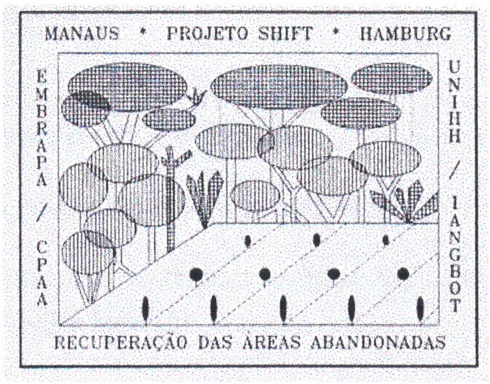

RECUPERAÇÃO DE ÁREAS DEGRADADAS E ABANDONADAS, ATRAVÉS DE SISTEMAS DE POLICULTIVO

PERÍODO: Janeiro a Dezembro/1997

Embrapa/CPAA - Universidade de Hamburg

Editores:

Luadir Gasparotto & Götz Schroth

Manaus-AM
Maio/1998

1. Introdução

O relatório anual de 1997 está apresentado de forma detalhada. Os resultados compreendem as atividades relacionadas ao projeto ENV. 23/2. Além desse projeto, na mesma área experimental, estão sendo desenvolvidos os projetos ENV. 42, ENV. 45 e ENV. 52, cujos resultados serão apresentados em relatórios próprios.

As principais atividades desenvolvidas no projeto ENV. 23 foram:

- Manejo da área experimental, compreendendo : limpezas, podas, tratamentos fitossanitários, adubações e colheita das plantas;

- Estudos de fitopatologia : observações contínuas sobre a incidência de doenças nas plantas, registro da incidência da vassoura-de-bruxa no cupuaçu assim como adoção de medidas de controle, quando necessário;

- Estudos da variabilidade do cupuaçu envolvendo a variabilidade das plantas nos diferentes sistemas de cultivo;

- Estudos da biologia do solo: análises de amostras do solo para quantificar a variabilidade de fungos micorrízicos vesicular-arbusculares na área experimental, na capoeira e na floresta primária;

- Estudos de vegetação: avaliação dos tipos de vegetação envolvendo a caracterização, o desenvolvimento e a identificação das espécies em áreas de capoeira e florestas primárias e secundárias;

- Avaliação biométrica e da produção das plantas de interesse econômico: diâmetro do tronco, altura e produção de frutos;

- Avaliação de isolados de bactérias na rizosfera de pupunha e cupuaçu;

- Estudos sobre a fermentação de amêndoas de cupuaçu para produção de chocolate;

- Avaliações sobre a distribuição do sistema radicular das plantas;

- Análise do custo/benefício dos sistemas agroflorestais.

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ATIVIDADES DE MANEJO NA ÁREA EXPERIMENTAL

Jeferson Luis V. de Macêdo

1. Limpeza da área

Sempre que necessário, são efetuados coroamentos das plantas na área experimental; o material cortado (restos vegetais de plantas invasoras e, principalmente, de puerária) é deixado sobre a coroa, para servir de cobertura morta. No caso específico do limão e da laranja, o material cortado é removido, deixando-se a coroa limpa, a fim de reduzir a umidade ao redor do tronco das plantas e evitar o aparecimento da gomose dos citros (*Phytophthora* sp.).

Duas vezes ao ano efetua-se a roçagem das parcelas, visando a eliminação das plantas invasoras nas entrelinhas dos cultivos.

2. Implantação de novas culturas

Em maio de 1997, eliminou-se os paricás do sistema 3 e em seus lugares estabeleceu-se 3 novas espécies madeiráveis : mogno africano (*Khais irvorensis*), louro pirarucú (*Licaria canela*) e jacareúba (*Colophyllum brasiliensis*). Um mês antes do plantio destas espécies, efetuou-se a abertura e a adubação das covas. Nesta última, utilizou-se 150 g/superfosfato triplo/cova.

3. Adubação das espécies na área experimental

Na Tabela 1, é apresentado a adubação efetuada no ano de 1997.

Tabela 1. Adubação das culturas na área experimental do Projeto SHIFT no ano de 1997.

		Dosagem (g/planta/ano)					
Cultura	**Tratamentos+**	*Sulfato de Amônio*	*Superfosfato triplo*	*Cloreto de potássio*	*Sulfato de Mg*	*FTE BR 12*	*Bórax*
Cupuaçu	1	135*	105*	75*	-	15*	-
	2	-	105*	75*	-	15*	-
	3	450*	525*	250*	-	50*	-
	4	450*	350*	250*	-	50*	-
Pupunha	1	60*	15*	15*	-	6*	-
	2	-	15*	15*	-	6*	-
	3	200*	75*	50*	-	20*	-
	4	200*	50*	50*	-	20*	-
Laranja**	1	180*	135*	90*	-	15*	-
	2	-	135*	90*	-	15*	-
	3	600*	675*	300*	-	50*	-
	4	600*	450*	300*	-	50*	-
Coco	1	180*	120*	150*	45*	15*	15*
	2	-	120*	150*	45*	15*	15*
	3	600*	600*	500*	150*	50*	50*
	4	600*	400*	500*	150*	50*	50*
Urucum	1	120*	54*	90*	-	15*	-
	2	-	54*	90*	-	15*	-
	3	400*	270*	300*	-	50*	-
	4	400*	180*	300*	-	50*	-
Castanha do Brasil	1	60*	30*	30*	-	-	-
	2	-	30*	30*	-	-	-
	3	200*	150*	100*	-	-	-
	4	200*	100*	100*	-	-	-
Limão	1	90*	150*	30*	-	6*	-
	3	300*	500*	100*	-	20*	-
Seringueira	1						
	2	100	100	60	-	15	-
	3						
	4	100	-	60	-	15	-

+ 1,2,3 e 4 = 30+M (30%), 30-M (30% -N -Calcário), 100+M (100% +P) e 100% -M (100%), respectivamente.

* Adubação parcelada em duas aplicações : 1ª em maio/1997 e a 2ª em dezembro/1997.

** A laranja recebeu 5 aplicações de adubo foliar. Produto comercial PRODPLANT (80 g/20l de água).

OCCURRENCE AND CHARACTERIZATION OF DIFFERENT BACTERIAL ISOLATES FROM THE RHIZOSPHERE OF *Bactris gasipaes* H.B.K. and *Theobroma grandiflorum* (WILLD. EX SPRENG.) SCHUM.

Wolfgang Kruse

1. INTRODUCTION

Ecosystem functioning is governed largely by soil microbial dynamics. Thus, soil microorganisms play a major role in ecosystems. Differences in microbial properties and activities in soils have been reported but are limited in their ability to describe specific plant-microbe interactions. Particularly for many tropical useful plants little is known about distribution, composition and description of physiological groups of microorganisms. In this study we focused on the compartments where plant microbe interactions are particularly pronounced:

1. The rhizoplane which refers to the actual surface of the root and
2. The rhizosphere which is defined as the narrow zone of soil surrounding the root strongly influenced by the root.

We investigated the distribution of bacteria in the rhizosphere of both plants and the community structure of isolated bacteria strains.

2. MATERIAL AND METHODS

Samples were collected from the rhizoplane, rhizosphere (2-10mm away from the rhizoplane) and bulk soil (>10-20mm away from the rhizoplane) of *Theobroma grandiflorum* and *Bactris gasipaes* in spring 1997 on the SHIFT area near Manaus, Brasil.

Carbon utilization of bacterial isolates was tested on BIOLOG® plates. Results were subjected to principal component analysis (PCA).

Dilutions of soil suspensions were plated on media with and without mineral nitrogen to distinguish between nitrogen-fixing and non-nitrogen-fixing bacteria.

3. RESULTS

In a graph resulting from principal component analysis (PCA) the highest variability is found in direction of the abscissa. Therefore the points found in one quarter represent data which are closely related to each other while points found in different quarters represent data which are less or not correlated (see figure 3B).

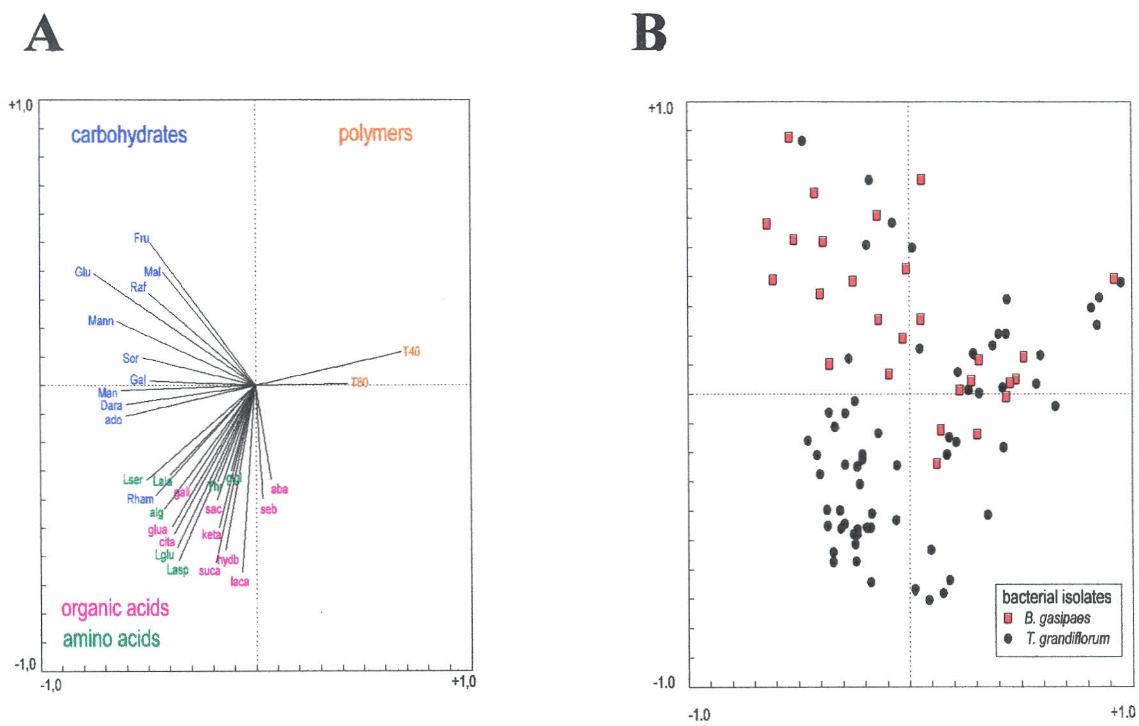

Fig. 3 : Biplot of the bacteria community in the rhizosphere of *Bactris gasipaes* and *Theobroma grandiflorum*

A. Substrate utilized by the bacteria isolates.

B. Distribution of isolates.

Rhizosphere communities of the two different crops show distinctive patterns of C source utilization. *Bactris gasipaes* rhizosphere isolates utilize mainly carbohydrates while isolates from *Theobroma grandiflorum* utilize mainly organic acids, amino acids and polymers (see figure 3 A).

The majority of oligotrophic bacteria is able to fix nitrogen. The number of nitrogen-fixing bacteria and non-nitrogen-fixing oligotrophic bacteria decreases with increasing distance from the rhizoplane (see figure 4).

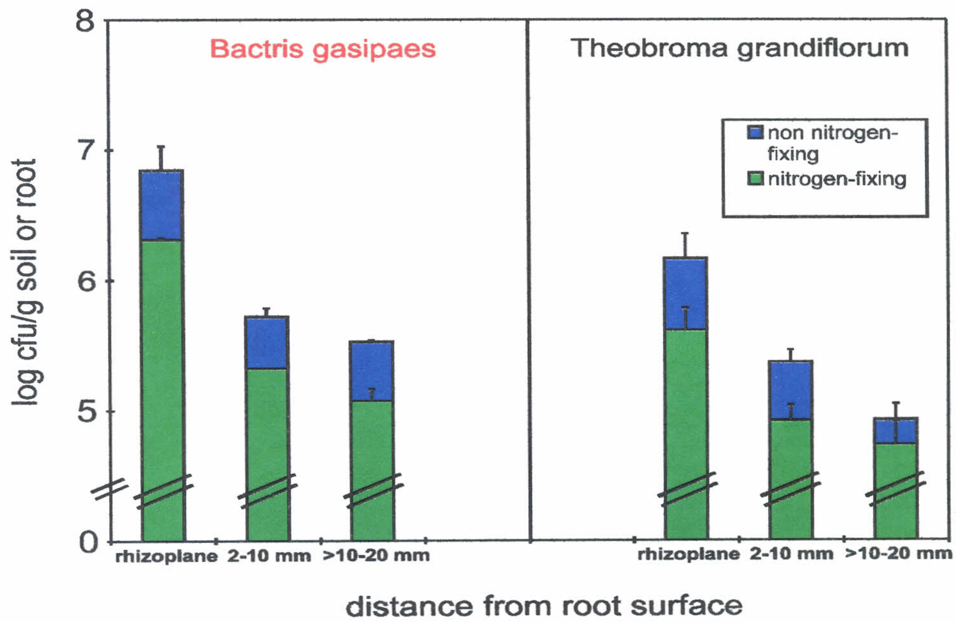

Fig. 4 : Number of non-nitrogen and nitrogen-fixing oligotrophic bacteria in the rhizosphere of *Bactris gasipaes* and *Theobroma grandiflorum*.

4. CONCLUSIONS

Plant species influence the microbial rhizosphere community structure probably by root exudation. In the nitrogen-limited tropical ecosystems the majority of oligotrophic bacteria is able to fix nitrogen.

5. OUTLOOK

Based on this preliminary study, the interactions between bacteria and plants will be examined under structural and physiological aspects. It will be determined if the main substrates which are used by the bacterial isolates are exuded by the plant roots.

It is well known that only 1 to 3% rhizosphere microbes can be isolated and cultured. In order to avoid the methodological restriction caused by isolation, in a second approach dilution series of soil suspensions will be used directly as inoculum for Biolog plates.

COMPOSIÇÃO DE COMUNIDADES DE FUNGOS MICORRÍZICOS ARBUSCULARES EM SISTEMAS NATURAIS E DE POLICULTIVOS

José Pereira da Silva Jr.

Falko Feldman

1. INTRODUÇÃO

O estudo faz parte do "Projeto Recultivo de Áreas Abandonadas e ou Degradadas Através de Sistemas de Policultivo". O estabelecimento dos tratamentos experimentais, através da queima, desestabelizou a comunidade de fungos micorrízicos arbusculares (FMA) e a infectividade simbiótica apenas foi recuperada seis meses depois da queima (Workshop SHIFT 93 e 95). A composição da comunidade de FMA determina a variação genética dos microsimbiontes e , por conseguinte, o potencial da formação de micorrizas efetivas .

Aqui apresentamos resultados dos 38 meses que seguiram-se à queima.

2. MATERIAL E MÉTODOS

As áreas estudas foram : Floresta primária, capoeira e dois sistemas de policultivo (I - Hevea spp., Theobroma *grandiflorum, Bactris gasipaes, e Carica papaya;* II - *Hevea* spp., *Theobroma grandiflorum, Citrus sinensis, Cocos nucifera* e *Schizolobium amazonicum*

A composição das comunidades foram descritas a partir dos esporos de FMA. Os esporos extraídos do solo por peneiramento úmido , com posterior cultivo dos monosporos em *Petrosilinum crispum* e *Pueraria phaseoloides.* A maioria dos fungos identificados não foram anteriormente descritos. Por isso descreveu-se numericamente os tipos morfológicos.

