARY

Palmito (*Bactris gasipaes H.B.K.*) growth and management was studied in the humid lowlands of the Atlantic Zone of Costa Rica. Nutrient removal from farmers' fields was calculated. It was found that the nutrient balance for N, P and K is negative, as farmers only fertilize nitrogen in very small amounts. Other fertilizers are seldomly used.

Palmito seedlings were transplanted in the field and growth and development was followed. A model of bifid leaf area estimation was made with correlation coefficient of 0.982. Potential growth under supposingly adequate circumstances could be estimated in the first period after transplanting. The regression function had a correlation of 0.991. During the observed 137 days, the partitioning of carbohydrates to roots, stem, leaves and rachis, as the allocation of N, P and K to these parts did not change significantly.

Palmito seedlings were transplanted in the field and treated with different N, P and K levels. Although recovery of the applied fertilizer was low and the palms were harvested only 2 months after first fertilizer application, significant effects were recorded for N on LAI, on number of leaves, on the maximal height of the palm, on number of shoots, on diameter at base, on total dry weight and dry weight of stem. Phosphorous had significant effect on diameter at base. Interaction effects were only recorded of PxK on dry weight of stem.

Palmito roots were studied on fertile and less fertile soils by excavating root profiles. Root numbers over the profile were counted, root densities were determined as were bulk densities of topsoil and deeper layers. It was found that palmito roots are superficial, forming thick layers with enormous density in top soil, especially by small sized roots. On relatively poorer soil types, palms react by creating finer root systems, so that nutrients are relatively closer to its roots. The roots, together with fauna activity have loosening effects on compacted areas, resulting in low bulk densities in top soil and solving of compaction of former land use.

SAMENVATTING

Er is onderzoek gedaan naar de teelt en management van palmito (*Bactris gasipaes H.B.K.*) in het humide laagland van de Atlantische Zone van Costa Rica. Nutrientenafvoer door de oogst van palmhart van boerenvelden is berekend met waarden die door boeren zelf gegeven werden. Resultaat was dat de nutrientenbalans voor N, P en K negatief uitvalt, door het feit dat boeren zelden (en alleen met N bevattende kunstmest) bemesten. Andere meststoffen die ook P en K bevatten worden bijna niet gebruikt.

Palmito zaailingen zijn in volle grond geplant en de ontwikkeling en groei van de palm is gevolgd door het periodiek oogsten van de palmen. Er werd een regressiefunktie voor het schatten van het oppervlak van jonge, gevorkte palmbladeren gemaakt, met een correlatiecoëfficient van 0.982. De potentiële groei van de palm is gevolgd in de eerste periode na overplanten onder vermeend ongelimiteerde omstandigheden, en beschreven door een formule met een correlatiecoëfficient van 0.991. Tijdens de geobserveerde

periode van 137 dagen, veranderde de verdeling van droge stof naar wortels, stam, bladeren en hoofdnerf niet significant, evenmin als de toewijzing van N, P en K naar genoemde organen.

Palmito zaailingen werden in volle grond geplant en behandeld met verschillende meststoffen en bemestingsniveaus (N, P, K). Ondanks de kleine hoeveelheden die door de palmen opgenomen werden en de vroege eerste oogst van het gewas, al 2 maanden na toediening van meststoffen, zijn significante effecten gemeten van N op LAI, op het aantal bladeren, op de hoogte van de palm, op het aantal scheuten, op de diameter van de stam aan de basis, op het totaal droge stofgewicht en op het droge stofgewicht van de stam. Fosfor had een significant effect op de diameter van de stam aan de basis. Interaktie effecten zijn alleen waargenomen voor PxK op het droge stofgewicht van de stam.

Door het uitgraven van wortelprofielen op een relatief rijke en een armere bodem zijn de wortels van de palmitopalmen bestudeerd. Het aantal wortels in het profiel werd geteld en de wortel- en bulkdensities werden bepaald op verschillende dieptes in het profiel. Bepaald werd dat het wortelsysteem van palmito oppervlakkig en lateraal groeit. Het vormt een dikke mat vlak onder het grondoppervlak. Vooral de kleine wortels bereiken zo een enorme dichtheid die de palm in staat stellen vrijgekomen nutrienten snel op te nemen, vooral op armere bodemtypes. Kleine wortels hebben een grotere dichtheid op relatief armere bodems. Samen met de bodemfauna hebben deze wortels een losmakend effekt op kompakte bodemlagen die een gevolg zijn van eerder langebruik. Bulk densities hebben daardoor een lagere waarde.

RESUMEN

El crecimiento del palmito (*Bactris gasipaes H.B.K.*), se ha estudiado en el clima húmedo que corresponde a la Zona Atlántica de Costa Rica. Se ha calculado los nutrientes removidos en las parcelas de pequeños agricoltores. Encontrando que el balanceo de los nutrientes N, P y K es negativo ya que los agricoltores aplican solamente abonos que contienen nitrógeno y en cantidades muy reducidas.

Pequeñas plantas de palmito se les transplantó en el campo y se ha seguido paso a paso su crecimiento y desarrollo. Un modelo para estimar el crecimiento del área foliar se ha hecho con un coeficiente (r^2) aproximado de 0.982. El crecimiento potencial bajo a circunstancias supuestamente no limitadas podría estimarse. La ecuación tenía un coeficiente de correlación de 0.991.

En el período de la observación de 137 días, la distribución de carbohidratos y materia seca a los tallos, a las hojas, a las raíces y al petíolo principal, no se ha observado cambios significantes en los flujos de materia seca, N, P y K a éstas partes.

Las plantas de palmito pequeñas, se ha transplantado en el campo y posteriamente se les ha tratado con diferentes tipos y niveles de fertilizantes (N, P y K). Aunque la absorción del fertilizante aplicado a las plantas fue baja y las palmas fueron cosechadas sólamente 2 meses después de la primera aplicación del fertilizante, se obtuvieron efectos significantes de nitrógeno (N) sobre LAI, número de plantas que retoñan, número de hojas, altura de la palma, número de hijos, diámetro de tallo a la base, peso de la materia

seca total y materia seca del tallo. El fósforo (P) tuvo efectos significantes sobre el diámetro de la base del tallo. Los efectos de interacción solamente fueron visibles en el PxK a la materia seca del tallo.

Las raíces del palmito fueron estudiadas en suelos fértiles y menos fértiles pòr escavación de perfiles a los raíces. El número de raíces sobre el perfil fue contado, tanto las densidades de las raíces fueron determinadas como densidades de suelo bajo una cultivación del palmito. Se encontró que las raíces del palmito son superficiales, formando gruesas capas con enorme densidad en la parte superior del suelo, especialmente por las raíces pequeñas. En tipos de suelo relativamente pobres, las palmas reactían creando fines sistemas de raíces. Las raíces, junto con la actividad de la fauna tiene efectos de decaimiento sobre áreas compactas dando como resultado bajas densidades de suelo en las partes superiores y solvando las áreas compactas en las áreas más profundas donde se encuentra los resultados del uso anterior.

1 INTRODUCTION

Agriculture in tropical environments is often seen as an inefficient way of elementary food production. Yields are low because of technical and social-economical restraints, subjects in many research programmes. Whatever production levels are and what kind of strategies are followed, all producers hope to maintain the fulfilments of their needs. Their policies will be adjusted for that. Ecological sustainable land use, in this sense, is very important, as it provides future crops with unchanged field potentials.

The Atlantic Zone of Costa Rica, with its humid tropical climate, is extremely suitable for the production of palmheart. Palmheart is the product of the young peach palm (*Bactris gasipaes H.B.K.*), known as palmito. Although commercially grown for more than 20 years, it is still seen as a 'future crop' with its expanding reputation and export market. Despite this, little is known about growth, development and nutrient uptake; most important issues with regard to ecological sustainable land use. The modelling of crop production in this context, is useful to describe crop reactions under various circumstances.

Management, as a prominent factor in land use systems, was studied in 2 parts of the Atlantic Zone by means of interviews and visits to small farmers and larger palmheart producing plantations. Focused was on nutrient removal from the field, with fertilizer applications as an important management factor.

To collect data for a simulation model, an experiment was done under supposingly adequate fertilization and management to describe the potential growth and development of palmito after transplanting.

A fertilizer trial was started with nitrogen, phosphorous and potassium, to relate growth, yield and quality to different levels of nutrient uptake. The efficiency of fertilizer applications on the experimental field could also be determined.

As the adaption of crops to soil type, soil conditions and management is known for long, a study was made of the root system of palmito on two different soil types (fertile and less fertile). Bulk densities of top soil and root architecture were determined.

The work presented in this report was carried out as partial fulfilment of the requirements for obtaining the Ir (MSc) degree at the Agricultural University Wageningen, The Netherlands. In this context two thesis and a practical period were done in the Atlantic Zone Programme in Costa Rica. The department of Tropical Crop Science and the department of Soil Science & Geology agreed to an intensively knitted programme for the work described above.

2 THE ATLANTIC ZONE OF COSTA RICA

2.1 The Atlantic Zone Programme

In 1986 the Wageningen Agricultural University (WAU) reached an agreement with the *Centro Agronómico Tropical de Investigación y Ensañanza* (CATIE) and the *Ministerio de Agricultura y Ganadería* (MAG) about the establishment of an outreach station in the Atlantic Zone of Costa Rica. The agreement offered the WAU opportunities for research and the training of students, and CATIE and MAG access to the information and experience of the WAU in the region.

In 1991 the WAU linked finance of projects like this to results of investigations. The continuation of the project was secured by provisional finance for two years, by the research programme *'A methodology for analysis and planning of sustainable land use, a case study in Costa Rica'*. In 1993 an evaluation of this research will take place. A proposal for new research will be presented to retain the project status.

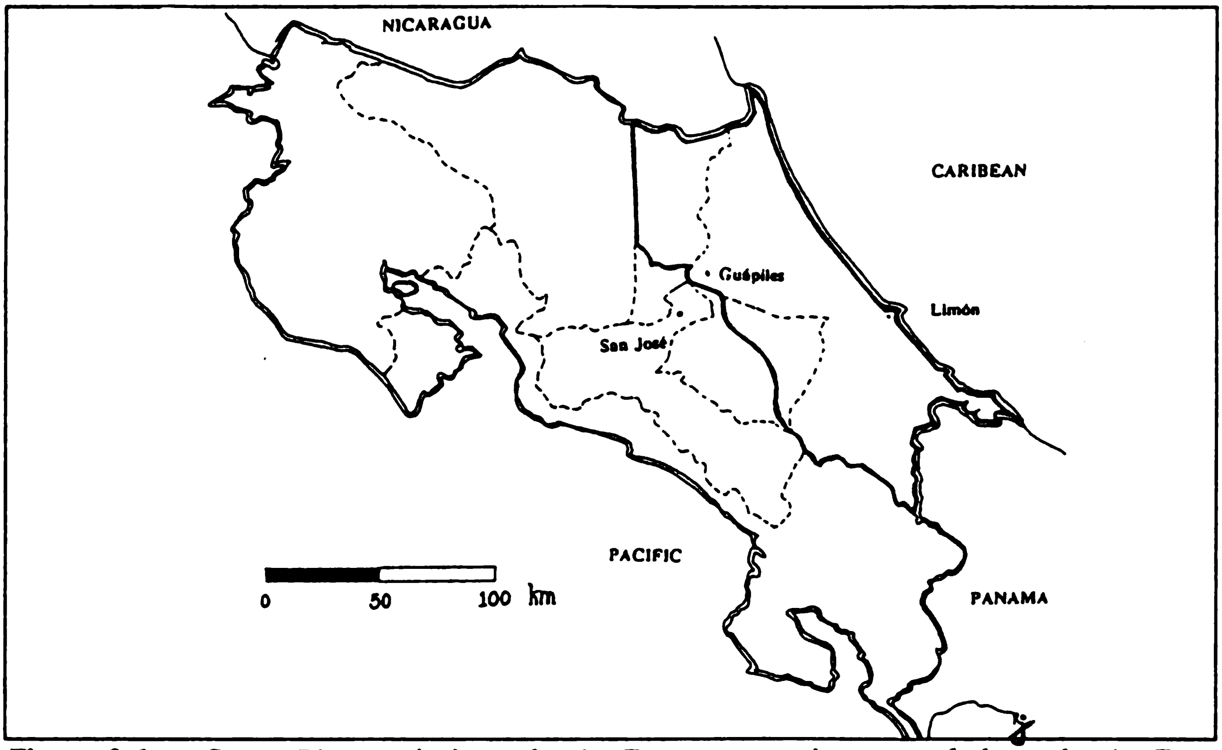

Figure 2.1 *Costa Rica and the Atlantic Zone, research area of the Atlantic Zone Programme.*

2.2 The Atlantic Zone

The Atlantic Zone (*la Zona Atlántica*) is the popular name for the research area of the Atlantic Zone Programme. This area is arbitrarily defined as the entire province of Limón, the canton Sarapíqui of the province of Heredia and the canton Turrialba of the province of Cartago. It is situated in the east of Costa Rica, enclosed at the west side by the Central and Talamancan mountain ranges and at the east by the Caribbean sea. In the north, the Atlantic Zone ends at the border with Nicaragua, whereas in the south it stops at the border of Panama (Figure 2.1).

In many reports, published by the Atlantic Zone Programme, extensive information can be found on subjects like climate, soils, vegetation and land use. Here they are briefly presented.

2.2.1 Climate

According to Nuhn (1978) the climate of the Atlantic Zone is characterized as tropical humid. Small temperature changes throughout the year occur. Annual variation of temperature is dominated by the monsoon with the highest temperatures before the onset of the summer rains (Portig, 1976). Rain figures vary from 2,500 $mm \cdot y^{-1}$ in the south-east to 4500 $mm \cdot y^{-1}$ in the north-east and east of the zone. Mean annual temperatures vary from 18 to more than 24 degrees Celsius, depending mainly on altitude. Most of the times the northern, northwestern and southwestern winds are not strong, stronger are the less frequent eastern and southeastern winds. Potential evapotranspiration in the Atlantic Zone varies between 3 $mm \cdot d^{-1}$ in June and July to 4.2 $mm \cdot d^{-1}$ in March and April (Rojas, 1985). This climate enables crop growth throughout the year. This goes also for weeds, pests and diseases.

2.2.2 Soil and vegetation

The Atlantic Caribbean lowland has been a sedimentation area since early Tertiary. The coast line is made up by a narrow strip of succeeding beach ridges with parallel canals. Behind the ridges and canals, coastal swamps occur, gradually passing into a vast alluvial plain. At the foot of the mountain ranges the alluvium takes the form of alluvial fan deposits. This flat landscape is at a few places interrupted by remnants of basaltic volcanoes.

Till recently, most of the area was covered by tropical moist and wet forest and pre-montane wet forest. On the higher parts of the central and Talamancan mountain ranges lower montane and montane rain forest could be found. At present much of the forest has been destroyed as a result of wood extraction (Veldkamp et al, 1992) and of conversion into pasture and crop land.

2.2.3 Land use

The land use in the Atlantic Zone is very variable with regards to crops, management and field size. In the plain lowlands enormous banana plantations are found as well as small maize and cassava producing farms. Large areas used for pasture are especially found in the north of the Zone. Recent studies of Finnema (1991) and v.d.Berg and Droog (1992) show that in one of the many settlements of the *Instituto de Desarollo Agrario* (IDA) a great variety of crops is grown and that some of these crops gain in importance, economically speaking. Palmito is such a crop.

2.3 The research areas

2.3.1 Nutrients export from farmers fields

The majority of soils in the settlements in the Atlantic Zone are not the most fertile ones. *Bananeras* occupy the best soil types and the left overs are partitioned between private and collective owners. Spacial distribution of banana plantations and pasture is correlated to soil fertility (Veldkamp *et al*, 1992). Settlements are found on large areas with mainly reddish soils. In these relatively easily accessed settlements the majority of the small producers of palmheart are found that have contracts with the processing factories to sell their harvests.

In the Neguev settlement and the Río Frío area of the Atlantic Zone of Costa Rica a study was made of the cultivation techniques of palmito. Interviews were held to gather information on management and flow of nutrients (see chapter 3.3).

Neguev settlement

The area is located in the south of the northern half of the Atlantic Zone. Coordinates are roughly between 10°08' and 10°17' N and 85°29' and 85°36' E. Meteorological figures as mean annual precipitation (3646 mm) and mean annual temperature (24.7°C) come from meteorological station El Carmen, situated just outside the settlement.

The settlement became a land reform project of the IDA after it was occupied by *precaristas* (landless farmers) in 1976. They cultivated the land which before only consisted of extensive grazed pastures and forest. Now farmers cultivate areas of 10-16 ha, most of it is used as pasture. Most general crops are maize, cassava, pineapple, maracuyá, and palmito. Most of the area has soils developed in lahars from the Turrialba vulcano.

Río Frío area

The area is situated between the rivers Río Puerto Viejo and Río Sucio, north of the highway Limón-San José and south of the Horquetas village. The meteorological stations in the area give figures for mean annual precipitation of 4100 mm. Mean annual temperature is 25.4 °C. Only in the months February and April the evapotranspiration exceeds the precipitation (mean annual evapotranspiration: 1635 $mm \cdot y^{-1}$).

In 1977 the IDA bought part of the area from *Standard fruit Co.* and private owners. It distributed areas of ca. 10 ha to farmers from the Central Valley and landless farmers, who now are growing various crops or use the land for pasture.

2.3.2 Potential production and nutrient trials

The experiments took place on the grounds of the palmheart producing company *Agropalmito S.A.* in Guápiles, in the north-west of the Atlantic Zone. At this farm, only 400 m east of the outreach station of the WAU, *Agropalmito* has some 400 ha sown with palmito in which 200 local labourers find their daily jobs. In the nearby future a processing factory will be build, on the grounds of the farm.

The test fields were situated at the utmost south part of the farm, close to the road Guápiles-Jiménez, at an altitude of about 250 m above sea level. Meteorological figures for the period Juli 1991 to December 1992 can be found in Appendix 4-V.

3 PEACH PALM

3.1 Plant characteristics

The peach palm is used in several ways, the most important being for fruits (pejibaye) and palmheart (palmito). The habitus of the plant differs with regards to its use, because of the different ways of cultivation for both types.

3.1.1 Taxonomy

The peach palm is placed in the Palmae family, Arecoidea, Cocoeae, in genus *Bactris* with specific name *gasipaes*. The author used in many publications is 'H.B.K.', but 'Khunt' is also considered. Some confusion exists which genus name to use. Apart from *Bactris* in the majority of recent publications, *Guilielma* is used in others. The International Board for Plant Genetic Resources (IBPGR) uses the former classification. The 14 species of the old genus *Guilielma* (created by Martius) are found in the described 239 species of the genus *Bactris*.

In Central America the name pejibaye is commonly used. Other names are peach palm (English), pejivalle, pejiballe, picbae and pixbay (Costa Rica), chomtaduro, chontaduro (Ecuador), pupunha, þirijao (Brazil), macanilla (Venezuela), chonta and pejijuayo (Peru and Colombia).

3.1.2 Morphology

Use for pejibaye or for palmito affects the morphology of the plants as different management is required. This report focuses on palmito, but morphological characteristics of pejibaye are also presented here.

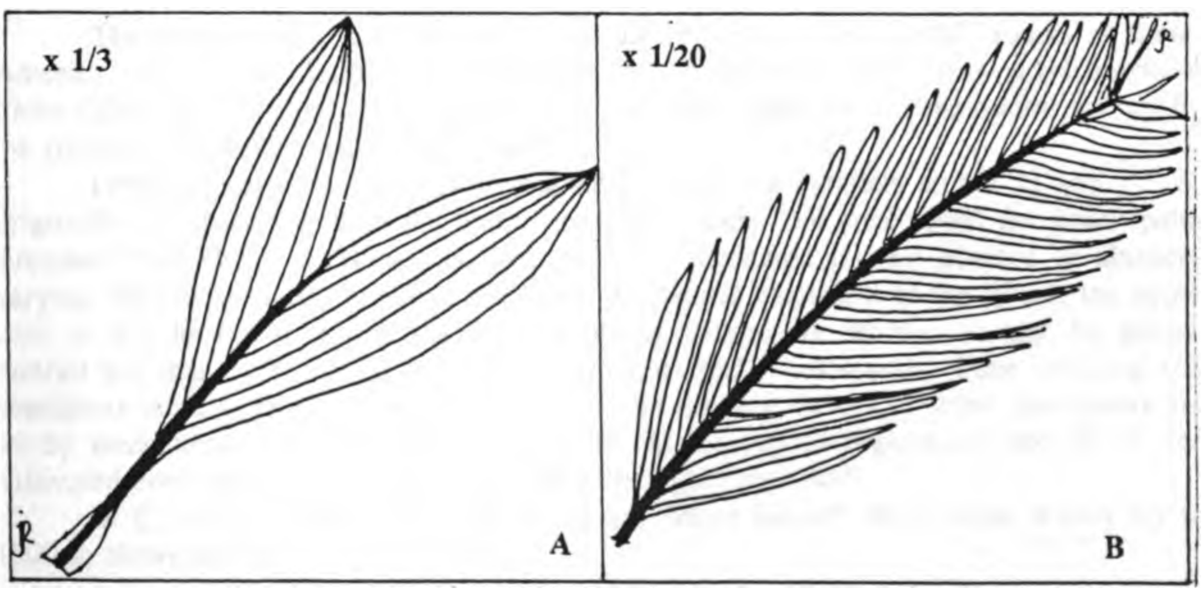

Figure 3.1 *Leaf types of Bactris gasipaes H.B.K.. Bifid (a) when young (up to 7 months after transplanting) and pinnate (b) when older.*

For both production types, the palm has a monopodial habitus. Leaves differ in size and shape in a progression from bifid (first leaves) to pinnate (mature) leaves (Fig. 3.1). As a monocotyledon the peach palm consists of primary tissues without tissues of secondary growth. The primary roots of all palms and thus of peach palm are very small, developing and functioning only a short time when the palm is young. Subsequent roots are lateral, borne near the base of the stem, forming large masses close under ground level. See also chapter 6 for more details about palmito roots.

For its use for palmito, the palm cannot fulfil its full growth cycle as sexual reproduction is not reached. The palm is cut down when the stem reaches a certain diameter, for the first time after 12-18 months. Meanwhile new shoots are formed at the base, which makes that the palm can be harvested continuously, with intervals of ca. 2 months.

3.1.3 Evolution and genetic variability

Peach palm developed on both sides of the Andean mountains, giving origin to two types: those from the Amazonian basis -Oriental or Amazonian type- and those from the noroccidental side of the Andes -the Occidental type-. Morphological variation (e.g. fruit size) is large in both races. An often cited theory of Mora Urpi (1989) is that the variation in the Amazon region is derived from the isolation of populations provided by rivers acting as physical barriers to gene exchange. On the occidental side of the Andes a similar process took place; the palm was repeatedly domesticated throughout the territories in which it occurred naturally.

In Costa Rica the mayor area is sown with palmito cultivar 'Tucurrique', which is categorized within the Occidental type. A large part is also sown with cultivar 'Guatoso' with fewer spines. Promising imported cultivars are 'Putumayo', 'Vaupes' and 'Darién' (Mora Urpi, 1989).

3.1.4 Ecology and geographical distribution

The peach palm is found in almost all regions of the humid tropics of Latin America. It has been cultivated by the indians of Latin America from pre-Columbian times (1500 A.D.), especially for its fruits. The outer limits of its distribution are set by the routes of the tribes that used the palm.

Geographically the palm is distributed between the parallels at 16° N and 17° S, originally in association with the humid tropical forests. The area suited for peach palm stretches from Brazil to Honduras. The palm in cultivation is well adapted to altitudes varying from 0 m to 800 m above sea level. As natural inhabitant of the forest, the upper limit is 300 to 400 m above sea level. Limiting factors are set by swamps, by annual rainfall less than 1900 mm or dry periods which exceed 3½-4 months. Poor soils and soil conditions other than drainage do not seem to be limiting factors. Further limitations are set by mean annual temperatures less than 25 °C for natural populations and 20 °C for cultivated ones. Mean relative humidity must be higher than 80%.

In Costa Rica cultivated populations are found beyond the Central Valley up to 1000 m above sea level.

3.2 Cultivation techniques for peach palm

The advised cultivation techniques for peach palm differ for the use for fruits or palmheart. In the descriptions below, mostly taken from 'The pejibaye palm (*Bactris gasipaes H.B.K.*)' (Mora Urpi *et al.*, 1984), special techniques for palmito are mentioned.

Field selection. If possible, fields are selected with good drainage. The palm does not exhaust the soil severely, but produces better on fertile soils. Because of the high returns of palmito, advise is given to search for flat, fertile areas. Palmito is preferably sown below altitudes of 800 m above sea level.

Nursery. Selected seeds germinate after ca. 3 months in plastic bags, or on germination tables. The seeds are placed in bags of 20 x 30 cm which are filled with ground and sometimes treated with chemicals to kill other seeds. On the tables, seeds are sown at 2-3 cm between seeds and 7-8 cm between rows. A so called 'complete fertilizer' (e.g. 12-24-12; 12% N, 24% P_2O_5, 12% K_2O and spore-elements) is given 1-2 months after germination. Often one or two weeding practices are needed. Plants can be moved to the field after about 6 months. For palmito, nursery bags are sometimes placed in the existing plantation which provides shadow.

Transplanting. With care plants are transported to the field, avoiding damaging the roots. Holes of 20 cm x 20 cm x 20 cm are dug and plants are taken from the bags and placed in the holes. Transplanting preferably takes place when the soil is humid and the weather is rainy or cloudy. Transplanting just before dry periods is avoided. Fertilizer can be given at transplanting or later.

Experiments performed by Cyrus (1983), in which various transplanting techniques were tested, could not prove significantly that the use of an anti-transpirate gives better results at transplanting. Another factor examined (and proved significant) was transplanting at 4 or 9 months after germination (vigorous plants: 75% vs 90%). Palmito plants are often brought earlier to the field than pejibaye plants. Because of higher planting densities the control of weeds is considered more worthwhile.

Planting densities. In natural populations i.e. as inhabitants of the primary forests, plant densities are very low. Although it is possible to find several palms in a relative small area, in general the density is around one or two palms per hectare.

Advised planting densities for cultivation of pejibaye are about 400 $pl \cdot ha^{-1}$ (5 m x 5 m), depending on field conditions (slope, fertility). The 'stem density' often is higher, because 1 or 2 shoots are retained for production also. In this way, plant densities increase to 1000-1200 $stems \cdot ha^{-1}$. But lower densities are often observed (Haan, 1988). Terraces are advised on slopes.

In the history of palmito, planting densities have increased enormously. From 2500 $pl \cdot ha^{-1}$ in the 1970-ies, to nowadays advised densities of 5000 $pl \cdot ha^{-1}$. The density is not set by limitations of plant growth, but by ergonomic conditions for labourers with regard to the spines of the plant. Farmers working in plantations with distances of 2 m x 1 m (5000 $pl \cdot ha^{-1}$) plant new areas with lower densities (ca. 4000 $pl \cdot ha^{-1}$), to ease working.

Intercropping. On sites with a slope it is recommended to intercrop pejibaye with species that covers the ground well. On fields also producing crops like maize or beans are recommended (Anai, 1986). Pejibaye itself is also used for intercropping. Actual intercropping as shadow tree takes place with coffee, bananas, other fruits and cacao. In palmito intercropping is only practised in the first or at most the second year after transplanting, to cover the space left open by the young plants. Common crops in intercropping are beans, maize, cassava and sometimes peppers. Weeds are combatted in this way. When the incoming radiation cannot pass through the canopy, intercropping is impossible. When in production, i.e. when palmheart is harvested and leaves and copious shoots are pruned, sowing of intercrops is difficult because of the mulch layer in between the palm rows. Management practices, performed by walking between the palm rows, also hamper intercropping.

Fertilization. In the humid tropics, the high precipitation and high temperature cause quick decomposition of organic material and rapid loss of nitrogen by lixivication. Phosphorous and potassium are or fixed in the soil, or could easily be leached. Therefore applications should be given more times in smaller amounts. Table 3.1 provides advised figures for palmito as production type. As seedlings in the growing bags, the plants often receive one application of 'complete fertilizer' (12-24-12; 12% N, 24% P_2O_5, 12% K_2O, and spore-elements).

