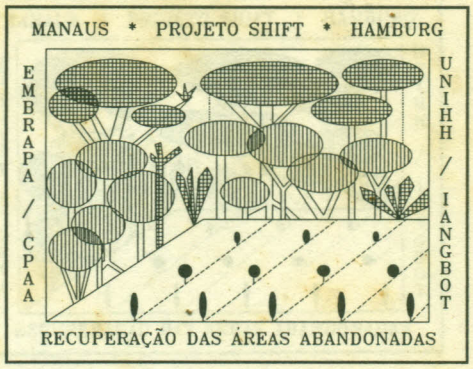

SHIFT-Projekt ENV-23

Rekultivierung degradierter, brachliegender Monokulturflächen in ausgewogene Mischkulturflächen unter besonderer Berücksichtigung bodenbiologischer Faktoren

Förderkennzeichen 0339457A

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Recultivation of abandonded monoculture areas in Amazonia

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Resumo:

Aproveitamento das áreas abandonadas de monocultura na Amazônia

O projeto é referente a um experimento instalado em um plantio de seringueira abandonado, de 17 ha, estabelecido com sistemas de policultivo de espécies selecionadas, principalmente árvores. Com o objetivo de atingir a sustentabilidade, diferentes combinações de culturas e estratégias de manejo da vegetação espontânea serão testados e os sistemas de cultivo serão estabilizados inoculando-se as plantas em espores de fungos micorrízicos. A área experimental foi dividida em 5 blocos, com 18 parcelas cada, para testar 4 sistemas de policultivo comparados com 4 sistemas de monocultivo convencional. Parcelas em pousio serão analisadas para servir de referência. A pesquisa científica está direcionada para a função ecológica dos fungos micorrízicos no ensaio de campo, para as análises dos aspectos funcionais e estruturais da vegetação espontânea devido ao manejo e para a identificação e controle das doenças das plantas. Além disso, estudos econômicos e de aceitação serão conduzidos para determinar se os produtores estão inclinados a aplicar, na prática, os sistemas de cultivo testados.

Summary:

The project concerns an experiment in recultivating a fallow rubber plantation of 19 ha by establishing mixed plantations of selected crops, mainly trees. In order to achieve sustainability, different crop combinations and different strategies for management of the spontaneous vegetation will be tested, and the crop systems stabilized by inoculation of the plants with spores of mycorrhizal fungi. The experimental area was divided into five blocks with eighteen plots each to test four mixed cultivation systems, compared to four conventional monoculture systems. Fallow plots will be analysed for reference. The scientific research is focused on the ecological role of mycorrhizal fungi in the field trial, analysis of the structural and functional traits of the spontaneous vegetation due to management and on identification and control of plant diseases. In addition, economic and acceptance studies will be conducted to find out whether farmers are willing to apply the tested cultivation systems in practice.

1 Introduction

The main objective of the project is to develop an ecologically, socially and economically viable system of agriculture better suited to the humid, tropical conditions of Amazonia than existing production methods. It concerns an experiment in recultivating a fallow rubber plantation by establishing mixed plantations of selected, mainly perennial, crops. The function of trees as reservoirs for nutrients and their role in the recycling of biomass in complex systems has often been demonstrated (e.g. Shubarth 1977, Sioli 1980, Burger 1986). Any scheme to recultivate fallow lands in the Amazon must take particular account of pedological and soil-microbiological factors: as the areas in question were originally taken into cultivation by slash-and-burn of primary forest, the soil structure has been altered. First soil-biological analyses in rubber plantations show a dramatic change in the populations of soil microbes (Feldmann & Lieberei 1992) and increased susceptibility of the plants to stress. In most cases, the lands were also cleared mechanically after burning and subjected to high inputs of pesticides during the cultivation phase (Faßbender 1990).