3. RESULTADOS

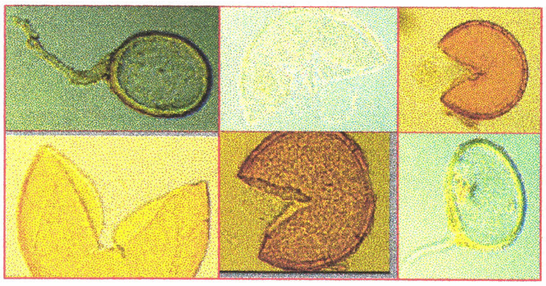

Figura 1. Da esquerda para a direita tipos morfológicos 14, 16, 21/ 36, 18,23

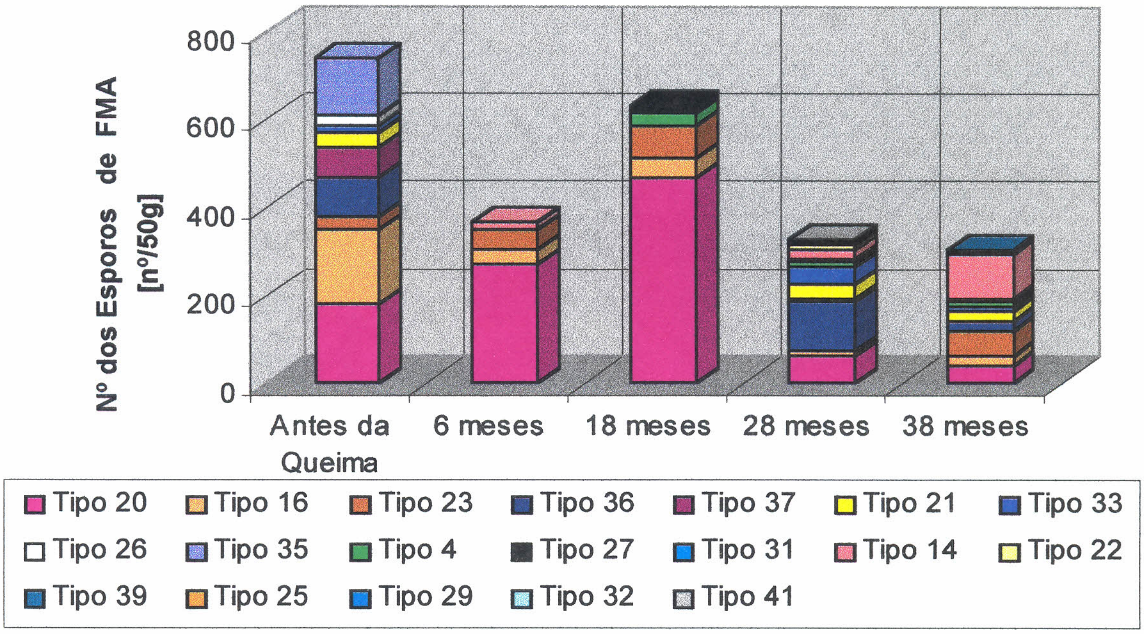

Fig. 2. Evolução de comunidade de FMA a partir da queima.

4. CONCLUSÕES

⇒ Os tratamentos (sistemas naturais e policultivo ; inoculação) diferiram na quantidade de esporo, porém não nos tipos de esporos.

⇒ Após três anos, uma sucessão dos FMA indígenas no campo experimental ainda está em progresso. Depois de uma fase mudança quantitativas, agora uma diversificação pode ser observada.

⇒ A fonte de inóculo para recuperação das comunidades de FMA é a comunidade autóctone sobrevivente da queima, bem como da floresta primária e/ou da capoeira.

⇒ Os esporos dos fungos exóticos, como os inoculados no experimento não foram observados.

⇒ Estudos sobre a significância destes resultados para a simbiose estão em andamento

PROTEIN PATTERNS OF RIPE SEEDS OF Theobroma cacao, Theobroma grandiflorum, AND Theobroma bicolor.

Christoph Reisdorff
Aparecida G. Claret de Souza
Reinhard Lieberei
Böle Biehl

1.INTRODUCTION

Theobroma cacao, the cocoa tree, became one of the main tropical crop plants due to the unique and delicious flavour of the product obtained from the seeds: raw cocoa, the base for the production of chocolate and related products which are consumed world wide. In Brazil cocoa trees widely suffer from the causal agent of witches broom, inflicting severe losses on the Brazilian cocoa production.

T. grandiflorum, the cupuaçu-tree, is considered an excellent crop for local adapted land use systems on former terra firme rain forest areas in the Amazon region. It has been shown that the cultivation in mixed cropping systems favours the development and productivity of cupuaçu-trees. The fruit pulp fetches relatively high market prices whilst the seeds, which amount up to 20% of the fruit's fresh weight, are not yet commercially used. Attempts to commercialise a type of chocolate-wares made from cupuaçu-seeds failed so far, probably due to the unsatisfactory and hardly reproducible quality of the product.

T. bicolor , which is reported to be a very robust tree, can be found nearly throughout the humid tropics of central and south America. In some regions the seeds are used for the production of chocolate for one's own consumption and for local markets.

The objective of the studies is to evaluate whether and under what conditions the seeds of *T. grandiflorum* and *T. bicolor* have the potential to develop a good chocolate-like aroma, revealing the option of producing a storable and valuable ware (in addition to the pulp in the case of cupuaçu).

It has been shown by BIEHL and co-workers that the precursors of the cocoa-aroma are formed from seed storage globulins by enzymatic digestion during fermentation. Thus, as a first approach we studied the seed proteins of the three species by denaturating poly-acryl-amide gel electrophoresis, paying special attention to the globulins.

2. MATERIAL AND METHODS

Fruits of *T. grandiflorum* and *T. bicolor* have been taken from the living collections and the SHIFT-experimental site at the Embrapa/CPAA, Manaus, Brazil.

The cocoa fruits (variety "Mexican Criollo") have been provided by Mrs. Frances Bekele from the Cocoa Research Unit, University of the West Indies, St. Augustine, Trinidad and Tobago.

After careful removal of the seed coat the embryos have been shock-frozen by liquid nitrogen. Subsequently the embryos have been freeze dried until the weight of the samples remained constant.

The seed fat of the freeze dried and ground material has been exhaustively extracted by petrol ether (Bp. 40-60°C) in a Soxhlett apparatus. The phenolic compounds have been removed by means of stepwise extraction with aqueous acetone (80% and 70%) containing 5 mmol/l sodium ascorbate or 1 % (v/v) thioglycolic acid. Final extraction by 100 % acetone and subsequent removal of the solvent by low pressure led to the completely water free powder (acetone dry powder, acdp).

In order to obtain the albumin fraction of the seed proteins the acdp has been extracted by low salt buffer (0.01 mol/l NaCl, 0.05 mol/l TRIS/HCl pH 7.5, 2 mmol/l Na_2-EDTA, 7 mmol/l 2-mercaptoethanol). The precipitate was extracted by a high salt buffer (0.5 mol/l NaCl, 0.2 mol/l TRIS/HCl pH 8.0) in order to obtain the globulin fraction.

For the analysis by sodium-dodecyl-sulfate gel electrophoresis of the albumin's and globulins the fractions have been diluted by SDS sample buffer (1:2) containing 8 mol/l urea and 2 % SDS. For the entire seed protein pattern the acdp has been extracted directly by SDS sample buffer. The electrophoresis has been conducted using BIO-RAD 10-20% poly-acryl-amid gradient ready gels. The protein bands have been stained by Coomassie Brilliant Blue or by silver staining methods.

3. RESULTS

The patterns of seed proteins of all three *Theobroma* species are marked by two predominant globulins and at least one predominant albumin. The molecular weights of the two classes of globulins are quite similar for all three species (49 ± 3 kDa and 33 ± 1 kDa). Considering the quantity of globulins the seeds of *T. bicolor* are prominent regarding their very high content of these storage proteins, while the seeds of *T. grandiflorum* are the only ones containing more albumins than globulins. However, in all three species the relative quantity of the globulins at the range between 32 and 34 kDa vary around 15% of total protein content (Table. 1, Figure. 1).

The results give rise to the suggestion that *T. grandiflorum* and *T. bicolor* meet at least one requirement for the generation of a chocolate like aroma: the seeds contain globulins similar to those of cocoa regarding the molecular weights and the relative quantities.

The degree of similarities will be further studied by investigating molecular details of the globulins through immune-serological and enzymatic techniques. Additionally we are studying the proteases which are responsible for the post-mortem degradation of the globulins leading to the flavour precursors of cocoa-aroma.

TABLE 1. Specifications of seed proteins (predominant globulins and albumins) of three *Theobroma* species.

Protein	Species	Molecular Weight (kDa)	Quantity (% of total protein)
globulin 1	*T. grandiflorum*	52 Da	2.4
	T. cacao	51 kDa	9.5
	T. bicolor	46 kDa	32.9
globulin 2	*T. grandiflorum*	32 kDa	13.4
	T. cacao	34 kDa	12.5
	T. bicolor	33 kDa	16.9
albumin 1	*T. grandiflorum*	23 kDa	30.4
	T. cacao	22 kDa	19.5
	T. bicolor	20 kDa	5
albumin 2	*T. grandiflorum*	12 kDa	10.3
	T. cacao	-	-
	T. bicolor	16 kDa	14.8
albumin 3	*T. grandiflorum*	-	-
	T. cacao	-	-
	T. bicolor	15 kDa	4.5

The relative quantity of proteins has been determined by analyzing densitometrically the SDS-PAGE pattern of seed proteins using a Sharp JX 325 scanner and the Imagemaster ® software of Pharmacia.

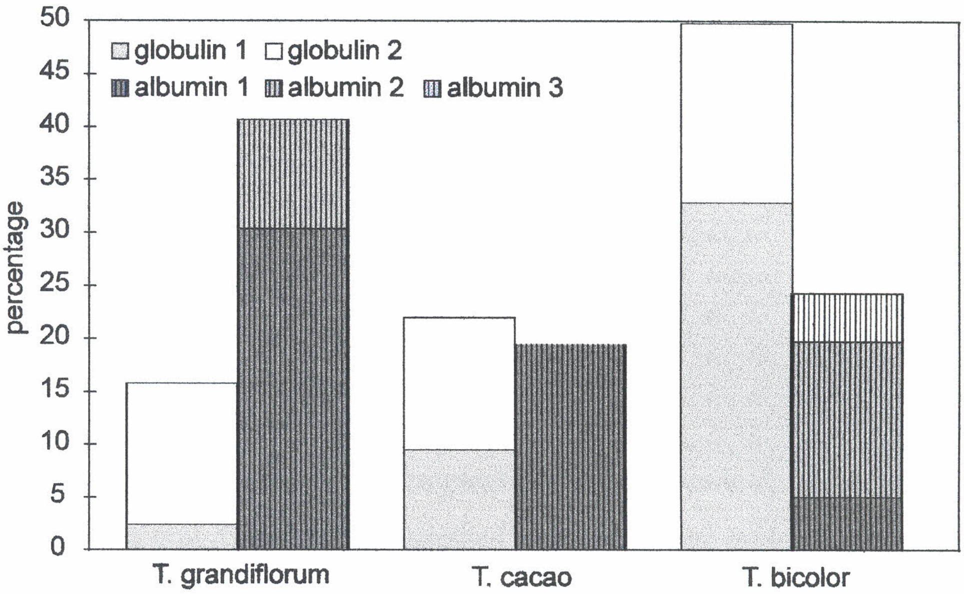

Figure. 1: relative quantity of the predominant globulins and albumins in the cotyledons of three Theobroma species (percent of total protein; cf. tab. 1).

DISTRIBUTION OF ROOTS OF TROPICAL USEFUL PLANTS IN AN AGROFORESTRY SYSTEM FOUR YEARS AFTER INSTALLATION.

Susanne Emmerich

1. INTRODUCTION

The distribution of roots of four tropical cultivated trees in an agroforestry system on terra firme in the Central Amazon was examined four years after installation of the plantation. Beside the horizontal expansion of roots and the vertical rooting of the ground by means of the individual cultivated trees the interspecific root-root interactions were of primary concern.

2. METHODS

2.1. Research site

The investigation was performed at the research sites of EMBRAPA-CPAA, Manaus, Central Amazonia (Road AM 10, km 28)

2.2. Tree species

* ***Bactris gasipaes*** Kunth (Pupunha), Arecaceae
* ***Theobroma grandiflorum*** (Willd. ex Spreng.) Schum. (Cupuacu), Sterculiaceae
* ***Bertholletia excelsa*** Humb. & Bonpl. (Castanha do Brasil), Lecythidaceae
* ***Bixa orellana*** L. (Urucum), Bixaceae

Root samples were taken with a hand auger from a *Th. grandiflorum* and a neighbouring *B. gasipaes* in the centre of thetransections with the neighbouring trees and between the *Th. grandiflorum* and *B. gasipaes* themselves.

The samples were taken starting at a distance of 40 cm from the respective trunks at intervals of 50 - 60 cm and to a depth of 40 cm and 60 cm (0 - 10 cm, 10 - 20 cm, 20 - 40 cm and 40 - 60 cm) with three replications in each case. Representative subsamples (10 - 20% of the sample) were taken from the individual auger cores (503 ml), as described by Schroth and Kolbe (1994). The roots were washed by hand over a sieve with an aperture size of 0.5 mm, were separated into species at 10 magnifications and subdivided into diameter classes of < 1 mm, 1 - 2 mm, > 2 - 5 mm, > 5 - 10 mm and > 10 - 20 mm. Differentiation was made between living and dead roots. The roots were dried at 65 °C for three days and the dry weight was determined.

The superficial coarse roots (diameter > 2 mm) at the research site were exposed to a soil depth of around 1 cm and plotted.

3. RESULTS AND DISCUSSION

With the partial exception of *B. excelsa* the greatest proportion of the fine root biomass of the four cultivated trees is situated in the top 10 cm of the soil; this is especially pronounced in the case of *B. gasipaes* **(Figure. 1)**. The fine root biomass decreases appreciably at greater depth. Of the species of tree examined, *B. excelsa* roots the soil the most uniformly. The root growth of *B. excelsa* is restricted by *Th. grandiflorum* and *B. gasipaes*. As these trees root more superficially, the fine root system of *B. excelsa* attains its maximal expansion in the transections with these trees not in the top 10 cm of the soil but at a depth of 20 - 60 cm. In the *Th. grandiflorum* - *B. excelsa* transection **(Figure. 2)** the length of the fine root system of *B. excelsa* is 5.05 m at a soil depth of 20 - 60 cm. The root system of *Th. grandiflorum* overlaps with the root systems of *B. orellana* and *B. excelsa* only in the marginal area. In its root growth, *B. orellana* is clearly restricted by *Th. grandiflorum* and is more compatible with *B. excelsa*. In the *Th. grandiflorum* - *B. orellana* transection, the fine root system of *B. orellana* attains a length of 2.50 m, but attains 4 m outside the root system of *Th. grandiflorum*. The fine root system of *Th. grandiflorum* has an extension of 2 m towards *B. orellana* and *B. excelsa* and a lesser extension of 1.40 m towards *B. gasipaes*. *B. gasipaes* forms an enormous root mass and its root system overlaps with those of *Th. grandiflorum* and *B. excelsa* up to their trunks (approx. 4 m). *B. gasipaes* obviously benefits from a supply of nutrients perhaps the fertilising in the trunk areas of the neighbouring trees. The root systems of *Th. grandiflorum* and *B. excelsa* are impeded in their growth by *B. gasipaes*. The distribution of the visible superficial coarse roots shows good correspondence with the results of the examination of the auger cores **(Figure. 3)** and can be taken as an indication of the extension of the root systems of *Th. grandiflorum*, *B. orellana* and *B. gasipaes*. *B. excelsa* has no coarse roots in the top 10 cm of the soil.

4. SUMMARY AND CONCLUSIONS

The distribution of roots of four tropical cultivated trees in an agroforestry system on terra firme in the Central Amazon was examined four years after installation of the plantation. The investigations were carried out with the trees *Bactris gasipaes*, *Theobroma grandiflorum Bertholletia excelsa* and *Bixa orellana.*

Beside the horizontal expansion of roots and the vertical rooting of the ground by means of the individual cultivated trees the interspecific root-root interactions were of primary concern.

With the partial exception of *B. excelsa* the greatest proportion of the fine root biomass of the four cultivated trees is situated in the top 10 cm of the soil; this is especially pronounced in the case of *B. gasipaes*. The fine root biomass decreases appreciably at greater depth. Of the species of tree examined, *B. excelsa* roots the soil the most uniformly. Three types of strategies can be distinguished:

✱ *B. excelsa* evades the competition of *Th. grandiflorum* and *B. gasipaes* roots in the top 10 cm of the soil and the fine root system of *B. excelsa* reaches the maximal extension in the transections at a depth of 20 - 60 cm.

✱ In his root growth *B. orellana* is clearly restricted by *Th. grandiflorum* and their root systems overlap only in the marginal area.