Table 3.1 *Advized fertilizer quantities ($kg \cdot ha^{-1} \cdot y^{-1}$) and application frequencies for a palmito plantation (4000 $pl \cdot ha^{-1}$).*

N	P_2O_5	K_2O	Source
200-400	200	150-300	Asbana, 1981
3x 120	100	2x 100	Mora Urpi *et al*, 1984
		275	Asbana, 1985
4x 120	4x 240	4x 120	Anai, 1986
200-250	20	160-200	Herrera, 1989
4x 125	4x 150		Agropalmito, 1991

Weed control. Peach palm suffers from weeds, especially *Graminae*. Competition for nutrients and space, particularly when young, is an important factor in delaying growth and development. Management practices consist of applications of pre-emergence and burning herbicides, but weeds are also removed by hand. Applications take place by spraying herbicides from a reservoir carried on the back.

Pruning. In pejibaye only a number of shoots is retained, but for palmito copious leaves and copious or bad shoots are also removed from the plants by cutting and are left in between the rows in a pile of litter. Pruning takes place to maintain working space and avoid a slow growth. At each plant 10-12 shoots are born, but only a number of them (4-6) is retained.

Harvest. Fruits of pejibaye can be harvested from the fifth year. Harvest takes place from 115 to 175 days after flowering, ripening can take place in storage. The palmito harvest is done by hand when stems have a diameter of ca. 15 cm. The cutting is done with a *machete* (large cutting knife). The stem is harvested and leaves are cut and left in between the rows. The outer two leaf sheaths are removed also. The length of palmheart for transportation is about 60-80 cm.

Yield levels are increasing in the first 3-4 year of production and reach stable rates after this period. Depending on management and soil fertility, yields can exceed 10000 palmhearts per ha per year. Each palmheart has a fresh weight of ca. 1.5 kg.

Composition of harvest product. Palmheart has a dry matter content of 8.5-12% (Herrera (1989) and analysis of harvest product of visited farmers). The composition of dry matter is given in table 3.2. The values come from samples of farmers' yield product. Seven farmers harvested 10 palmhearts each. The obtained material was cut and a sample of about 1 kg was oven dried at 70 °C for 24 hours. The samples were analyzed chemically by the laboratory of CORBANA in La Rita (CR).

Table 3.2 Mean composition and standard deviation figures of dry matter of harvested and removed palmhearts of 7 farmers growing palmito in the Atlantic Zone in 1991.

N	P_2O_5	K_2O	CaO	MgO	S	Fe	Cu	Zn	Mn
%	%	%	%	%	%	ppm	ppm	ppm	ppm
1.8	0.4	3.0	0.4	0.3	0.2	346	15	61	75
0.33	0.16	0.91	0.13	0.13	0.04	171	6	23	29

3.3 Growing palmito in the Atlantic Zone

The actual growth and management of palmito was studied in two different areas of the Atlantic Zone, the Neguev settlement and the Río Frío area. This was done by means of single visits to palmheart producing farmers. The visits took about 2½ hour per farmer and consisted of an introduction of the Atlantic Zone Programme, an interview (Appendix 3-I), a visit to the field and if allowed, the sampling of soil and harvest product.

Farmers were found by exploring field trips and information given by other farmers. Transportation of palmheart requires good infra-structure, thus no problems were faced reaching the fields. Problems mainly arose by farmers doing off-farm work, and the fact that the information given by the farmers was based on rough guesses, or worse, not true. Furthermore, loss of samples was caused by failing electricity power and the reorganization of the laboratory of the *Programa Zona Atlántica* (PZA). In the next paragraphs however, calculations of nutrient removal and replenishment were made with the figures provided by the farmers.

3.3.1 Actual situation in Río Frío and Neguev

The visited farmers in the research areas, all had about 10 to 15 ha to their disposal, half of it planted with palmito. Although producing farmers gained relatively more with palmito than with other crops, recently starting farmers had planted small areas of ca. 1 ha, due to financial reasons. The investment in palmito is rather high, with no returns the first 2 years. The majority of the farmers were 4 year in production, reaching yield levels of 8000-9000 palmhearts per ha per year. The harvested product is bought by brokers of processing companies, mostly of *DEMASA* or *Tucarico S.A.*. Small amounts are also sold on the street to neighbours and people passing by.

The so called 'commodity approach' of processing industries, in which the chance for palmito growth for smallholder is only possible because of well organized brokers, together with a monopoly on the market of processing companies, has had large influence on the actual growth of palmito in the research areas. As a farmer alone, it is hard to sell your harvest. Farmers can only conclude contracts with the brokers of processing companies if the crop is grown under certain circumstances. This includes planting densities (5000 $pl \cdot ha^{-1}$), fertilization, stem diameter at harvest (>15 cm), retained number of shoots (4-6) and production level. Under these measures and the advice given by various organizations operating in the area (MAG, IDA), the majority of plantations look alike. Some farmers do have their own ideas however, resulting in deviating densities, different fertilizer levels and/or intercropping.

Most smallholder are very proud on their plantation. Palmito as a cash crop gives them better returns each year. Therefore, management practices are performed very seriously and neatly. All the management practices are performed by the owners of the plantation, often helped by one or two of their sons. If possible, harvesting is handed to *peones* (labourers), as it is a dangerous job, avoiding the spines and your own *machete*.

3.3.2 Field practices

The palmito areas were in all cases originally used as pasture, or grazing lands with shrubs and trees. Land preparation consisted mainly of cleaning, burning and sometimes ploughing the fields, which took about 25 hours per ha. Large trees often were retained in the field, as were fruit producing trees. The majority of the farmers had grown their own planting material in nurseries, using seeds from pejibaye palms from neighbours. Some had bought seedlings from the IDA or MAG. Depending on fertilization, plants remained 3.5 to 12 months in the plastic bags before they were transplanted. Transplanting took considerably more time, about 60 hours per ha. The time spent on management practices can be found in table 3.3.

Values are the median of the provided answers. Difficulties in transforming the answers to general values per ha arose by farmers estimating the size of their property and time spent on the various practices, as it often was expressed in days. The economical studies of Finnema (1991) and Van den Berg & Droog (1992) in the Neguev settlement show more detailed information on palmito and many other crops.

Table 3.3 *Time spent on various management practices for palmito. Figures come from 15 farmers, growing palmito under various circumstances. Distinction is made between recurrent management practices and those which occur only once.*

	Time (hours$\cdot$ha^{-1})	Range
Land preparation (once)	25	10 - 60
Transplanting (once)	60	40 -112
Fertilization (recurrent)	10	1 - 16
Pruning (recurrent)	35	8 - 40
Harvesting (recurrent)	25	5 - 40
Applying herbicides/pesticides (recurrent)	5	0.5 - 9

3.3.3 Nutrient removal and replenishment

In palmito hardly any other fertilizer is given than NUTRAN (NH_4NO_3, 33.5% N), especially at smaller farms. Advised is to apply every 3 months, but because of lack of money and time this advice is often not practised. This results in nutrient flows from the field which are not replenished. The small amount of nitrogen and phosporous brought by rain is not enough with regards to the removal.

Although relative small parts of the crop are removed, the continuous flow of nutrient from the field is not or hardly compensated by inputs. The farmers who claimed to have fertilized their crop regularly, often did not speak the truth. Fact is that knowledge of fertilization is present, and nearly all farmers could tell me what and how much of it was necessary for palmito. The same goes for pesticides, although I never came across a field with symptoms of plagues or diseases, and no one could describe clearly what these symptoms were.

Reasons can be sought in a few directions. Unlike other crops, with exception of pine-aple, palmito performs rather well on the acid soils of the Atlantic Zone, even without heavy fertilization. The crop lives on a certain surplus of nutrients of the soil (mineralisation), and small amounts of nitrogen coming in naturally. Farmers producing palmheart more then 4 years are inclined to fertilize as they note that the crop is performing less after this period. If they have access to capital, fertilization (N only) is practised.

Table 3.4 . Nutrient removal and replenishment of 15 palmito smallholders.

Farm nr.	Years in production	Size ha	Plant density pl/ha	Yield palmheart/ha/y	Fresh weight kg/palmheart	Dry matter removed kg/ha/y	N removed kg/ha/y	P205 removed kg/ha/y	K20 removed kg/ha/y	N applied kg/ha/y	N balance
1	8	6	3850	9333	?	1440	25.9	5.8	43.2	740	714.1
2	5	4	3333	7000	1.28	999	17.9	4.0	30.0	87	69.1
3	5	10	5000	5200	1.56	900	12.9	3.1	23.5	?	?
4	4	3	4000	8400	?	1296	15.6	5.2	38.9	?	?
5	4	1	5000	8145	1.45	1257	15.1	5.0	37.7	543	527.9
6	3	6	3850	2917	1.20	384	8.0	1.5	8.9	322	314
7	3	2	4000	8174	?	1261	24.1	5.0	37.8	109	84.9
8	3	1	4444	6533	1.96	1484	24.2	5.2	38.4	370	345.8
9	2	6	5000	8000	?	1015	20.3	4.1	30.5	?	?
10	2	6	4000	8000	1.68	2852	7.0	13.1	77.0	?	?
11	2	5	5000	4480	1.29	693	12.5	2.7	20.8	268	255.5
12	2	5	4000	2489	1.80	385	6.9	5.4	11.6	31	24.1
13	2	4	4500	3033	1.47	379	8.0	3.1	19.6	175	167
14	2	4	4000	4605	?	711	14.8	2.9	21.3	435	420.2
15	1	1	3500	9800	1.56	1653	19.8	5.0	40.5	308	288.2

The outcomes on nutrient removal and replenishment of the interviewed farmers are presented in table 3.4. In only 50% of the cases a full data set was available for the calculation of the composition of harvest product. Other values were calculated using the given yield levels, dry matter content and mean composition figures (table 3.2) of palmito.

The nutrient balance for N seems to be positive, but as is shown in chapter 4 and 5, N uptake efficiency is extremely low. Feared must be that heavy rain showers are the cause of severe nitrogen leaching, leading to insufficient N replenishment. The role of the mulch layer in between the palm rows, however, must not be neglected in its capacity to hold nitrogen longer available.

4 POTENTIAL GROWTH OF PALMITO AFTER TRANSPLANTING

The production capacity of a crop under different circumstances may differ largely. Experimental research is done under many environmental situations to make general predictions about crop performance. But if the potential of a crop can be described and put into a model, its performance may be predicted when tested in simulation with variable field conditions. If true, lots of labour, time and space could be saved. Growth at a given time depends largely on growth at a former moment. With each amount of new formed green tissue, new carbohydrates can be assimilated. Growth rates increase until a maximum amount of dry matter per day is reached. Not a single publication on dry matter production and partitioning could be found for palmito. This hiatus is to be filled.

Aim of this study was to describe the potential growth of palmito (*Bactris gasipaes H.B.K.*) in terms of parameters to be used for modelling. The term 'potential' is used here to indicate growth without limitations of water and nutrients.

A small model is presented, made to estimate leaf area of the young plants. The distribution of dry matter in palmito plants and the development of morphological characteristics were followed by harvesting the crop periodically, up to 137 days after transplanting. Also the allocation of nutrients to the different organs of the plant was observed during this period.

4.1 Trial circumstances and methodology

All management practices are presented chronologically in Appendix 4-II.

4.1.1 Location

On a more or less flat field, on the farm of *Agropalmito S.A.* in Guápiles with a fertile soil type (for profile description see Appendix 6-I), an experiment with 4 replicates was laid out. Lay out of the experimental field can be found in Appendix 4-I. Every replicate fitted one block with 9 plots, one for each periodic harvest and 2 reserves. The blocks were placed north to south, following the small slope in the field. Each plot consisted of 28 plants, placed in 4 rows of 7 plants, of which the central 10 were harvested. Distance between the rows was 2.5 meters with 1.0 meter in the row between plants (4000 $pl \cdot ha^{-1}$). Rows were orientated east-west. Total area of the test site was 0.25 ha. All management practices concerning the field can be found in 4-II.

4.1.2 Selection

Seeds were taken from peach palms growing at the farm. Before sowing, they were tested on vigour. Criteria for vigour was if seeds floated in water or not. Dry (floating) seeds were removed. In the nursery of the farm, seeds were placed in black polyethylene bags filled with the ground of the nursery. The bags were placed in rows orientated east-west, in a width of 6 bags. Plants germinated after ca. 3 months and received 2 months later a (handly given) doses of 'complete fertilizer' (12-24-12). Weeds were removed two times from the plastic bags. At transplanting plants had been 7 months in the nursery.

To obtain uniform planting material, plants were selected by eye on uniform size and number of leaves. However, the selected planting material showed considerable variation in total dry matter (n=50 measurements, average of 67.36 $kg \cdot ha^{-1}$ with standard deviation of 16.84 $kg \cdot ha^{-1}$).

4.1.3 Fertilizer

Fertilizers were given in the form of NUTRAN (NH_4NO_3, 33.5% N), TSP (46% P_2O_5) and KCl (60% K_2O). The levels applied ($kg \cdot ha^{-1} \cdot y^{-1}$) were 150 N, 300 P_2O_5 and 175 K_2O. The fertilizers were put at ca. 20 cm from the plant. See Appedix 4-II for exact quantities per plant.

These relative high applications for young plants and the application distance are probably related with the drying and yellowing of the leaves and the attack of fungi one week after the applications. The farm manager was familiar with the problem and advised to applicate a fungicide. Fungicide (KOCIDE; 77% copper hydrate and 23% inert materials) was applied in a low doses (144 g copper hydrate$\cdot ha^{-1}$) 90 days after transplanting.

4.1.4 Harvest and measurements

Harvest dates were assigned at random to each experimental unit. Harvesting took place in the 3rd, 4th, 5th, 7th, 10th, 14th and 20th week after transplanting. Plants were lifted out of the soil with great care to minimize loss of roots. Roots were washed in a nearby river to remove the attached soil. In the laboratory, the height of the plants was measured from the basis of the plant to the end of the longest leaf. Girth of the stem was determined at the basis and at the place where the last leaf appeared. For further studies this could be used to estimate contents of the stem. Width and length of the main rachis were counted to estimate leaf area, using equation 11 of chapter 4.3. Number of full developed leaves were counted, as were number of shoots. The plants were divided into roots, stem, leaves and rachis to determine dry matter distribution. Figure 4.1 shows where the distinction was made between leaf and stem. All samples were oven dried in paper bags for 48 hours at 70 °C. These samples were analyzed chemically at the laboratory of CORBANA, La Rita (CR) on N, P, K, Ca, Mg, S, Fe, Cu, Zn and Mn. For chemical analysis see Appendix 4-III. Physical measurements are stored in Appendix 4-IV.

4.2 Estimation of leaf area

4.2.1 Need for the development of the model

During the experiments the increase in leaf area of the palmito plants was measured. To determine this parameter with a leaf area meter it is necessary to destroy the plants. As this equipment was lacking and because of the fact that not always plants can be destroyed, a regression function was developed to estimate leaf area.

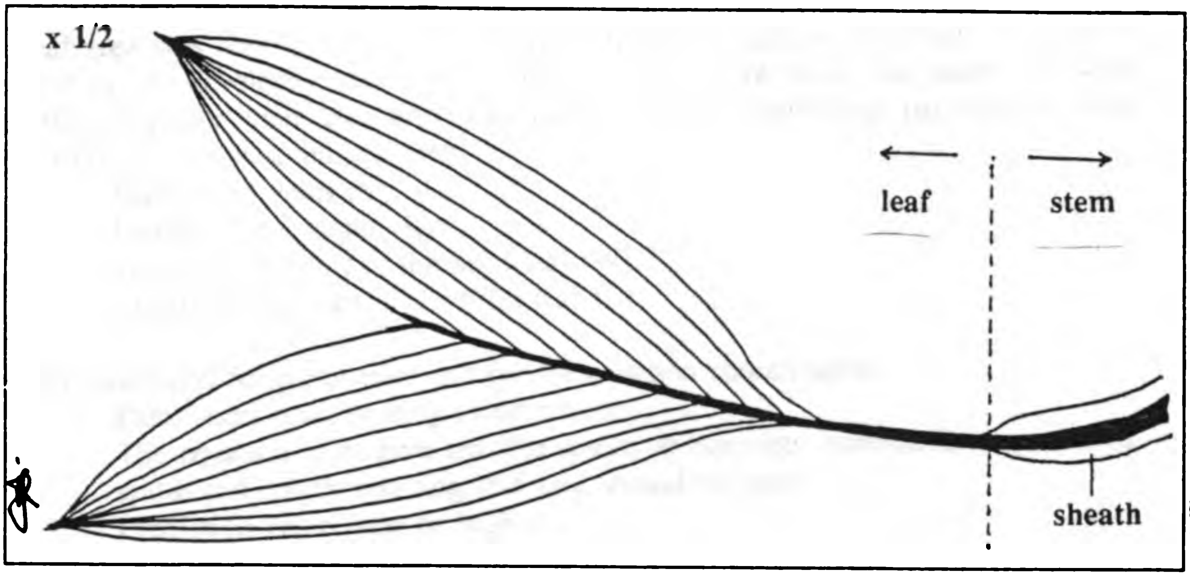

Figure 4.1 ***Distinction made between stem and leaf of young palmito plants. At place where sheaths end on rachis, the distinction is made.***

Nothing has been written about the estimation of leaf area of young palmito, and only one reference could be found on the estimation of leaf area of older leaves in peach palms (Clement *et al.*, 1985). In the latter study leaf area is related to length and width of certain leaflets (leaflets of peach palms are organized in groups of two at its rachis (figure 3.1b), of the 6th, 8th, 10th, 12th, 14th and 16th group, leaflets were taken from alternating right and left side of the rachis, and used in equation 4.1). The value of ß was calculated to be 0.72.

$$LA = \beta \cdot (l \times w)_{6R-16L} \cdot n \qquad \textbf{Eq. 4.1}$$

with: LA = leaf area (m^2)
ß = regression coefficient
l = mean length of 6 leaflets (m)
w = mean width of 6 leaflets (m)
L = left
R = right
n = total number of leaflets at leaf

This equation can be used for mature pinnate leaves, but the regression coefficient (ß) might need to be recalculated as another population of younger plants with different use and management is observed.

4.2.2 Model of bifid leaf area estimation

Leaf area was determined of ca. 150 fresh leaves of palmito seedlings, varying in size as first to last developed leaves were taken. Leaves were drawn on paper and with the use of a digitizer their leaf area was calculated. The following parameters were measured to relate to measured leaf area:

a) Number of veins (V)
b) Length of the rachis (R))
c) Width of one part of the bifid leaf (W)
d) Length of one part of the bifid leaf (L)

Considered conditions for parameters and for the equation chosen were:

- Parameters must be easy to determine
- The equation must give sensible results at boundery conditions (e.g. at zero width and length resulting leaf area should be zero)
- Prediction value must be high (r^2)

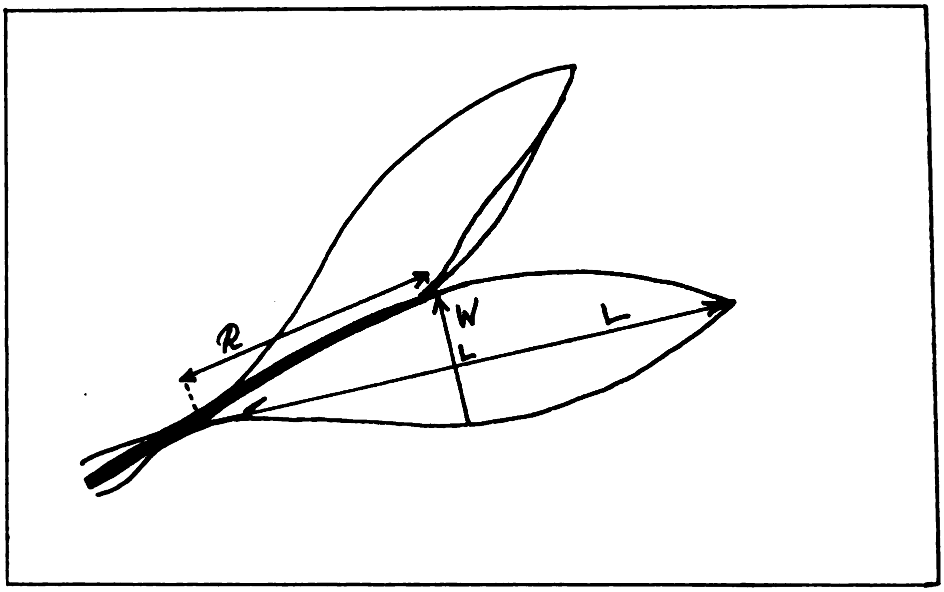

Figure 4.2 Palmito leaf (bifid) and place where leaf parameters were determined.

4.3 Results and discussion

4.3.1 Model of bifid leaf area estimation

Table 4.1 shows the equations tested. Equation 11 has the best fit with a correlation coefficient of 0.982. The used parameters are the length and width of one part of the bifid leaf (figure 4.2).

Table 4.1 *Equations to estimate bifid leaf area of young peach palm (leaf 1 till 7). n = 150 fresh leaves.*

N°	Equation	r^2	N°	Equation	r^2
1	8.63 x V	0.542	7	3.00 x (R x L)	0.918
2	18.39 x R	0.713	8	4.38 x L^2	0.924
3	2.02 x R^2	0.760	9	1.58 x (V x W)	0.932
4	7.44 x W	0.787	10	0.34 x W^2	0.939
5	29.97 x L	0.800	11	1.25 x (W x L)	0.982
6	0.54 x V^2	0.811			

The effect of leaf number on the calculated regression coefficient is pictured in figure 4.3. The figure shows that the oldest leaves as well as the youngest ones have a smaller area of confidence for their regression coefficient. An explanation could be that the youngest leaves are not full grown yet and also the oldest ones obviously have another shape, difficult to estimate with this equation type. But as the oldest leaves have relatively small leaf areas, no other equation was made.

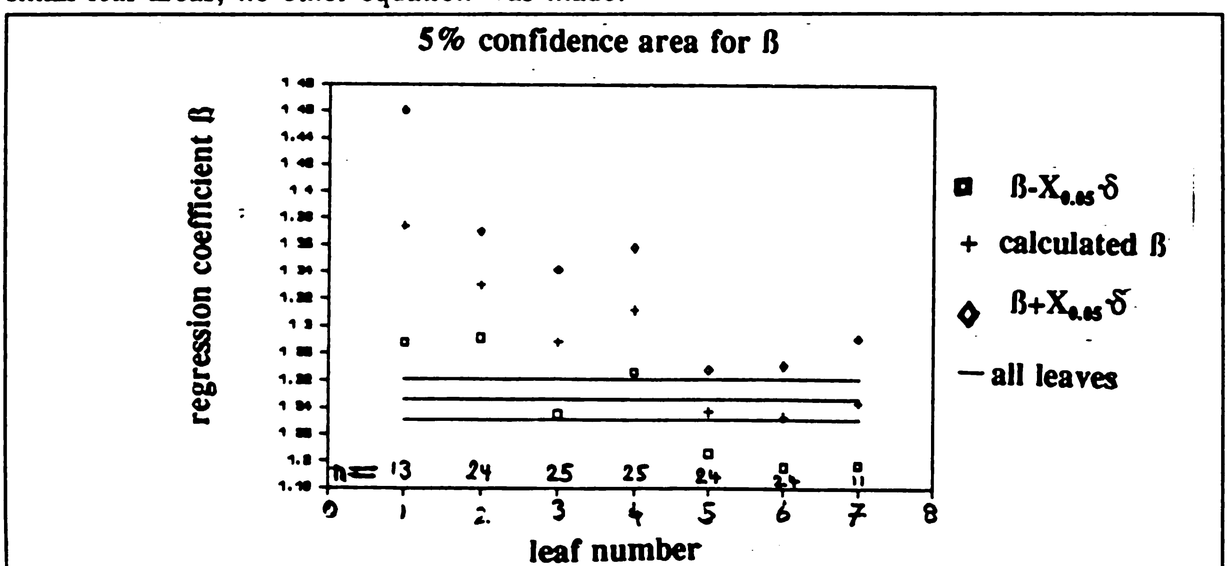

Figure 4.3 *Means and confidence interval (5%) of regression coefficient β in model LA = β · (W x L) in relation to leaf age group.*

4.3.2 Dry matter production

The production of dry matter is determined by three important factors. First by the interception of radiation. Secondly by the use of this intercepted radiation for the production of carbohydrates, then the allocation of carbohydrates to the different organs of the plant. For a young crop of palmito, high interception of radiation is not possible because of low planting densities which make that a large part of the area is not covered by the canopy.

The LAI (leaf area index) increased from 0.03 to 0.17 in the research period (table 4.2). The clustering of leaves, leading to partial shading of the older leaves, results in a lower effective leaf area and thus in even lower interception rates. Assuming an extinction factor of 0.5 for visible radiation, with these LAI values maximally about 1.5% to 8% of the incoming light can be intercepted (Equation 4.2). In reality this percentage might even be lower, as is proven for oilpalm that extinction factors are positively correlated with LAI values (Kraalingen, Breure and Spitters, 1989). Dry matter production is therefore very low (table 4.3).

$$RAD_I = RAD_\phi \cdot (1 - e^{-kLAI}) \qquad \textbf{Eq. 4.2}$$

With k = extinction factor
RAD = radiation ($J \cdot m^{-2} \cdot d^{-1}$)
I = intercepted
ϕ = above canopy

Table 4.2 Means of observed parameters on a palmito stand (4000 $pl \cdot ha^{-1}$) to 137 days after transplanting.

DAT	LAI	LA $cm^2 \cdot pl^{-1}$	SLA $cm^2 \cdot g^{-1}$	Nr of leaves $plant^{-1}$	Max. height cm	Diameter at base cm
19	0.03	823	194.5	6.3	43.1	1.72
26	0.03	844	195.6	6.9	46.1	1.99
33	0.04	976	212.4	7.2	46.8	2.05
47	0.05	1212	208.5	7.4	49.6	2.39
68	0.06	1506	203.6	7.7	53.0	2.57
95	0.12	2886	179.6	8.6	67.5	3.55
137	0.17	4143	139.9	9.5	84.7	4.92

DAT Days after transplanting; LAI Leaf area index
SLA Specific leaf area; LA Leaf area

Table 4.3 Means of observed and calculated dry matter production and growth rate of young palmito palms (4000 pl·ha⁻¹). Equation 4.5 (TDM) and equation 4.6 (RGR) were used for calculated figures.

DAT	OBSERVED			CALCULATED		
	TDM	GR	RGR	TDM	GR	RGR
19	62			61		
		0.4	0.006		0.2	0.003
26	65			61		
		-0.1*	-0.002*		0.5	0.008
33	64*			64		
		1.0	0.026		1.1	0.017
47	79			74		
		0.8	0.010		2.2	0.030
68	95			108		
		3.8	0.041		3.9	0.036
95	198			189		
		5.3	0.026		7.3	0.039
137	419			420		

DAT = Days after transplanting GR = Growth rate ($kg \cdot ha^{-1} \cdot d^{-1}$)
TDM = Total dry matter ($kg \cdot ha^{-1}$) RGR = Relative growth rate (d^{-1})

(* Due to little time between the two harvests and obviously the variation in total dry matter, these harvest values turned out lower than the former one).

For growth curve calculations, a few equations are often used. Three equations are presented here, as well as their correlation coefficient of the measured data. In the equations assumptions are made about maximal amount of dry matter and initial amount of dry matter per hectare (table 4.4). The calculated figures in table 4.3 come from equation 4.5 and 4.6.

$$Y = \frac{MAX}{1 + \frac{(MAX - I)}{I} \cdot e^{\beta \cdot t}} \qquad \text{Eq. 4.3}$$

$$Y = \alpha \cdot e^{\beta t} \qquad \text{Eq. 4.4}$$

$$Y = \alpha \cdot t^3 + \beta \cdot t^2 + \gamma \cdot t + I \qquad \text{Eq. 4.5}$$

With: Y = dry matter ($kg \cdot ha^{-1}$)
MAX = maximal dry matter ($kg \cdot ha^{-1}$)
I = initial dry matter ($kg \cdot ha^{-1}$)
α, β, γ = regression coefficient
t = days after transplanting

Table 4.4 Values of variables and coefficients used in equations 4.3 to 4.5

Equation	MAX	I	α	β	γ	r^2
4.3	19.5 t	63.36 kg	-	0.121	-	0.899
4.4	-	-	38.34	0.017	-	0.946
4.5	-	67.36 kg	$8 \cdot 10^{-5}$	0.012	-0.61	0.991

From table 4.4 can be seen that equation 4.5 has the best fit, with a correlation coefficient of 0.991 (figure 4.4). This one was taken for further calculations.