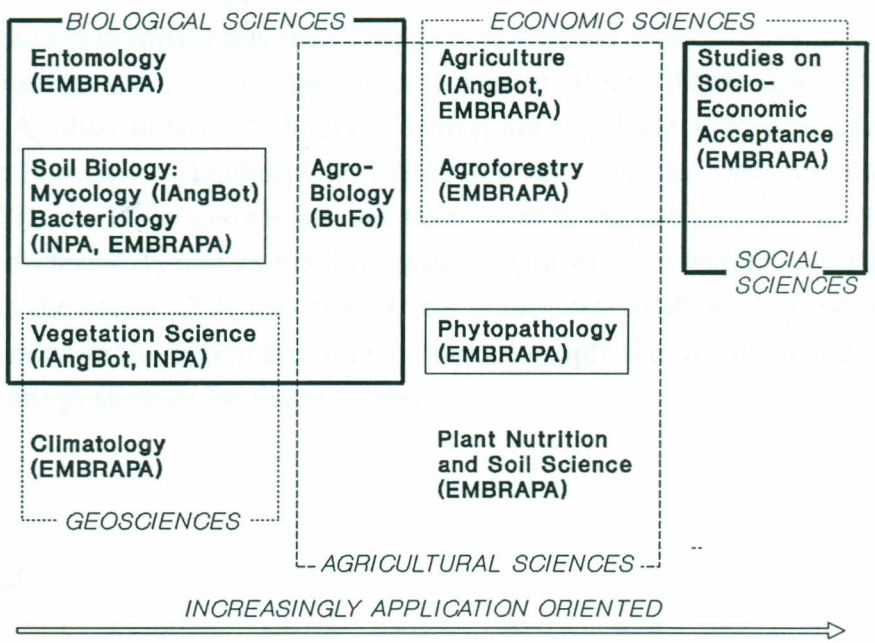

Fig. 1:
Scientific disciplines and institutions involved in the project "Recultivation of abandoned areas ...".
IAngBot = Institut für Angewandte Botanik, Hamburg; BuFo = Bundesforschungsanstalt für Holz- und Forstwirtschaft, Hamburg; EMBRAPA = Empresa Brasileira de Pesquisa Agropecuária da Amazônia, Manaus; INPA = Instituto Nacional de Pesquisa da Amazônia, Manaus

Mycorrhizal fungi can promote the growth and health of crop plants in the humid tropics. There is evidence that young rubber trees (*Hevea sp.*) inoculated with spores of mycorrhizal fungi grow faster and are more resistant to South American leaf blight (*Microcyclus ulei*) compared with reference plants (Feldmann, 1990). But there are also other measures which can be taken to improve plant growth and health in a plantation setting.

In the 19 ha plantation, we intend to test the three following ways of stabilizing crops in different test variants and to analyse the crop systems on a scale close to practical conditions:

1. Inoculation of the plants with spores of mycorrhizal fungi,
2. Testing of different mixed cultivation systems,
3. Experiments on management of the spontaneous vegetation in the crop systems to improve the competitive conditions for the planted crops.

The project has its scientific basis in the field of phytopathology and mycology. However, the operational basis for implementation of the project is much broader: The existing working group is composed of scientists from EMBRAPA, Manaus, the Institute of Applied Botany of Hamburg University, the Federal Research Institute for Timber and Forestry in Hamburg and INPA, Manaus. It covers areas of the disciplines shown in Fig. 1. Basic knowledge has been or is being accumulated in the field of mycology, bacteriology and vegetation science; application-orientedness increases in the direction of the arrow. For this reason, the acceptance studies designed to find out whether farmers in the region are in fact willing to apply the tested cultivation systems in practice are positioned on the far right.

2 Field trial

The experimental area concerns terra firme lands on the EMBRAPA site to the north of Manaus, which were first cleared of primary forest about ten years ago to make way for a rubber plantation. The plantation was abandoned soon after. In August/September 1992, the approximately eight-year-old secondary forest which had evolved in the meantime was cleared and burnt in the traditional manner. The plantation is now established, some short lived plants already being harvested (beans, maize, fruits of papaya).

2.1 Planted crops and plantation systems

Fourteen species of useful plants are planted in the experimental field (table 1). Four different mixed cultivation systems (systems 1-4, see table 2) and four conventional monocultures (systems 6-9) are to be compared in the field trial. System 5 is land which was prepared in the same way as the other systems and then left to follow its own course. Perennials, short-term crops for planting between the rows and cover plants are being used in the systems. The choice of crops was based largely on current marketing prospects.