✱ The root system of *B. gasipaes* overlaps with th e root systems of the neighbouring trees *Th. grandiflorum* and *B. excelsa* up to their trunk and impedes their root growth.

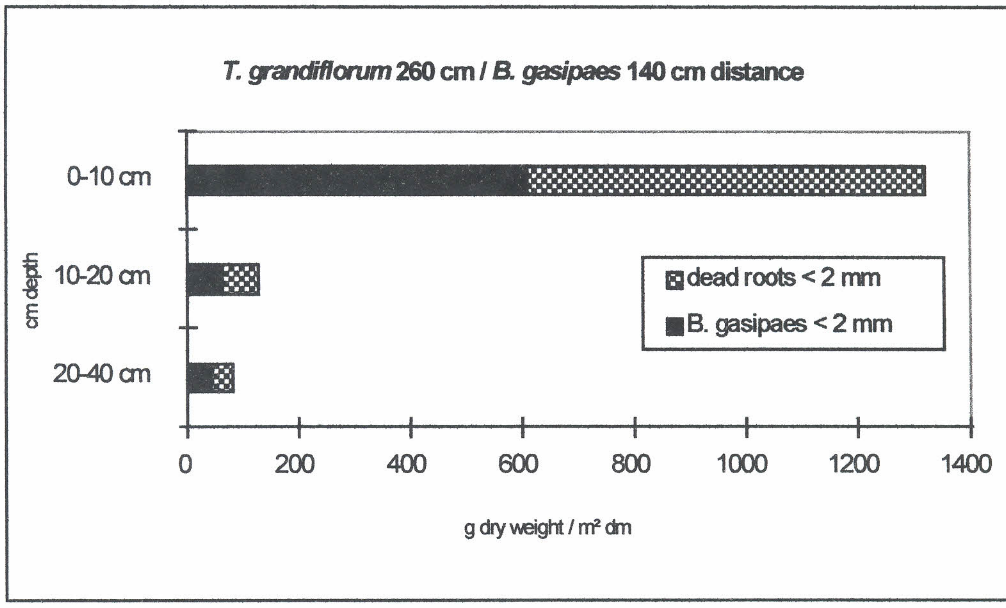

FIGURE 1. Vertical root distribuition. Part of the transection *T. grandiflorum* - *B. gasipaes*.. The high portion of dead roots belongs almost exclusively to *B.gasipaes*.

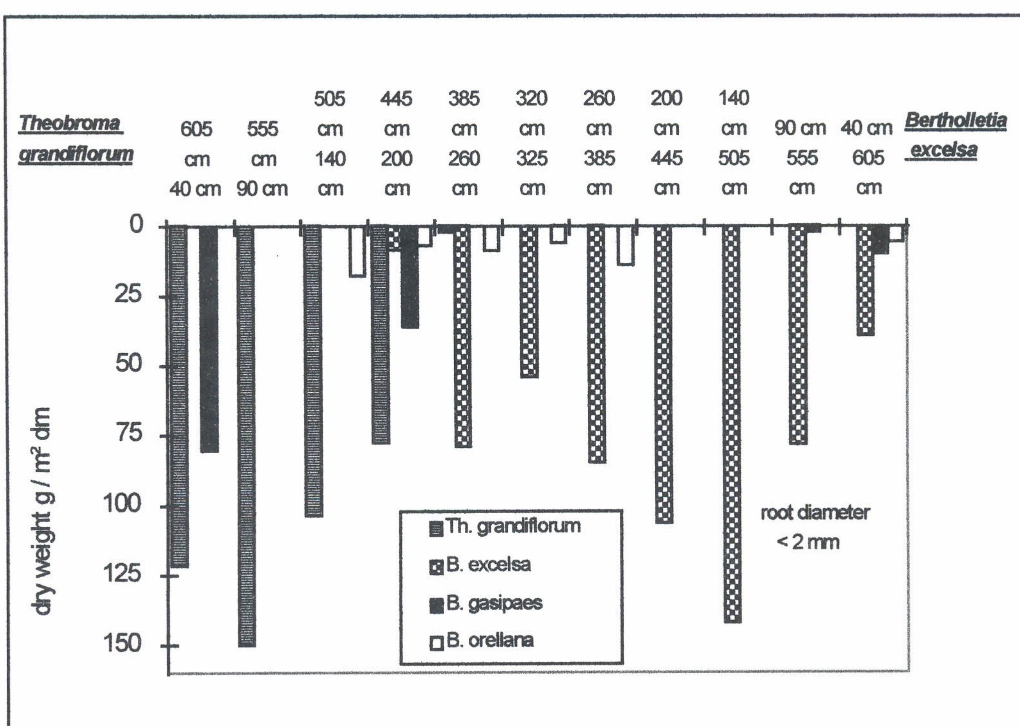

FIGURE 2. Root distribuition in the top 10 cm of the soil in the transection *T. grandiflorum* - *B. gasipaes*. The transection runs parallel to a row of *B. orellana* and a row of *B. gasipaes*.

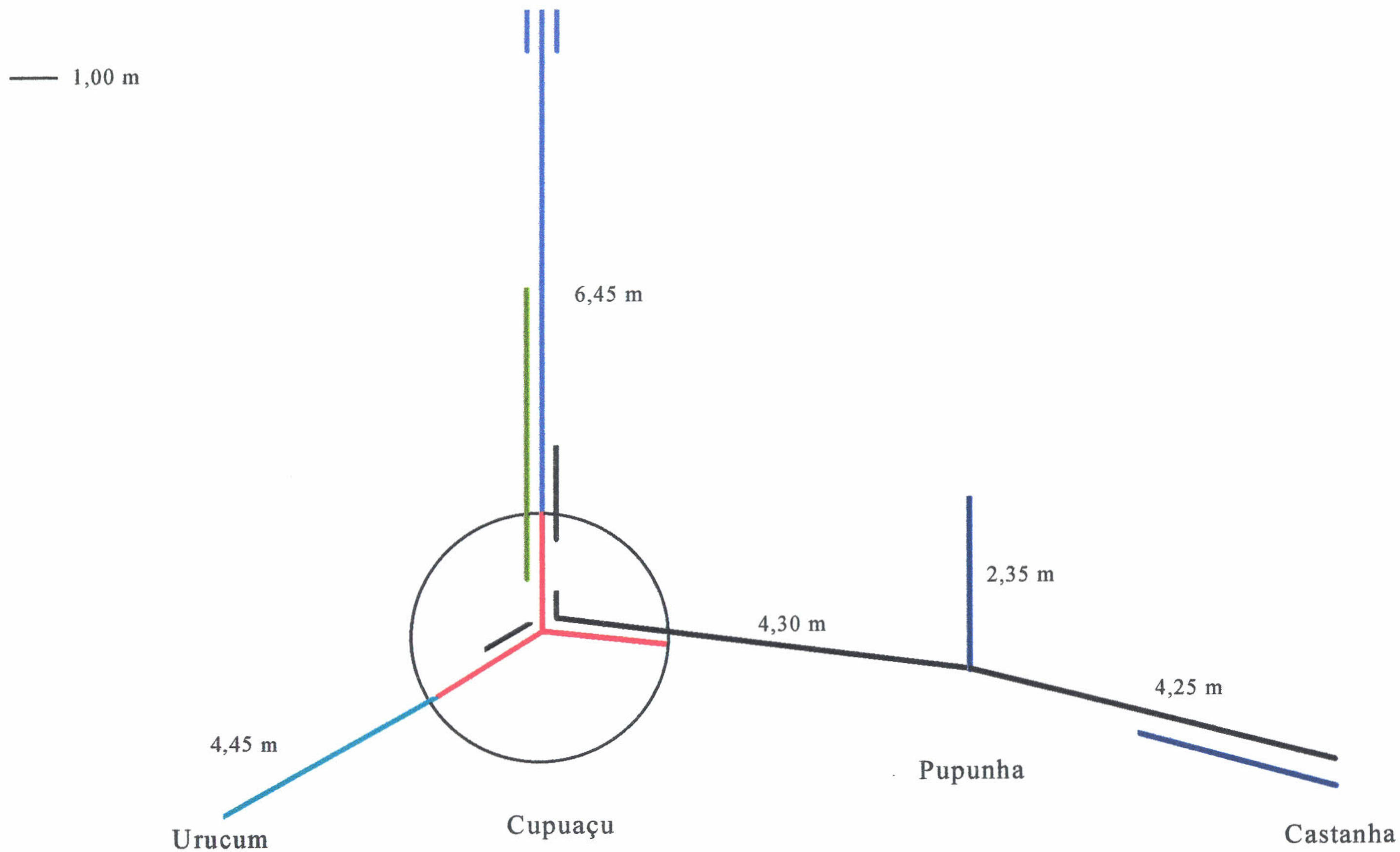

Figure 3. Maximal extension of fine roots in the transections in the top 10 cm of the soil. *T.grandiflorum* (red), *B. orellana* (green), *B. excelsa* (blue) and *B. gasipaes* (black.)

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INDICATOR VALUE OF ANTHROPOGENIC VEGETATION IN THE AMAZON

- ANTECEDENTS -

Helmut Preisinger

1. INTRODUCTION

The annual report is presented in the following form: after a short communication on the general state of the scientific programme in 1997, the subproject is presented in a concise form, comprising aspects of the theoretical concept applied, a synthesis of some results available at present and some concluding remarks (annex 1). Moreover, results with regard to the mechanisms of regeneration and reproduction of flowering plants in primary forest, secondary forest and Capoeiras of the EMBRAPA/SHIFT experimental site are given (annex 2).

The travel report of a journey to Manaus, from August - November 1997, is part of the annual report. It was already handed to the employer.

2. STATE OF THE SCIENTIFIC PROGRAMME

In 1997, the working group consisted of the following persons:

1. Dr. Helmut Preisinger (scientific consultant);
2. Dipl.-Biol. Martina Skatulla (scientific collaborator and PhD student, University of Hamburg);
3. Luiz F. Coêlho (specialist of flora, INPA, Manaus: contracted temporarily for fieldwork and identification of plant species);
4. Ronaldo Ribeiro de Morais (grantee of CNPq: joint activities on autecology of 4 species of *Miconia* (Melastomataceae) with project ENV 42);
5. Katja Richter (student of biology and geography, University of Hamburg: comparative studies on *Bellucia grossularioides* and *B. dichotoma* (thesis for "Höheres Lehramt").

The scientific programme is being carried out and continued as it was planned (cf. proposal of partial project 5).

In August 1997, a third floristic survey of all the 90 plots of the field experiment was carried out. An estimation of cover values of different morphological groups (growth form types) in the plots had to be shifted to April 1998, because the herbacous vegetation cover in the agricultural plots showed an untypical decline, caused by the drought at that time ("El Niño effect" of 1997). The vegetation surveys mentioned above, the last one to be carried out in 1999, will inform on the spatial and temporal development of the spontaneous vegetation due to plot management.

At the end of 1997, the majority of the field work for the "regeneration part" of project had been done and a first exploration of the complex data sets of the vegetation surveys was carried out (multivariate analyses applying PCA and TWINSPAN). The results with regard to seedling behaviour presented in annex 2 permit conclusions which are of major importance for the understanding of successional processes in disturbed Terra Firme sites and of the interaction of these sites with primary forest margins.

In 1997, the work on autecology of secondary forest species was extended to 11 frequently occurring species. The studies on species of Melastomataceae were continued with two species of *Bellucia* (see Poster of SHIFT congress "Comparative Studies on Autecology of *Bellucia grossularioides* (L.) Triana and *B. dichotoma* Cogn. (Melastomataceae) in the Central Amazon"). The work reveals morphological differences between the species which are relevant for differences in ecological behaviour. The surprisingly large differences between the understorey vegetation found under the trees of the two species are discussed as to their causes and their consequences for the different competitive ability of the *Bellucia* species in succession. At present, the life history of individual leaves of the 11 species mentioned are under study.

The synecological approach presented in annex 1 requires a good knowledge of the autecological behaviour of frequently occurring plant species, but little or nothing is known about the majority of the species. It can therefore be stated that there is a strong need to study as many species as possible with regard to morphological traits and ecological behaviour. Nevertheless, within the project there are strong limitations for the size of the studies to be carried out because of the small working group.

Annex 1:

H. Preisinger et al. / Indicator value of anthropogenic vegetation in the Amazon

Annex 2:

M. Skatulla / Mechanisms of forest regeneration in the Central Amazon

INDICATOR VALUE OF ANTHROPOGENIC VEGETATION IN THE AMAZON

Helmut Preisinger, Martina Skatulla, Katja Richter and Reinhard Lieberei
Gerhard Gottsberger
Raunira da C. Araújo, Ronaldo R. de Morais and Luadir Gasparotto
Luiz F. Coelho

1. ABSTRACT

The paper presents the conceptual basis for the vegetation science approach to the ENV 23/2 project. This project attempts to provide a comparative, functional description of different types of anthropogenic vegetation in Terra Firme sites of the Central Amazon and of the plant types occurring in these sites. The main objective is to devise a system whereby individual species of vascular plants and structural traits of vegetation can serve as indicators of site conditions. The classification of frequently occurring plant species on the basis of growth form types and characteristics of generative and vegetative propagation was a first step towards this goal. The approach requires floristic, syn- and autecological studies at a broad range of sites. The data sets and the results of their analysis to date are presented and discussed.

VALOR INDICATIVO DE VEGETAÇÃO ANTRÓPICA NA AMAZÔNIA

O artigo apresenta a base conceptual do trabalho desenvolvido no projeto ENV 23/2, com o enfoque em ciência de vegetação. É uma tentativa para elaborar uma descrição comparativa e funcional de diferentes tipos de vegetação antrópica e identificar os tipos de plantas que ocorrem em sítios de terra firme na Amazônia Central. O principal objetivo é desenvolver uma base para a indicação de condições ecológicas através de espécies isoladas de plantas vasculares e de caraterísticas estruturais da vegetação. O primeiro passo para atingir este objetivo foi a classificação das espécies que ocorrem frequentemente, considerando os tipos de formas de crescimento e as caraterísticas de dispersão vegetativa e propagação generativa. O enfoque requer estudos florísticos, sinecológicos e auto-ecológicos em uma grande variedade de

sítios. Os conjuntos de dados e alguns resultados obtidos até o momento são apresentados e discutidos.

ZEIGERWERT ANTHROPOGENER VEGETATION IN AMAZONIEN

Der Aufsatz stellt die konzeptionellen Grundzüge für den vegetationskundlichen Teil des Projekts ENV 23/2 dar. Dabei handelt es sich um den Versuch einer vergleichenden, funktionalen Beschreibung unterschiedlich anthropogen veränderter Vegetation von Terra-Firme-Standorten Zentralamazoniens sowie der dort vorkommenden Pflanzentypen. Das Hauptziel ist die Erarbeitung von Grundlagen für die Indikation von Standortbedingungen mit Hilfe einzelner Gefäßpflanzenarten und von Strukturmerkmalen der Vegetation. Erste Schritte hierbei waren die Klassifikation häufiger Arten nach Wuchsformentypen und nach Merkmalen der generativen und vegetativen Ausbreitung. Der Ansatz erfordert floristische sowie syn- und autökologische Untersuchungen von einer Vielzahl von Standorttypen. Die bisher erarbeiteten Datensätze und bereits vorliegende Ergebnisse werden dargestellt und diskutiert.

2. OBJECTIVES, ASSUMPTIONS AND CONCEPTS

The comparative vegetation-science approach to the project "Recultivation ..." (ENV 23/2) is a continuation and amplification of the studies carried out from 1992 to 1996 for the predecessor ENV 23/1 project. These first studies on the spontaneous vegetation at the EMBRAPA/SHIFT experimental site near Manaus-AM had shown that the species combination and structural traits (e.g. cover, stratification and composition of growth forms) of vegetation stands are closely linked to the pre-use and present management of the sites (see Preisinger et al. 1994), which suggests that *disturbance* (as defined in Grime 1979) is one of the key factors in the variation of vegetation. It was therefore decided to focus the follow-up studies on *the indicator value of common species and of vegetation types, mainly with regard to disturbance* (i.e. slashing and burning, cutting, trampling, hoeing).