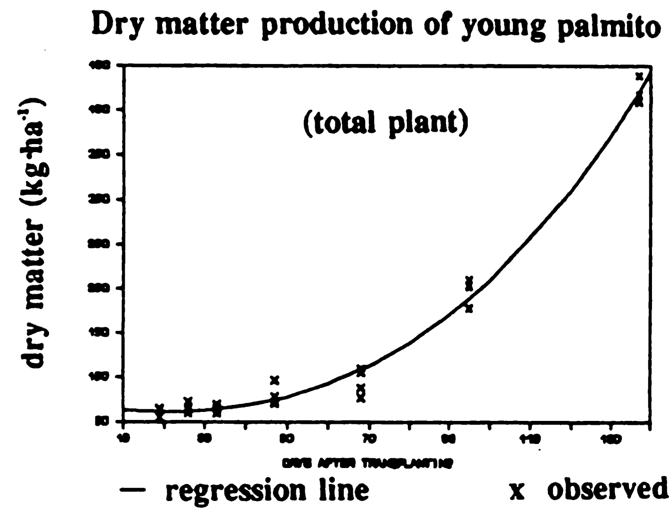

Figure 4.4 Regression function of growth rate (eq. 4.5) and values of measured data.

Derivation of equation 4.5 gives the equation for growth rate (GR). This equation (4.6) is used to calculate the values of table 4.3. Values are low because of the cited problems with light interception. The value for I has been established by a selection of the planting material used in this trial, MAX was found in the research of Herrera (1989).

$$Y' = 3 \cdot \alpha \cdot t^2 + 2 \cdot \beta \cdot t + \gamma \qquad \textbf{Eq.4.6}$$

4.3.3 Dynamic distribution of dry matter

After assimilation, carbohydrates flow from the green parts of the plant to other organs. Partitioning of carbohydrates is a dynamic process, that for many crops is influenced by phenological development, variety, water and nutrient supply (Evans, 1990). Palmito invests in roots, stem, leaves and rachis, but it is unknown wether or how this allocation of carbohydrates changes with growth stage. This information is needed for modelling and simulation of growth of palmito.

In the 137 days and 7 harvests this partitioning did not change significantly ($P<0.01$). The percentages of dry matter weight were respec-tively roots (34%), stem (32%), leaves (34%) of which 5% for the rachis (table 4.5).

One can imagine that a strong development of shoots (which did not occur yet), would be an important change in dry matter partitioning and must be taken into account for. At the other hand, shoots only develop when a surplus of carbohydrates is assimilated. Then the part of total dry matter assigned to an organ might be lower in absolute sense, but the ratio between the different organs of the same plant might be the same.

4.3.4 Allocation of nutrients

The uptake of nutrients by roots and the allocation of them through the plant to the different organs is another factor regarded in simulation.. During the experiment the nutrient content of the divers organs was analyzed. Figures can be found in Appendix 4-III. During the trial a significant change in allocation of N, P or K, nor partitioning of dry matter for one of the cited organs was noted (table 4.5).

Table 4.5 *Allocation factors (%) of N, P and K and partitioning factors of dry matter to the organs of palmito palms, to 137 days after transplanting.*

/	Roots	Stem	Leaf	Rachis
Partitioning factor of dry matter	0.34	0.32	0.29	0.05
N %	0.87	1.18	2.40	0.79
P_2O_5 %	0.18	0.27	0.22	0.27
K_2O %	1.32	1.76	2.00	2.85

Assuming the sufficient availability of the nutrients, maximal nutrient uptake under these circumstances, together with maximal recovery figures (as is asumed that all nutrients come from fertilization) were as is shown in table 4.6. These recovery figures show very clearly that in this growth stage the uptake of nutrients is very low and that the young palms cannot take considerable advantage of the high level of fertilization. Actual recovery figures are even lower, because of the uptake of elements already available in the soil. As a result, not only the fertilized nutrients are found in the chemical analisis.

Table 4.6 Nutrients applied, maximal nutrient uptake and recovery of fertilizer of young palmito palms (4000 $pl \cdot ha^{-1}$) in potential production trial at 137 days after transplanting.

Applied ($kg \cdot ha^{-1} \cdot y^{-1}$)		Fertilizer	Maximal nutrient uptake ($kg \cdot ha^{-1} \cdot y^{-1}$)	Recovery
N	150	NUTRAN	17.15	0.114
P_2O_5	300	TSP	2.52	0.008
K_2O	175	KCl	18.10	0.103

If equation 4.5 is used for growth estimation, together with nutrient percentages and recovery figures for fertilizer types from table 4.5 and 4.6, a fertilizer advice can be given for this growth stage. Therefore a general equation is made (eq. 4.7), which can be used for various fertilizer types, if their recovery figures for palmito are known.

$$N_t = \sum \frac{(Y_t \cdot PF_{organ} \cdot AF_{organ} - N_{seedling})}{recovery} \qquad \textbf{Eq. 4.7}$$

With N_t = Necessary amount of fertilizer ($kg \cdot ha^{-1}$) at t
Y_t = Dry matter ($kg \cdot ha^{-1}$)
PF_{organ} = Partitioning factor for dry matter per organ
AF_{organ} = Allocation factor for nutrient per organ
$N_{seedling}$ = Amount of nutrient in seedling ($kg \cdot ha^{-1}$)
t = time (days after transplanting)

4.3.5 Leaf development

The appearance of leaves on palmito, as most other crops, shows a certain rhythm. For cereal crops it has been demonstrated that the formation rate (plastochron) and/or appeareance (phyllochron) of new leaves is related to temperature more than to any other environmental variable, whereas the duration of the leaf formation period might also be influenced by photoperiod.

The appearance of palmito leaves was studied in two different ways. One in which the phyllochron was depending on time (days) and the other in which it was depending on the sum of temperature (Tsum), as for most palms. The development of a full leaf takes a certain amount of degree-days (°·d). Weather data was collected at the 'Los Diamantes' metereological station, situated 400 m west of the test side at *Agropalmito*, Guápiles (Appendix 4-V).

The figures which represent the development of leaves (of which figure 4.5 -Tsum- is shown only) are very similar, as the fluctuation of mean daily temperature in the data was little. Means for number of days per leaf, and degree-days per leaf were respectively 43 and 540.

A theory was suggested by Jansen (pers. comm.) in which the plastochron of palmito palms is not delayed, but the phyllochron is held back by causes as nutrient shortage or other limiting factors in the nursery. Once in the field these restraints are withdrawn rapidly. Therefore leaf development seems rather quick immediately after transplanting. This theory should be a matter of further research.

If this assumption is true, however, the phyllochron reaches a stable rate of 94 days per leaf, or 1049 degree-days (coefficient of drawn line in figure 4.5). The deviation from the interpolated line of leaf appearance, could be the explanation for the cited problems in the nursery.

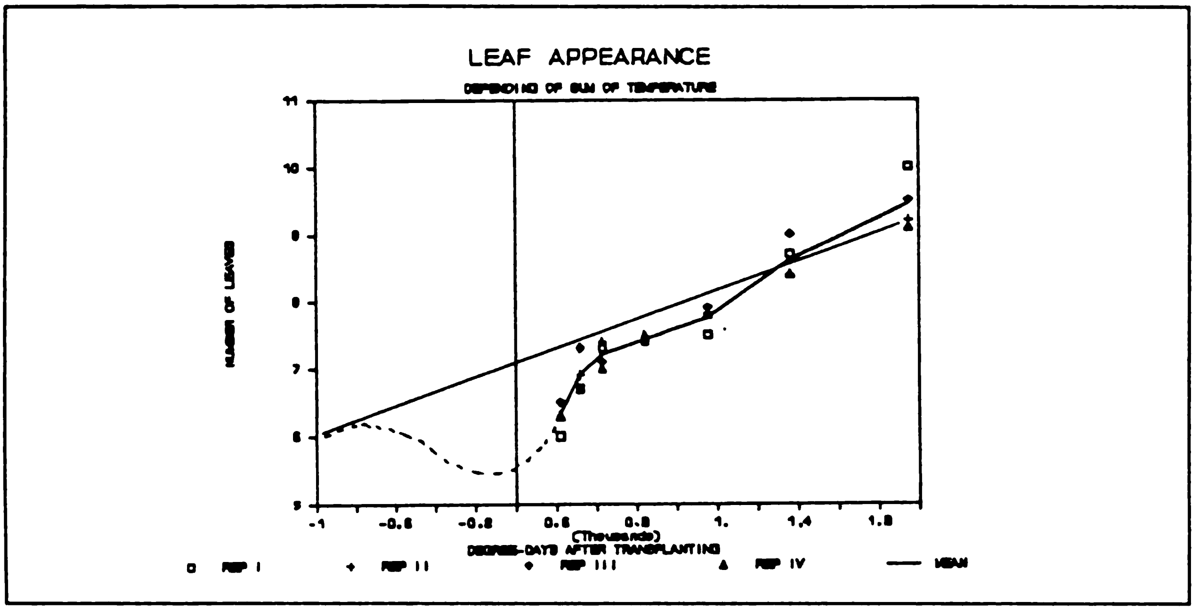

Figure 4.5 *Leaf appearance of young palmito palms depending on sum of temperature (degree-days).*

4.4 Conclusions

1. Bifid leaf area of palmito palms can be estimated as $LA=1.25 \cdot (W \times L)$ with LA = leaf area of bifid leaf (m^2), W = width of one side of leaf (m), measured perpendicular at L-line, L = length of leaf (m), measured from leaf top to last contact point with main rachis.

2. Dry matter production of palmito, immediately after transplanting can be estimated as $Y = \alpha \cdot t^3 + \beta \cdot t^2 + \tau \cdot t + I$ (Y = dry matter in $kg \cdot ha^{-1}$ at t (days) after transplanting, I = dry matter of palms in $kg \cdot ha^{-1}$ at transplanting. Regression coefficients have values of: $\alpha=8 \cdot 10e^{-5}$, $\beta= 12.28 \cdot 10e^{-3}$, $\tau=-0.613$, I= 67.36 kg).

3. Growth rate of palmito immediately after transplanting is slow because interception of radiation is low, caused by low planting density, partial shading of its leaves by other leaves and low extinction factors at this growth stage.

4. In the growth stage uptil 137 days after transplanting, the unchanging partitioning ($P<0.01$).of assimilated carbohydrates to roots is 34%, to stem 32%, to leaves 34%, of which 5% in its rachis.

5. The percentage of nutrient allocation to roots, stem, leaves and rachis does not change significantly ($P<0.01$) for N, P and K in the first period (137 days) after transplanting.

6. After a settling period after transplanting, in which withheld leaves are quickly appearing, the phyllochron of palmito takes 94 days or 1049 degree-days.

5 AN N-P-K FERTILIZER TRIAL FOR PALMITO

5.1 The humid tropics and crop environment

Permanent humid and hot weather conditions affect plant growth in several ways. Problems with water are related more to excess than to shortage. Clouds and rainfall reduce available radiation at a time that other conditions are favourable for photosynthesis. High temperatures do not only favour crop growth, but also the development of weeds and pathogens, particularly fungi. Pests and diseases occur more frequently than in less humid and less warm climates. Weeds are a bigger problem with annuals than perennials (Beets, 1990).

Soil processes (e.g. oxidation of organic matter) are speeded up by high temperatures and with the high precipitation, leaching of the released nutrients. Soil detoriation takes place easier when a field is cultivated. It is exposed to higher temperatures and more sun, and this goes together with less formation of organic matter. In this way a rapid decline in organic matter content of the soil and a gradual decrease in total soil porosity and increase in bulk density is favoured. Gas exchange and water penetration is more difficult and plant growth is limited.

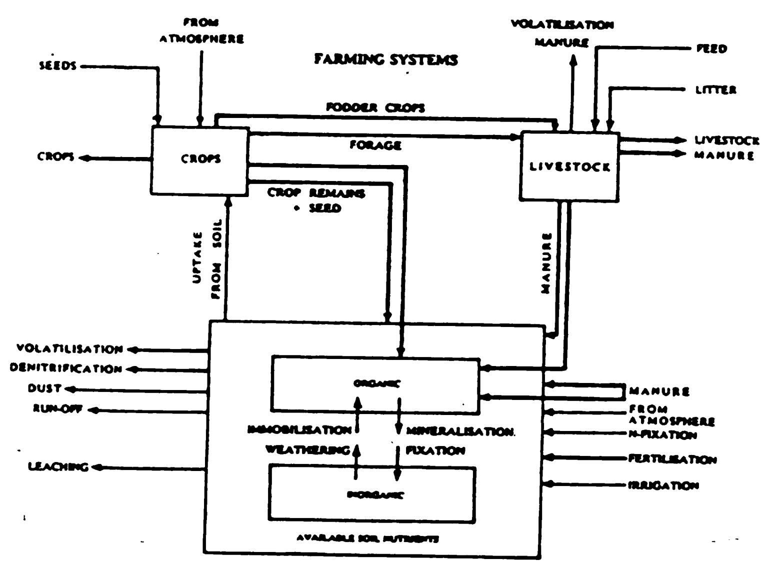

Figure 5.1 Nutrient cycle in a farming system (from Beets, 1990).

In farming systems the nutrient cycle (Fig 5.1) is more open than in natural ecosystems, caused by the cited problems of cultivation and due to extra losses, such as removal of harvested products. The losses of nutrients have to be compensated by inputs if the system is to be sustained in sense of nutrients. Therefore it is necessary to quantify the losses that have to be replenished. The relative high amount of biomass of perennials on the field, and, for most cases, the relative small part of it which is removed at harvest, make them more sustainable than annual crops. Perennials are less susceptible to stress factors, and when disturbed, a return to the old level is possible (Beets, 1990).

5.2 Needs and methodology for palmito research

Palmito, as a perennial, has a high amount of biomass on the field of which a relative small part, the palmheart, is harvested. Remainders are thrown in piles of litter between the rows and in this way, nutrients remain available in the field. But the flow of nutrients is not fully investigated yet, and plant reactions to different types and levels of fertilizer are not thoroughly examined.

The possibility was given by the *Agropalmito* company in Guápiles to start up fertilizer tests. A field, earlier used for *achiote* (*Baexa orelana*) and turned into waste land 12 months before the start of the experiment, was cleaned. With some effort a well controlled fertilizer test could be laid down.

A first estimate of growth limiting factors (on basis of discussion with local experts) indicated that in the region nitrogen and phosphor would be the most important nutrients to consider. Potassium was not among the factors expected to limit growth of palmito on the soil of the experimental site. However, *Agropalmito* expressed its interest in the effect of potassium on the quality of palmheart, as was thought that potassium would increase the fibrousity.

An experiment was set up with three levels of nitrogen (0, 336 and 672 $kg \cdot ha^{-1} \cdot y^{-1}$) and of phosphorous (0, 408 and 816 $kg \cdot ha^{-1} \cdot y^{-1}$), combined with two levels of potassium (0 and 360 $kg \cdot ha^{-1} \cdot y^{-1}$). An enormous field would be necessary for a complete factorial experiment, considering four replicates and the four periodic harvests to follow growth, nutrient uptake and development over time. Using a statistical approach (confounded 3x3x2 factorial trial) decreased the space needed to manageable levels.

Because of the long growth duration of palmito, and the relatively short period available for research (due to restrictions in the university system of the Netherlands), only the first of the periodic harvests could be done. The results presented here are therefore preliminar. It is expected that other students will continue the experiment described here (e.g. Tönjes, in prep.).

5.2.1 The confounded 3x3x2 factorial test

To decrease the area needed it was necessary to confound some of the effects of the treatments. Of course the main effects (N, P, K) were kept clear of block effects. A statistical procedure was followed as described by Cochran and Cox (1957) to get maximal information of the confounded lay out. A summary is given below.

The main effects of a factor are kept clear of block effects if every block contains an equal number of each level of the factor. With N and P at three levels, block size has to be a multiple of 3. For K at two levels block size must be a multiple of 2. Hence a feasible block size is 6 experimental units per block.

With 6 units in a block every possible combination of N and K and likewise P and K remains unconfounded. Not all the 9 combinations of N and P can be placed in a block so they will be partially confounded.

The allocation of the 6 possible combinations in a block will be such that N and P are confounded as little as possible. Therefore any NP combination must not appear more than once in a block. In this way only four types of replicates can be made up as shown in table 5.1. The four sets of three blocks can be grouped into 4 separate replications. As the effects of fertilizer is examined over 4 harvests, a replicate was provided with 4 times the combinations given in table 5.1.

In this way the NPK is partially confounded in all replicates. Only in the first 2 replicates, NP is partially confounded. The relative information on NP is 7/8 and that on NPK, 5/8.

Table 5.1 *Possible blocks for a 3x3x2 factorial test with NP (7/8) and NPK (5/8) confounded.*

Replicate:	I	II	III	IV
Block:	a b c	a b c	a b c	a b c
P K	N			
0 0	1 2 0	2 0 1	1 2 0	2 0 1
1 0	2 0 1	0 1 2	0 1 2	1 2 0
2 0	0 1 2	1 2 0	2 0 1	0 1 2
0 1	2 0 1	1 2 0	2 0 1	1 2 0
1 1	0 1 2	2 0 1	1 2 0	0 1 2
2 1	1 2 0	0 1 2	0 1 2	2 0 1

5.2.2 Lay out of the field

Following the reasoning above, a field design was made as shown in Appendix 5-I. Six combinations in a block, 4 (harvest dates) times 3 blocks (a, b and c) in a replicate and 4 replicates in the field resulted in 288 plots.

The 4 replicates were placed perpendicular at the gradient of expected variation, related to the topographic relief in the field. Within the replicates, the blocks (a, b and c) were assigned at random as were the 24 combinations of harvest date and treatment within each block.

5.2.3 Location

The nutrient trial was laid out east of the potential production experiment (Chapter 4). The blocks were placed east to west. Rows were also orientated east-west. Distance between the rows was 2.5 meters and 1.0 meter in the row between plants (4000 $pl \cdot ha^{-1}$). Every plot had 16 plants, placed in 4 rows of 4 plants of which the central 4 were harvested. The total area of the test field was 1.15 ha. At the southern side of the field a canal was dug to drain the water coming from the adjacent houses.

5.2.4 Selection

The same procedure as described in Chapter 4 was used to select plants. The field was damaged 2 weeks after transplanting by a horse eating the plants. The affected plants were replaced by new plants, selected from the same population of the nursery. In Appendix 5-II the affected areas are shown, as well from the horse as from a rain hazard, which showed the problem areas in the field.

5.2.5 Fertilization and management

The fertilizers were applied bi-monthly to reduce leaching of nitrate and fixation of phosphorous and potassium. Fertilizers were given in the form of NUTRAN (Ammonium nitrate-NH_4NO_3 (33.5% N)), Triple Super Phosphate (46% P_2O_5) and KCl (60% K_2O). Fertilizing was done with the help of labourers. Applications were given throwing a known volume of fertilizer (taking in account a constant specific weight for each fertilizer) on the soil near the plants. Specially made tubes were used with the required volume that were filled from carried reservoirs. Per application the plants received 0, 42 or 84 g of NUTRAN and 0, 37 or 74 g of TSP and 0 or 25 g KCl. Application quantities and application distance were probably related to the same problems as referred to in Chapter 4.

When needed, weeds were removed by hand or by applying herbicides. Once traps were placed to catch an annoying *'taltuza'* (*Orthogeomys* spp.) but this remained unsuccessful. All practices that concerned the field are listed in Appendix 4-II.

5.2.6 Harvest and measurements

Harvesting took place at 4½ months after transplanting. Other harvests are planned after 8½ (Tönjes, 1993), 13 and around 18 months. The latter concurrently with the first commercial harvest for palmheart. Harvesting took place in the same way as described for the potential growth experiment (Chapter 4).

5.3 Results and discussion

Although the palmito was harvested in an early stage and only 2 months after the fertilizer applications, the experimental set up resulted in some significant effects. It is expected that in later harvests the trends will become stronger.

5.3.1 Factorial effects on physical parameters

Data was recorded for leaf area index (LAI), number of leaves (NL), height of plants (HP), number of shoots (NS), diameter of stem at base (DB), dry weight of total plants (DWT) and dry weight of stem (DWS). Mean figures can be found in table 5.2. The complete set of recorded data can be found in Appendix 5-III.

Table 5.2 Significance level and area of confidence at first harvest of the effects of *fertilizer on various parameters of young palmito palms (4000 pl·ha⁻¹). n.s. not significant * 5% significant ** 1% significant*

Parameter	Code	N	P	K	PxK	Mean	area of confidence		
							5%	1%	
Leaf area index	LAI	**	n.s.	n.s.	n.s.	0.36	0.06	0.07	
Number of leaves	NL	n.s.	n.s.	n.s.	n.s.	9.11	0.68	0.78	
Height of plant	HP	**	n.s.	n.s.	n.s.	81.57	6.21	7.11	cm
Number of shoots	NS	*	n.s.	n.s.	n.s.	2.74	0.97	1.12	
Diameter at base	DB	**	*	n.s.	*	4.62	0.35	0.40	cm
Dry weight total	DWT	**	n.s.	n.s.	n.s.	328.09	47.88	54.90	kg/ha
Dry weight stem	DWS	**	n.s.	n.s.	n.s.	112.10	23.68	27.15	kg/ha

For all parameters except NL the effects of nitrogen was significant. Significant effects of phosphorous were only found for DWS, while no significant effect of potassium could be indicated. Field results, treatment totals and the analysis of variance of the recorded parameters are given in Appendix 5-IV.

NxP interaction was not recorded, only the interaction effects of PxK for DWS was found to be significant at this harvest. The data however indicate a tendency for NxK interaction for NS.

Nitrogen, as an essential nutrient in chlorophyll, and thus directly related with the photosynthetical production of the plant, caused an increase in dry matter and weight. This indicates that even on this relatively rich soil (compared to others in the region) N is a factor limiting growth more than any of the other nutrients.

The effect of phosphorous, only significant for DWS at 5%, seems disappointing. Reasons can be sought in a few directions. Above all, the young stage of the palmito palms as mentioned before. Accumulation of phosphorous was not yet high enough to result in significant differences in uptake between the treatments. Secondly, the trial was executed on a field probably not exhausted by other crops. The chemical analysis of the field in contrast with other fields used for palmheart production, shows that P-Olsen values are low. The P applied might be fixed in this soil and at this age, the crop has no measures to overcome that. It might be that the P used by the palms is quickly recovered out of the P reserve in the soil, resulting in little difference between treatment levels. Thirdly, mycorrhizae might have provided the palm with phosphorous. If mycorrhizae release phosphorous in plots that received little or no P and not (or less) in plots with high P applications, the differences between plots are diminished and effects are harder to find. These three possible causes, might also be responsible not finding any interaction effects of NxP, together with the fact that this interaction effect is confounded (7/8).

In this harvest no single effect of potassium on dry matter content was found. Though, PxK interaction was found on DWS. This would indicate that the fibrousity might increase at higher K applications, at least when fibrousity is related to dry matter content. The tendency of the NxK and PxK interaction in DWS indicates that it might become important in later harvests. In following harvests the effect of potassium on NS might become interesting, especially when the fibrousity of stems does not increase.

5.3.2 Efficiency of nutrient uptake

The efficiency of nutrient uptake depends on how palmito is able to use the nutrients which are released in the soil by processes as decomposition or fertilization. In the trial high levels of fertilizer were applied. In figure 5.2 can be seen that the actual uptake of nutrients is very low, resulting in low efficiency of this crop. As significant differences do exist between the treatments, as well for dry matter production as for other examined parameters, the most possible cause must be that the applied fertilizer is quickly unavailable for the palms. If the palms only needed these small ammounts of fertilizer, significant differences would not have been found with these fertilizer quantities.

Figure 5.2 is a so called 3-quadrants presentation of the relation between applied fertilizer vs. dry matter production (Quadrant I), fertilizer uptake vs. dry matter production (Quadrant II) and applied fertilizer vs. fertilizer uptake (Quadrant III). In the third quadrant the efficiency of fertilizer uptake is clearly shown.

Pleaded must be for very low fertilization quantities in the first growth stage after transplanting. Quantities should be given in small amounts and more often. The losses of nutrients caused by the bi-montly doses are too large.

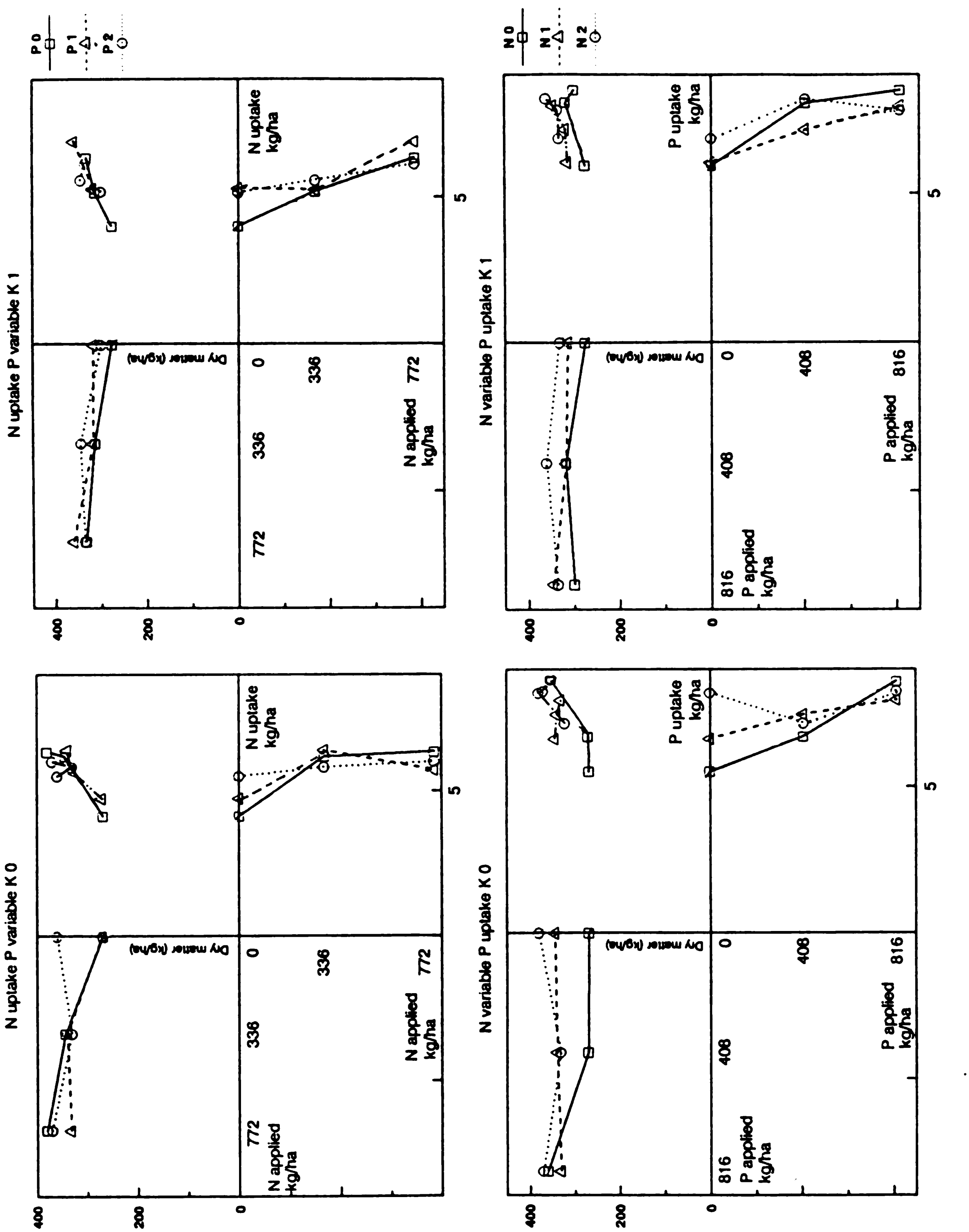

Figure 5.2 *Nutrient uptake of young palmito palms under various fertilization levels. N0= no N fertilization, N1= 336 kg·ha⁻¹·y⁻¹, N2= 772 kg·ha⁻¹·y⁻¹, P0= no P fertilization, P1= 408 kg·ha⁻¹·y⁻¹, P2= 816 kg·ha⁻¹·y⁻¹, K0= no K fertilization, K1= 360 kg·ha⁻¹·y⁻¹*

5.4 Conclusions

1. Nitrogen has a significant effect (1%) on LAI development of palmito in the first period after transplanting.

2. Nitrogen has a significant effect (1%) on height of palmito in the first period after transplanting.

3. Nitrogen has a significant effect (5%) on number of shoots palmito in the first period after transplanting.

4. Nitrogen has a significant effect (1%) on diameter at base of palmito in the first period after transplanting.

5. Nitrogen has a significant effect (1%) on total dry weight of palmito in the first period after transplanting.

6. Nitrogen has a significant effect (1%) on dry weight of stem of palmito in the first period after transplanting.

7. Phosphorous has a significant effect (5%) on diameter at base of palmito in the first period after transplanting.

8. Phosphorous and Potassium have significant interaction effect (5%) on dry weight of stem in the first period after transplanting.