It is assumed that the behaviour of vascular plants in the humid tropics can be explained in part with the help of CSR theory (Grime 1974, 1979), a life history concept which has already proven its practical validity for anthropogenic vegetation of temperate regions (see e.g. Preisinger 1991). The starting point for the autecological studies is the classification of species in a growth form system (see Preisinger et al., in print) and morphological traits that are thought likely to be closely linked to important ecological factors, such as types of pre-use or of management (= extent and frequency of disturbance events), which are key factors in the suitability of sites for agriculture. The conclusions are to be incorporated in an indicator value system of practical applicability. Such a system would be useful for assessing the potential of fallow land for agricultural recultivation. In this context, the vegetation subproject can be divided into five partial objectives, each of which must first be accomplished in order to proceed to the next stage:

- Recording of important autecological traits of frequently occurring secondary forest species and comparison with corresponding traits of useful plants which were planted in the experimental site.
- Attempts to devise a functional description of successional stages of vegetation, growing in the agricultural experimental plantation and in surrounding secondary and primary forests.
- Development of an indicator value system of practical applicability, especially to indicate types of pre-use, i.e. suitability for agricultural use.
- Analysis of the field experiment using multivariate analysis techniques and the indicator system.
- Comparison of structural traits of the vegetation of the experimental site with selected agricultural sites of smallholders of the Manaus region.

The approach requires three main branches of activity: **floristic**, **autecological** and **synecological** (see table 1).

Recording of the **flora** is the basic precondition for the other approaches. Because very little is known of the ecological behaviour of the vast majority of the approximately 1.100 species of vascular plants occurring in the experimental site, it is necessary to accumulate a basic knowledge of the **autecology** of selected secondary forest "key species". The species to be studied in detail were selected by personal judgement, taking into account both the (assumed) importance of the species in the successional sequence and the species' frequency and biomass production. In a **synecological approach**, a sequence of vegetation types, ranging from extensively used primary forest sites to agricultural land, is compared with regard to floristic composition and structural traits (composition of growth form types, propagation and regeneration types, inter alia; see table 1 for an overview of the data sets). Some results of the synecological and the autecological approach available so far are then presented in a concise form.

Table 1: Overview of the data sets built up so far in the vegetation subproject

1. Floristic data - **Recording of all vascular plants** in the habitats mentioned below, preferably on the species level (approx. 1.100 species); - **Classification** of the most frequently occurring species with regard to **growth form types** and **regenerative behaviour** (approx. 300 species classified).
2. Synecological data - **Habitats recorded:** extensively used primary forest plots of 100 m² each (2.200 m² total), secondary forest plots of 100 m² each of 8 years of age and more (10.000 m² total) and plots of 1.600 m² used for the agricultural systems to be tested in the EMBRAPA/SHIFT experimental site (140.000 m² total); plots of 100 m² on farm land and fallow areas of smallholders near Manaus (total area of approx. 3.000 m²); - **Structural traits recorded:** stratification, distribution and dynamics of diameters of tree individuals (> 1 cm), total vegetation cover and cover of single growth form types [%] in the plots of the experimental site; biomass of all tree individuals (> 1 cm of diameter) in a 100 m² secondary forest plot; - **Temporal sequences recorded:** 1. in all plots of the experimental sites: vegetation cover before planting of the useful plants (1993) and two and four years after; last survey planned in 1999; 2. in the secondary forest: all plots in 1994, 10 plots in 1996 and 1998 (planned); - **Seed rain and dynamics of seedling populations** in primary forest, secondary forest and Capoeira plots.
3. Autecological data - **Morphological and anatomical traits** of individuals of four species of *Miconia* and two of *Bellucia* (Melastomataceae), as well as biomass and content of mineral nutrients of the overground parts of plants; - **Life history of leaf development** of individuals of 11 species of different plant families, including the six species of Melastomataceae mentioned; - **Phenology** of frequently occurring species of flowering plants; characteristics of fruits and seeds.

3. SYNECOLOGICAL STUDIES

The vegetation types which were studied in the EMBRAPA/SHIFT experimental site represent a combination of a spatial and a temporal sequence (cf. table 1), and are the result of different types of pre-use (= different intensities and frequencies of disturbance). The vegetation was recorded in a quantitative form and its floristic and structural traits analysed. Table 2 summarizes the floristic, taxonomic and structural traits of the vegetation types under study.

The number of species found in the 1.600 m² plots decreases drastically with the intensity and frequency of disturbance, from approximately 500 in the primary forest to 30 in the agricultural plots. The different vegetation types are characterized by a specific range of plant families, indicating that different taxonomic groups show a specific range of ecological behaviour. Hence, some of the plant families present in a vegetation can be used as "key families" for the different types of habitat. The structural and functional traits presented in table 2 are restricted to stratification, growth form types and types of reproduction and/or regeneration. In table 2, the different layers are named after the growth form type of which they are mainly composed, and numbered from top to bottom.

The physiognomy of the **Terra Firme primary forest** studied is characterized by a canopy of tall trees up to 40 m of height and an understorey layer of palm trees (*Astrocaryum* spp., *Oenocarpus* spp., inter alia). Applying the Beard (1955) classification system, the forest has to be classified as "tropical rain forest", but showing a tendency towards an "evergreen seasonal forest". It is not possible to decide whether the forest type is similar to the "open forest with palms" of Pires & Prance (1985), because of the concise description given there. Klinge (1973) and Prance, Rodriguez & da Silva (1976) do not propose any classification. In our first vegetation survey, carried out in 1994, the **secondary forest** had reached a height of 10 m. It was dominated by low trees, e.g. *Vismia guianensis* agg., and treelets, whereas *Miconia* (Melastomataceae) represented the largest number of species. These characteristics are special to the site studied and cannot be generalized for other secondary forests of the same age in the Central Amazon, because the course of succession greatly depends on the initial site conditions soon after the disturbance event, which might be different elsewhere. The **spontaneous vegetation of the agricultural plots** show a decline in the proportion of tree species, compared to primary and secondary forest, but the proportion of liana species remained constant. There are also differences in the number of species and structural traits between the different mixed cropping systems (not considered in table 2).

The **reproduction of woody plant species by seeds** plays an important role in the primary and secondary forest. In the primary forest, seed production is comparably low, the majority of the seeds are large and the dispersors are mainly larger animals. Seed production in the secondary forest is higher and the seeds are smaller than in the primary forest. In both the primary and the secondary forest, the site conditions are favourable to seed germination, but poor light conditions on the ground normally prevent the immediate growing of the seedlings. Seed production in the Capoeira and in the secondary forest is similar, but the majority of the seedlings in the Capoeira does not survive for more than one year. In the agricultural plots, the woody plants **regenerate vegetatively by roots and shoots**, but do not reach the reproduction phase.

Table 2: Charcteristics of a sequence of Terra Firme sites with different use histories in the Central Amazon (EMBRAPA/SHIFT experimental site near Manaus-AM); n = number of species of vascular plants found in an area of 1.600 m²; see text for more details!

Vegetation type	History of sites		Floristic and taxonomic traits: n	Floristic and taxonomic traits: Key families[1] *Dominant species*	Some structural and functional characteristics of vegetation: Stratification and growth form types of spontaneous vegetation	Some structural and functional characteristics of vegetation: Characteristics of reproduction and regeneration
(1) Primary forest	extensively used for timber extraction (mainly *Minquartia guianensis* Aubl. = Acuaricuara)		500	Sapotaceae Chrysobalanaceae Burseraceae Lecithidaceae *Astrocaryum spp.*	1. Epiphytes 2. Tall Trees 3. Medium and Low Trees; Lianas and Spread-climbers 4. Rosette Trees (palms) 5. Regenerating Trees 6. Herbs	Preferably reproduction by low quantities of large seeds; autochory, anemochory (large, winged seeds); zoochory (bats, large specialized frugivorous birds, large mammals)
(2) 8 year old secondary forest	Primary forest slashed and burned, rubber trees planted and abandoned 2 years after		200	Melastomataceae Moraceae Rubiaceae Bignoniaceae *Vismia guianensis agg.* *Miconia spp.* *Bellucia spp.*	(Epiphytes) 1. Medium and Low Trees; Lianas 2. Treelets 3. Regenerating Trees 4. Stolon Grasses and Herbs	Preferably reproduction by higher quantities of small seeds; autochory, anemochory, zoochory (unspecialised, frugivorous birds, bats, large mammals)
(3) 5 year old Capoeira	as in (2), but slashed and burned for a second time	sites left unattended	30-60	Bignoniaceae Rubiaceae *Vismia spp.*	1. Low (Medium and Tall) Trees 2. "Shrubs"[2] and Lianas 3. Stolon Grasses	Regeneration and subsequent spreading of woody plants by shoots and roots; reproduction by small seeds; anemochory, zoochory (unspecialised frugivorous birds and bats)
(4) Forestry system		timber trees planted in rows	30-60			
(5) Mixed cropping system		3 plantation systems	20-50	Poaceae Bignoniaceae Rubiaceae *Pueraria phaseoloides* (Roxb.) Benth., *Homolepis aturensis* (Kunth) Chase; locally dominace is reached by other species, e.g. *Clidemia hirta* (L.) D.Don)	1. Stolon and Tussock Grasses, herbaceous and woody Lianas, Herbs, regenerating Trees, "Shrubs"[2]	Regeneration of woody plants and grasses by stolons, rhizomes, roots and by tillering; reproduction of herbs and grasses by small seeds; anemochory, zoochory (unspecialised frugivorous birds and bats)
(6) Monoculture system		4 plantation systems	30-60			

[1] Families which respresent the largest number of species in the vegetation types.

[2] "Real shrubs", marked by a basipetalic growth (see Raunkiaer 1934), obviously do not exist in the humid tropics. The growth form type "shrub" in the table is characterized by a mesopetalic growth and a low maximum height.

The ability to regenerate vegetatively after slashing and/or burning is one of the most important attributes governing the survival of the majority of woody plant species in a frequently disturbed environment. Lianas, grasses and herbs, but only few tree species (see example in chapter 3) can invade such open sites, spreading by stolons and rhizomes and reproducing by small seeds. In the experimental site, the habitats "primary forest", "secondary forest" and "Capoeira" are situated in close proximity to one another. Nevertheless, plant species do not often spread from one habitat to another and a spreading of primary forest species into the Capoeira was seldom observed, propably because the dispersors (e.g. large mammals and birds) avoid the open landscape (Howe 1990).

4. AUTECOLOGICAL STUDIES

The studies on autecology of secondary forest species started with six species of Melastomataceae (*Bellucia dichotoma* Cogn., *B. grossularioides* (L.) Triana, *Miconia alata* (Aubl.) DC., *M. phanerostila* Pilger, *M. pyrifolia* Naud. and *M. tomentosa* (Rich.) D. Don. ex DC.). The studies are being extended to other common species of different taxonomic groups representing morphological types which are thought to be of major importance in secondary forests of the Central Amazon.

Table 3: Links between some morpho-physiological traits and site characteristics of 6 species of Melastomataceae (genera *Bellucia* and *Miconia*) occurring frequently at the experimental site.

No.	Species of *Bellucia* and *Miconia*	Growth form type	max. tree height [m]	av. leaf area [cm^2]	Site characteristics or successional stages
1	*M. alata*	treelet	2	(109)[1]	open landscape and abandoned agricultural sites = degraded areas
2	*M. tomentosa*	treelet	6	776	Preferably Capoeiras and young secondary forests, forest gaps, roadsides
3	*M. phanerostila*	treelet	10	416	
4	*B. dichotoma*	low tree	12	330	
5	*B. grossularioides*	low tree	15(-25)	140	Preferably older secondary forests
6	*M. pyrifolia*	medium tree	25(?)	51	

[1] large variability of leaf size observed.

The selected species of Melastomataceae represent a wide range of physiognomic and morphological traits and of ecological behaviour, but within one taxonomic group, and among plants growing on the same site. This permits an ecologically meaningful comparison of the results. The studies on autecology are being complemented by the comparison of nutrient patterns in different organs of secondary forest species and of useful plant species grown in the experimental site.

Observations in the field and the studies mentioned indicate that it is possible to identify "plant functional types" not only at the global scale (cf. Box 1981, Box 1996, Díaz & Cabido 1997), but also at the **regional scale**. The selected species form a sequence of morphological types, whereas the morphological traits are linked to a distinct ecological behaviour (table 2). Note that five of the species occur in different successional stages of regenerating secondary forests (= progressive, secondary succession) and one species (*Miconia alata*) primarily invades the open landscape of degraded areas, sometimes as a dominating species, indicating regressive successional processes. The species produces a large quantity of small seeds, dispersed by birds. Vegetative spreading was never observed. *M. alata* shows a marked variability of leaf size, depending on the site conditions.

5. CONCLUSIONS

The forest vegetation of Terra Firme sites of the Amazon responds to different intensities and frequencies of disturbance events by changes in species composition and structural traits, resulting in a continuum of vegetation characteristics linked to a distinct type of disturbance (see table 2). The comparative studies of stands in primary and secondary forest vegetation of different use history (= **synecological approach**) permits a functional classification of frequently occurring species with regard to their ecological behaviour after disturbance events, provided that the history of the sites is known. This is true for the majority of the study areas mentioned in table 1.

Growth form types and some single morphological traits of species of vascular plants show close interrelations with the ecological behaviour of the species in a disturbance gradient. In principle, those traits can be used for the indication of past disturbance events, or pre-use and possible reversible or irreversible changes of site conditions, respectively. The comparative analysis of the morphology and sites of individual plant species of secondary forest vegetation (= **autecological approach**) contributes to a better understanding of the ecological behaviour of

Amazonian plant species and to the identification of functionally important morphological traits ("morpho-physiological traits"), e.g. leaf characteristics (see table 3).

Classification of frequently occurring species of secondary forest vegetation on the basis of growth form types and single morpho-physiological traits, including characteristics of regenerative behaviour (approx. 300 species classified until now), makes it possible to present the composition of traits in a stand and draw conclusions about site conditions (= **combination of synecological and autecological approach**).

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MECHANISMS OF FOREST REGENERATION IN THE CENTRAL AMAZON - A COMPARATIVE APPROACH

Martina Skatulla

1. INTRODUCTION

The present structure and the future development of a vegetation depend on the presence or absence of plant species with their different regenerative behaviour. The studies were realised in the following vegetation types: Capoeira, secondary forest and primary forest. The close proximity of these sites and similar ecological conditions except for the disturbance factor, allow to compare mutual effects on the regeneration between the different vegetation types.

Therefore the following characteristics of generative behaviour of common plant species were studied in 1997:

- Phenology
- Description of fruits
- Seed rain
- Seed bank
- Seedling germination
- Seedling growth
- Plant growth of individuals with a diameter > 1 cm.

2. RESULTS

The results show different regenerative behaviours for common plant species of the three vegetation types.

<u>Capoeira:</u>

The species of a 5 year old secondary vegetation are characterised by a marked regeneration potential. In average 4 % of all individuals have flowers respectively fruits (table

1), the highest flowering and fruiting rates of the three vegetation types. The seed rain of approximately 5700 seeds por m² all over the year comes mainly from the Capoeira vegetation and comprises primarily seeds of *Vismia guianensis* (table 2). The dynamics of the seedling population is characterised by extreme fluctuations because of a high germinating rate and a high mortality during the first year of life (fig.1). The few established seedlings show a high average growth rate of 11 cm/year (fig. 2).

Secondary forest:

Compared to the Capoeira, the 11 year old secondary forest shows a lower flowering and fruiting rate (table 1) and the heaviest seed rain of the three vegetation types, originated from the secondary vegetation, especially from *Bellucia grossularioides* and *B. dichotoma* (Melastomataceae) (table 2). The germination rate and mortality of seedlings are low, leading to a constant population of 4 seedlings/m² (fig. 1). Seedlings from primary forest species occur more frequently, in contrast to the seedling population in the Capoeira.

Primary forest:

The low flowering and fruiting rate of less than 0,1 % (table 1) caused a weak seed rain, which contains mainly seeds from species of the secondary vegetation (table 2). The seedlings can survive for many years without growing much (fig. 1 and 2).

3. CONCLUSIONS

Primary forest species cannot establish in the Capoeira often, but more frequently in the secondary forest. In contrast, secondary forest species often establish in the Capoeira. The secondary forest can therefore be seen as a "functional link" between primary forest and Capoeira.