9. Fertilizer quantities in the first period after transplanting must be given frequently in very small dosis, as nutrients stay shortly available for uptake by palmito under these circumstances. P is lost by fixation in the Andosol soil type and N is lost by volatilization or leaching caused by the heavy rainfall.

6 ROOT BEHAVIOUR IN RELATION TO SOIL CONDITIONS

The root, as the inlet of water and nutrients, is related to two of the most important factors of plant growth (besides radiation). Roots also provide plants steady foothold in the soil. Still, little research on palm roots has been done, compared to other research topics. But roots are not only the inlet of water and nutrients, they are influenced by and have large influence on soil conditions.

Root growth may differ in different soils as a result of different fertility levels. Also compaction or other disturbances of soil may have profound impacts on rooting patterns and, therefore, root functioning. Different root distribution may affect competition with other crops or weeds and may, in general, govern plant reactions to different environmental conditions.

Palmito roots were studied on two different soil types in the humid lowlands of the Atlantic Zone, in order to describe palmito root behaviour in relation to soil properties.

6.1 Palmito roots

The major part of the root system of the palmito palm occurs laterally and superficially. In free space it can occupy a circle with a diameter of 10 m around the palm. In search for water roots can, however, grow several meters under ground level (Mora Urpi, 1989).

For palmheart production, the palms are situated in rows and their roots compete for space and nutrients. Palmito can be reproduced by its corm, a part of the plant growing partly below surface with buds, at the base of the palm, where new shoots grow from. For clonal reproduction the corm can be used by separating it and sowing the parts, a normal practice for banana reproduction. Experiments with this technique for palmito didn't lead to satisfactory results. Death rate was high and primary growth was slow (BNCR and UCR, 1982). Reproduction mostly takes place by using seeds from fruit producing pejibaye palms (Chapter 3).

The root system is fibrous and does not regenerate easily when damaged (Mora Urpi, 1989). Lopez and Sancho (1990) state however, that palmito roots are constantly renewed, given the fact of large numbers of non functional roots found in their study. When palmheart is harvested, the connecting roots of the harvested shoot will die, as carbohydrates no longer flow to the roots and the sink function of the part above the ground is taken away. If present, palmito roots can live together with mycorrhizae, which make phosphor available for plant growth, even in very acid soils. Few studies focussed on this matter although it seems to be an interesting one, especially on the Andosols in Costa Rica, in which phosphor fixation seems to play an important role.

6.2 Investigation of palmito roots

For this study, two palmito sites of similar age and under similar management were chosen. The sites were located on two Andosol soil types (of Vulcanic origin). The study was done in the upper 60 cm of the soil. Roots were counted and root length was measured. Bulk densities of top soil were determined at various distances from the plants. At one site, bulk densities were also determined at different depths.

6.2.1 Location

In two palmito plantations of *Agropalmito*, areas were selected for the investigations. One site was in Guápiles on a relatively fertile soil type, classified as Thaptic Hapludand (Soil Survey Staff, 1990), from now on referred to as 'Soil A'. The less fertile soil type, an Oxic Humitropept ('Soil B'), was found at the other farm of *Agropalmito* in the Río Frío area. See Appendix 6-I for profile descriptions.

Plants were situated in rows orientated north-south. Distances were 2.5 meters between rows and 1.0 meter in the rows between plants, resulting in a density of 4000 $pl \cdot ha^{-1}$. Both sites in the plantations had an age of about 4 years, the age after which palmheart is produced at a constant level. Each plant had about 5 shoots of which one was ready to be cut, or just had been cut (to be recognized at its fresh wound). The pit of 1.30 m length and 0.60 m depth was always dug at the side of this shoot, perpendicular at row orientation.

6.2.2 Methodology

To count the roots a raster was made with a width of 1.30 m and a depth of 0.60 m. It was placed against the fresh and cleaned profile. The raster was partitioned in squares of 0.10 m x 0.10 m. Roots which appeared in the squares were classified by eye on diameter. Three classes were used to distinguish the roots: large roots; $d > 0.5$ cm, medium sized roots; $0.5 > d > 0.2$ cm and small sized roots; $d < 0.2$ cm.

At a distance of 0.05-0.30 m and 0.50-0.75 m from the plants, undisturbed soil samples were taken with metal cylinders of 300 cm^3 to determine the bulk densities of the top soil. A hammer was used when driving by hand became impossible because of root thickness. On the B soil, in Río Frío, samples were also taken at depths of 0.00-0.07 m, 0.15-0.22 m and 0.30-0.37 m, out of each defined distinct layer. This data was made available by the research of two soil scientist operating in this area. Cylinders were transported to the laboratory of the Atlantic Zone Programme and oven dried at 105 °C for 24 hours. After drying and cooling they were weighted. Bulk density was calculated in $kg \cdot m^{-3}$.

At 0.45 m and 1.15 m from the plant to the centre of the path between the palm rows, a metal cylinder of ca. 8 dm^3 was driven into the ground and a sample of soil and roots was taken to estimate root densities. Root Density (RD) was expressed as total length of roots in a known volume ($m \cdot m^{-3}$), rather than as weight of roots in the same volume, to avoid that thick roots would dominate the outcome. The Equivalent Diffusion Volume (EDV (in $m^3 \cdot m^{-1}$) = RD^{-1}) gives an idea of the distance between nutrients and roots. Low EDV values correspond with high possibilities for nutrient uptake.

Roots were washed from the sample and spread in a box with about a centimetre water to ease the counting. On the bottom of the box a raster was drawn (0.02 m x 0.02 m) and the number of crossings of roots and lines were counted. Total root length was estimated as:

$$RL = \frac{C \cdot A}{0.69 \cdot L} \qquad \text{Eq. 6.1}$$

With RL = root length (m)
C = number of crossings between roots and lines
A = area on which roots are laid (m^2)
L = total length of lines used for counting (m)

The correction factor 0.69 was found after testing the method with pieces of rope with a known length. Root density was estimated as:

$$RD = \frac{RL}{V} \qquad \text{Eq. 6.2}$$

With RD = root density ($m \cdot m^{-3}$)
V = volume of sample (m^3)

$$EDV = \frac{1}{RD} = \frac{V}{RL} \qquad \text{Eq. 6.3}$$

With EDV = equivalent diffusion volume ($m^3 \cdot m^{-1}$)

6.3 Results and discussion

6.3.1 Root distribution

Distribution of roots in soil type A and B is visualized in figure 6.1. For exact numbers and percentages of total, see Appendix 6-II.

Similarities in distribution

In the upper 0.10 m of both soil types, many small roots were found, much more than at other depths. Important in this layer is the mulch on the surface, the remainders of harvested palmheart and removed shoots and leaves. Small roots grow well under this layer, also above ground level. The micro climate is warmer and more humid than in the other layers and the decomposition process releases lots of nutrients. The mulch breaks the forces of rain and minimizes evaporation losses of water. It also reduces the negative side effects of management practices. Roots under the mulch are not quickly damaged.

Differences in distribution

In the A soil thick roots are distributed to a depth of 0.40 m, while distribution in soil B is limited to the first 0.20 m. Further away from the plant, both root types show a decrease in number. In the relatively richer A soil the development of large roots takes place over the whole profile, while in soil B this growth and development is restricted.

Medium sized roots occur throughout the whole profile of soil A, but are more frequent in the first 0.20 m from the plant, to a depth of 0.40 m. In the profile of soil B these are more frequent in the upper 0.10 m. If these medium sized roots can be regarded as a preliminary stage of large roots, profile B could be a preliminary version of profile A. Development is slower.

Small roots are distributed abundantly over the whole profile in soil B, whereas in soil A areas with less frequency occur at depths larger than 0.30 m. Below 0.30 m small roots are present but few. The decrease in number at Horizontal:0.10-0.70 m from the palms (A) and Horizontal:0.50-0.80 m (B) from the palms, in the first layer (Vertical:0-0.10 m) can be related to the placement of the litter, which is put in a pile in the centre of the rows. At the sides of the pile much less litter is found than in the centre, resulting in less favourable micro climate for root growth. In addition disturbance of top soil might occur more rapidly along the sides of the pile, as it stays unprotected against insolation, sun and human disturbance. Walking beside the pile is easier than on it, although one is forced to the centre by the spiny leaves.

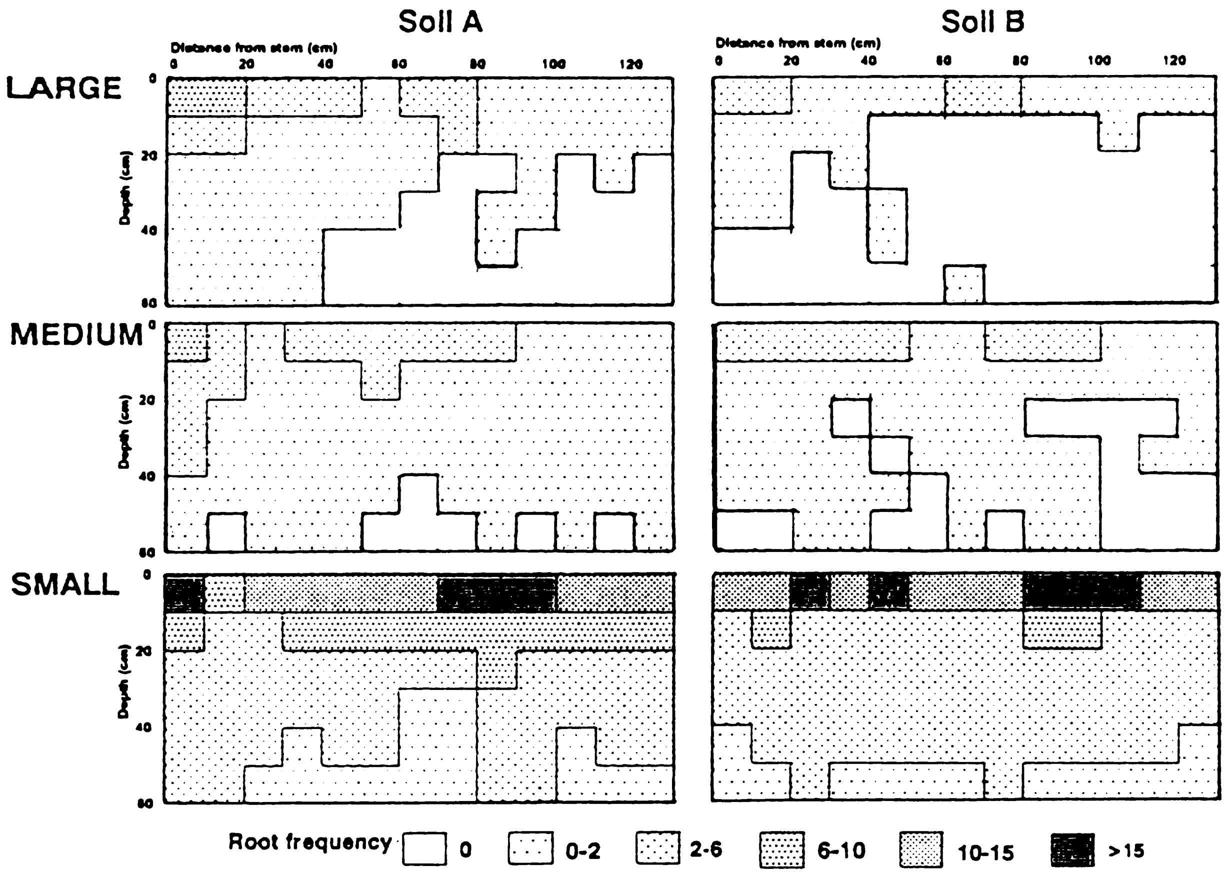

Figure 6.1 *Root number in 0.10 m x 0.10 m square of palmito roots in two different soil types A (fertile) and B (less fertile). Distinction is made between large, medium and small sized roots.*

Table 6.1 *Significant difference (P< 0.01) of root number per class in two soil types (A and B).*

Soil type and depth	Number[y] of roots over total distance (1.3 m)			
	Root class			
	Large	Medium	Small	All
A 0-10 cm	36.2a[z]	35.8a	187.4a	258.8a
10-20 cm	24.6 b	27.0a	98.2 b	149.8 b
20-30 cm	7.6 c	17.2 b	60.8 bc	85.6 c
30-40 cm	7.2 c	13.0 bc	45.4 c	65.6 c
40-50 cm	2.0 c	9.2 bc	36.2 c	47.4 c
50-60 cm	1.4 c	3.0 bc	22.0 c	26.4 c
B 0-10 cm	24.4 b	28.8a	214.6a	267.8a
10-20 cm	3.8 c	7.0 bc	71.8 bc	82.6 c
20-30 cm	1.0 c	5.6 c	67.0 bc	73.6 c
30-40 cm	0.6 c	6.8 bc	56.6 bc	64.0 c
40-50 cm	0.2 c	3.4 c	49.2 bc	52.8 c
50-60 cm	0.2 c	1.4 c	21.0 c	22.6 c

[y] values are average from 5 replications
[z] values within a *column* followed by different letters are significantly different (P<0.01)

With a statistical approach (Duncan Multiple Range Test - DMRT) the significant difference between number of roots per layer in both root profiles is tested (table 6.1). In this test, the Least Significant Difference (1%) is calculated and compared to the difference found between parameter of the layers. Layers which are not significantly different from another receive the same letter (a, b or c). In this way can be seen from table 6.1, if the number of roots (per class) of a certain layer is significantly different from another layer. The summation of roots over increasing distance from the plants makes that the visualized distribution of figure 6.1 is not found in table 6.1. Nevertheless the significant difference of the layers is found in all root classes, especially between the top layers (0.00-0.20 m depth) and deeper layers.

6.3.2 Root density

Small roots account for the largest part in the root density of the two soil types (table 6.2). The uptake of nutrients is mainly determined by these small roots. Large and medium sized roots don't show significant difference in root density, nor at different distances from the plant, as in different soil types, but small roots do. This distribution in the top soil (0-0.10 m) also shows the favourable conditions for (small) root growth under the relatively rich litter layer.

The significant difference in densities of small roots between soils, at the same distance from the plants, might be caused by the fact that in relatively poorer soil types (B) concentration of nutrients is found in the upper layer. This might be by fertilization or decomposition of organic matter. Small roots tend to react more with growth and extension in this direction, than in the relatively richer soil (A), where higher nutrient levels occur throughout the profile.

Table 6.2 Root density ($m \cdot m^{-3}$) for each root class in top soil (0-0.10 m) of two soil types at 0.45 m and 1.15 m perpendicular at row orientation in 4 year old palmito plantation (4000 $pl \cdot ha^{-1}$).

	Soil A		Soil B	
Distance from plant to centre of path	0.45 m	1.15 m	0.45 m	1.15 m
Root class	root density ($m \cdot m^{-3}$)[y]			
large d>0.5 cm	240a[z]	200a	220a	210a
medium 0.5<d<0.2 cm	290a	300a	460a	480a
small d<0.2 cm	1520a	2780b	2550b	4780c
all	2050a	3280b	3230b	5470c
EDV ($m^3 \cdot m^{-1}$) (small roots)	$6.6 \cdot 10^{-4}$a	$3.6 \cdot 10^{-4}$b	$3.9 \cdot 10^{-4}$b	$2.1 \cdot 10^{-4}$c

[y] values are average from 5 replications
[z] values within a *row* followed by different letters are significantly different ($P<0.01$)

The equivalent diffusion volume (EDV) for small roots in top soil reaches very low values. If EDV-values are compared to those of *Graminae* with fine root systems, palmito roots come very near the value of maize (*Zea mays*) e.g., with an EDV of $1 \cdot 10^{-4}$ $m^3 \cdot m^{-1}$ in uncompacted soils (Tardieu, 1988). These low values enable palmito palms the immediate uptake of released or fertilized nutrients on less fertile soil types.

6.3.3 Bulk density

The samples taken at both sites (table 6.3) show that at closer distances to the plants, bulk densities of top soil are higher than at further distances. This can be related to the placement of the pile of litter in the path between two rows. The remainders of the crop, together with the abundant growth of small roots in this layer and the high activity of soil fauna (especially earthworms) give a rather loose structure.

The difference between the bulk densities between the soils is significantly different (1%) but the values between distances from the plant on the same soil are not proved to be significantly different (table 6.3).

In general, the bulk densities of Andosols material is low and not just in the surface horizon; it is typically less than 900 $kg \cdot m^{-3}$, but values as low as 300 $kg \cdot m^{-3}$ have been recorded in highly hydrated Andosols (Driessen & Dudal, 1989).

At the sides of this pile, bulk densities can be higher by compaction of human weight, caused by managements practices. Management procedures (harvesting, applying fertilizer and herbicides, pruning of shoots and leaves) are performed by walking on and at the sides of the pile. To give new shoots free space, soil surface immediately beside the plant is cleaned. No litter is found, and fauna activity with its loosening effects must be lower.

Table 6.3 *Bulk densities[y] of top layer (0.00-0.07 m) at two distances from palmito plants (4000 pl·ha⁻¹).*

	Soil A	Soil B
0.05-0.30 m from plant	610 kg·m⁻³ a[z]	790 kg·m⁻³ b
0.50-0.75 m from plant	550 kg·m⁻³ a	710 kg·m⁻³ b

[y] values are average from 5 replications
[z] values followed by different letters are significantly different ($P<0.01$)

The difference in values between A and B soil type can be related to the structure of the soil, which is a result of texture, environmental influences (biological activity, weather) and fertility of the soil. Texture of A soil is silty clay loam and B soil silty clay.

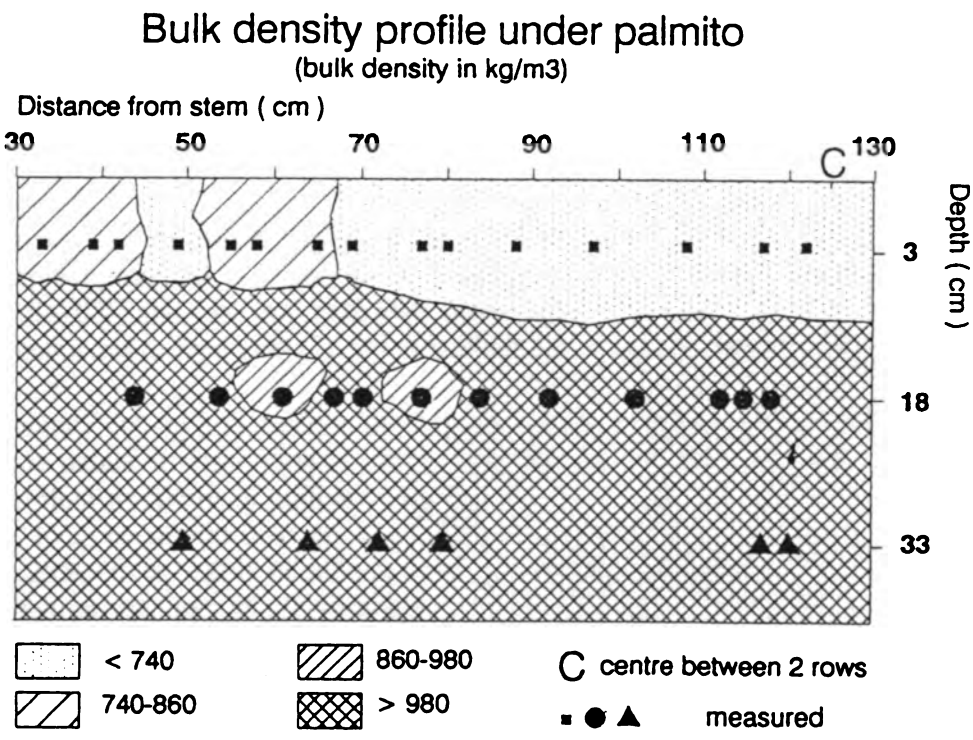

Figure 6.2 *Bulk density profile under palmito (4000 pl·ha⁻¹) at various distances and depths from the plants on soil type B. Mean value of measurements= 860 kg·m⁻³, Least Significant Difference (5%) = 120 kg·m⁻³.*

In his promotion research, ir E. Veldkamp (WAU) has studied bulk density profiles under deforestated areas and under various edible crops and pasture. He also showed interest in palmito figures, and offered me the possibility to analyze the profile on soil B together with him. Soil A was not examined, as this soil type was not within his field of interest, and time was lacking for further research on A soil.

Under the top layer of soil B, more compact areas are found (0.15-0.35 m) with bulk density values of ca. 1000 $kg \cdot m^{-3}$ and more. Compaction of this layer, which is a result of physical pressure caused by the former land use (cattle) and human weight (pers. comm. ir E. Veldkamp and dipl. geogr. A. Weitz), is solving by the loosening effect of root growth and fauna activity as is shown by the solved areas in figure 6.2.

The areas with solving compaction are found at 0.15-0.22 m depth. The effects of the pile of litter, in the middle of the row, is clearly shown. When figure 6.2 is compared to figure 6.1, there can be seen that the lowest bulk density values go together wit the largest amount of root growth (top soil). In general the bulk densities are very low, probably not restricting root growth deeper in the profile.

6.4 Conclusions

1. Root distribution of palmito roots is superficial, with 65% of all roots in the first 0.20 m of the soil. Within a radius of 0.50 m from the palms, 50% of all the roots are found. Especially large and medium sized roots occur near the stem, small sized roots are distributed equally over the distance from stem to centre of the path between the palm rows.

2. A relatively richer soil type has a higher number of palmito roots but the ratio between large:medium:small is biased towards larger roots. On the relatively fertile soil type: 13%:17%:70% and on the relatively poor soil type 5%:9%:86%. Small roots (active roots) occur more frequently in the less fertile soil type, especially in top layer.

3. Root density ($m \cdot m^{-3}$) is mainly determined by *small* roots. The enormous density enables palmito palms to immediately adsorb applied or released nutrients. Values are (distance from plant to centre of path between rows):

A soil: 1520 $m \cdot m^{-3}$ (at 0.45 m) and 2780 $m \cdot m^{-3}$ (at 1.15 m),

B soil: 2550 $m \cdot m^{-3}$ (at 0.45 m) and 4780 $m \cdot m^{-3}$ (at 115 cm).

Equivalent diffusion volumes of *all* roots are:

A soil: $4.9 \cdot 10^{-4}$ $m^3 \cdot m^{-1}$ (at 0.45 m), $3.0 \cdot 10^{-4}$ $m^3 \cdot m^{-1}$ (at 1.15 m),

B soil: $3.1 \cdot 10^{-4}$ $m^3 \cdot m^{-1}$ (at 0.45 m), $1.8 \cdot 10^{-4}$ $m^3 \cdot m^{-1}$ (at 1.15 m).

4. Bulk densities under palmito have low values in top soil (0.00-0.07 m) by the loosening effects of abundant root growth and decomposition remainders. Compaction at certain distances from the palm rows occur (0.05-0.70 m), by the impact of management practices and the thickness of the pile of litter at these distances. The higher values under this layer (0.15-0.35 m) are caused by physical pressure of former land use and/or management practices (human weights), but are slowly solving by the root system of palmito. Values of bulk densities are relatively low, and are not likely to significantly affect root patterns.

Values in top soil (A) vary from 550 $kg \cdot m^{-3}$ at the centre in between the palm rows under a thick layer of litter, to 610 $kg \cdot m^{-3}$ closer to the palms where this layer is absent. On B soil values tend to be higher by a denser structure, the effect of texture, environmental circumstances like biological activity and weather, and fertility of the soil. Values in top soil (B) vary from 710 $kg \cdot m^{-3}$ at the centre in between the palm rows under a thick layer of litter, to 790 $kg \cdot m^{-3}$ closer to the palms where this layer is absent.

5. The relatively quick solving effects palmito palms have on compacted areas in soil profiles is an interesting property of the crop. It can be explained by the thorough exploration of the soil by its roots, and the continuous pruning and harvesting which takes place. If a shoot is cut, the connected roots will die, leaving organic matter deep in the profile, which stimulates biological activity and ultimately give bio-pores and a loosened structure.

7 GENERAL CONCLUSIONS AND RECOMMENDATIONS

The research on palmito in general has many aspects, but lots of these are neglected for unknown reasons. The popularity of the crop in the humid tropics is largely based on its performance, which is very good in the climate and on the reddish acid soils like those in Costa Rica's Atlantic Zone. Palmito growth is a promising alternative, as well under smallholder conditions as on large agro-industrial farms, with its high returns compared to other cash crops. The expanding area grown with palmito, and the increasing number of smallholders starting to grow the crop, justifies the research on palmito. The crop and its management possess some interesting properties for soil conservation and sustainable land use, which are not thoroughly examined yet. This report focused on several topics useful in this sense.

The modelling of crop growth in the 'exponential growth phase' immediately after transplanting, highlights the problems of interception of radiation during this period. Aim of further research could be the early closure of the canopy after palmito is transplanted. Activities should be undertaken while the palms are still in the nursery. Especially N fertilizing seems to have significant effect on leaf area development. Plant densities can not be increased, as it would threaten the ergonomic conditions for management practices. Further research can be done on the spineless cultivars. Farmers state that these cultivars show slower development and delay in production, but this is not studied yet. Growth rates of spineless cultivars can be compared to the modelled growth rate of palmito in this study. If growth rates are the same, higher plant densities can be considered. The intercropping with other edible crops, however, must not become in danger, as smallholders often need the intercrops in the period while palmito is not producing.

Continuation of studying growth rates and partitioning of dry matter is advised to relate morphological characteristics like number of shoots and management practices like pruning to crop performance. The study should also be continued to complete the model of crop growth for a whole growth cycle, to test palmito performance under various field conditions. Certain parameters of palmito palms have maximum absolute values, which are to be determined, as they are important in modelling. These includes LAI values (as is shown that 5 to 6 leaves per shoot are retained), the height of the palm (2-3 m), the number of shoots (4-6), the total dry matter present on a plantation (including the size of the root system).

In this report the efficiency of nutrient uptake of young palmito palms is found to be extremely low. As is proved that palmito performance shows various significant reactions induced by different fertilizer types and levels, further research is needed concerning fertilizing strategies. Experimental research should be done in already producing plots, especially with regards to the influence of the mulch layer in between the palm rows, which can play an important role in fixing and releasing nutrients. In the Andosol soil type phosphorous is easily fixed. Trials with slow release fertilizer types (e.g. 'Rock phosphate') seem interesting. The recovery of nitrogen fertilizer can be elevated by smaller gifts which are given more frequently.

The various effects of fertilization which are presented in this study, concern many properties of the crop. Dry matter content of the stem, the harvest product, seems the most important one, but the other examined factors have indirect influence on production rates of palmito. The fertilization with KCl did not (yet) increase significantly the dry matter content of the stem, as was thought. May be in later harvests dry matter of stem is effected significantly by K fertilization. Important to investigate afterwards is if fibrousity is related to dry matter content, and thus have negative influence on the quality of palmheart.

As is shown in various studies, palmito can live together with mycorrhizae which can release phosphorous even in very acid soils (like in the Atlantic Zone). It should be examined if these mycorrhizae are present in palmito plantations in the Atlantic Zone. It could be that infection of soil with mycorrhizae is necessary to let palmito take advantage of it. The effects with regards to phosphorous fertilization must be investigated also. In this report phosphorous effects were hard to find. It might be caused by this phenomenon.

The superficial root system of palmito has large influence on the conditions of especially topsoil. The management of the crop, resulting in thick mulch layers of copious leaves, bad shoots and remainders of the harvested palmheart, is the cause of this mulch layer. In this report is proven that palmito reacts differently on relatively poorer or richer soil types. The mulch layer seems to play an important role in this process, so this should be a matter of further investigation. Interesting in this case is the rate of mulch accumulation under different fertility regimes. This is to be related to the capacity of the mulch layer to hold and release nutrients and the protecting properties (thickness) of the mulch layer. Fauna activity under this layer could also be a matter of research.

On relatively less fertile soil types, palmito reacts by the formation of a finer root system. It enables the palm to immediately absorb released nutrients, more then in relatively richer soils. Future studies could focus on the limiting Equivalent Diffusion Volumes in which root growth is restricted because of the distance between roots and nutrients. In this way areas unsuitable for palmito production can be appointed, and if necessary, modified by fertilization schemes.

The bulk density under a palmito crop, decreased by abundant root growth and soil fauna activity in the profile (stimulated by the effects of the mulch layer and the dying of roots deeper in the profile), is to be examined more thoroughly. The capability of the root system to loosen up the soil and create its own favourite growth climate is an interesting property of palmito. In this way palmito upgrades its production capacity.

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8 PERSONAL EXPERIENCE

As a student of Tropical Crop Science at the WAU, one has to pass at least half a year under tropical conditions. Personal preference of certain areas can be considered, but, as in my position, if one wants to work on a thesis abroad, possible places to stay are reduced to well attended outreach stations of the WAU, as in Costa Rica and Côte d'Ivoir.

In contrast with a large group of students, which had raised an unhealthy climate around particularly the Costa Rican outreach station, in a discussion about the function(ing) of it, I couldn't raise resistance to do my practical period and partial (field) work on my thesis in Costa Rica. I supposed that for a first experience in tropical research, adequate possibilities in a Dutch/Costa Rican team would be encouraging.

As a student from a western country, you enjoy full confidence of the Costarican people you work with. It sometimes is hard to explain that you don't have all the answers and that the farmer you work with has more knowledge of his field and crops. This hiatus cannot be filled, as we are educated to be scientists, and not farmers. It is even hard to understand for them that you can use your hands too. At the transplanting of the palmito seedlings, all eyes were aimed at me at the moment I bent and tried to transplant the palms my self. Some compassionate looks I gained, with the immediate help of everyone, to ease my work as much as possible. As I set up a fertilizer test, especially the statistical elements of my study came in handy, as was the understanding of soil properties. What I was really lacking at the beginning of my practical training, was a good set-up of my research period. I learned a lot gradually, but may be it could have been a bit more constructive.

Spanish, the language spoken in most part of Central and South America, is no common language in Dutch education system. It was a first barrier to take. The training coarse at the linguistical centre (CENTA) in Wageningen provided me with the utmost basics. During my stay in Costa Rica, the social contacts, not the least the personal ones, were a quick and effective way to improve my expression power. No student should fear the country for it's language, as the *ticos*' willingness to help is large.

During my stay, however, I faced some things I'd like to mention here, as in no other communications than in vague backbiting circuits you'll become aware of the severeness of the maintenance of a type of hierarchy not accustomed to and hard to work with, as a person of my generation. Discrimination on origin, skin colour and sexe is hard to believe, but impudently practised. One should be aware of that. I wasn't.

Part of the staff was living at the CATIE, in Turrialba, some 80 km away from the project station. This, to my opinion, hampered the communication, as full imagination in your work by supervisors was not possible. Local staff members not always understood your demands and needs, which made working quite difficult sometimes. Nevertheless, the well equipped experimental station, together with some improvising and help of other students, often made a satisfying solution possible.

When I look back at the period spent in Costa Rica, I must say that I enjoyed every bit of it, including the trip I made afterwards to neighbouring countries as Nicaragua, Honduras, El Salvador, Guatemala and Belize. I must admit that I have lost my heart completely to this continent!

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APPENDICES

3-I Interview:
'Encuesta de la investigación sobre el cultivo de palmito

4-I Lay-out of potential production trial for palmito

4-II Management practices of palmito trials

4-III Chemical analysis of potential production trial
(6 harvest dates)

4-IV Physical measurements on potential production trial
(6 harvest dates)

4-V Climatological data meteo station Los Diamantes
July 1991-December 1991

5-I Lay-out of fertilizer trial for palmito

5-II Affected areas in the fertilizer trial
(Damage by inundation and horse)

5-III Chemical analysis of fertilizer trial
(4 replications)

5-IV Physical measurements on fertilizer trial
(Block results and ANOVA tables for effects)

6-I Soil profile descriptions root study
(2 profiles)

6-II Root distribution in numbers
(Means of 5 profiles per soil type)

CONVENIO CATIE/UAW/MAG
ENCUESTA DE LA INVESTIGACION SOBRE EL CULTIVO DE PALMITO
(Universidad Agricola Wageningen)
HOLANDA

Raymond Jongschaap

Código: NE·5

Encuesta en la región: Neguev.

Fecha: 21.1.92

Encuestador: Raymond

I INFORMACION GENERAL

Nombre del agricultor (Nº de parcela): Carlos Vargas Nº 161

Nombre de la finca y lugar: Milano

Superficie de la finca: 10 ha

Area usada para Palmito de Pejibaye: 1 ha

¿Qué variedad de palmito usa Ud.? con espinas

¿De dónde recibe Ud. la asistencia sobre el cultivo? IDA, empiezo

¿Hace cuánto tiempo comienzó Ud. con palmito? 4 años

¿A dónde van las 'candelas' cortadas? Cartago, Turbifrut/Demasa

¿Cuántas candelas produce Ud. cada año/mes?

¿Cuántas personas están trabajando en el cultivo de palmito? padre/hijo + peon

¿Tienen trabajo especializado? ¿Lo cual? peon saca palmito más que el otro trabajo

¿Cuáles son las perspectivas para el futuro?

¿Van a sembrar más palmito (Cuánto)? ± 0.5 ha

¿Van a usar otras variedades? no

¿Van a cambiar la manera de producción? 2½ x 1½ la densidad

II MANERA DE PRODUCCION

¿De dónde viene la semilla que usa Ud. para sembrar? IDA matas.

¿Tiene Ud. su propio vivero? no ¿Ud. usa bolsas plasticas? /

¿Qué piense Ud. de sembrar las partes de la planta que quedan después una corta? no, se puede

¿A qué edad trasplanta Ud.? X meses

¿Qué cultivo tenía Ud. antes en este campo? pasto

¿Por qué cambió Ud.? esta parte tiene mejor suelo que las otras.

¿A qué distancia siembra Ud.? 2 m x 1 m (5000 plantas/ha)

¿Por qué usa Ud. esta densidad? IDA lo consejó

¿Cómo ha preparado su terreno? chapián, regó (herbicidas), hiero.

¿Ha tenido otros cultivos entre el palmito en el primer año? no ¿Lo cuales? /

¿Por qué? /

¿Y en qué densidad? /

¿Tiene Ud. problemas con malas hierbas, enfermedades o plagas?

¿Cuáles? sí no talbuzas

¿Cómo combate Ud. estas? limpiando, rozcando aplicar herbicidas veneno.

¿Qué tipo(s) de herbicidas/pesticidas/fungicidas usa Ud.?

Tipo	Contra	Cantidad usada por ha	Cada ...
gramoxone		1 l	3 meses.
no → 2,4 afecta las matas			

¿Qué tipo(s) de abono usa Ud.?

Tipo	Formula	Cantidad usada por ha	Cada ...	
Nutran		350 kg	3 meses	(3 x / jo... work)
peg	12-24-12			(1 vez)

¿Qué edad tiene el cultivo a la primera cosecha? 15 meses

¿Cuántas veces cosecha Ud. cada semana/mes/año? 1 veces cada semana

¿Qué superficie corta Ud. a una cosecha? 1/4 ha.

¿Y cuántas 'candelas' tiene cada cosecha por medio? 250 candelas

¿Después cuanto tiempo regresa Ud. a la misma parte? 1 mes

¿Qué criteria usa Ud. para cortar una candela? gruesa

Cuánto tiempo por		en 1 día (___horas)	la percela (_____ ha)	por ha
	preparar su tereno			72 h
	sembrar			72.
	aplicar abono			40 h.
	cosechar	} en juntos		8 h
	deshijar			
	deshojar			
	aplicar -*-cidas			4 h

III SOBRE SUS SUELOS

¿Ud. tiene diferencias en los suelos en sus parcelas con palmito? igual

¿Como distingue Ud. las diferencias? de los otros

Seleccionaron esta ha. por ~~maíz a bajo~~ experiencia cultivo

¿Ud. trata los cultivos que están en sus diferentes suelos de una u otra manera? /

¿Cuáles son las maneras? /

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

¿Cuál será el razón? /

IV INFORMACION NOTADA Y MEDIDA DE LAS PARCELAS DE LA FINCA ______________

NOMBRE DEL AGRICULTOR _Carlos_______Vargas____CODIGO __NE:5.______

Estimación de número de plantas al vivero__/__________

Sobre la percela medida: superficie:__1__ha

Edad del cultivo de palmito______________________4 años

Densidad del cultivo ___2m x __1__m (__5000__plantas/ha)

Número de hijos por medio de las plantas _______4.6__hijos

Diamétro de tallo por medio de las plantas ____________cm

Número de hojas vividas por medio de las plantas____6.1__

Pendiente estimada del campo con palmito: ______0_ grados

Cosecha (precio pagado ¢ 250.-)

Peso fresco de __10__candelas: _17,991_kg (_1,799_g/u)

Una muestra fresca de__976_____g pesa __144,83__g después secarla (_____%)

Removado del campo: _________ kg/ha/año (seco)

Contenido muestra de _______g		Porcentaje	Nutrivos removados (kg/ha/año
N	__________	__________	__________
P	__________	__________	__________
K	__________	__________	__________
Ca	__________	__________	__________
Mg	__________	__________	__________
S	__________	__________	__________
Fe	__________	__________	__________
Ca	__________	__________	__________
Zn	__________	__________	__________
Mn	__________	__________	__________
B	__________	__________	__________

Análisis químico de suelo:

pH-H2O __________	P __________	Mg __________	Mn __________
Acidez __________	Fe __________	Zn __________	N __________
Ca __________	Cu __________	K __________	S __________
B __________			

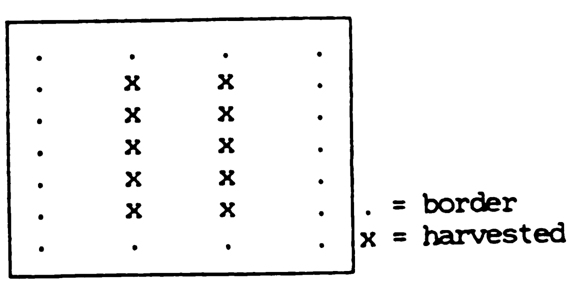
Lay-out of potential production trial for palmito

FERTILIZER TRIAL APPENDIX 5-I

6	1	2	Replicate IV
R1	7	4	
5	3	R2	
4	5	3	Replicate III
7	2	6	
R1	R2	1	
2	7	R1	Replicate II
5	1	4	
R2	6	3	
2	6	R1	Replicate I
3	4	R2	
7	5	1	

Numbers refer to harvest dates:
1 07-08-1991
2 14-08-1991
3 21-08-1991
4 04-09-1991
5 25-09-1991
6 22-10-1991
7 03-12-1991
R1 reserve 1
R2 reserve 2

PLOT



Management practices of palmito trials

	DAT*	
03 Jul 1991		Start of selection of *palmito* seedlings
10 Jul 1991		End of selection of *palmito* seedlings
16 Jul 1991		Start of sowing potential production trial (1)
		Start of sowing fertilizer trial (2)
19 Jul 1991	0	End of sowing trial 1 and 2
02 Aug 1991	14	Application of 'Round-up'
07 Aug 1991	19	1st harvest trial 1
09 Aug 1991	21	Soil samples of trial 1
		Application of NUTRAN to trial 1
12 Aug 1991	24	Application of TSP to trial 1
14 Aug 1991	26	2nd harvest trial 1
		Soil samples taken trial 1
20 Aug 1991	32	Application of KCl to trial 1
21 Aug 1991	33	3rd harvest trial 1
		Soil samples taken trial 1
02 Sep 1991	45	Marking of plots with field codes trial 2
03 Sep 1991	46	Marking of plots of trial 2
04 Sep 1991	47	4th harvest trial 1
		Soil samples taken trial 1
25 Sep 1991	68	5th harvest trial 1
		Soil samples taken trial 1
28 Sep 1991	71	Trial 2:
		Application of NUTRAN (0, 42 and 84 $g \cdot plant^{-1}$)
		Application of TSP (0, 37 and 74 $g \cdot plant^{-1}$)
		Application of KCl (0 and 25 $g \cdot plant^{-1)}$
17 Oct 1991	90	Application of 200 g KOCIDE to trial 1 and 2
22 Oct 1991	95	6th harvest trial 1
		Soil samples taken trial 1
06 Nov 1991		Placement of '*taltuza*' traps
25 Nov 1991	129	Harvest of replication I trial 2
26 Nov 1991	130	Harvest of replication II trial 2
27 Nov 1991	131	Harvest of replication III trial 2
28 Nov 1991	132	Harvest of replication IV trial 2
29 Nov 1991	133	Soil samples taken of 72 plots trial 2
03 Dec 1991	137	7th harvest trial 1
		Soil samples taken trial 1.
		End of trial 1
13 Dec 1991	147	Trial 2: Application of KCl (0 y 25 $g \cdot plant^{-1}$)
16 Dec 1991	150	Trial 2: Application of NUTRAN (0, 42 and 84 $g \cdot plant^{-1}$)
		Application of TSP (0, 37 and 74 $g \cdot plant^{-1}$)

* Days after transplanting

Chemical analysis of potential production trial for palmito (6 harvest dates)

harvest date 21-08-1991

Nº DE MUESTREO :

CODIGO DE INGRESO	CODIGO DE CAMPO	% sobre base seca						ppm					OBSERVAC
		N	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	B	
234467	1 I RAI 2108	0.89	0.17	1.22	0.20	0.13	0.18	1681	126	60	109		
234468	2 I TAL 2108	1.46	0.28	1.60	0.24	0.25	0.23	2201	20	67	84		
234469	3 I HOJ 2108	2.43	0.27	1.78	0.42	0.24	0.27	621	10	51	90		~~Banano~~ Palmito
234470	4 I PEC 2108	0.91	0.28	2.46	0.21	0.13	0.15	303	8	43	36		
234471	5 II RAI 2108	0.91	0.17	1.39	0.18	0.13	0.18	2178	110	53	129		
234472	6 II TAL 2108	1.31	0.27	1.59	0.25	0.24	0.21	2637	19	65	87		
234473	7 II HOJ 2108	2.34	0.22	2.03	0.40	0.23	0.27	606	9	51	83		
234474	8 II PEC 2108	0.83	0.25	3.09	0.21	0.13	0.15	345	8	42	37		
234475	9 III PAI 2108	0.91	0.15	1.28	0.20	0.12	0.16	1185	84	61	100		
234476	10 III TAL 2108	1.26	0.26	1.59	0.25	0.25	0.20	2507	18	64	94		
234477	11 III HOJ 2108	2.31	0.23	1.98	0.40	0.24	0.27	591	46	53	87		
234478	12 III FEC 2108	0.80	0.26	2.72	0.21	0.13	0.14	309	8	42	40		
234479	13 I VRAI 2108	1.03	0.14	1.41	0.19	0.12	0.17	1589	107	66	121		
234480	14 I VTAL 2108	1.49	0.26	1.81	0.25	0.23	0.22	1998	16	62	74		
234481	15 I VHOJ 2108	0.86	0.23	3.01	0.24	0.13	0.16	719	9	45	49		
234482	16 I VPEC 2108	2.71	0.22	1.98	0.42	0.25	0.23	585	10	59	97		

JEFE DE LABORATORIO : B.Q. Javier Jaen D. FIRMA :

SUPERVISOR : Ing. Antonio López M. FIRMA :

CORBANA S.A., LA RITA FOLIA

LABORATORIO QUIMICO DE SUELOS Y FOLIARES

RESULTADO DE ANALISIS FOLIARES

REPORTE Nº : 756

FECHA DE RECIBO : 17/08/9

FECHA DE ENTREGA : 16/10/9

Sr. Programa: Convenio CATIE/UAW/MAG

FECHA DEL MUESTREO: 16/08/9

Nº DE MUESTREO :

harvest date 14-08-1991

CODIGO DE INGRESO	CODIGO DE CAMPO	% sobre base seca						ppm					OBSERVA
		N	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	B	
234165	1 I RAI 1408	1.03	0.17	1.27	0.18	0.12	0.15	1418	128	48	123		
234166	2 I TAL 1408	1.20	0.22	1.26	0.27	0.23	0.17	2974	18	19	109		Pejibay
234167	3 I HOJ 1408	2.08	0.18	1.76	0.43	0.24	0.19	461	8	15	94		
234168	4 I PEC 1408	0.83	0.21	2.20	0.22	0.14	0.15	1045	8	5	56		
234169	5 II RAI 1408	0.86	0.14	1.11	0.17	0.12	0.15	2241	120	27	107		
234170	6 II TAL 1408	1.23	0.27	1.24	0.24	0.24	0.20	2312	15	28	84		
234171	7 II HOJ 1408	2.23	0.20	1.70	0.40	0.23	0.22	572	7	15	89		
234172	8 II PAC 1408	0.89	0.27	2.15	0.23	0.15	0.13	625	8	11	44		
234173	9 III RAI 1408	0.86	0.12	0.99	0.18	0.12	0.16	1752	109	21	145		
234174	10 III TAL 1408	1.14	0.22	1.29	0.23	0.22	0.15	3036	14	23	116		
234175	11 III HOJ 1408	2.08	0.17	1.69	0.44	0.23	0.24	668	6	14	109		
234176	12 III PEC 1408	0.80	0.21	2.20	0.23	0.13	0.14	751	5	13	58		
234177	13 IV RAI 1408	0.97	0.14	1.11	0.20	0.12	0.16	2341	142	31	144		
234178	14 IV TAL 1408	1.40	0.26	1.48	0.24	0.22	0.17	2353	16	27	86		
234179	15 IV HOJ 1408	2.34	0.18	1.57	0.45	0.24	0.25	841	9	19	102		
234180	16 IV PEC 1408	1.20	0.25	2.05	0.21	0.14	0.13	604	6	8	48		

JEFE DE LABORATORIO : B.Q. Javier Jaen D. FIRMA :

SUPERVISOR : Ing. Antonio López M. FIRMA :

JJD/jmg.

CORBANA S.A., LA RITA
LABORATORIO QUIMICO DE SUELOS Y FOL
RESULTADO DE ANALISIS FOLIARES

FECHA DE RECIBO : 13/09/9
FECHA DE ENTREGA : 19/10/9
FECHA DEL MUESTREO:
Nº DE MUESTREO :

Sr. Programa: Convenio CATIE/UAW/MAG

harvest date: 04-09-1991

CODIGO DE INGRESO	CODIGO DE CAMPO	% sobre base seca						ppm					OBSERVA
		N	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	B	
234847	1 I RAI 0.409	0.94	0.32	1.99	0.28	0.28	0.19	1743	14	32	81		
234848	2 I TAL 0.409	1.20	0.24	1.88	0.27	0.27	0.20	2581	15	31	98		Palmito
234849	3 I HOJ 0.409	2.63	0.32	2.04	0.37	0.22	0.24	491	6	15	88		
234850	4 I PEC 0.409	0.80	0.17	3.14	0.25	0.17	0.15	684	6	8	50		
234851	5 II RAI 0.409	1.00	0.17	1.43	0.20	0.13	0.17	1838	145	30	115		
234852	6 II TAL 0.409	1.46	0.20	1.46	0.20	0.14	0.16	1421	103	31	111		
234853	7 II HOJ 0.409	2.71	0.24	2.11	0.38	0.27	0.19	356	7	16	83		
234854	8 II PAC 0.409	0.83	0.31	3.33	0.22	0.15	0.14	498	6	7	41		
234855	9 III RAI 0.409	1.06	0.15	1.51	0.17	0.12	0.17	1483	89	31	134		
234856	10 III TAL 0.409	1.34	0.30	1.95	0.26	0.25	0.19	2382	17	34	112		
234857	11 III HOJ 0.409	1.09	0.21	1.78	0.38	0.22	0.15	504	6	13	116		
234858	12 III PEC 0.409	1.00	0.27	3.36	0.24	0.14	0.11	540	6	11	65		
234859	13 IV RAI 0.409	0.97	0.17	1.50	0.19	0.13	0.13	1445	132	28	129		
234860	14 IV TAL 0.409	1.49	0.31	1.93	0.28	0.24	0.20	3048	21	35	125		
234861	15 IV HOJ 0.409	2.43	0.22	2.06	0.34	0.21	0.19	432	8	16	102		
234862	16 IV PEC 0.409	0.80	0.30	3.52	0.21	0.13	0.14	491	6	8	54		

JEFE DE LABORATORIO :D.Q. Javier Jaen B. FIRMA :
SUPERVISOR :Ing. Antonio López M. FIRMA :

JJD/jmg.

CORBANA S.A., LA RITA FOLIA
LABORATORIO QUIMICO DE SUELOS Y FOLIARES
RESULTADO DE ANALISIS FOLIARES

REPORTE Nº : 812 F
FECHA DE RECIBO :07/10/91
FECHA DE ENTREGA :25/11/91
FECHA DEL MUESTREO:07/10/91
Nº DE MUESTREO :

Sr. Programa: CATIE/UAW/MAG

harvest date: 25-09-1991

CODIGO DE INGRESO	CODIGO DE CAMPO	% sobre base seca						ppm					OBSERVACIO
		N	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	B	
235312	I RAI 2509	1.20	0.19	1.62	0.24	0.14	0.29	1623	139	31	144		
235313	I TAL 2509	1.63	0.43	2.32	0.33	0.29	0.38	1384	17	47	86		Palmito de
235314	I HOJ 2509	2.86	0.26	2.11	0.45	0.25	0.42	484	10	20	106		pejibaye
235315	I PEC 2509	0.94	0.32	3.17	0.24	0.14	0.22	377	7	8	38		
235316	II RAI 2509	1.11	0.19	1.34	0.20	0.14	0.25	1906	144	32	158		
235317	II TAL 2509	1.26	0.35	1.90	0.25	0.27	0.33	1008	13	40	74		
235318	II HOJ 2509	2.66	0.26	2.24	0.33	0.24	0.20	298	9	34	85		
235319	II PEC 2509	0.80	0.27	2.94	0.23	0.15	0.28	395	7	8	54		
235320	III RAI 2509	0.86	0.19	1.39	0.20	0.14	0.34	1617	175	40	171		
235321	III TAL 2509	1.34	0.36	2.08	0.25	0.27	0.43	1236	16	40	84		
235322	III HOJ 2509	2.66	0.26	1.95	0.52	0.31	0.23	469	10	20	139		
235323	III PEC 2509	0.86	0.33	3.38	0.22	0.15	0.20	343	10	11	59		
235324	IV RAI 2509	0.80	0.13	1.16	0.18	0.13	0.31	1466	114	20	136		
235325	IV TAL 2509	1.34	0.27	2.16	0.27	0.27	0.41	2070	20	45	112		
235326	IV HOJ 2509	2.43	0.24	2.40	0.49	0.27	0.21	501	10	20	140		
235327	IV PAC 2509	0.77	0.25	3.47	0.23	0.14	0.20	392	8	7	82		

JEFE DE LABORATORIO :D.Q. Javier Jaen B. FIRMA :
SUPERVISOR :Ing. Antonio López M. FIRMA :

SECCION SUELOS
PLANTAS Y DRENAJES

Appendix 4-III

3/3

CORBANA S.A., LA RITA
LABORATORIO QUIMICO DE SUELOS Y FOLIARES
RESULTADO DE ANALISIS FOLIARES

REPOR
FECHA DE RECIBO :01/11/91
FECHA DE ENTREGA :14/01/92
FECHA DEL MUESTREO:29/10/91
No DE MUESTREO :

Sr. Programa CATIE/UAW/MAG

harvest date: 22-10-1991

CODIGO DE INGRESO	CODIGO DE CAMPO	N	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	B	OBSERVACIO
		% sobre base seca						ppm					
235784	1 I RAI 2210	0.74	0.15	1.09	0.22	0.13	0.14	1020	138	32	103		
235785	2 I TAL 2210	1.03	0.36	1.95	0.27	0.25	0.16	375	53	12	47		
235786	3 I HOJ 2210	2.74	0.24	1.80	0.52	0.33	0.28	289	88	14	110		
235787	4 I REC 2210	0.69	0.36	3.10	0.29	0.19	0.17	240	64	9	55		
235788	5 II RAI 2210	0.69	0.17	1.24	0.23	0.12	0.17	954	149	31	103		PALMITO
235789	6 II TAL 2210	1.26	0.39	2.41	0.32	0.29	0.20	578	103	22	58		PEJIBAYE
235790	7 II HOJ 2210	2.40	0.25	2.11	0.49	0.31	0.27	247	77	20	97		
235791	8 II PEC 2210	0.74	0.42	3.73	0.28	0.19	0.19	199	80	5	51		
235792	9 III RAI 2210	0.63	0.16	1.37	0.26	0.12	0.14	1097	146	36	104		
235793	10 III TAL 2210	0.97	0.33	2.23	0.30	0.26	0.17	327	83	14	56		
235794	11 III HOJ 2210	2.40	0.23	2.16	0.46	0.28	0.28	263	89	16	111		
235795	12 III REC 2210	0.63	0.33	3.32	0.28	0.17	0.18	310	87	7	53		
235796	13 IV RAI 2210	0.57	0.16	1.28	0.25	0.12	0.15	913	144	42	91		
235797	14 IV TAL 2210	0.63	0.30	2.13	0.33	0.27	0.19	360	88	17	57		
235798	15 IV HOJ 2210	2.46	0.21	1.34	0.47	0.27	0.34	270	81	14	106		
235799	16 IV PEC 2210	0.69	0.30	2.47	0.25	0.18	0.16	415	95	6	57		
235800	17 IV HIJ 2210	1.20	0.27	2.38	0.27	0.21	0.22	621	22	13	62		

JEFE DE LABORATORIO :B.Q. Javier Jaen D. FIRMA :

SUPERVISOR :Ing. Antonio López M. FIRMA :

CORBANA S.A., LA RITA FOLIA
LABORATORIO QUIMICO DE SUELOS Y FOLIARES
RESULTADO DE ANALISIS FOLIARES

REPORTE No : 807
FECHA DE RECIBO :30/12/91
FECHA DE ENTREGA :19/06/92
FECHA DEL MUESTREO:
No DE MUESTREO :

Sr. Convenio CATIE-UAW-MAG

harvest date: 03-12-1991

CODIGO DE INGRESO	CODIGO DE CAMPO	N	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	B	OBSERVACIO
		% sobre base seca						ppm					
237254	II RAI 0312	0.87	0.18	1.24	0.16	0.14	0.15	3350	142	53	153		PALMITO
237255	21 TAL 0312	1.10	0.27	1.75	0.23	0.23	0.18	746	42	15	60		PEJIBAYE
237256	31 HOJ 0312	3.00	0.20	1.71	0.41	0.27	0.34	369	24	16	83		
237257	41 PEC 0312	0.75	0.28	2.72	0.21	0.16	0.18	159	18	9	39		
237258	5II RAI 0312	0.81	0.15	1.12	0.15	0.12	0.13	1911	144	36	112		
237259	6II TAL 0312	0.98	0.27	1.63	0.22	0.22	0.17	679	44	16	72		
237260	7II HOJ 0312	2.97	0.20	1.81	0.28	0.20	0.25	288	22	25	85		
237261	8II PEC 0312	0.75	0.28	2.60	0.20	0.16	0.14	250	22	12	63		
237262	9III RAI 0312	0.81	0.18	1.20	0.15	0.13	0.16	2480	183	46	117		
237263	10III 0312	1.07	0.34	2.00	0.21	0.23	0.20	219	28	15	41		
237264	11III 0312	2.63	0.22	1.58	0.36	0.24	0.27	246	19	19	74		
237265	12III 0312	0.80	0.37	2.90	0.20	0.15	0.18	105	26	10	42		
237266	13IV 0312	0.75	0.13	1.14	0.14	0.10	0.14	1705	40	31	86		
237267	14IV 0312	1.24	0.31	1.81	0.25	0.26	0.21	959	42	19	69		
237268	15IV 0312	3.06	0.22	1.98	0.36	0.25	0.28	307	26	19	89		
237269	16IV 0312	0.87	0.27	3.10	0.19	0.14	0.19	170	28	11	50		
237270	17IV 0312	1.53	0.26	2.45	0.16	0.17	0.19	1048	28	21	72		