There are many reasons for this behavior, all of them related to the very different structure of layering in the two vegetation types (often herb layer and no tree layer in the Capoeira, tree layer and bare soil with litter in the secondary forest). Therefore the spatial proximity of the habitats studied will not inevitably secure the regenerative spreading of species into other vegetation types.

Table 1: Flowering and fruiting rates in three different vegetation types in 1997: Percentage of flowering (*) and fruiting (o) individuals per month.

		J	F	M	A	M	J	J	A	S	O	N	D
Capoeira	*	4	6	4	4	4	3	3	3	6	6	3	4
	o	12	8	4	3	3	4	3	3	2	3	6	6
Secondary forest	*	0,5	1	0	0,5	1	2	1,5	1,5	0,5	1	3,5	2,5
	o	2	1	0,5	0	0	2	1,5	2,5	1,5	1,5	1,5	0,5
Primary forest	*	0,1	0,1	0,1	0	0,2	0	0	0,5	0,3	0,4	0,1	0
	o	0,1	0,2	0,1	0,1	0	0	0	0,1	0,2	0,2	0	0,2

Table 2: Seed rain in three different vegetation types: Average seed quantity per m² in 1997.

	Capoeira	Secondary forest	Primary forest
all species	5743	12533	94
Vismia guianensis	4322	354	12
Cecropia concolor	243	151	27
Passiflora auriculata	142	404	2
Mikania sp.	330		
Bellucia dichotoma		2245	
Bellucia grossularioides		8812	10
Miconia tomentosa		802	16
Machaerium spp.			4
Inga spp.			3
Palms			2
other species	706	265	18

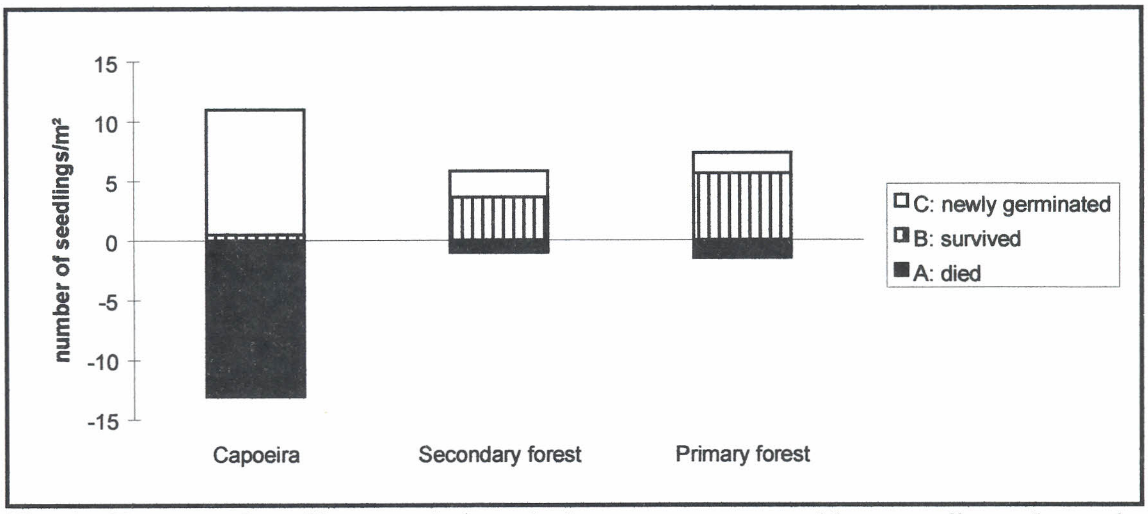

Fig. 1: Changes of seedling populations during one year, caused by mortality and germination:
A + B: individuals of seedlings observed in 1996,
B + C: individuals of seedlings observed in 1997.

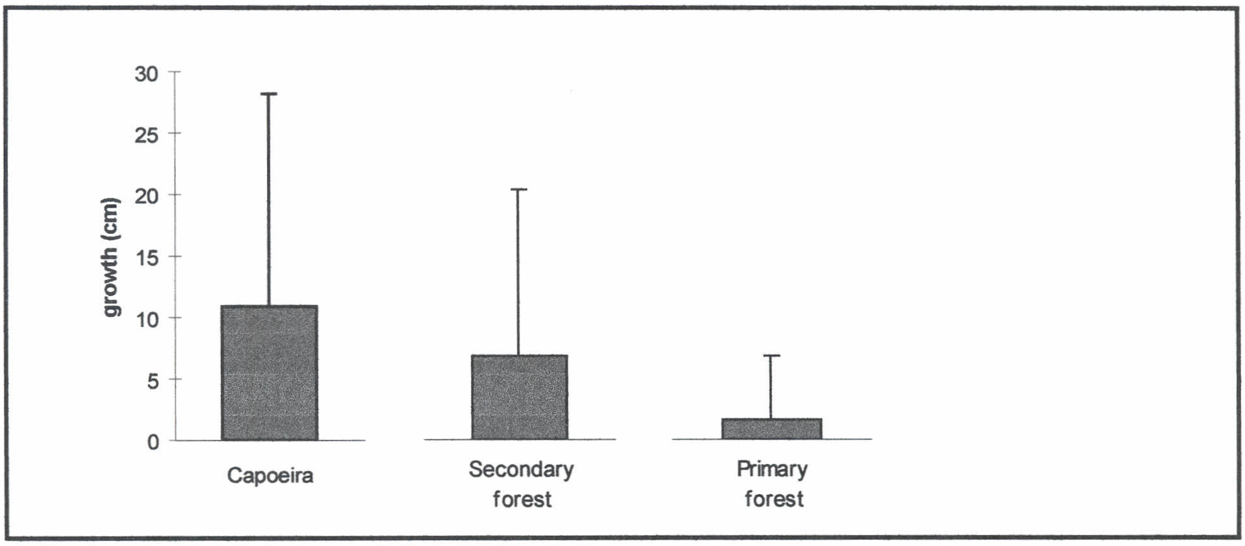

Fig. 2: Average growth of seedlings ("survived seedlings", see in Fig. 1) and standard deviation (T) in the year 1997, observed in three vegetation types.

DEVELOPMENT AND PRODUCTION OF COCONUT PALM (*Cocos nucifera* L.) IN AN AGROFORESTRY SYSTEM

Cássia Regina A. Moraes
Jeferson Luis V. de Macêdo
Adelaide M. Mota
Raunira C. Araújo

1. INTRODUCTION

The Amazon region provides edaphic and climatic condition favorable for the development of the coconut palm. However, its cultivation in this region is still insignificant.

Since the crown of the coconut palm allows the radiation to pass sufficiently and since it is a compact plant of high productivity, this species is considered a promiser component of agroforestry systems.

In this study, the development and production of the coconut palm were evaluated in the course of three and one year, respectively.

2. MATERIALS AND METHODS :

The coconut palm was planted in a system together with rubber, cupuaçu, orange, lemon, mahogany, "louro pirarucú", "jacareúba", cassava, maize and beans. This system have been treated by application of 30% or 100% of the recommended fertilizer dose combined with inoculation or not of seedlings with VA-mycorrhizal fungi.

The field experiment was conducted as a randomized complete block with five repetitions. Tukey's multiple range test was used to evaluate differences among treatments.

3. RESULTS AND DISCUSSIONS :

In the Figure 1 and 2, the development data of the coconut palm in agroforestry system are presented. The statistical analysis of the data shows that the higher level of fertilization has had a significant influence on the girth of the stem only.

The production data of the coconut palm in the agroforestry systems are presented in Figure 3. It could be observed that the plants, which received the higher level of fertilizer, presented a faster production compared with the production of the lower level.

The mycorrhizal inoculation did not show a significant effect on the development and production of this species.

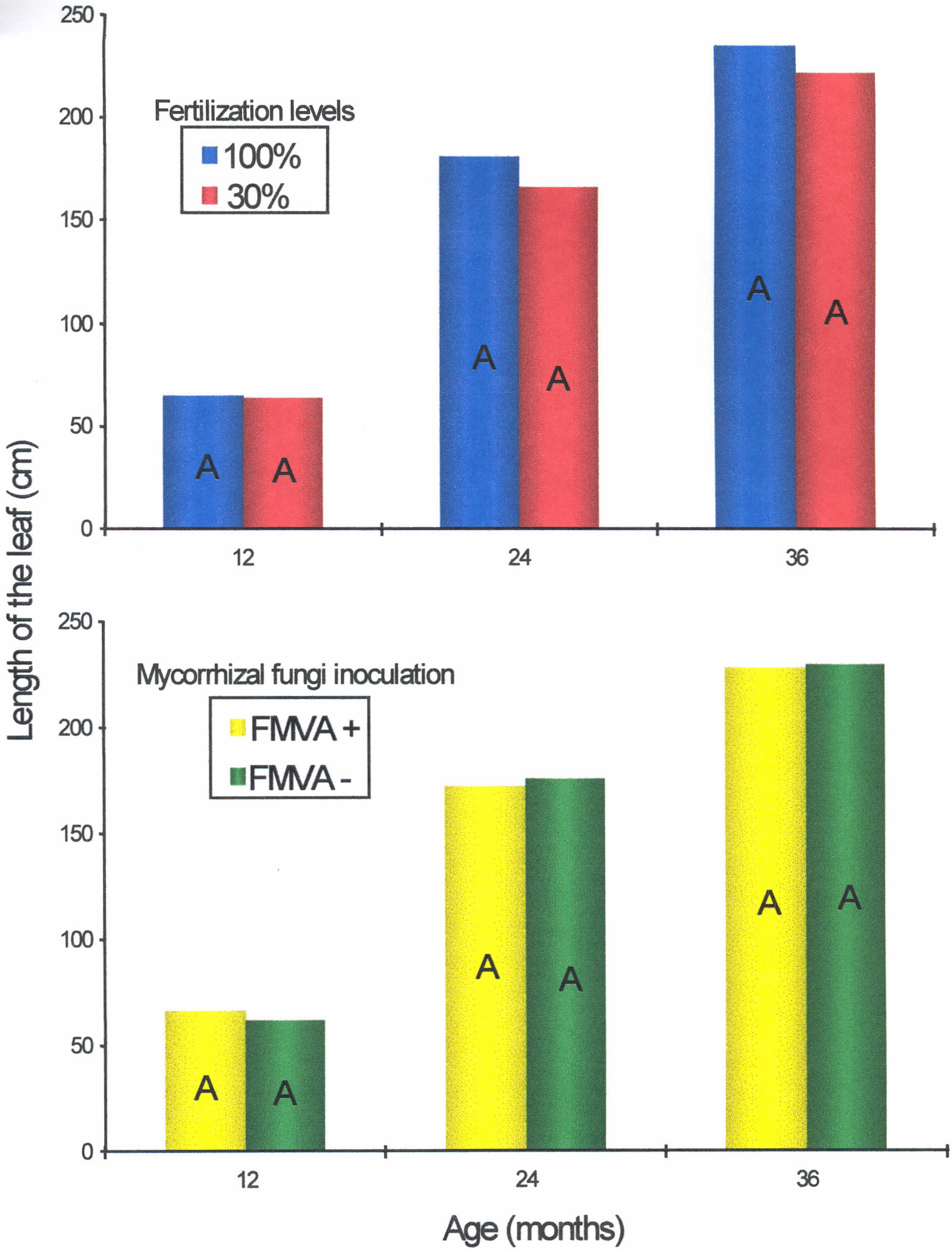

FIGURE 1. Lenght of the laef of coconut palm at 12, 24 and 36 months in an agroforestry system treated with two fertilization level (30 and 100 %) and mycorrhizal fungi inoculation [presence (+) and absence (-)].

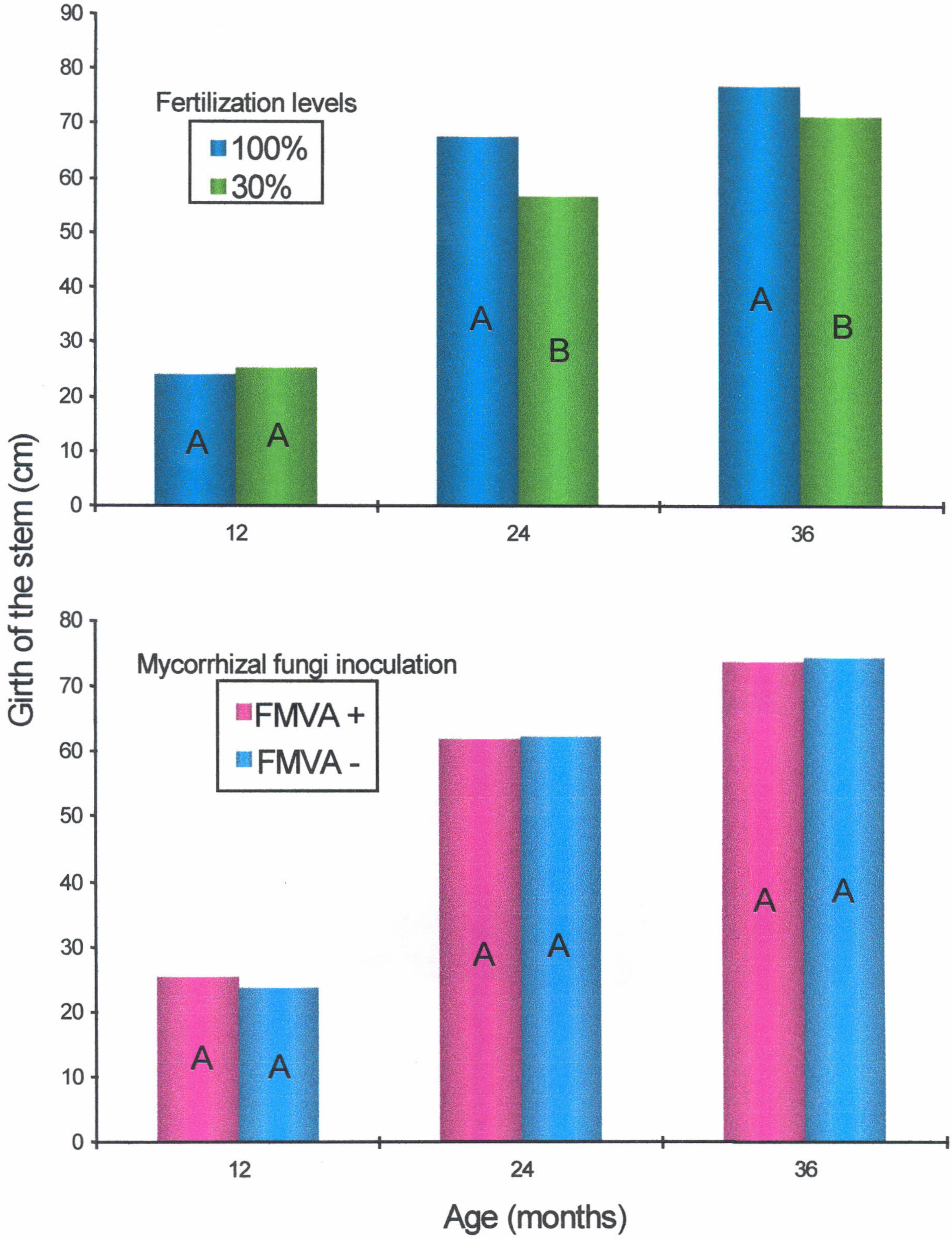

FIGURE 2. Girth of the stem of coconut palm at 12, 24 and 36 months in an agroforestry system treated with two fertilization level (30 and 100 %) and mycorrhizal fungi inoculation [presence (+) and absence (-)].