JEFE DE LABORATORIO :B.Q. Javier Jaen D. FIRMA :

SUPERVISOR :Ing. Antonio López M. FIRMA :

RAYMOND JONGSCHAAP
T52313 TROPICAL AGRICULTURE WAGENINGEN AGRICULTURAL UNIVERSITY THE NETHERLANDS
RESULTS POTENTIAL PRODUCTION TRIAL at AGROPALMITO GUAPILES COSTA RICA

Sowing: 23-07-91

MEANS PER REPLICATE

	NUMBER OF LEAVES	MAXIMAL HEIGHT OF PLANT (WITH LAST LEAF) (cm)	HEIGHT OF PLANT (AT LAST LEAF) (cm)	DIAMETER OF STEM AT BASE (mm)	DIAMETER OF STEM AT LAST LEAF (mm)	LEAF AREA (cm2)	LEAF AREA INDEX and SPECIFIC LEAF AREA	
	I II III IV	I II III IV	I II III IV	I II III IV	I II II IV	I II III IV		I II III IV MEAN
Cosecha: 1	6.0 6.5 6.5 6.3	42.9 43.5 43.2 42.9	12.5 13.0 12.8 9.1	18.3 19.0 18.9 12.7	5.6 5.9 5.8 5.8	781.15 760.84 807.03 942.15	LAI	0.031 0.030 0.032 0.038 0.033
Fecha: 07-08-91 Mean:	6.3	43.1	11.8	17.2	5.8	822.79	SLA (cm2/g)	18.29 20.56 18.64 20.32 19.45
Cosecha: 2	6.7 6.9 7.3 6.7	46.7 44.6 45.1 48.4	13.6 12.3 13.7 15.3	20.4 19.9 19.7 19.6	6.2 5.8 5.4 5.4	880.26 824.30 887.64 781.66	LAI	0.035 0.033 0.036 0.031 0.034
Fecha: 14-08-91 Mean:	6.9	46.1	13.7	19.9	5.7	843.47	SLA (cm2/g)	21.07 18.67 17.96 20.66 19.59
Cosecha: 3	7.3 7.4 7.1 7.0	46.0 48.5 45.5 47.3	13.9 13.9 12.5 13.9	21.0 20.4 20.4 20.3	4.8 5.0 5.0 5.1	901.31 1022.75 1013.80 964.96	LAI	0.036 0.041 0.041 0.039 0.039
Fecha: 21-08-91 Mean:	7.2	46.8	13.5	20.5	5.0	975.71	SLA (cm2/g)	19.98 23.03 19.84 22.10 21.24
Cosecha: 4	7.4 7.4 7.4 7.5	49.6 49.3 50.2 49.5	15.4 15.8 15.8 14.9	24.0 23.5 25.7 22.7	5.8 6.0 5.6 5.5	1136.47 1249.90 1201.47 1258.74	LAI	0.045 0.050 0.048 0.050 0.048
Fecha: 04-09-91 Mean:	7.4	49.6	15.4	23.9	5.7	1211.64	SLA (cm2/g)	19.70 22.69 18.22 22.77 20.85
Cosecha : 5	7.5 7.8 7.9 7.8	52.6 46.8 56.0 56.7	17.3 16.3 18.8 19.7	28.2 24.5 24.7 25.5	5.3 4.9 5.2 5.0	1444.56 1442.33 1443.89 1691.41	LAI	0.058 0.058 0.056 0.068 0.060
Fecha: 25-9-91 Mean:	7.7	53.0	18.0	25.7	5.4	1505.55	SLA (cm2/g)	21.08 22.33 17.80 20.23 20.36
Cosecha : 6	8.7 8.4 9.0 8.4	64.6 70.3 66.8 68.5	25.1 25.2 25.7 24.9	33.5 36.1 36.6 35.9	6.3 7.0 7.1 6.6	2469.27 3167.31 2951.20 2914.52	LAI	0.099 0.127 0.120 0.117 0.115
Fecha: 22-10-91 Mean:	8.6	67.5	25.2	35.5	6.7	2885.57	SLA (cm2/g)	17.35 19.22 18.12 17.13 17.957
Cosecha : 7	10 9.2 9.5 9.1	85.3 81.9 85.3 86.4	31.3 28.5 30.2 31.4	54.1 49.1 47.9 45.5	6.7 7.0 7.6 8.1	4190.10 4438.33 3682.20 4261.22	LAI	0.168 0.178 0.147 0.170 0.166
Fecha: 03-12-91 Mean:	9.5	84.7	30.4	49.2	7.4	4142.96	SLA (cm2/g)	14.01 15.79 11.69 14.44 13.99

Physical measurements of potential production trial for palmito (7 harvest dates)

DRY WEIGHTS per plot (g)

	ROOTS	STEMS	LEAVES	RACHIS	SHOOTS	TOTAL	kg/ha	
I	62.96	46.38	42.72	8.24	-	160.30		
II	48.11	44.25	37.00	6.52	-	135.88		
III	62.35	49.50	43.30	7.55	-	162.70		
IV	59.12	50.78	46.36	6.87	-	163.13		
Mean:	58.14	47.73	42.35	7.30	-	155.50	62.20	07-08-1991
I	40.19	56.79	41.78	7.93	-	146.69		
II	52.94	54.47	44.15	6.39	-	157.95		
III	64.66	57.70	49.43	7.86	-	179.65		
IV	47.60	72.08	37.84	7.15	-	164.67		
Mean:	51.35	60.26	43.30	7.33	-	162.24	64.90	14-08-1991
I	59.18	51.15	45.10	8.23	-	163.66		
II	59.71	45.29	44.40	8.20	-	157.60		
III	64.61	50.42	51.11	7.87	-	174.01		
IV	48.39	46.70	43.67	7.49	-	146.25		
Mean:	57.97	48.39	46.07	7.95	-	160.38	64.15	21-08-1991
I	69.70	55.33	57.70	10.50	-	193.23		
II	61.05	49.22	55.09	9.12	-	174.48		
III	92.05	71.79	65.93	10.50	-	240.27		
IV	63.44	51.01	55.27	10.13	-	179.85		
Mean:	71.56	56.84	58.50	10.06	-	196.96	78.78	04-09-1991
I	69.43	68.54	69.54	11.63	-	219.14		
II	54.95	64.59	61.17	10.73	-	191.44		
III	96.04	81.11	70.38	13.57	-	261.10		
IV	104.80	83.60	71.46	15.10	-	274.96		
Mean:	81.31	74.46	68.14	12.76	-	236.66	94.66	25-09-1991
I	140.46	137.79	142.28	22.75	1.14	444.42		
II	185.17	147.73	164.77	24.89	1.11	523.67		
III	169.2	145.94	165.04	23.83	1.86	505.87		
IV	168.66	142.07	170.17	26.29	2.42	509.61		
Mean:	165.87	143.38	160.57	24.44	1.63	495.89	198.36	22-10-1991
I	304	391	299	46	4	1044		
II	407	356	281	49	5	1098		
III	325	335	315	49	3	1027		
IV	348	327	295	49	6	1025		
Mean:	346.00	352.25	297.50	48.25	4.50	1049	419.40	03-12-1991

Appendix 4-V

1/1

...teo figures 'Los Diamantes' Guápiles Costa Rica:
...nimum, maximum and mean temperatures (°C),
...ecipitation (mm) and sum of temperature (Tsum).

...y:	July 1991 Tmin	Tmax	Tmean	prec	Tsum	August 1991 Tmin	Tmax	Tmean	prec	Tsum
1	20.3	30.0	25.2	0.0	25.2	21.5	28.0	24.8	40.5	796.1
2	21.2	30.5	25.9	0.0	51.0	21.0	29.0	25.0	26.3	821.1
3	21.2	30.0	25.6	5.4	76.6	21.0	29.0	25.0	0.0	846.1
4	23.0	28.5	25.8	6.3	102.4	20.5	29.1	24.8	1.4	870.9
5	21.7	27.7	24.7	0.0	127.1	20.6	30.1	25.4	2.3	896.2
6	21.7	29.0	25.4	0.0	152.4	20.8	25.1	23.0	12.9	919.2
7	20.5	28.2	24.4	29.9	176.8	21.5	26.2	23.9	67.4	943.0
8	22.0	28.8	25.4	21.2	202.2	21.0	29.1	25.1	15.0	968.1
9	22.5	25.5	24.0	21.0	226.2	20.5	27.7	24.1	1.7	992.2
10	21.0	28.8	24.9	75.8	251.1	21.7	26.5	24.1	8.5	1016.3
11	22.0	29.5	25.8	4.0	276.8	21.9	30.0	26.0	92.7	1042.2
12	21.5	27.0	24.3	3.1	301.1	21.5	26.4	24.0	26.6	1066.2
13	22.2	28.0	25.1	17.8	326.2	21.5	24.4	23.0	20.8	1089.1
14	21.4	29.2	25.3	3.8	351.5	19.5	29.3	24.4	0.4	1113.5
15	21.0	26.2	23.6	51.0	375.1	21.4	29.4	25.4	2.8	1138.9
16	22.2	27.8	25.0	46.4	400.1	21.7	29.4	25.6	37.5	1164.5
17	21.0	29.7	25.4	0.0	425.4	22.8	28.7	25.8	2.2	1190.2
18	22.0	26.8	24.4	40.5	449.8	21.5	29.0	25.3	9.5	1215.5
19	22.7	28.0	25.4	36.1	475.2	22.5	28.5	25.5	0.0	1241.0
20	21.9	25.3	23.6	18.7	498.7	21.0	30.2	25.6	1.4	1266.6
21	21.4	27.4	24.4	1.6	523.1	21.5	29.0	25.3	24.6	1291.8
22	22.0	30.8	26.4	55.9	549.5	22.7	25.7	24.2	38.8	1316.0
23	21.9	27.0	24.4	82.1	573.9	21.5	29.5	25.5	2.1	1341.5
24	22.5	28.8	25.7	47.0	599.6	21.6	28.2	24.9	1.0	1366.4
25	22.8	27.5	25.2	10.2	624.7	21.0	29.5	25.3	6.7	1391.7
26	22.5	25.7	24.1	17.3	648.8	22.0	26.5	24.3	29.2	1415.9
27	21.5	27.5	24.5	19.6	673.3	22.5	28.5	25.5	6.2	1441.4
28	20.5	28.4	24.5	1.5	697.8	20.0	30.0	25.0	5.3	1466.4
29	20.5	29.6	25.1	0.0	722.8	20.5	29.4	25.0	19.9	1491.4
30	20.2	28.4	24.3	4.4	747.1	20.7	28.8	24.8	39.3	1516.1
31	21.9	26.5	24.2	35.0	771.3	20.2	27.7	24.0	1.4	1540.1
...tal	670.5	872.1	771.3	656.1	771.3	659.6	877.9	768.75	544.4	768.8
...an	21.6	28.1	24.9			21.3	28.3	24.8		

...y:	September 1991 Tmin	Tmax	Tmean	prec	Tsum	October 1991 Tmin	Tmax	Tmean	prec	Tsum
1	20.9	30.5	25.7	0.1	1565.8	21.5	29.4	25.5	0.9	2320.7
2	23.6	30.9	27.3	0.0	1593.0	20.3	30.6	25.5	0.0	2346.2
3	22.5	30.4	26.5	11.2	1619.5	22.0	28.9	25.5	54.4	2371.6
4	20.5	30.4	25.5	0.0	1644.9	21.0	29.5	25.3	13.9	2396.9
5	21.4	28.8	25.1	3.5	1670.0	22.0	28.9	25.5	23.4	2422.3
6	21.6	25.5	23.6	10.4	1693.6	20.5	29.5	25.0	0.0	2447.3
7	19.8	28.4	24.1	13.5	1717.7	20.2	30.0	25.1	0.3	2472.4
8	20.3	29.3	24.8	36.5	1742.5	19.0	31.2	25.1	0.0	2497.5
9	22.0	29.7	25.9	4.8	1768.3	19.7	31.2	25.5	0.0	2523.0
10	22.0	25.7	23.9	9.5	1792.2	21.2	29.5	25.4	62.6	2548.3
11	21.5	28.7	25.1	36.3	1817.3	19.5	29.0	24.3	22.0	2572.5
12	22.5	30.0	26.3	4.0	1843.5	20.7	30.0	25.4	55.3	2597.9
13	21.7	30.0	25.9	0.9	1869.4	20.0	30.0	25.0	42.2	2622.9
14	21.2	29.4	25.3	15.5	1894.7	19.5	29.0	24.3	19.1	2647.2
15	21.0	29.0	25.0	55.9	1919.7	19.6	28.3	24.0	0.0	2671.2
16	21.5	27.0	24.2	42.2	1943.9	21.2	28.0	24.6	0.9	2695.7
17	21.0	28.3	24.7	2.2	1968.6	22.0	28.9	25.5	1.2	2721.3
18	20.6	29.2	24.9	2.9	1993.5	20.0	28.5	24.3	0.6	2745.4
19	22.0	28.5	25.2	7.5	2018.7	21.0	27.0	24.0	0.0	2769.4
20	21.0	29.5	25.3	2.2	2044.0	20.7	27.5	24.1	1.5	2793.5
21	22.0	29.0	25.5	6.0	2069.5	21.5	30.0	25.8	0.0	2819.3
22	20.7	28.0	24.4	4.2	2093.8	20.5	29.0	24.8	0.0	2844.0
23	21.5	28.3	24.9	0.0	2118.7	21.5	27.2	24.4	4.4	2868.4
24	21.0	28.0	24.5	1.3	2143.2	22.0	28.0	25.0	16.1	2893.4
25	21.0	30.2	25.6	0.0	2168.8	20.6	29.5	25.1	1.5	2918.4
26	20.5	30.5	25.5	15.0	2194.3	21.0	29.0	25.0	1.8	2943.4
27	21.6	30.6	26.1	8.2	2220.4	20.3	29.2	24.8	13.9	2968.2
28	21.5	29.4	25.5	30.3	2245.9	20.0	29.5	24.8	1.8	2992.9
29	20.5	28.2	24.4	5.8	2270.2	20.3	29.0	24.7	32.8	3017.6
30	22.0	28.2	25.1	26.1	2295.3	20.0	29.0	24.5	3.0	3042.1
31						21.5	29.6	25.6	0.0	3067.6
...tal	640.9	869.6	755.25	356.4	755.2	640.8	903.9	772.35	354.8	772.3
...an	21.4	29.0	25.2			20.7	29.2	24.9		

...y:	November 1991 Tmin	Tmax	Tmean	prec	Tsum	December 1991 Tmin	Tmax	Tmean	prec
1	20.4	28.5	24.5	17.2	3092.1	21.0	29.2	25.1	7.4
2	21.5	25.0	23.3	37.8	3115.3	20.5	29.4	25.0	0.0
3	21.0	25.5	23.3	18.3	3138.6	20.5	28.7	24.6	6.2
4	20.5	25.5	23.0	15.5	3161.6	21.5	25.2	23.4	20.3
5	19.5	28.5	24.0	0.0	3185.6	20.5	28.0	24.3	0.0
6	19.5	29.7	24.6	0.0	3210.2	19.5	26.7	23.1	5.1
7	19.2	29.7	24.5	0.1	3234.6	17.5	28.3	22.9	7.4
8	19.7	29.3	24.5	0.0	3259.1	21.5	28.0	24.8	33.8
9	19.0	28.2	23.6	19.1	3282.7	22.0	26.5	24.3	49.3
10	20.0	27.9	24.0	55.7	3306.7	20.5	27.5	24.0	4.1
11	18.9	22.0	20.4	64.3	3327.1	20.5	28.5	24.5	1.2
12	20.2	23.5	21.9	40.1	3348.9	20.2	25.4	22.8	6.3
13	20.7	25.9	23.3	0.9	3372.2	18.8	28.0	23.4	0.0
14	21.2	28.5	24.9	0.3	3397.0	18.5	26.5	22.5	1.3
15	20.0	28.1	24.1	0.0	3421.1	18.4	28.0	23.2	0.4
16	19.5	29.7	24.6	0.0	3445.7	19.2	27.9	23.6	1.5
17	19.8	28.7	24.3	0.0	3469.9	19.0	26.7	22.9	0.6
18	19.0	29.4	24.2	0.0	3494.1	17.5	28.4	23.0	0.0
19	19.0	28.9	24.0	0.0	3518.1	18.5	27.7	23.1	0.0
20	19.5	30.1	24.8	0.0	3542.9	17.7	28.7	23.2	3.8
21	21.5	24.9	23.2	45.8	3566.1	20.8	27.8	24.3	0.0
22	21.2	24.4	22.8	35.4	3588.9	18.5	26.9	22.7	8.7
23	20.2	27.3	23.8	4.6	3612.6	19.8	27.5	23.7	1.1
24	20.7	26.2	23.5	39.8	3636.1	17.5	25.5	21.5	0.9
25	21.0	24.0	22.5	60.8	3658.6	16.6	23.3	20.0	0.8
26	21.0	24.5	22.8	19.1	3681.3	19.0	27.0	23.0	0.5
27	20.4	24.9	22.7	87.9	3704.0	20.0	28.2	24.1	0.0
28	21.5	26.2	23.9	24.4	3727.8	20.7	28.5	24.6	10.0
29	20.0	27.3	23.7	1.8	3751.5	21.5	27.4	24.5	34.5
30	22.0	28.4	25.2	2.6	3776.7	18.0	27.4	22.7	5.3
31						17.2	28.0	22.6	0.0
...tal	607.5	810.6	709.05	641.5	709.0	602.9	850.8	726.85	210.5
...an	20.3	27.0	23.6			19.4	27.4	23.4	

Lay out of N-P-K fertilizer trial for palmito

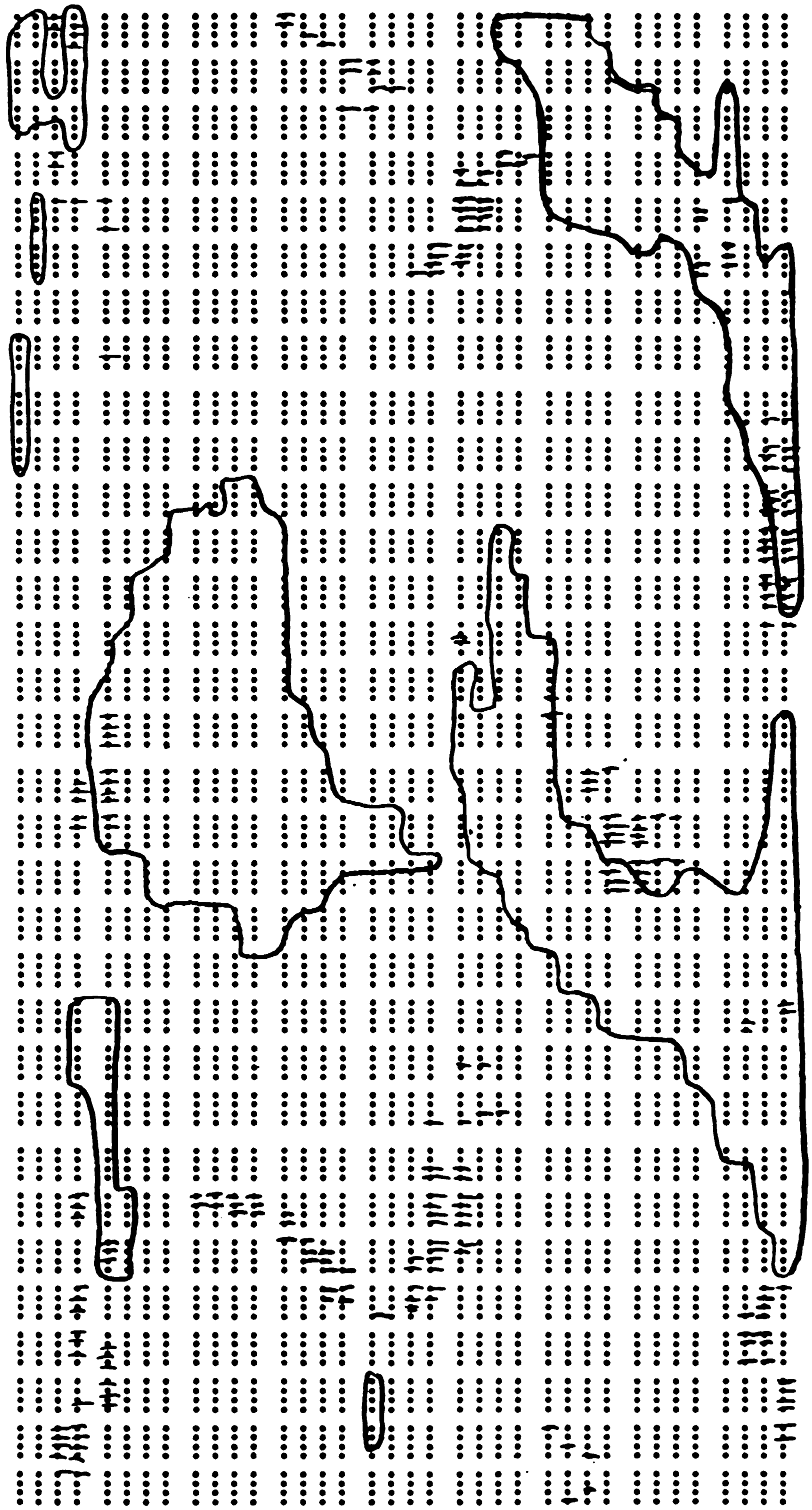
Code: NPK H

N = quantity of nitrogen: 0, 1 or 2 times 372 kg·ha^{-1}·y^{-1}
P = quantity of phosphor: 0, 1 or 2 times 408 kg·ha^{-1}·y^{-1}
K = quantity of potassium: 0 or 1 x 360 kg·ha^{-1}·y^{-1}
H = harvest number 1 to 4 (1st harvest was realized)

121 2	020 1	121 4	110 3	101 1	021 3	010 1	001 3	120 4	Replicate I
011 3	100 1	201 4	211 3	000 4	220 3	200 1	221 2	120 3	
210 4	201 1	100 2	110 4	000 3	000 1	001 2	010 4	111 3	
201 3	201 2	020 2	101 2	000 2	101 3	221 4	001 1	111 1	
100 4	100 3	011 4	110 1	220 1	220 4	010 3	111 4	200 2	
121 3	210 1	020 3	220 2	211 4	110 2	111 2	200 3	120 1	
121 1	011 1	011 2	211 1	021 1	021 4	221 3	200 4	221 1	
210 3	020 4	210 2	021 2	101 4	211 2	020 2	001 4	120 2	
110 4	220 1	201 2	020 2	111 3	111 4	101 4	211 3	120 3	Replicate II
011 2	121 4	110 3	111 2	100 3	210 4	211 1	010 3	120 1	
110 2	000 1	220 3	111 1	001 2	001 3	021 3	211 2	021 4	
000 4	000 2	011 1	020 1	100 2	221 2	200 3	021 2	101 3	
201 3	220 4	121 1	100 4	221 1	221 3	101 1	120 2	211 4	
121 2	201 1	000 3	221 4	210 1	210 3	200 4	101 2	021 1	
011 3	110 1	201 4	020 4	020 3	001 1	010 1	010 4	010 2	
011 4	121 3	220 2	210 2	001 4	100 1	200 1	200 2	120 4	
000 4	210 2	221 1	111 1	010 4	010 3	020 2	200 2	211 4	Replicate III
120 3	210 3	101 3	111 3	201 1	220 4	110 2	211 1	020 4	
000 2	210 1	000 1	100 3	021 4	021 2	121 2	121 1	020 3	
221 3	011 3	011 2	100 2	111 2	220 3	200 3	110 4	001 2	
101 4	120 2	011 4	100 1	220 2	021 1	001 3	001 4	020 1	
011 1	221 2	210 4	111 4	201 3	010 1	121 4	001 1	110 3	
101 1	000 3	120 4	100 4	220 1	021 3	211 2	200 1	211 3	
221 4	101 2	120 1	201 4	201 2	010 2	110 1	121 3	200 4	
000 2	021 2	120 4	010 3	211 4	121 3	221 3	110 1	011 4	Replicate IV
111 3	210 2	111 1	001 3	211 2	220 1	020 3	200 4	020 4	
201 3	021 4	021 1	121 4	001 2	010 4	200 1	221 4	200 2	
210 3	120 2	111 4	220 3	211 1	100 4	101 3	110 2	011 2	
210 1	201 4	000 3	220 4	121 1	121 2	110 4	020 2	011 3	
111 2	120 3	000 1	001 4	100 1	220 2	101 2	011 1	221 1	
210 4	201 1	201 2	001 1	100 3	010 2	200 3	221 2	020 1	
000 4	120 1	021 3	010 1	211 3	100 2	101 4	110 3	101 1	
Potential production trial (Appendix 4-I)									

N

Affected areas in the fertilizer trial



Replicate I

Replicate II

Replicate III

Replivate IV

Areas affected by
-- Horse eating
__ Inundations

Sr. CONVENIO CATIE/UAW/MAG

Replicate I

FECHA DE RECIBO : 05/12/91
FECHA DE ENTREGA : 26/02/92
FECHA DEL MUESTREO :
No DE MUESTREO :