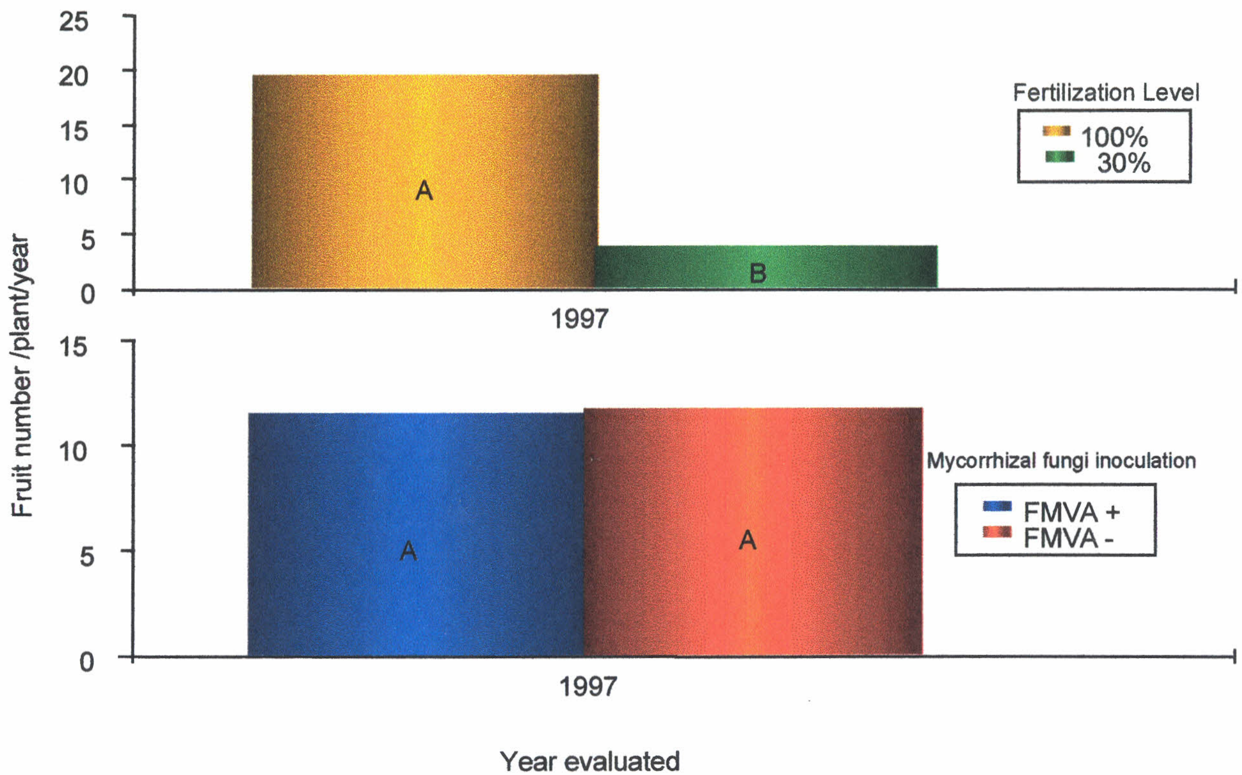

FIGURE 3. Production of coconut palm in an agroforestry system treated with two fertilization level (30 and 100 %) and mycorrhizal fungi inoculation [presence(+) and absence(-)].

CONCLUSIONS :

- ➡ The higher level of fertilization employed has had a significant influence on the girth of the stem and on the production of the coconut palm;

- ➡ The mycorrhizal fungi inoculation did not show any significant effect on the development and production of the coconut palm.

PRODUCTION OF CUPUAÇU (*Theobroma grandiflorum*) IN DIFFERENT POLYCULTURE SYSTEMS

Jeferson Luis V. de Macêdo
Cássia Regina de A. Moraes
Adelaide M. Mota

1. INTRODUCTION

Agroforestry is expected to be a good alternative towards sustainable agriculture in the amazon basin. Among the species used in this agroforestry system, the cupuaçu, a typical species of the amazon region, is considered the most promising one for commercial exploitation

In this study, the production of the cupuaçu was evaluated in the course of two years.

2. MATERIALS AND METHODS :

The production of cupuaçu was evaluated in three agroforestry systems : a) System 1 - Cupuaçu, peach palm, rubber and papaya; b) System 2 - Cupuaçu, peach palm, brazil nut, urucum and manioc; c) System 3 - Cupuaçu, coconut palm, rubber, orange, lemon, mahogany, "louro pirarucú", "jacareúba", cassava, maize and beans. This system have been treated by application of 30% or 100% of the recommended fertilizer dose combined with inoculation or not of seedlings with VA-micorrhizal fungi.

The field experiment was conducted as a randomized complete block with five repetitions. Tukey's multiple range test was used to evaluate differences among treatments.

3. RESULTS AND DISCUSSIONS :

In the Table 1, the production data of the cupuaçu in agroforestry systems were presented. The statistical analysis of the data, in all systems, did not shows any significant effect of the higher fertilization employed and micorrizhal inoculation on the production of this species during the years evaluated.

Figure 1 shows a statistical analysis between systems. The results show that the production of cupuaçu plants is higher in system 1 than in the other systems.

TABLE 1. Production data of the cupuaçu during two years in three agroforestry systems treated with two fertilization levels (30 and 100%) and mycorrhizal fungi inoculation (presence and absence).

SYSTEM	TREATMENT	LEVELS	Evaluated years			
			1996		1997	
			Fruit number per plant	Weight fruit (g)	Fruit number per plant	Weight fruit (g)
1	Fertilization*	100	8.0 a	901.3 a	8.0 a	970.0 a
		30	6.0 a	864.5 a	7.0 a	943.5 a
	VAMF*	presence	8.0 a	892.2 a	7.0 a	918.8 a
		absence	6.0 a	873.6 a	8.0 a	995.1 a
2	Fertilization*	100	4.0 a	788.9 a	3.0 a	806.8 a
		30	1.0 a	807.6 a	3.0 a	908.2 a
	VAMF*	presence	3.0 a	712.9 a	3.0 a	874.6 a
		absence	2.0 a	883.6 a	3.0 a	840.3 a
3	Fertilization*	100	2.0 a	650.3 a	5.0 a	942.4 a
		30	2.0 a	604.7 a	3.0 a	849.1 a
	VAMF*	presence	3.0 a	648.5 a	5.0 a	978.5 a
		absence	1.0 a	606.5 a	2.0 a	812.9 a

* Treatment with same letters within a column are not significantly different at the 0.05 level according to Tukey's multiple range test.

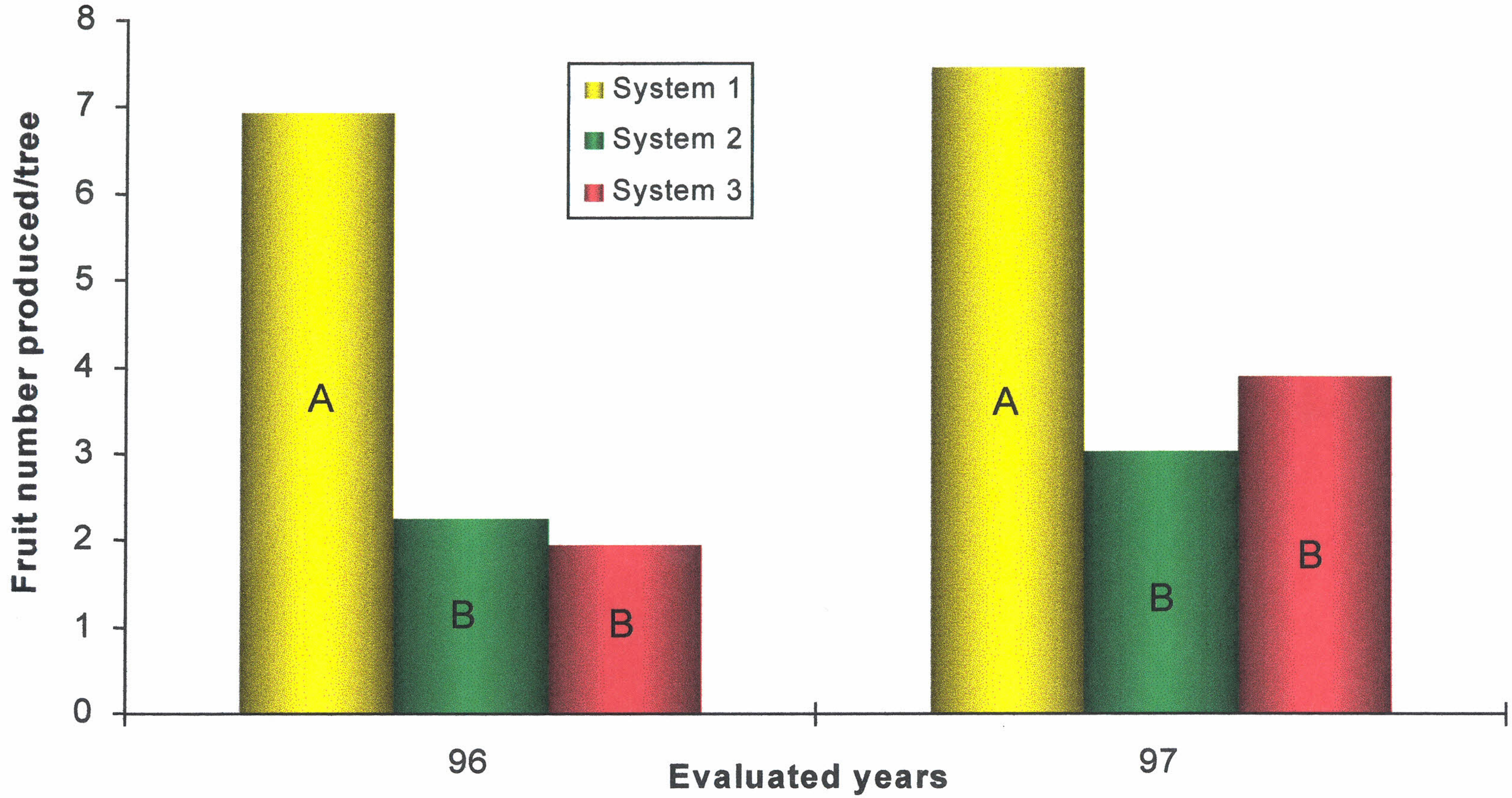

FIGURE 1. Production of cupuaçu plants in three agroforestry systems during two years.

4. CONCLUSIONS :

➡ In the studied agroforestry systems the higher fertilization and micorrizhal inoculation did not lead to a higher productivity of cupuaçu;

➡ The cupuaçu plants in system 1 showed a more rapid development towards productivity than in the other systems.

PRODUCTION OF PEACH PALM (*Bactris gasipaes*) FOR PALM HEART IN DIFFERENT POLYCULTURE SYSTEMS

Jeferson Luis V. de Macêdo
Cássia Regina de A. Moraes
Adelaide M. Mota

1. INTRODUCTION

The peach palm (*Bactris gasipaes*) is a native species of the american humid tropics, adapted to acid and poor soils. Because of its precocity, rusticity, and abundant shooting, this species offering a good alternative for cultivation in agroforestry system for production of palm heart.

In this study, the development and production of the peach palm were evaluated in the course of three years.

2. MATERIALS AND METHODS :

The development and production of peach palm were evaluated in two agroforestry system: a) **System 1** - Peach palm, rubber, cupuaçu and papaya; b) **System 2** - Peach palm, cupuaçu, brazil nut, urucum and manioc. Both systems have been treated by application of 30% or 100% of the recommended fertilizer dose combined with inoculation or not of seedlings with VA-micorrhizal fungi.

The field experiment was conducted as a randomized complete block with five repetitions. Tukey's multiple range test was used to evaluate differences among treatments.

3. RESULTS AND DISCUSSIONS :

In the Table 1, the development data of the peach palm in agroforestry systems 1 and 2 are presented. In both systems, it could be observed that the high level of fertilization has had a significant influence on the development of peach palm. In the other hand, the micorrizhal fungi inoculation did not show any effect on the development of this species.

The production data of the peach palm in the agroforestry systems 1 and 2 were presented in the Figure 1 and 2, respectively. The data for palm heart production in the System 1 show no significant difference between the treatments with 30% and 100% fertilizer. In the System 2 a significant difference in palm heart yield between the two fertilization levels was observed at 30 months only. The micorrizhal inoculation did not show any effect on the production of the peach palm in both systems.

TABLE 1. Development data of the peach palm in two agroforestry systems treated with two fertilization levels (30 and 100%) and mycorrhizal fungi inoculation (presence and absence).

SYSTEM	TREATMENT	LEVELS	Height of plants at 12 months (cm)	Height of plants at 18 months (cm)	number of shoot per plant at 12 months
1	Fertilization *	100	114.5 a	235.6 a	6.7 a
		30	93.6 b	184.4 b	3.9 b
	VAMF *	presence	106.5 a	214.9 a	5.6 a
		absence	101.7 a	205.1 a	5.1 a
2	Fertilization *	100	118.0 a	192.1 a	5.4 a
		30	100.5 b	152.2 b	3.8 b
	VAMF *	presence	110.6 a	175.1 a	4.8 a
		absence	107.9 a	169.1 a	4.4 a

* Treatment with same letters within a column are not significantly different at the 0.05 level according to Tukey's multiple range test.

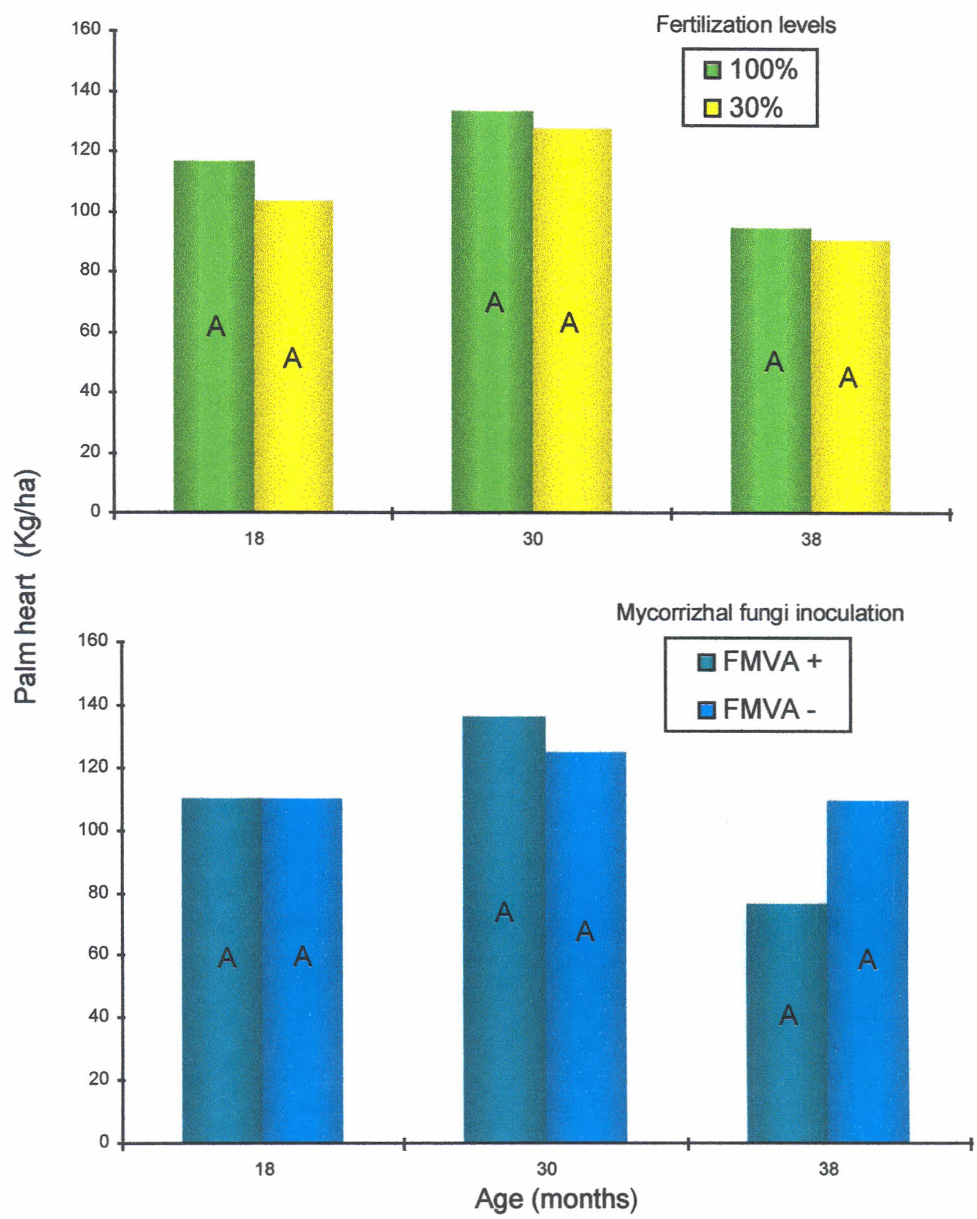

FIGURE 1. Production of palm heart at 18, 30 and 38 months in system 1 treated with two fertilization levels (30 and 100 %) and mycorrhizal fungi inoculation [(presence(+) and absence(-)].