CODIGO DE INGRESO	CODIGO DE CAMPO				% sobre base seca: N	P	K	Ca	Mg	S	ppm: Fe	Cu	Zn	Mn	B	OBSERVACIONES
236591	1	I	RAI	000	0.92	0.14	1.33	0.18	0.13	0.31	2270	124	59	137		
236592	2	I	TAL	000	1.13	0.27	1.35	0.20	0.23	0.22	1428	43	23	69		PEJIBAYE
236593	3	I	HOJ	000	2.89	0.21	1.67	0.31	0.27	0.24	458	18	27	79		ENSAYO I
236594	4	I	PEC	000	0.89	0.30	1.70	0.19	0.15	0.39	380	24	11	43		
236595	5	I	RAI	001	0.81	0.14	2.75	0.15	0.11	0.24	1495	113	61	128		
236596	6	I	TAL	001	1.27	0.27	2.05	0.22	0.20	0.18	1759	44	26	92		
236597	7	I	HOJ	001	2.68	0.20	1.58	0.37	0.26	0.20	284	21	27	104		
236598	8	I	PEC	001	0.81	0.30	3.14	0.21	0.15	0.28	395	20	14	61		
236599	9	I	RAI	010	0.87	0.16	1.20	0.18	0.12	0.18	1549	151	51	132		
236600	10	I	TAL	010	1.13	0.32	1.87	0.21	0.23	0.24	1559	79	30	79		
236601	11	I	HOJ	010	2.66	0.22	1.52	0.35	0.24	0.34	694	40	35	104		
236602	12	I	PEC	010	0.84	0.33	2.88	0.19	0.16	0.22	428	36	19	55		
236603	13	I	RAI	011	0.75	0.15	1.18	0.17	0.12	0.18	1541	137	33	108		
236604	14	I	TAL	011	1.21	0.30	[illegible]	[illegible]	0.24	0.20	1115	33	20	76		
236605	15	I	HOJ	011	3.15	0.21	[illegible]	[illegible]	[illegible]	0.44	662	29	26	129		
236606	16	I	PEC	011	0.75	0.38	[illegible]	0.21	[illegible]	0.23	640	22	18	67		
236607	17	I	RAI	020	0.72	0.13	1.47	0.18	0.11	0.20	1209	128	31	111		
236608	18	I	TAL	020	1.18	0.30	1.89	0.21	0.22	0.20	445	31	17	38		
236609	19	I	HOJ	020	2.71	0.20	1.82	0.30	0.24	0.40	354	27	29	83		
236610	20	I	PEC	020	0.78	0.34	[illegible]	0.20	0.15	0.22	325	25	10	42		
236611	21	I	RAI	021	0.89	0.15	[illegible]	0.15	[illegible]	0.20	1250	138	40	93		
236612	22	I	TAL	021	1.18	0.30	1.74	0.23	0.25	0.15	1240	44	17	79		
236613	23	I	HOJ	021	3.20	0.22	1.98	0.31	0.26	0.36	453	28	19	57		
236614	24	I	PEC	021	0.75	0.26	2.99	0.16	0.15	0.20	259	23	6	35		
236615	25	I	RAI	100	0.84	0.11	1.44	0.14	0.11	0.17	1558	83	23	121		
236616	26	I	TAL	100	1.24	0.22	1.90	0.18	0.22	0.16	1087	51	13	97		
236617	27	I	HOJ	100	2.89	0.19	1.43	0.38	0.25	0.21	688	27	18	156		
236618	28	I	PEC	100	0.81	0.16	2.61	0.18	0.15	0.14	706	31	10	91		
236619	29	I	RAI	101	0.89	0.13	1.40	0.15	0.11	0.17	860	124	33	152		
236620	30	I	TAL	101	1.18	0.22	1.97	0.21	0.21	0.16	1685	54	22	159		
236621	31	I	HOJ	101	3.38	0.16	3.07	0.18	0.13	0.15	449	27	11	104		
236622	32	I	PEC	101	0.78	0.17	1.77	0.30	0.21	0.19	502	26	31	187		
236623	33	I	RAI	110	1.04	0.15	1.24	0.17	0.14	0.21	1639	198	39	208		
236624	34	I	TAL	110	1.18	0.26	1.89	0.20	0.23	0.16	650	43	18	70		
236625	35	I	HOJ	110	3.26	0.22	1.61	0.33	0.30	0.30	464	19	17	121		
236626	36	I	PEC	110	0.84	0.22	2.53	0.19	0.12	0.16	493	28	11	81		
236627	37	I	RAI	111	1.01	0.18	1.26	0.18	0.13	0.22	1386	249	127	187		
236628	38	I	TAL	111	1.07	0.23	2.08	0.21	0.18	0.17	1226	47	25	37		
236629	39	I	HOJ	111	3.00	0.22	1.64	0.35	0.22	0.32	805	27	30	108		
236630	40	I	PEC	111	0.98	0.23	2.61	0.22	0.16	0.18	901	36	17	79		
236631	41	I	RAI	120	0.81	0.19	1.13	0.16	0.13	0.17	1246	226	64	146		
236632	42	I	TAL	120	1.04	0.30	1.71	0.23	0.22	0.18	1799	74	30	56		
236633	43	I	HOJ	120	2.86	0.22	1.89	0.31	0.21	0.37	578	27	23	81		
236634	44	I	PEC	120	0.75	0.33	2.84	0.18	0.13	0.18	369	27	9	46		
236635	45	I	RAI	121	0.89	0.17	1.52	0.17	0.13	0.18	988	143	40	97		
236636	46	I	TAL	121	1.24	0.31	2.02	0.29	0.24	0.18	1279	28	15	83		
236637	47	I	HOJ	121	2.97	0.22	1.77	0.39	0.25	0.25	453	18	24	97		
236638	48	I	PEC	121	0.84	0.30	2.78	0.27	0.17	0.15	897	23	9	70		
236639	49	I	RAI	200	0.95	0.12	1.36	0.17	0.12	0.18	999	134	32	204		
236640	50	I	TAL	200	1.24	0.23	1.82	0.25	0.22	0.16	972	51	20	109		
236641	51	I	HOJ	200	2.80	0.20	1.46	0.42	0.25	0.25	340	23	20	126		
236642	52	I	PEC	200	0.78	0.18	2.78	0.24	0.16	0.14	360	34	29	86		
236643	53	I	RAI	201	0.95	0.11	1.39	0.14	0.10	[illegible]	1275	[illegible]	[illegible]	172		
236644	54	I	TAL	201	1.18	0.25	1.84	0.18	0.21	0.16	482	32	13	95		
236645	55	I	HOJ	201	4.33	0.20	2.66	0.17	0.14	0.18	325	22	7	93		
236646	56	I	PEC	201	1.07	0.20	1.49	0.34	0.23	0.30	384	20	17	128		
236647	57	I	RAI	210	0.95	0.14	1.08	0.16	0.12	0.18	1084	134	29	145		
236648	58	I	TAL	210	1.18	0.27	1.80	0.21	0.22	0.16	796	41	13	81		
236649	59	I	HOJ	210	3.00	0.20	1.44	0.39	0.21	0.21	325	20	18	102		
236650	60	I	PEC	210	0.92	0.26	2.59	0.21	0.17	0.17	381	33	5	56		
236651	61	I	RAI	211	1.04	0.12	1.19	0.13	0.10	0.16	1160	103	29	247		
236652	62	I	TAL	211	1.41	0.30	2.23	0.23	0.25	0.16	1181	55	25	127		
236653	63	I	HOJ	211	3.81	0.20	1.49	0.30	0.27	0.21	554	32	18	177		
236654	64	I	PEC	211	0.95	0.17	3.04	0.31	0.16	0.14	580	33	9	107		
236655	65	I	RAI	220	0.92	0.14	1.20	0.19	0.11	0.13	1549	150	30	115		
236656	66	I	TAL	220	1.33	0.27	1.60	0.15	0.21	0.16	793	55	13	65		
236657	67	I	HOJ	220	3.32	0.21	1.69	0.19	0.24	0.25	360	29	14	82		
236658	68	I	PEC	220	0.78	0.26	2.42	0.29	0.15	0.15	304	27	5	49		
236659	69	I	RAI	221	[illegible]	[illegible]	[illegible]	[illegible]	0.11	0.20	1579	197	48	158		
236660	70	I	TAL	221	1.44	0.28	2.12	0.20	0.20	0.17	739	39	21	93		
236661	71	I	HOJ	221	2.91	0.20	1.85	0.21	0.23	0.21	249	22	20	154		
236662	72	I	PEC	221	0.72	0.25	2.84	0.20	0.13	0.16	233	24	6	73		

JEFE DE LABORATORIO : B.Q. Javier Jaen D. FIRMA :

SUPERVISOR : Ing. Antonio Lopez M. FIRMA :

JJD/jmg.

CONVENIO CATIE/UAW/MAG

Replicate II

FECHA DE RECIBO : 09/12/91
FECHA DE ENTREGA : 28/02/92
FECHA DEL MUESTREO: 03/12/91
No DE MUESTRAS : [illegible]

CODIGO DE INGRESO	CODIGO DE CAMPO				% sobre base seca N	P	K	Ca	Mg	S	ppm Fe	Cu	Zn	Mn	B	OBSERVACIONES
236739	1	II	RAI	000	0.75	0.11	1.16	0.14	0.09	0.17	1502	149	29	99		
236740	2	II	TAL	000	1.07	0.22	1.54	0.17	0.23	0.20	2348	57	26	130		PEJIBAYE
236741	3	II	HOJ	000	2.83	0.20	1.80	0.26	0.23	0.26	556	20	24	75		ENSAYO II
236742	4	II	PEC	000	0.84	0.20	2.66	0.18	0.15	0.18	584	26	11	44		
236743	5	II	RAI	001	0.81	0.10	1.11	0.12	0.10	0.15	1061	159	37	106		
236744	6	II	TAL	001	1.07	0.20	1.77	0.17	0.20	0.18	831	35	14	74		
236745	7	II	HOJ	001	3.03	0.20	2.01	0.23	0.20	0.34	380	19	19	115		
236746	8	II	PEC	001	0.84	0.19	2.80	0.18	0.14	0.20	645	24	10	71		
236747	9	II	RAI	010	0.89	0.20	1.44	0.15	0.14	0.18	1169	245	46	89		
236748	10	II	TAL	010	1.53	0.31	2.10	0.19	0.21	0.23	418	39	16	46		
236749	11	II	HOJ	010	3.64	0.22	1.76	0.26	0.22	0.30	250	23	19	90		
236750	12	II	PEC	010	0.87	0.28	3.07	0.17	0.15	0.24	219	229	114	38		
236751	13	II	RAI	011	0.87	0.17	1.32	0.15	0.11	0.18	1367	201	32	122		
236752	14	II	TAL	011	1.24	0.32	2.41	0.21	0.25	0.20	1948	44	18	99		
236753	15	II	HOJ	011	3.00	0.20	1.29	0.39	0.25	0.29	1949	28	22	139		
236754	16	II	PEC	011	0.92	0.33	3.07	0.21	0.17	0.20	896	30	9	77		
236755	17	II	RAI	020	0.81	0.17	1.19	0.15	0.10	0.16	1059	147	44	99		
236756	18	II	TAL	020	1.18	0.32	1.86	0.20	0.24	0.20	342	36	11	77		
236757	19	II	HOJ	020	3.20	0.30	1.57	0.37	0.29	0.30	214	29	14	84		
236758	20	II	PEC	020	0.84	0.35	2.92	0.20	0.17	0.22	204	23	8	39		
236759	21	II	RAI	021	0.89	0.16	1.47	0.16	0.11	0.19	2057	136	46	132		
236760	22	II	TAL	021	1.21	0.36	2.15	0.23	0.25	0.23	1109	54	16	75		
236761	23	II	HOJ	021	3.06	0.16	1.18	0.30	0.21	0.29	414	3[illegible]	17	67		
236762	24	II	PEC	021	0.89	0.33	3.01	0.19	0.16	0.21	335	15	7	44		
236763	25	II	RAI	100	1.27	0.15	1.38	0.16	0.12	0.18	2295	154	35	234		
236764	26	II	TAL	100	1.30	0.23	1.55	0.22	0.22	0.18	700	41	15	56		
236765	27	II	HOJ	100	3.20	0.19	1.34	0.33	0.26	0.17	580	23	15	145		
236766	28	II	PEC	100	0.89	0.17	2.03	0.18	0.16	0.14	260	26	7	74		
236767	29	II	RAI	101	0.78	0.09	1.20	0.14	0.10	0.13	1127	114	23	122		
236768	30	II	TAL	101	1.24	0.24	2.07	0.26	0.22	0.14	636	37	13	59		
236769	31	II	HOJ	101	3.26	0.19	1.78	0.39	0.24	0.27	435	22	14	193		
236770	32	II	PEC	101	0.84	0.17	3.40	0.22	0.14	0.13	316	25	8	59		
236771	33	II	RAI	110	0.84	0.14	1.08	0.17	0.11	0.16	1674	147	40	129		
236772	34	II	TAL	110	1.13	0.26	1.62	0.22	0.22	0.16	905	26	14	52		
236773	35	II	HOJ	110	2.74	0.18	1.40	0.43	0.26	0.24	728	27	19	109		
236774	36	II	PEC	110	0.78	0.23	2.31	0.20	0.15	0.14	246	17	5	43		
236775	37	II	RAI	111	0.81	0.13	1.15	0.13	0.12	0.16	1814	128	24	120		
236776	38	II	TAL	111	1.36	0.28	1.92	0.20	0.25	0.14	730	24	17	66		
236777	39	II	HOJ	111	2.40	0.20	1.63	0.32	0.24	0.20	400	22	14	133		
236778	40	II	PEC	111	0.89	0.20	2.79	0.19	0.15	0.13	296	24	6	67		
236779	41	II	RAI	120	0.87	0.15	1.28	0.16	0.12	0.19	1841	114	34	154		
236780	42	II	TAL	120	1.27	0.28	1.84	0.22	0.22	0.18	647	41	13	[illegible]		
236781	43	II	HOJ	120	3.17	0.20	1.66	0.32	0.25	0.26	296	23	16	85		
236782	44	II	PEC	120	0.87	0.24	2.48	0.18	0.15	0.14	216	26	6	45		
236783	45	II	RAI	121	0.81	0.13	[illegible]44	0.14	0.11	0.15	1560	106	28	145		
236784	46	II	TAL	121	1.10	0.21	1.89	0.20	0.21	0.14	810	40	12	50		
236785	47	II	HOJ	121	3.17	0.16	1.39	0.35	0.23	0.26	1198	27	25	123		
236786	48	II	PEC	121	0.89	0.16	2.54	0.18	0.14	0.14	395	21	15	52		
236787	49	II	RAI	200	0.87	0.12	1.18	0.15	0.11	0.17	1367	156	27	151		
236788	50	II	TAL	200	1.36	0.25	1.92	0.22	0.25	0.17	1075	40	23	89		
236789	51	II	HOJ	200	3.06	0.21	1.53	0.28	0.22	0.21	260	19	14	129		
236790	52	II	PEC	200	0.84	0.17	2.40	0.18	0.15	0.13	201	22	8	68		
236791	53	II	RAI	201	0.84	0.12	1.34	0.14	0.11	0.16	1186	134	26	110		
236792	54	II	TAL	201	1.21	0.24	1.98	0.23	0.24	0.14	1076	4[illegible]	15	72		
236793	55	II	HOJ	201	3.00	0.19	1.56	0.39	0.24	0.2[illegible]	447	22	18	106		
236794	56	II	PEC	201	0.81	0.18	1.54	0.39	0.25	0.21	436	21	17	103		
236795	57	II	RAI	210	0.84	0.21	2.89	0.19	0.17	0.14	320	19	14	46		
236796	58	II	TAL	210	1.13	0.14	1.14	0.14	0.11	0.15	1497	150	63	119		
236797	59	II	HOJ	210	3.26	0.18	1.47	0.26	0.21	0.21	194	18	16	92		
236798	60	II	PEC	210	0.92	0.23	2.49	0.19	0.16	0.14	244	25	9	63		
236799	61	II	RAI	211	0.84	0.12	1.06	0.16	0.11	0.15	1908	1	79	139		
236800	62	II	TAL	211	1.13	0.27	2.01	0.21	0.23	0.13	1240	55	18	85		
236801	63	II	HOJ	211	3.32	0.20	1.50	0.35	0.27	0.20	359	22	18	125		
236802	64	II	PEC	211	0.95	0.24	2.81	0.20	0.17	0.15	630	35	11	82		
236803	65	II	RAI	220	0.87	0.15	1.16	0.14	0.11	0.16	1332	113	23	156		
236804	66	II	TAL	220	1.15	0.30	1.72	0.20	0.23	0.16	1421	42	19	87		
236805	67	II	HOJ	220	3.12	0.20	1.42	0.38	0.29	0.29	1324	25	16	139		
236806	68	II	PEC	220	0.87	0.27	2.39	0.18	0.16	0.17	950	27	7	76		
236807	69	II	RAI	221	0.87	0.12	1.10	0.13	0.10	0.14	1810	145	29	134		
236808	70	II	TAL	221	1.18	0.28	2.00	0.23	0.22	0.13	880	57	20	91		
236809	71	II	HOJ	221	3.61	0.20	1.73	0.34	0.24	0.20	290	20	15	162		
236810	72	II	PEC	221	0.95	0.21	2.93	0.13	0.15	0.12	299	29	8	74		
236811	73	II	HIJOS		1.76	0.25	2.37	0.13	0.17	0.20	1006	23	33	56		

JEFE DE LABORATORIO : B.Q. Javier Jaen D. FIRMA : [signature]

SUPERVISOR : Ing. Antonio Lopez M. FIRMA : [signature]

RESULTADO DE ANALISIS FOLIARES

REPORTE No : 908 F
FECHA DE RECIBO : 02/01/92
FECHA DE ENTREGA : 19/06/92
FECHA DEL MUESTREO :
No DE MUESTREO :

Sr. Programa CATIE/UAW/MAG

Replicate III

CODIGO DE INGRESO	CODIGO DE CAMPO			% sobre base seca N	P	K	Ca	Mg	S	ppm Fe	Cu	Zn	Mn	B	OBSERVACIONES
237271	II	RAI 000	1	1.01	0.16	1.31	0.18	0.13	0.09	1813	170	100	121		
237272	II	TAL 000	2	1.21	0.31	2.04	0.20	0.20	0.13	890	52	37	46		PALMITO
237273	II	HOJ 000	3	2.77	0.20	1.87	0.34	0.23	0.30	398	30	21	62		
237274	II	PEC 000	4	0.84	0.30	3.02	0.19	0.14	0.19	246	35	18	35		PEJIBAYE
237275	II	RAI 001	5	0.84	0.17	1.26	0.17	0.13	0.15	1383	210	60	124		
237276	II	TAL 001	6	1.15	0.29	2.15	0.21	0.25	0.19	1515	50	21	68		
237277	II	HOJ 001	7	0.66	0.22	1.54	0.46	0.32	0.34	430	33	19	121		
237278	II	PEC 001	8	3.17	0.30	2.89	0.22	0.17	0.20	227	26	8	66		
237279	II	RAI 010	9	0.84	0.17	1.36	0.17	0.12	0.17	1391	157	40	99		
237280	II	TAL 010	10	1.36	0.36	2.00	0.24	0.24	0.24	472	62	16	62		
237281	II	HOJ 010	11	3.00	0.23	1.76	0.31	0.21	0.37	403	26	23	97		
237282	II	PAC 010	12	0.84	0.35	2.63	0.22	0.15	0.25	252	34	8	62		
237283	II	RAI 011	13	0.98	0.17	1.38	0.19	0.12	0.19	4371	209	48	169		
237284	II	TAL 011	14	1.21	0.38	2.33	0.25	0.24	0.21	1363	52	19	245		
237285	II	HOJ 011	15	2.74	0.21	1.95	0.40	0.24	0.36	368	32	18	100		
237286	II	PEC 011	16	0.87	0.39	3.06	0.21	0.14	0.20	365	35	11	66		
237287	II	RAI 020	17	0.95	0.19	1.12	0.17	0.12	0.19	1973	209	53	135		
237288	II	TAL 020	18	1.18	0.34	1.97	0.22	0.21	0.22	945	49	15	77		
237289	II	HOJ 020	19	1.01	0.20	1.49	0.38	0.23	0.34	212	33	15	104		
237290	II	PEC 020	20	0.92	0.33	2.83	0.20	0.13	0.22	261	28	8	52		
237291	II	RAI 021	21	1.18	0.18	1.23	0.18	0.12	0.18	700	166	68	158		
237292	II	TAL 021	22	1.21	0.31	2.10	0.21	0.20	0.19	1749	32	17	76		
237293	II	HOJ 021	23	3.06	0.22	1.92	0.31	0.19	0.37	300	32	20	65		
237294	II	PEC 021	24	0.87	0.38	2.92	0.21	0.14	0.22	309	27	16	44		
237295	II	RAI 100	25	1.53	0.14	1.22	0.20	0.13	0.17	1586	155	59	120		
237296	II	TAL 100	26	1.15	0.26	1.75	0.24	0.24	0.15	676	51	14	68		
237297	II	HOJ 100	27	3.52	0.21	1.49	0.34	0.26	0.23	272	20	18	107		
237298	II	PEC 100	28	0.87	0.21	2.30	0.22	0.17	0.14	211	23	8	10		
237299	II	RAI 101	29	0.92	0.12	1.06	0.19	0.13	0.17	3546	146	32	85		
237300	II	TAL 101	30	1.18	0.27	1.98	0.25	0.22	0.15	1077	42	16	36		
237301	II	HOJ 101	31	3.00	0.20	1.46	0.39	0.23	0.22	311	22	17	59		
237302	II	PEC 101	32	0.98	0.19	2.71	0.21	0.13	0.14	261	46	12	20		
237303	II	RAI 110	33	0.84	0.13	1.14	0.17	0.15	0.15	5004	166	46	104		
237304	II	TAL 110	34	1.30	0.27	1.89	0.21	0.22	0.17	1145	50	16	35		
237305	II	HOJ 110	35	3.29	0.20	1.68	0.25	0.20	0.19	497	25	16	54		
237306	II	PEC 110	36	0.92	0.20	2.95	0.18	0.14	0.15	435	32	8	22		
237307	II	RAI 111	37	1.01	0.20	1.45	0.19	0.12	0.15	1482	126	55	142		
237308	II	TAL 111	38	1.21	0.31	2.04	0.25	0.24	0.13	483	53	18	40		
237309	II	HOJ 111	39	3.15	0.22	1.68	0.37	0.26	0.21	274	29	20	93		
237310	II	PEC 111	40	0.92	0.30	2.02	0.26	0.25	0.15	224	43	17	40		
237311	II	RAI 120	41	1.01	0.16	1.73	0.29	0.18	0.17	1781	30	29	89		
237312	II	TAL 120	42	1.27	0.36	2.82	0.27	0.19	0.15	1154	30	16	38		
237313	II	HOJ 120	43	3.41	0.21	1.28	0.16	0.12	0.26	426	133	16	61		
237314	II	PEC 120	44	0.89	0.27	2.34	0.24	0.17	0.13	673	30	10	29		
237315	II	RAI 121	45	0.87	0.16	1.18	0.18	0.11	0.15	1696	157	17	109		
237316	II	TAL 121	46	1.27	0.34	2.25	0.28	0.20	0.15	1037	46	16	57		
237317	II	HOJ 121	47	3.35	0.23	1.72	0.34	0.22	0.23	385	19	16	60		
237318	II	PEC 121	48	0.89	0.27	3.07	0.25	0.16	0.18	290	26	7	32		
237319	II	RAI 200	49	4.18	0.16	1.37	0.17	0.12	0.19	1863	149	40	85		
237320	II	TAL 200	50	2.80	0.28	2.00	0.29	0.21	0.17	1374	43	20	47		
237321	II	HOJ 200	51	3.58	0.20	1.48	0.49	0.25	0.29	404	27	20	65		
237322	II	PEC 200	52	0.98	0.26	2.82	0.24	0.15	0.15	518	26	14	16		
237323	II	RAI 201	53	0.95	0.14	1.43	0.17	0.11	0.16	703	158	38	120		
237324	II	TAL 201	54	1.36	0.35	2.40	0.22	0.24	0.15	361	41	19	42		
237325	II	HOJ 201	55	3.03	0.20	1.80	0.37	0.23	0.24	329	24	16	114		
237326	II	PEC 201	56	0.84	0.31	3.15	0.19	0.15	0.16	189	27	8	37		
237327	II	RAI 210	57	0.98	0.16	1.20	0.16	0.12	0.20	1328	128	51	82		
237328	II	TAL 210	58	1.59	0.36	2.27	0.28	0.28	0.22	1244	53	27	55		
237329	II	HOJ 210	59	2.83	0.22	1.91	0.41	0.27	0.29	263	27	22	68		
237330	II	PEC 210	60	0.95	0.26	2.99	0.26	0.19	0.18	277	29	10	27		
237331	II	RAI 211	61	0.92	0.07	0.84	0.10	0.06	0.14	459	76	17	52		
237332	II	TAL 211	62	1.30	0.29	2.28	0.26	0.29	0.19	1110	37	18	71		
237333	II	HOJ 211	63	3.35	0.21	1.71	0.37	0.26	0.26	386	30	18	126		
237334	II	PEC 211	64	0.84	0.19	2.69	0.20	0.16	0.14	455	33	12	49		
237335	II	RAI 220	65	0.84	0.14	1.22	0.16	0.13	0.19	1907	120	28	64		
237336	II	TAL 220	66	1.39	0.32	2.11	0.24	0.24	0.16	1228	49	18	90		
237337	II	HOJ 220	67	3.26	0.23	1.66	0.35	0.27	0.23	377	40	19	80		
237338	II	PEC 220	68	1.07	0.23	2.65	0.23	0.18	0.16	446	36	13	24		
237339	II	RAI 221	69	0.87	0.16	1.16	0.17	0.11	0.18	1048	140	42	63		
237340	II	TAL 221	70	1.33	0.31	1.99	0.26	0.24	0.22	1403	44	21	41		
237341	II	HOJ 221	71	2.97	0.25	2.09	0.25	0.20	0.25	391	22	19	63		
237342	II	PEC 221	72	0.92	0.32	2.98	0.21	0.14	0.22	350	25	9	28		
237343	II	HIJOS	73	1.85	0.27	2.15	0.19	0.19	0.27	746	24	25	23		

JEFE DE LABORATORIO : B.Q. Javier Jaen D. FIRMA :

SUPERVISOR : Ing. Antonio Lopez M. FIRMA :

RESULTADO DE ANALISIS FOLIARES

REPORTE No : 909 F
FECHA DE RECIBO : 02/01/92
FECHA DE ENTREGA : 19/06/92
FECHA DEL MUESTREO :
No DE MUESTREO :

Sr. Programa CATIE/UAW/MAG

Replicate IV

CODIGO DE INGRESO	CODIGO DE CAMPO		N	P	K	Ca	Mg	S	Fe	Cu	Zn	Mn	B	OBSERVACIONES
			% sobre base seca						ppm					
237344	IV RAI 000	1	0.87	0.17	1.03	0.17	0.17	0.25	56334	215	63	107		
237345	IV TAL 000	2	1.04	0.26	1.46	0.23	0.23	0.26	1700	50	15	12		PALMITO
237346	IV HOJ 000	3	2.91	0.20	1.52	0.51	0.27	0.39	843	28	19	32		
237347	IV PEC 000	4	0.84	0.23	2.31	0.25	0.17	0.22	700	35	9	29		PEJIBAYE
237348	IV RAI 001	5	0.81	0.15	1.13	0.16	0.11	0.20	1994	161	29	28		
237349	IV TAL 001	6	1.33	0.36	2.43	0.28	0.29	0.29	995	42	18	8		
237350	IV HOJ 001	7	3.32	0.22	1.70	0.36	0.24	0.36	1171	27	21	32		
237351	IV PEC 001	8	1.01	0.33	3.19	0.25	0.19	0.28	462	30	9	3		
237352	IV RAI 010	9	0.81	0.17	1.11	0.16	0.12	0.19	3747	193	39	56		
237353	IV TAL 010	10	1.33	0.35	2.12	0.22	0.24	0.27	105	54	20	27		
237354	IV HOJ 010	11	2.86	0.23	1.57	0.34	0.27	0.36	517	24	23	9		
237355	IV PAC 010	12	0.87	0.35	2.56	0.22	0.17	0.28	317	36	7	23		
237356	IV RAI 011	13	1.18	0.20	1.33	0.25	0.19	0.28	4224	209	89	140		
237357	IV TAL 011	14	1.39	0.39	2.43	0.24	0.24	0.25	1469	54	16	10		
237358	IV HOJ 011	15	2.98	0.24	1.91	0.36	0.24	0.37	446	20	22	9		
237359	IV PEC 011	16	0.95	0.46	3.16	0.23	0.17	0.28	523	33	7	47		
237360	IV RAI 020	17	1.90	0.17	1.38	0.20	0.16	0.22	3421	165	49	80		
237361	IV TAL 020	18	1.27	0.35	1.73	0.24	0.30	0.25	5397	102	17	20		
237362	IV HOJ 020	19	3.20	0.23	1.67	0.30	0.26	0.32	302	23	13	39		
237363	IV PEC 020	20	0.86	0.34	2.54	0.22	0.17	0.26	945	36	7	25		
237364	IV RAI 021	21	0.81	0.16	1.06	0.15	0.14	0.21	5733	193	32	77		
237365	IV TAL 021	22	2.19	0.35	2.13	0.26	0.30	0.27	4155	61	19	25		
237366	IV HOJ 021	23	3.55	0.23	1.96	0.36	0.29	0.33	713	19	19	24		
237367	IV PEC 021	24	0.81	0.36	3.07	0.20	0.16	0.26	291	24	7	76		
237368	IV RAI 100	25	1.04	0.13	1.00	0.22	0.17	0.25	5142	187	48	78		
237369	IV TAL 100	26	1.18	0.27	1.40	0.26	0.25	0.23	1568	45	12	49		
237370	IV HOJ 100	27	3.49	0.19	1.04	0.53	0.33	0.29	482	31	13	17		
237371	IV PEC 100	28	0.89	0.20	1.97	0.24	0.16	0.24	371	29	4	26		
237372	IV RAI 101	29	0.84	0.15	1.20	0.15	0.13	0.21	6102	143	31	118		
237373	IV TAL 101	30	1.36	0.29	2.64	0.25	0.26	0.24	1221	82	13	41		
237374	IV HOJ 101	31	3.46	0.20	1.64	0.49	0.29	0.32	446	32	15	77		
237375	IV PEC 101	32	1.27	0.24	3.34	0.25	0.18	0.23	474	41	6	43		
237376	IV RAI 110	33	3.49	0.19	1.21	0.20	0.16	0.23	6303	177	84	166		
237377	IV TAL 110	34	1.41	0.35	1.87	0.27	0.25	0.27	4974	53	31	88		
237378	IV HOJ 110	35	3.03	0.22	1.70	0.38	0.25	0.32	897	24	24	59		
237379	IV PEC 110	36	1.04	0.28	2.43	0.23	0.14	0.24	518	31	8	20		
237380	IV RAI 111	37	0.92	0.15	1.06	0.15	0.14	0.21	4641	186	49	154		
237381	IV TAL 111	38	1.44	0.30	2.14	0.23	0.25	0.22	4125	53	12	82		
237382	IV HOJ 111	39	2.97	0.21	1.66	0.36	0.25	0.22	767	31	16	96		
237383	IV PEC 111	40	1.10	0.23	2.85	0.19	0.14	0.17	294	27	5	34		
237384	IV RAI 120	41	0.89	0.18	1.22	0.16	0.13	0.12	243	153	41	50		
237385	IV TAL 120	42	1.27	0.35	1.83	0.26	0.28	0.19	1311	38	16	18		
237386	IV HOJ 120	43	3.43	0.22	1.44	0.40	0.28	0.28	654	30	17	46		
237387	IV PEC 120	44	1.01	0.32	2.57	0.25	0.18	0.17	466	28	6	41		
237388	IV RAI 121	45	0.87	0.17	1.12	0.16	0.13	0.15	3987	206	43	82		
237389	IV TAL 121	46	0.29	0.32	2.09	0.23	0.24	0.16	1027	48	12	24		
237390	IV HOJ 121	47	2.89	0.25	1.97	0.24	0.21	0.21	443	17	13	64		
237391	IV PEC 121	48	0.98	0.32	2.96	0.21	0.17	0.16	467	27	5	42		
237392	IV RAI 200	49	0.92	0.17	0.96	0.18	0.16	0.18	6111	205	60	126		
237393	IV TAL 200	50	1.30	0.30	1.86	0.23	0.24	0.14	1701	40	15	48		
237394	IV HOJ 200	51	3.15	0.22	1.47	0.35	0.26	0.21	908	24	17	59		
237395	IV PEC 200	52	0.95	0.22	2.26	0.20	0.17	0.15	850	34	9	28		
237396	IV RAI 201	53	2.45	0.13	0.81	0.19	0.18	0.19	6258	171	40	165		
237397	IV TAL 201	54	0.46	0.30	1.64	0.26	0.30	0.15	6441	64	20	122		
237398	IV HOJ 201	55	3.46	0.22	1.38	0.37	0.29	0.26	1302	27	25	96		
237399	IV PEC 201	56	0.84	0.21	2.11	0.25	0.19	0.13	826	25	5	34		
237400	IV RAI 210	57	0.95	0.15	0.96	0.20	0.15	0.16	5469	149	44	125		
237401	IV TAL 210	58	1.41	0.34	1.75	0.25	0.27	0.16	1739	56	17	38		
237402	IV HOJ 210	59	3.12	0.22	1.41	0.36	0.26	0.20	482	27	18	33		
237403	IV PEC 210	60	0.89	0.24	2.17	0.21	0.16	0.13	354	21	5	11		
237404	IV RAI 211	61	1.01	0.14	1.11	0.16	0.12	0.15	3594	131	43	73		
237405	IV TAL 211	62	1.53	0.36	2.08	0.25	0.25	0.16	1059	49	15	37		
237406	IV HOJ 211	63	3.49	0.22	1.47	0.37	0.22	0.23	341	21	12	84		
237407	IV PEC 211	64	0.63	0.23	2.11	0.21	0.17	0.11	385	29	5	47		
237408	IV RAI 220	65	0.81	0.15	0.94	0.16	0.12	0.12	1971	165	37	101		
237409	IV TAL 220	66	0.18	0.28	1.61	0.26	0.26	0.13	715	37	12	49		
237410	IV HOJ 220	67	3.15	0.22	1.45	0.38	0.27	0.23	460	24	20	83		
237411	IV PEC 220	68	0.87	0.18	2.14	0.22	0.17	0.12	260	25	7	40		
237412	IV RAI 221	69	1.01	0.16	1.19	0.18	0.14	0.15	5538	129	47	133		
237413	IV TAL 221	70	1.39	0.33	2.17	0.28	0.25	0.13	3702	59	18	77		
237414	IV HOJ 221	71	3.55	0.20	1.36	0.43	0.24	0.21	905	47	16	93		
237415	IV PEC 221	72	0.98	0.26	2.70	0.25	0.15	0.11	370	31	11	44		
237416	IV HIJOS	73	1.79	0.26	2.31	0.13	0.16	0.19	1619	24	13	51		