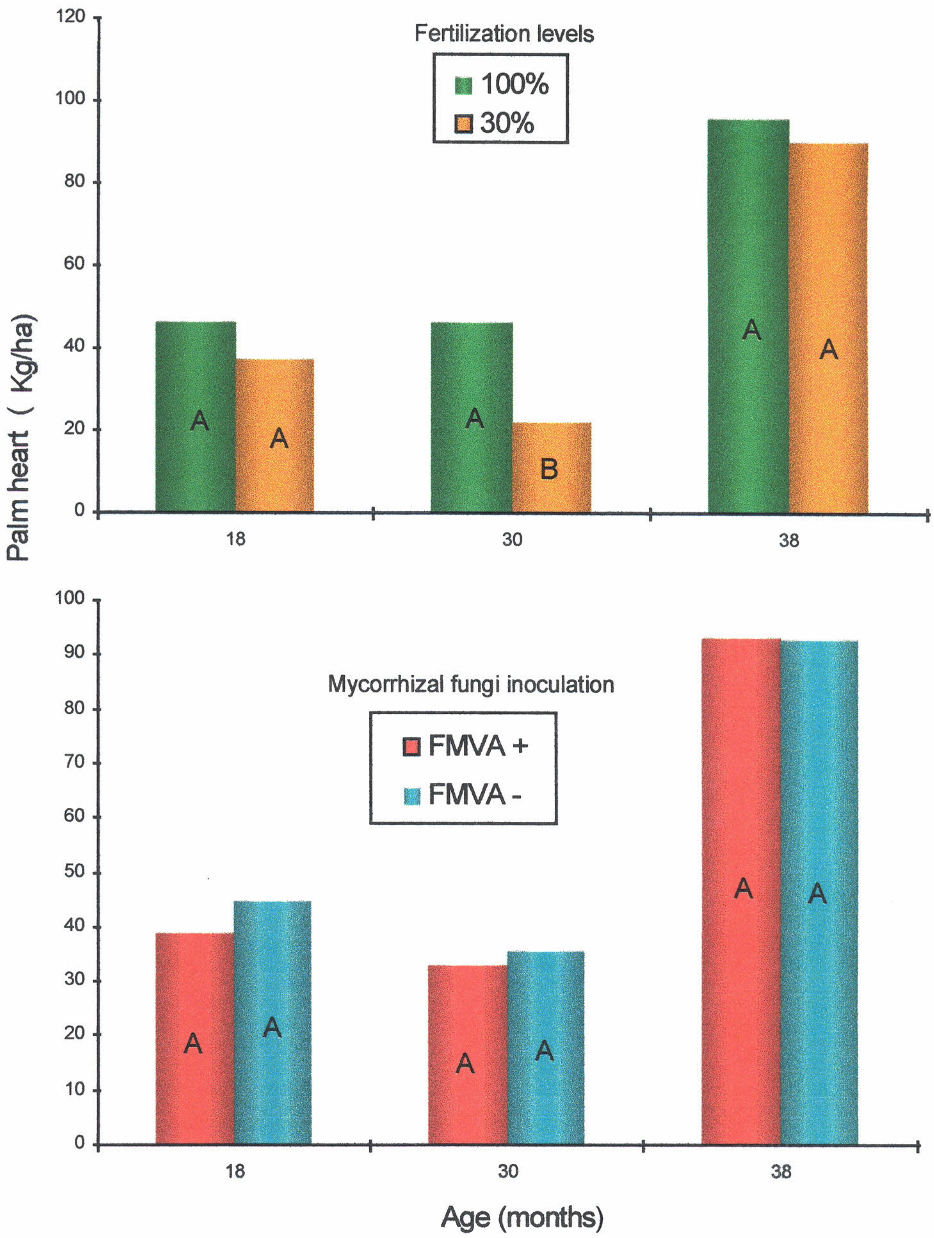

FIGURE 2. Production of palm heart at 18, 30 and 38 months in system 2 treated with two fertilization levels (30 and 100 %) and mycorrhizal fungi inoculation [(presence (+) and absence(-)].

4. CONCLUSIONS :

➡ In all agroforestry systems wich have been studied neither the development nor the productivity of peach palm was influenced by the inoculation of VAMF;

➡ The higher level of fertilization improved the development of peach palm significantly, whereas the production has not been significantly influenced by the different fertilization treatment.

PRODUCTION OF ANNATO (*Bixa orellana* L.) IN AN AGROFORESTRY SYSTEM

Adelaide M. Mota
Jeferson Luis V. de Macêdo
Cássia Regina A. Moraes
Raunira C. Araújo

1. INTRODUCTION

The state Pará is the most important producer of annato seeds in the northern region of Brazil (Falesi & Kato, 1992). In 1990 the average production of annato seeds in Pará was about 1045 kg per hectare of monoculture areas. Thus, annato is considered a comercially promissing crop plant, also suitable for the recultivation of abandoned areas.

In 1993, annato has been planted as part of an agroforestry system on a fallowed rubber plantation (SHIFT experimental site, CPAA/Embrapa-Manaus).

2. OBJECTIVE

The objective of the study is to evaluate the productivity of annato in a agroforestry system which has been treated in four different manners: a) 100 % and 30 % of recommended fertilization; b) with and without inoculation of the seedlings with mycorrhizal fungi of the genus *Glomus.*

3. SHIFT EXPERIMENTAL AREA

The soil of the experimental site is a clay yellow Latossol (oxissol), characterized by high acidity and a high level of exchangable aluminium. The experimental field is located at the north of Manaus, at 3° 8' 5" Southern latitude and 60° 1' Western longitude. According to the Köppen classification the climate is to be characterized as AF (Rainy Tropical Climate) with an average of pluviometric precipitation of 2606.2 mm/a.a, an average of relative humidity of 86.7% and an average of air temperature of 26.7° C.

The agricultural system consists of annato, cupuaçu (*Theobroma grandiflorum*), Brazilian nuts (*Bertholletia excelsa*) and peach palm (*Bactris gasipaes*) with a spacing of 4 x

4 m, all in all 156 plants per hectare. The experiment is conducted in randomized blocks with four treatments and five repetitions.

Seedlings were utilized after they had been inoculated in the nursery with mycorrizhal fungi or not.

From 1994 until 1996, has been evaluated by means of the dry weight of the seeds. The analysis of variance and the Tukey test have been conducted by the aid of the SAS program.

4. RESULTS

The production data, presented in the Figure 1, demonstrate that the productivity of dry seeds (kg/ha) increases from 52% to 73% with 100% of recommended fertilization. No significant effect of mycorrizhal inoculation could be observed in any treatment variant.

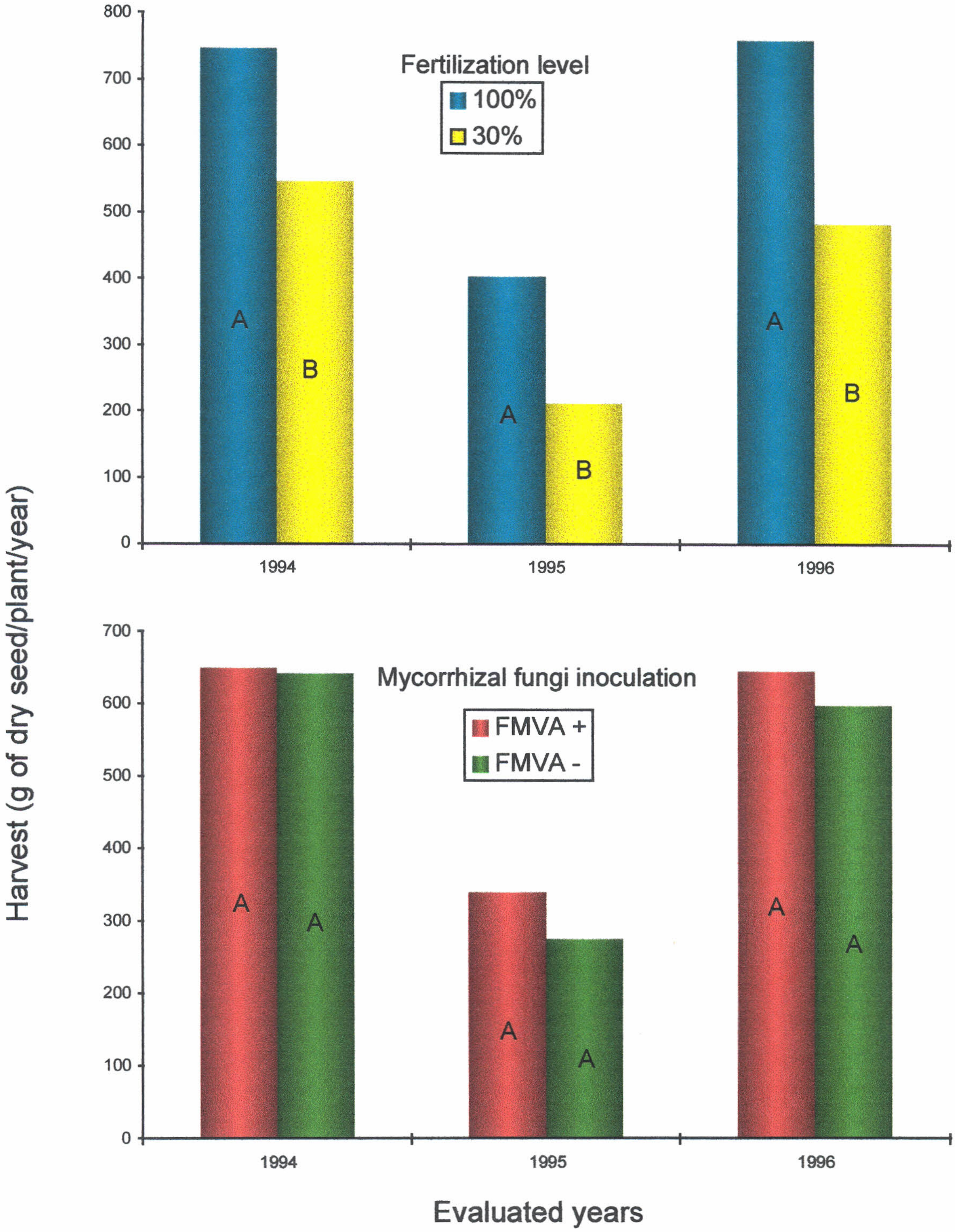

FIGURE 1. Production of urucum in an agroforestry system treated with two fertilization level (30 and 100 %) and mycorrhizal fungi inoculation [presence (+) and absence (-)].

6. CONCLUSIONS

- ➡ The use of complete fertilization (100% of the recommendation) increased significantly the production of the annato in agroforestry systems;

- ➡ The inoculation of seedlings with mycorrizhal fungi did not influence the productivity of annato.

SERINGUEIRA - CRESCIMENTO EM PERÍMETRO DO CAULE.

Vicente Haroldo F. Moraes

As médias do perímetro do caule da seringueira, a partir do novembro de 1994 (após a conclusão da enxertia de copa), para os blocos A, B e C, são mostradas na Tabela 1. A média mais alta continua sendo a do sistema S_1 100C, porém sem diferir significativamente, pelo teste de Tukey a 5%, dos sistemas S_1 100S, S_3 100S, S_3 100 C, S_1 30C, S_3 30C e S 6, ao contrário de 1996, em que o sistema S_1 100C foi significativamente diferente, pelo mesmo teste, dos sistemas S_1 30S, S_1 30C, S_3 30S, S_3 100S, S_4 e S_6 (Tabela 1).

O incremento do perímetro do caule do sistema S_1 100C, em 1997, foi de 6,2m e de 6,4cm em 1996, porém o incremento de 1997 deveria ter sido bem maior em função da maior área foliar. Tal fato deve ser atribuído a estação seca prolongada de junho a outubro, provocado pelo fenômeno El Niño de 1997.

O programa de adubação foi alterado. Em todos os tratamentos, exceto no S_1 30S, foi aplicado calcário dolomítico e o sulfato de magnésio foi suprimido da mistura de adubos, salvo no S_1 30S, no qual também ocorreu a alterações da omissão de nitrogênio, o que não provocou redução do incremento anual, comparado ao dos tratamentos com 30% da dose de fertilizantes. Nos tratamentos com 100% da dose de fertilizantes os incrementos foram mais altos.

A tabela 2 contém os dados dos blocos D e E. Como nos anos anteriores, não houve diferença significativa entre os tratamentos, provavelmente pelas razões sugeridas em relatório anterior.

TABELA 1- Perímetro do caule e incrementos anuais (entre parênteses), das seringueiras, a partir de novembro de 1994. Médias dos blocos A, B e C (cm).

Anos	SISTEMAS										C.V.%
	S_1 30S	**S_1 30C**	**S_1 100S**	**S_1 100C**	**S_3 30S**	**S_3 30C**	**S_3 100S**	**S_3 100C**	**S_4**	**S_5**	
1994	7,1 ab	7,3 ab	7,7 b	7,7 b	6,3 a	8,0 b	7,1 ab	7,6 b	6,5 a	6,7 ab	**5,01**
1995	10,0b (2,9)	10,3 bc (3,0)	11,9 cd (4,2)	12,9 (5,2)	8,1 a (1,8)	10,8 bc (2,0)	10,5 bc (3,4)	11,9 cd (4,3)	8,3 a (1,8)	10,0 b (3,3)	**6,02**
1996	14,5 bc (4,5)	14,9 bc (4,6)	18,0 cd (6,1)	19,3 d (6,4)	11,5 ab (3,4)	16,4 cd (5,6)	15,6 c (5,1)	16,6 cd (4,7)	10,7 a (1,6)	14,8 bc (4,8)	**6,46**
1997	18,6 b (4,1)	19,7 bc (4,8)	24,4 c (6,4)	25,5 c (6,2)	15,1 ab (3,6)	20,6 (4,2)	22,2 c (6,6)	22,1 c (5,5)	11,7 a (1,0)	19,8 bc (5,0)	**11,55**

TABELA 2 - Perímetro do caule e incrementos anuais (entre parênteses), das seringueiras, a partir de novembro de 1994. Médias dos blocos D e E.

Anos	SISTEMAS										C.V.%
	S_1 30S	**S_1 30C**	**S_1 100S**	**S_1 100C**	**S_3 30S**	**S_3 30C**	**S_3 100S**	**S_3 100C**	**S_4**	**S_5**	
1994	6,7 a	6,4 a	7,0 a	6,8 a	6,1 a	6,2 a	6,7 a	6,4 a	5,7 a	6,6 a	**8,21**
1995	8,6 a (1,9)	9,1 a (2,7)	9,9 a (2,9)	9,8 a (3,0)	7,5 a (1,4)	7,7 a (1,5)	7,9 a (1,2)	8,4 a (2,0)	7,5 a (1,8)	7,6 a (1,0)	**5,78**
1996	12,9 ab (4,3)	12,4 ab (3,3)	14,4 b (4,5)	13,2 ab (4,4)	10,2 ab (2,7)	10,6 ab (2,9)	11,0 ab (3,1)	12,9 ab (4,5)	9,0 a (1,5)	10,3 a (2,7)	**11,27**
1997	16,2 a (3,3)	16,0 a (3,6)	17,3 a (2,9)	17,7 a (4,5)	12,8 a (2,6)	12,9 a (2,3)	13,6 a (2,6)	15,3 a (2,4)	10,3 a (1,3)	12,3 a (2,0)	**13,16**

DISEASES IN USEFUL PLANTS CULTIVATED IN POLYCULTURE SYSTEMS

Luadir Gasparotto
Solange Mello Véras

1. INTRODUCTION

In Amazon region, the conditions of high temperature and humidity are extremely favorable to disease attack. In this region all attempts to introduce monoculture systems with perennial species have failed, which in the majority of cases, be attributed to the incidence of diseases: the rubber trees destroyed by *Microcyclus ulei* and the cocoa trees by *Crinipellis perniciosa*.

Rubber trees and cupuaçu trees intersperse in the natural habitat with other species, which are not hosts to their parasites. This make their dispersal more difficult, reducing the intensity of the disease attack. The ideal would be a plantation of economically interesting species in mixed cropping systems, where non host species act as barriers to impede their dispersion, minimizing the risks of failure.

2. MATERIAL AND METHODS

The entire experimental area of the project ENV.23/2, was observed in intervalls of 2 months to evaluate the incidence of diseases on all species of useful plants.

3. RESULTS

In cupuaçu, the attack of witche's broom (*Crinipellis perniciosa*) is extremely low and was controlled by pruning, removing each 2 months the seized shoots.

In citrus, there were incidences of fungi *Septobasidium pseudopedicelatum* and *S. saccardinum* in stems and branches and of *Phytophthora* spp. in the trunk near the soil and in the roots, controlled by painting of trunk with copper-based fungicides.

In rubber trees, the incidence of *Microcyclus ulei* was controlled by crown budding (changing the canopy of the clone Fx 4098 by canopy of the clone PA31-resistant).

Coconut was attack of *Corticium penicillatum* without causing damage.

Brazil nut have been attacked by a new disease in the region, whose pathogen was not yet identified.

4. DISCUSSION

In established mixed cropping and monoculture systems, the incidence of diseases has been extremely low. In most cases there was no need of using fungicides. Until now, there were no differences in the intensity of occurring diseases between the mixed cropping and monoculture systems, probably because the plots size (32 x $48m^2$) is to small to evaluate this problem. However, in relation to areas of production within the region, the intensity of diseases in the experimental area has also been lower, probably because the plants are better fed and the experimental area is found distant from other plantations, therefore less exposed to inoculation.

In the experimental area occurred the first attack observed in the region of *Corticium penicillatum* in coconut and of the new disease in brazil nut. In primary and secondary forest there exists wild host species of a number of pathogens. The installation of cultivated areas close to or in deforested areas within the forest, facilitates the attack and appearance of new parasites. This in part explains the appearance of new pathogens, mentioned before in the experimental area.

COST/BENEFIT ANALYSIS OF AGROFORESTRY SYSTEMS: A CASE STUDY

Francisco Mendes Rodrigues
Cássia Regina de A. Moraes
Luadir Gasparotto

1. INTRODUCTION

The loss of economic relevance of the extractive activity with prominence for rubber, brasil-nut and timber, complemented by subsistence, reshaped in the eighties, in spite of its social importance, it is attributed to the "irrationality of the exploration", as well as to the economic unfeasability of this activity, denounced by the growing costs of extraction, processing and transport of the product to the consuming centers. With relation to the slash and burn agriculture, its relative loss is explained by the lack of competitiveness in price and, mainly, the low quality of the products.Picture has been reshaped, in the recent years, by the need to conserve and to preserve the environment.

Results of agricultural research indicate that the diversification of cultivations through agroforestry systems can contribute to the farmer's economic and financial stability and, consequently, for the sustainability provide that the different crops are adjusted to the market opportunities and the environmental conditions.

This study objetive to make cost/benefit analysis of agroforestry systems indicated for the recovery of degraded areas in the Amazon.

2. METHODOLOGY

The analysis of the experimental production systems, obeyed the following procedures: a) comparison of the new production systems with the traditional system, based on coefficients of internal return rate (IRR), present value (LPV) and benefit/cost ratio (B/C); b) explication of the effects of the new production systems on the sustaintability c) sensibility analysis of those systems based on the more important variable ones more important; and d) accomplishment of simulations to evaluate the risk and the underlying uncertainty to the referred systems.

$$LPV = ILBt / (1 + i)^t$$

in that:

ILB = incremental liquid benefit;

i = market interest rate (financial analysis) or it rates of discount (economic analysis);

t = 1, 2,..., n years.

IRR = ILBt / $(1 + i)^t = 0$

$$B/C = \frac{\sum_{t=0}^{n} B_t/(1+i)^t}{\sum_{t=0}^{n} C_t/(1+i)^t} \text{ in that:}$$

Bt = incremental benefit in the year t

Ct = incremental cost in the year t.

The risk and the underlying uncertainty of the production systems, should be considered what will be made in, this research, through sensitivity analysis and probability analysis.

The basic data of this research were surveyed between December of 1996 and January of 1997, close to technicians that work in the SHIFT project.

3. RESULTS AND DISCUSSION

The analysis of the experimental agroforestry systems and to the traditional system was accomplished from its respective cash flows, in the Tables 1 and 2.

The Table 1 presents the esteemed values of the profitability coefficients IRR, LPV and the B/C ratio of the systems of experimental production and of traditional agriculture in the periods of 10 and 20 years.

Table 2, display LPV of the agroforestry experimental systems nº 2, 3 and 4, present 5% of probability of being smaller or equal the R$ 11.895,00, R$ 6.442,00 and R$ 6.442,00, respectively. There is a 90% probability of these indicators being placed between R$ 11.895,00 and R$ 12.975,00 - system nº 2, R$ 6.442,00 and R$ 7.173,00 - system nº3 and R$ 6.442,00 and R$ 7.173,00 - system nº4. These results confirm the possibility of these systems to contribute to the sustainability of the regional agricultural activity.

Table 1 - Internal Return Rates (IRR), Liquid Present Value (LPV) and benefit/cost ratio (B/C) corresponding to the cash flows of the tradicional systems and of itinerant agriculture and of the experimental agroforestry systems. State of Amazonas, 1997.

PARAMETERS	Traditional Systems	Experimental Agroforestry Systems			
		1	2	3	4
IRR - 10 years	-1	(-)	16%	23%	35%
IIR - 20 years	1%	(-)	26%	28%	39%
LPV - 6% - 10 years	R$ 9.031,1	(R$ 2.933,04)	R$ 1.938,31	R$ 1.971,99	R$ 3.476,76
LPV - 6% - 20 years	R$ 13.675,8	(R$ 2.782,14)	R$ 11.416,85	R$ 6.196,29	R$ 8.109,56
Ratio B/C - 10 years	1,19	(-)	1,57	1,65	1,71
Ratio B/C - 20 years	0,98	0,57	2,55	2,49	2,32

Table 2 - Distribution of accumulated probability of IRR, LPV and relationship B/C, of the agroforestry systems of numbers (1), (2), (3) and (4), in the 20 year-old horizon.

Parameters	*EXPERIMENTAL AGROFORESTRY SYSTEMS*											
	1			2			3			4		
	IRR	LPV	Ratio B/C	IIR	LPV	Ratio B/C	IRR	LPV	Ratio B/C	IRR	LPV	Ratio B/C
Minimum =	-	(2,815)	0.57	26%	11,477	2.97	27%	6,142	2.47	27%	6,142	2.47
Maximum =	-	(2,594)	0.63	29%	13,501	3.26	33%	7,439	2.71	33%	7,439	2.71
Mean =	-	(2,699)	0.60	27%	12,405	3.10	30%	6,800	2.61	30%	6,800	2.61
Std Deviation =	-	46	0.01	1%	344	0.05	1%	222	0.04	1%	222	0.04
Mode =	-	(2,687)	0.60	27%	12,211	3.10	30%	6,593	2.59	30%	6,593	2.59
5% Perc =	-	(2,786)	0.58	26%	11,895	3.02	28%	6,442	2.54	28%	6,442	2.54
10% Perc =	-	(2,752)	0.58	27%	12,007	3.03	29%	6,544	2.55	29%	6,544	2.55
15% Perc =	-	(2,745)	0.58	27%	12,089	3.05	29%	6,575	2.57	29%	6,575	2.57
20% Perc =	-	(2,740)	0.59	27%	12,147	3.06	29%	6,619	2.58	29%	6,619	2.58
25% Perc =	-	(2,732)	0.59	27%	12,185	3.07	29%	6,641	2.58	29%	6,641	2.58
30% Perc =	-	(2,728)	0.59	27%	12,212	3.07	30%	6,683	2.59	30%	6,683	2.59
35% Perc =	-	(2,719)	0.59	27%	12,243	3.08	30%	6,707	2.59	30%	6,707	2.59
40% Perc =	-	(2,713)	0.59	27%	12,255	3.08	30%	6,737	2.59	30%	6,737	2.59
45% Perc =	-	(2,707)	0.60	27%	12,336	3.09	30%	6,755	2.60	30%	6,755	2.60
50% Perc =	-	(2,702)	0.60	27%	12,375	3.09	30%	6,783	2.61	30%	6,783	2.61
55% Perc =	-	(2,693)	0.60	27%	12,422	3.10	30%	6,796	2.61	30%	6,796	2.61
60% Perc =	-	(2,687)	0.60	27%	12,472	3.11	30%	6,844	2.61	30%	6,844	2.61
65% Perc =	-	(2,681)	0.60	27%	12,531	3.11	31%	6,892	2.62	31%	6,892	2.62
70% Perc =	-	(2,678)	0.60	27%	12,548	3.12	31%	6,921	2.63	31%	6,921	2.63
75% Perc =	-	(2,672)	0.61	28%	12,614	3.13	31%	6,943	2.64	31%	6,943	2.64
80% Perc =	-	(2,667)	0.61	28%	12,670	3.14	31%	6,971	2.65	31%	6,971	2.65
85% Perc =	-	(2,644)	0.61	28%	12,698	3.15	32%	7,005	2.66	32%	7,005	2.66
90% Perc =	-	(2,634)	0.62	28%	12,820	3.16	32%	7,083	2.67	32%	7,083	2.67
95% Perc =	-	(2,626)	0.62	28%	12,975	3.17	32%	7,173	2.69	32%	7,173	2.69

4. SUMMARY AND CONCLUSIONS

Among the results of the study, a substantial contribution come out of the agroforestry systems for the sustainability of the agricultural activity.

The reach of this goal requests more biological researche to fill the gaps of knowledge of the potential of the region, on one side; and socioeconômic research, that can offer subsidies for the consolidation of the alternatives of development of systems that provide larger economic and social benefit to the farmers. The accomplishment of investments in the improvement of the human resources, in order to enable them to use the compatible channels of information within the demands of the global market is also an acute.

DESENVOLVIMENTO DE ESPÉCIES FLORESTAIS ESTABELECIDAS EM SISTEMAS DE POLICULTIVO

Roberval M. B. de Lima

1. METODOLOGIA

O experimento foi instalado no Campo Experimental do Centro de Pesquisa Agroflorestal da Amazônia Ocidental (CPAA), localizado no Km 29 da rodovia AM 010 no município de Manaus, Amazonas. A área, anteriormente cultivada com seringueira, encontrava-se abandonada. A área do experimento foi instalada em Latossolo Amarelo de textura muito argilosa, cuja análise revelou uma elevada e generalizada acidez e pobreza de nutrientes. Em fevereiro de 1993 foram plantadas as espécies florestais: castanha-do-brasil (*Bertholletia excelsa);* mogno (*Swietenia macrophylla*); paricá (*Schizolobium amazonicum*); andiroba (*Carapa guianensis*) e seringueira (*Hevea brasiliensis*), como componentes dos seguintes sistemas:

Sistema 2: Urucum X **Castanha-do-brasil** X Cupuaçu X Pupunha

Sistema 3: **Paricá** X **Seringueira** X Coqueiro X Citrus

Sistema 4: **Seringueira** X **Andiroba** X **Mogno** X **Paricá**

Nas entrelinhas do sistema 2 foi plantado mandioca mais pueraria como cobertura do solo, e nas do sistema 3, mandioca, milho e feijão caupi mais pueraria como cobertura. Os sistemas 2 e 3 receberam os seguintes tratamentos: a) 30C - 30% da adubação recomendada; b) 100C - 100% da adubação recomendada, ambos com todas as plantas inoculadas com o fungo micorrízico *Glomus etunicatum* ; c) 30S - 30% da adubação recomendada e d) 100S - 100% da adubação recomendada, ambos sem inoculação do fungo micorrízico.

2. RESULTADOS E DISCUSSÃO

Os resultados obtidos com o desempenho das espécies florestais aos 4 anos de idade serão apresentados agrupados nos diferentes sistemas que as mesmas fazem parte.

Sistema 2 : Urucum X **Castanha-do-brasil** X Cupuaçu X Pupunha.

Na tabela 1 apresenta-se os resultados aos 4 anos de idade obtidos entre as interações do tratamento dose de adubação com e sem micorrizas com a castanha-do-brasil quando consorciada com urucum, cupuaçu e pupunha.

A análise de variância realizada para avaliar os tratamentos aos 4 anos de idade para os parâmetros altura e diâmetro, revelou não haver diferença significativa entre os tratamentos aplicados (F = 0.284 e 0.138, respectivamente) .

Tabela 1. Desempenho da Castanha-do-Brasil (*Bertholletia excelsa*), aos 4 anos de idade, no sistema 2 em relação à altura e diâmetro a altura do peito (DAP). Manaus, 1998.

TRATAMENTO[1] (Adub. X Mic.)	ALTURA MÉDIA [2] (m)	DAP MÉDIO [2] (cm)
30 C	5,80 a	9,39 a
100 S	6,12 a	9,88 a
30 S	6,40 a	9,99 a
100 C	6,42 a	10,19 a

[1] **30S**=30% de adubação, sem aplicação de micorriza; **30C**=30% de adubação com aplicação de micorriza; **100S**=100% de adubação sem aplicação de micorriza; **100C**=100% de adubação com aplicação de micorriza.
[2] médias seguidas pela mesma letra não diferem estatisticamente entre si pelo teste de Tukey a 95% de probabilidade.

Observa-se que no período de 4 anos, o efeito da aplicação da micorriza com adubaçao continua não apresentando significância no desenvolvimento da espécie em altura e diâmetro. Aos 4 anos de idade, a castanheira apresentou maior crescimento em altura e diâmetro (6,42 m e 10,19 cm, respectivamente) no tratamento 100% da adubação recomendada com aplicação da micorriza.

<u>Sistema 3</u> : **Paricá** X Seringueira X Coqueiro X Citrus.

Apesar do bom desenvolvimento em altura e diâmetro, a espécie paricá no sistema 3, apresentou um grande número de árvores com fustes quebrados, o que ocasionou, em algumas parcelas, uma média de altura menor devido a perda da dominância apical e diminuição do tamanho do fuste comercial. Esta ocorrência se deve principalmente ao fato do paricá possuir uma madeira leve (0,32 a 0,40 g/cm^3) com baixa retratibilidade, que quando estabelecido em um grande espaçamento entre as plantas, sem uma proteção lateral eficiente proporcionado pelos outros componentes do sistema, ficam sujeitas aos ventos e tempestades. Tal fato fez com que o paricá fosse eliminado do sistema e substituído por outras espécies florestais com melhor comportamento nas condições experimentais do sistema.

<u>Sistema 4</u>: **Seringueira** X **Andiroba** X **Mogno** X **Paricá**.

Os resultados das análises de variância, aos 4 anos de idade, utilizando-se o teste de F para comparar as espécies no sistema 4 revelaram haver diferenças no comportamento em altura (F=21,284) e diâmetro (F=14,880).

Na tabela 2 apresenta-se os resultados para as diferentes espécies. Para as variáveis altura e DAP comparou-se as médias pelo teste de Tukey a 5%.

Aos 4 anos de idade as espécies seringueira, andiroba e mogno não apresentaram diferença de crescimento em altura, apenas o paricá, por ser uma espécie de rápido crescimento, se destacou das demais (altura média de 11,91m) . As espécies com melhor crescimento diamétrico foram a andiroba e o paricá. Entre as espécies de médio crescimento, a andiroba foi a espécie que apresentou a melhor performance neste sistema. As plantas de mogno apresentaram sérios danos causados pelo ataque de *Hypsipylla grandella* Zeller, o que ocasionou uma perda de 85% do stand.

Tabela 2. Comparação entre as espécies estabelecidas no sistema 4 em relação à altura e ao diâmetro a altura do peito (DAP) - **Seringueira** (*Hevea brasiliensis*); **Andiroba** (*Carapa guianensis*); **Mogno** (*Swietenia macrophilla*); e **Paricá** (*Schizolobium amazonicum*). Manaus, 1998.

TRATAMENTO	ALTURA MÉDIA [1] (m)	DAP MÉDIO [1] (cm)
Seringueira	3,95 a	3,26 a
Mogno	3,50 a	4,45 a
Andiroba	5,46 a	8,32 a
Paricá	11,91 b	12,14 a

[1] médias seguidas pela mesma letra não diferem estatisticamente entre si pelo teste de Tukey a 95% de probabilidade.

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