JEFE DE LABORATORIO : B.Q. Javier Jaen D. FIRMA :

SUPERVISOR : Ing. Antonio López M. FIRMA :

DATA FOR 3 x 3 x 2 FACTORIAL EXPERIMENT (CONFOUNDED)
PARAMETER: weight of stems of young palmito de pejibaye
EXPRESSED IN: kg/ha

Ia		Ib		Ic			IIIa		IIIb		IIIc		
011:	103	001:	68	000:	75		010:	78	001:	87	000:	63	
020:	98	010:	57	021:	123		021:	100	020:	89	011:	80	
100:	108	111:	105	101:	93		100:	132	110:	99	101:	95	
121:	107	120:	85	110:	136		111:	116	121:	119	120:	132	
201:	114	200:	85	211:	105		201:	82	200:	142	210:	117	
210:	103	221:	107	220:	132		220:	114	211:	126	221:	118	
	633		507		664	1804		622		662		605	1890
IIa		IIb		IIc			IVa		IVb		IVc		
010:	103	000:	115	001:	95		011:	93	000:	105	001:	111	
021:	101	011:	165	020:	162		020:	101	021:	84	010:	79	
101:	115	110:	125	100:	79		101:	125	111:	112	100:	177	
120:	85	121:	125	111:	120		110:	115	120:	94	121:	121	
200:	177	201:	111	210:	156		200:	167	201:	128	211:	169	
211:	110	220:	124	221:	171		221:	128	210:	85	220:	142	
	691		765		785	2241		729		608		799	2136

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ANALYSIS OF VARIANCE:

SOURCE OF VARIATION	DEGREES OF FREEDOM		SUM OF SQUARES	MEAN SQUARES	F	5%	1%
REPLICATIONS	3		6990.71	2330.24	4.07	3.21	5.12
BLOCKS IN REPLICATIONS	8		6517.44	814.68	1.42	2.17	2.95
N	2		5201.03	2600.51	4.54	3.22	5.13
P	2		169.36	84.68	0.15	3.22	5.13
K	1		15.13	15.13	0.02	4.06	7.25
N x P	4	* 7/8	1902.10	475.53	0.83	2.58	3.76
N x K	2		690.08	345.04	0.60	3.22	5.13
P x K	2		4069.75	2034.88	3.55	3.22	5.13
N x P x K	4	* 5/8	2447.77	611.94	1.07	2.58	3.79
ERROR	43		24609.95	572.30			
TOTAL	71		52613				

DATA FOR 3 x 3 x 2 FACTORIAL EXPERIMENT (CONFOUNDED)
PARAMETER: diameter of stem at base
EXPRESSED IN: mm

Ia		Ib		Ic			IIIa		IIIb		IIIc	
011:	44.75	001:	37.25	000:	39.00		010:	42.00	001:	43.75	[illegible]	[illegible]
020:	43.00	010:	33.00	021:	41.50		021:	46.50	020:	40.25	[illegible]	[illegible]
100:	44.00	111:	43.25	101:	42.50		100:	39.00	110:	48.00	[illegible]	[illegible]
121:	46.25	120:	45.75	110:	50.25		111:	46.50	121:	48.25	[illegible]	[illegible]
201:	44.75	200:	40.50	211:	48.50		201:	45.25	200:	50.00	[illegible]	[illegible]
210:	44.75	221:	44.00	220:	50.50		220:	48.00	211:	51.00	[illegible]	[illegible]
	267.50		243.75		272.25	763 50		267.25		281.25		
IIa		IIb		IIc			IVa		IVb		IVc	
010:	49.25	000:	45.50	001:	41.50		011:	45.75	000:	40.75	[illegible]	[illegible]
021:	45.00	011:	53.50	020:	50.25		020:	41.50	021:	45.00	[illegible]	[illegible]
101:	48.75	110:	48.25	100:	42.50		101:	45.00	111:	46.50	[illegible]	[illegible]
120:	46.50	121:	51.25	111:	54.75		110:	44.25	120:	41.75	[illegible]	[illegible]
200:	47.00	201:	49.00	210:	51.50		200:	50.25	201:	41.00	[illegible]	[illegible]
211:	47.50	220:	52.50	221:	52.25		221:	45.25	210:	54.25	[illegible]	[illegible]
	284.00		300.00		292.75	876.75		272.00		269.25		

IIIa IIIb IIIc

ANALYSIS OF VARIANCE: diameter of stem at base (mm)

SOURCE OF VARIATION	DEGREES OF FREEDOM		SUM OF SQUARES	MEAN SQUARES	F	5%	1%
REPLICATIONS	3		248.52	82.84	6.59	3.21	5.12
BLOCKS IN REPLICATIONS	8		198.40	24.80	1.97	2.17	2.95
N	2		317.69	158.85	12.64	3.22	5.13
P	2		84.57	42.28	3.37	3.22	5.13
K	1		13.13	13.13	1.05	4.06	7.25
N x P	4	* 7/8	60.22	15.06	1.20	2.58	3.76
N x K	2		12.02	6.01	0.48	3.22	5.13
P x K	2		17.08	8.54	0.68	3.22	5.13
N x P x K	4	* 5/8	16.70	4.17	0.33	2.58	3.79
ERROR	43		540.29	12.56			
TOTAL	71		1509				

Physical measurements on fertilizer trial for palmito
(Block results and ANOVA tables for effects)

DATA FOR 3 x 3 x 2 FACTORIAL EXPERIMENT (CONFOUNDED)
PARAMETER: total biomassa of young palmito de pejibaye
EXPRESSED IN: kg/ha

Ia		Ib		Ic			IIIa		IIIb		IIIc		
011:	325	001:	244	000:	256		010:	248	001:	279	000:	202	
020:	374	010:	197	021:	305		021:	274	020:	314	011:	266	
100:	351	111:	278	101:	250		100:	340	110:	307	101:	259	
121:	354	120:	357	110:	384		111:	334	121:	332	120:	371	
201:	345	200:	260	211:	299		201:	252	200:	395	210:	322	
210:	327	221:	308	220:	349		220:	337	211:	369	221:	286	
	2076		1644		1843	5563		1785		1996		1707	5488
IIa		IIb		IIc			IVa		IVb		IVc		
010:	374	000:	329	001:	297		011:	267	000:	289	001:	288	
021:	340	011:	418	020:	412		020:	339	021:	286	010:	264	
101:	375	110:	338	100:	243		101:	374	111:	313	100:	441	
120:	299	121:	352	111:	351		110:	330	120:	296	121:	348	
200:	407	201:	354	210:	393		200:	459	201:	383	211:	456	
211:	321	220:	382	221:	396		221:	353	210:	267	220:	413	
	2116		2173		2092	6381		2122		1854		2210	6186

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ANALYSIS OF VARIANCE: total biomassa of young palmito de pejibaye (kg/ha)

SOURCE OF VARIATION	DEGREES OF FREEDOM		SUM OF SQUARES	MEAN SQUARES	F	5%	1%
REPLICATIONS	3		33133	11044	4.72	3.21	5.12
BLOCKS IN REPLICATIONS	8		35074	4384	1.87	2.17	2.95
N	2		34124	17062	7.29	3.22	5.13
P	2		5985	2992	1.28	3.22	5.13
K	1		1760	1760	0.75	4.06	7.25
N x P	4	* 7/8	6930	1732	0.74	2.58	3.76
N x K	2		863	431	0.18	3.22	5.13
P x K	2		7410	3705	1.58	3.22	5.13
N x P x K	4	* 5/8	3271	818	0.35	2.58	3.79
ERROR	43		100615	2340			
TOTAL	71		229164				

DATA FOR 3 x 3 x 2 FACTORIAL EXPERIMENT (CONFOUNDED)
PARAMETER: number of leaves of palmito de pejibaye
EXPRESSED IN: number per plant

Ia		Ib		Ic			IIIa		IIIb	
011:	9.50	001:	7.50	000:	8.00		010:	8.75	001:	9.25
020:	9.75	010:	7.50	021:	8.25		021:	8.75	020:	8.50
100:	10.00	111:	8.75	101:	8.75		100:	9.00	110:	8.75
121:	8.75	120:	9.50	110:	9.75		111:	8.75	121:	9.75
201:	9.50	200:	8.75	211:	9.00		201:	8.00	200:	9.50
210:	9.75	221:	9.25	220:	7.75		220:	8.50	211:	10.50
	57.25		51.25		51.50	160.00		51.75		56.25
IIa		IIb		IIc			IVa		IVb	
010:	9.75	000:	9.50	001:	8.50		011:	7.50	000:	8.25
021:	9.00	011:	10.00	020:	9.50		020:	10.00	021:	10.25
101:	10.00	110:	10.00	100:	9.00		101:	9.00	111:	8.50
120:	8.50	121:	9.00	111:	9.50		110:	8.75	120:	8.75
200:	8.50	201:	10.50	210:	9.00		200:	9.00	201:	8.25
211:	8.75	220:	10.25	221:	9.75		221:	10.00	210:	9.75
	54.50		59.25		55.25	169.00		54.25		53.75

ANALYSIS OF VARIANCE: number of leaves of palmito de pejibaye (per plant)

SOURCE OF VARIATION	DEGREES OF FREEDOM		SUM OF SQUARES	MEAN SQUARES	F	5%	1%
REPLICATIONS	3		2.34	0.78	1.64	3.21	5.12
BLOCKS IN REPLICATIONS	8		8.74	1.09	2.30	2.17	2.95
N	2		2.09	1.05	2.20	3.22	5.13
P	2		1.10	0.55	1.15	3.22	5.13
K	1		0.00	0.00	0.01	4.06	7.25
N x P	4	* 7/8	1.29	0.32	0.68	2.58	3.76
N x K	2		0.97	0.48	1.02	3.22	5.13
P x K	2		0.21	0.11	0.22	3.22	5.13
N x P x K	4	* 5/8	2.34	0.59	1.23	2.58	3.79
ERROF	43		20.42	0.47			
TOTAL	71		39				

DATA FOR 3 x 3 x 2 FACTORIAL EXPERIMENT (CONFOUNDED)
PARAMETER: leaf area of palmito de pejibaye
EXPRESSED IN: (m2 leaf*10e3)/ m2 ground

Ia		Ib		Ic			IIIa		IIIb		IIIc		
011:	37	001:	26	000:	37		010:	30	001:	29	000:	21	
020:	38	010:	22	021:	36		021:	28	020:	27	011:	31	
100:	39	111:	29	101:	29		100:	42	110:	32	101:	28	
121:	38	120:	41	110:	42		111:	41	121:	40	120:	41	
201:	41	200:	28	211:	37		201:	31	200:	37	210:	41	
210:	35	221:	33	220:	39		220:	38	211:	49	221:	42	
	228		179		220	627		210		214		204	628
IIa		**IIb**		**IIc**			**IVa**		**IVb**		**IVc**		
010:	49	000:	41	001:	32		011:	31	000:	23	001:	33	
021:	37	011:	43	020:	43		020:	37	021:	31	010:	26	
101:	41	110:	36	100:	25		101:	36	111:	32	100:	40	
120:	30	121:	36	111:	41		110:	37	120:	31	121:	42	
200:	40	201:	41	210:	39		200:	52	201:	39	211:	51	
211:	37	220:	42	221:	41		221:	33	210:	32	220:	37	
	234		239		221	694		226		188		231	645
													2594

ANALYSIS OF VARIANCE: LAI

SOURCE OF VARIATION	DEGREES OF FREEDOM		SUM OF SQUARES	MEAN SQUARES	F	5%	1%
REPLICATIONS	3		165	55	1.31	1.63	2.00
BLOCKS IN REPLICATIONS	8		354	44	1.06	1.68	2.04
N	2		393	196	4.69	1.54	1.85
P	2		180	90	2.15	1.57	1.91
K	1		0	0	0.00		
N x P	4	* 7/8	44	11	0.26	2.02	2.70
N x K	2		4	2	0.05	3.22	5.15
P x K	2		10	5	0.12	2.44	3.49
N x P x K	4	* 5/8	85	21	0.51	1.82	2.35
ERROR	43		1801	42			
TOTAL	71		3036				

DATA FOR 3 x 3 x 2 FACTORIAL EXPERIMENT (CONFOUNDED)
PARAMETER: maximal height of plant
EXPRESSED IN: cm

Ia		Ib		Ic			IIa		IIb		IIc
011:	82.00	001:	67.00	000:	76.25		010:	87.50	000:	79.75	001:
020:	82.25	010:	67.25	021:	82.25		021:	80.75	011:	83.00	020:
100:	85.75	111:	74.25	101:	74.75		101:	87.75	110:	84.75	100:
121:	91.75	120:	91.25	110:	87.75		120:	76.00	121:	83.25	111:
201:	86.75	200:	73.25	211:	79.00		200:	87.75	201:	86.00	210:
210:	84.50	221:	85.25	220:	86.50		211:	83.00	220:	86.50	221:
	513.00		458.25		486.50	1457.75		502.75		503.25	
IIa		**IIb**		**IIc**			**IVa**		**IVb**		**IVc**
010:	87.50	000:	79.75	001:	76.25		011:	76.25	000:	66.50	001:
021:	/80.75	011:	83.00	020:	82.25		020:	85.00	021:	74.25	010:
101:	87.75	110:	84.75	100:	65.75		101:	81.00	111:	76.25	100:
120:	76.00	121:	83.25	111:	82.25		110:	81.75	120:	80.75	121:
200:	87.75	201:	86.00	210:	86.25		200:	92.75	201:	92.75	211:
211:	83.00	220:	86.50	221:	92.00		221:	89.25	210:	77.25	220:
	502.75		503.25		484.75	1490.75		506.00		467.75	

ANALYSIS OF VARIANCE: maximal height of young palmito de pejibaye (cm)

SOURCE OF VARIATION	DEGREES OF FREEDOM		SUM OF SQUARES	MEAN SQUARES	F	5%	1%
REPLICATIONS	3		38.77	12.92	0.33	3.21	5.12
BLOCKS IN REPLICATIONS	8		446.10	55.76	1.42	2.17	2.95
N	2		885.24	442.62	11.27	3.22	5.13
P	2		219.46	109.73	2.79	3.22	5.13
K	1		14.52	14.52	0.37	4.06	7.25
N x P	4	* 7/8	56.74	14.19	0.36	2.58	3.76
N x K	2		16.57	8.29	0.21	3.22	5.13
P x K	2		0.05	0.02	0.00	3.22	5.13
N x P x K	4	* 5/8	42.87	10.72	0.27	2.58	3.79
ERROR	43		1688.97	39.28			
TOTAL	71		3409				

Description of profile A

Date:	06-11-1‘
Location:	Guápile: palmito Lote 5
Authors:	Frank v: enbeek Raymon schaap
Weather last week:	Rain
Geology:	Alluvial ts alluvial ndesitic
Geomorphology:	Undulati pe: 1°
microtopography:	plain
Drainage:	Well dra
condition of profile:	humid
Vegetation:	Palmito ion
Land use:	Palmhea uction
state of crop:	4 year: ormal
use before:	Trees ss
Fauna:	Earthwo d ants

Classification: Andos
Thapti iodand

HORIZONT			COLOUR	STRUCTURE			TEX-TURE	CONSISTENCE			F O	PORES	
Sym	depth	bound.	(moist)	grade	size	form		hum.	wet			abund	diameter
A	0 - 5 cm	clear wavy	10YR 3/2	strong	fine - medium	subang blocky	SCIL	fria	slight sticky	non plastic	-	few	fine
AB	6 - 12 cm	clear wavy	10YR 3/3	modera	fine + medium	subang	SL	fria	sticky	plastic	ve gr ro ve a	common	fine + med
B1	13 - 35 cm	gradu wavy	10YR 4/3	weak - modera	medium	subang	SL SL	fria	slight sticky	slightl plastic	ve st ro wet a	many	very f + fine
B2 Ab?	35 - 60 cm		10YR 3/2	weak - modera	medium	subang!	SL	very fria	sticky	slightl plastic	ver sto rou wet a	any	very f + fine

Description of profile B

Date:	22-01-1992
Location:	Río Frío, Agropalmito Lote 2
Authors:	Ed Veldkamp Antje Weitz Raymond Jongschaap
Weather last week:	Rain nearly each day
Geology:	Fluvial laharic deposit
Geomorphology:	Hilly
microtopography:	small plateau, flat
Drainage:	Well drained
condition of profile:	humid
Vegetation:	Palmito plantation
Land use:	Palmheart production
state of crop:	4½ years old, normal
use before:	trees
Soil fauna:	Eartworms and few ants

Classification: Andosol
Oxic Humitropept

HORIZONT			COLOUR	STRUCTURE			TEXTURE	CONSISTENCE			FRAGMENTS OF STONES +MINERALS	PORES	
Sym	depth	bound.	(moist)	grade	size	form		hum.	wet			abund	diameter
A	0 - 8 cm	clear wavy	10YR 3/3	strong	medium	subang blocky	SCl	very fria	-	-	No -	many	very f - coarse
B	8 - 50 cm		10YR 4/4	modera	very fine to fine	angular blocky	SCl	fria	-	-	small concretions	many	fine to very fine

APPENDIX 6-II

SPOT/SOIL: A: AGROPALMITO GUAPILES/ 'LOS DIAMANTES'
AVERAGE NUMBER OF ROOTS IN 3 DIFFERENT CLASSES (5 REPLICATIONS)

CM/CM		CLASS	DISTANCE FROM THE PLANT 0	10	20	30	40	50	60	70	80	90	100	110	120	TOTAL	PERC: CLASS			TOTAL	CUM.
DEPTH	0-10	1	7.0	6.6	3.8	3.4	2.6	1.8	3.0	2.8	1.4	1.4	1.4	0.6	0.4	36.2	45.8			40.8	40.8
		2	6.8	3.6	2.0	2.4	3.0	2.8	2.8	2.6	2.6	1.8	1.8	1.2	1.8	35.2		33.7			
		3	18.8	9.6	10.6	12.8	13.4	12.8	12.6	19.0	18.8	20.2	12.6	13.2	13.0	187.4			41.6		
	10-20	1	5.8	3.8	1.6	2.0	1.4	1.0	1.6	2.2	1.4	0.8	0.6	1.4	1.0	24.6	31.1			23.6	64.5
		2	4.6	3.8	1.0	1.8	1.8	2.6	1.6	2.0	1.4	1.6	1.8	1.0	2.0	27		25.8			
		3	9.0	5.6	6.0	7.4	7.0	6.6	6.2	6.8	9.0	7.8	8.2	9.4	9.2	98.2			21.8		
	20-30	1	2.0	2.0	0.2	0.4	0.0	1.2	0.6	0.0	0.0	1.0	0.0	0.2	0.0	7.6	9.6			13.5	78.0
		2	2.4	1.4	2.0	1.4	0.8	1.6	0.8	1.4	1.2	1.2	1.4	1.2	0.4	17.2		16.4			
		3	4.8	4.4	4.6	4.4	5.0	5.6	4.4	4.4	6.4	4.6	2.8	4.8	4.6	60.8			13.5		
	20-40	1	1.4	2.0	1.4	0.6	0.8	0.6	0.0	0.0	0.2	0.2	0.0	0.0	0.0	7.2	9.1			10.3	88.4
		2	2.8	1.0	1.6	0.8	1.0	1.2	0.6	0.4	0.6	1.2	1.0	0.4	0.4	13		12.4			
		3	5.2	5.0	2.2	2.4	5.0	4.2	1.8	1.8	3.2	2.8	2.8	5.8	3.2	45.4			10.1		
	40-50	1	0.4	0.6	0.4	0.4	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	2	2.5			7.48	95.8
		2	1.6	1.2	1.4	1.0	0.4	0.6	0.0	0.2	0.8	0.8	0.6	0.2	0.4	9.2		8.8			
		3	4.0	3.2	5.6	2.0	2.2	2.4	1.4	2.0	3.4	2.2	1.4	4.0	2.4	36.2			8.0		
	50-60	1	0.4	0.6	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.8			4.16	100.0
		2	0.4	0.0	0.4	0.8	0.4	0.0	0.0	0.0	0.6	0.0	0.2	0.0	0.2	3		2.9			
		3	2.4	2.6	2.0	2.0	2.0	1.4	1.0	1.0	2.2	2.4	0.6	1.2	1.2	22			4.9		
	TOTAL	1	17.0	15.6	7.6	7.0	4.8	4.6	5.2	5.0	3.2	3.4	2.0	2.2	1.4	79.0					
		2	18.6	11.0	8.4	8.2	7.4	8.8	5.8	6.6	7.2	6.6	6.8	4.0	5.2	104.6					
		3	44.2	30.4	31.0	31.0	34.6	33.0	27.4	35.0	43.0	40.0	28.4	38.4	33.6	450.0					
	PERC.		12.5	8.99	7.41	7.29	7.38	7.32	6.06	7.35	8.42	7.89	5.87	7.03	6.34	633.6					
	CUM.		12.5	21.5	29.0	36.3	43.6	51.0	57.0	64.4	72.8	80.7	86.6	93.6	100						

SPOT/SOIL: B: AGROPALMITO RIO FRIO/ 'NEGUEV'
AVERAGE NUMBER OF ROOTS IN 3 DIFFERENT CLASSES (5 REPLICATIONS)

CM/CM		CLASS	DISTANCE FROM THE PLANT 0	10	20	30	40	50	60	70	80	90	100	110	120	TOTAL	PERC: CLASS			TOTA
DEPTH	0-10	1	5.2	4.0	2.0	2.0	1.2	1.0	2.2	2.2	0.8	1.2	1.0	1.2	0.4	24.4	80.8			47.5
		2	2.8	2.8	2.2	2.6	2.8	1.6	1.8	2.4	2.2	2.8	1.6	1.4	1.8	28.8		54.3		
		3	11.8	14.8	19.8	14.2	16.6	14.0	14.6	14.0	23.8	23.0	21.4	13.0	13.6	214.6			44.7-	
	10-20	1	1.8	1.2	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	3.8	12.6			14.6
		2	0.6	0.8	0.6	1.2	0.8	0.2	0.6	0.2	0.2	0.2	0.6	0.6	0.4	7		13.2		
		3	5.8	6.2	4.6	4.4	3.8	6.0	5.0	4.8	8.4	7.8	5.8	5.4	3.8	71.8			15.0	
	20-30	1	0.4	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	3.3			13.0
		2	0.8	1.4	1.0	0.0	0.2	0.6	0.6	0.8	0.0	0.0	0.0	0.0	0.2	5.6		10.6		
		3	2.8	4.6	4.4	6.0	5.2	5.2	7.0	6.2	5.6	5.8	4.0	5.4	4.8	67			14.0	
	30-40	1	0.2	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.0			11.3
		2	0.8	1.4	0.8	1.2	0.0	0.4	0.2	0.6	0.2	0.4	0.0	0.2	0.6	6.8		12.8		
		3	3.2	4.2	5.2	5.6	4.4	3.4	5.6	5.0	4.6	3.6	4.6	3.8	3.4	56.6			11.8	
	40-50	1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7			9.37
		2	0.4	0.2	0.8	0.6	0.4	0.0	0.2	0.4	0.2	0.2	0.0	0.0	0.0	3.4		6.4		
		3	1.8	3.4	6.0	3.4	5.0	2.6	5.4	4.2	3.8	3.8	4.0	4.4	1.4	49.2			10.2	
	50-60	1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7			4.01
		2	0.0	0.0	0.2	0.4	0.0	0.0	0.2	0.0	0.2	0.4	0.0	0.0	0.0	1.4		2.6		
		3	1.2	0.8	2.6	1.6	1.6	1.8	1.8	3.0	2.0	1.8	1.6	0.8	0.4	21			4.4	
	TOTAL	1	7.6	5.8	2.4	2.4	1.6	1.0	2.4	2.2	0.8	1.2	1.2	1.2	0.4	30.2				
		2	5.4	6.6	5.6	6.0	4.2	2.8	3.6	4.4	3.0	4.0	2.2	2.2	3.0	53.0				
		3	26.6	34.0	42.6	35.2	36.6	33.0	39.4	37.2	48.2	45.8	41.4	32.8	27.4	480.2				
	PERC.		7.02	8.23	8.98	7.73	7.52	6.53	8.05	7.77	9.22	9.05	7.95	6.42	5.46	563.4				
	CUM.		7.02	15.2	24.2	31.9	39.5	46.0	54.1	61.8	71.1	80.1	88.1	94.5	100					