System 1 is a comparatively intensive cultivation system with little space left between the rows. More space was left between rows in systems 2 and 3, which can be used for growing short-term crops in the first year. In practice, this would help farmers survive the first years after establishment of the plantation, during which the longer-lived species are not generating any income. System 4 is the most "extensive" of the test systems. The species planted produce timber. Secondary vegetation is tolerated between the trees. In systems 1-3 and in monocultures 6-8, on the other hand, a cover plant (*Pueraria phaseoloides*) was sown.

2.2 Plantation systems and test variants implemented

The nine plantation systems described are being established in different test variants (table 3). In systems 1-3, plants inoculated with mycorrhizal fungi are compared to control plants. The fungi were applied to all plants cultivated in system 4, but not to the monocultures. The fertilization variants include zero fertilizer, 30 % and 100 % of the recommended dose for the respective species. That gives a total of n=54 possible test variants. In our experiment we are implementing the 18 variants which promise to give the most meaningful comparisons.

2.3 Experimental area and layout of the field test

In the field test the 18 variants are being laid out in five separate, i.e. repeat blocks. The position of the variants within the blocks is completely randomized. The plots have an area of 48 x 32 m^2 each. The arangement of the plants in the four mixed culture systems is shown in table 4. The layout of the plots is determined by the elongated, irregular shape of the experimental area (see Fig. 2). A 100 x 100 m^2 patch of secondary forest was left standing at the edge of the area for comparative studies of the secondary vegetation.

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Table 1: List of species planted

Common name	Scientific name	Plant family	Use
Seringueira	Hevea spp.	Euphorbiaceae	Rubber production, oil production from seeds
Cupuaçu	Theobroma grandiflorum	Sterculiaceae	Pulp (juice,ice, dessert), pods (chocolate)
Pupunha	Bactris gasipaes	Arecaceae	Fruit, palmito, fodder (leaves), food colourings (fruitflesh), weaving material
Castanha do Brasil	Berthollecia excelsia	Lecythidaceae	Brazil nuts, timber
Urucum	Bixa orellana	Bixaceae	Dyestuffs sunscreens
Cocos	Cocos nucifera	Arecaceae	Oil, copra, coconut milk, feeding stuffs (oil cake), weaving material, fibres, construction timber, particle board
Citrus	Citrus sinensis	Rutaceae	Fruit, oil, pectin
Paricá	Schizolobium amazonicum	Caesalpiniaceae	Timber, charcoal
Mogno	Swietenia macrophylla	Meliaceae	Timber
Andiroba	Carapa guianensis	Meliaceae	Timber, oil
Mamão	Carica papaya	Caricaceae	Fruit, papain, carpain, feeding stuffs
Mandioca	Manihot esculenta	Euphorbiaceae	Starch, vegetables from the leaves
Feijão	Vigna sinensis	Fabaceae	Green fodder, starch
Milho	Zea mays	Poaceae	Starch, edible oil, feeding stuffs
Puerária	Pueraria phaseoloides	Fabaceae	Cover crops

Table 2:
Useful plants and plantation systems

	Plantation systems									
	mixed cultivations				f	monocultures				
	1	2	3	4	5	6	7	8	9	
Seringueira	*		*	*		*				perennial useful plants
Cupuaçu	*	*	*				*			
Pupunha	*	*						*		
Castanha do Brasil		*								
Urucum		*								
Côcos			*							
Citrus			*						*	
Paricá			*	*						
Mogno				*						
Andiroba				*						
Mamão	*									short lived useful plants
Mandioca		*	*							
Feijão			*							
Milho			*							
Puerária	*	*	*			*	*			cover crops
spontan. vegetation				*	*			*	*	

f = fallow (for comparison)

Table 3:
Plantation systems and test variants applied

n = 54	0 fertilizer		30% fertilizer		100% fertilizer		
	-myc.	+myc.	-myc.	+myc.	-myc.	+myc.	
system 1			*	*	*	*	mixed
system 2			*	*	*	*	culti-
system 3			*	*	*	*	vation
system 4				*			
system 5	*						fallow
system 6					*		
system 7					*		mono-
system 8					*		culture
system 9					*		

- myc. = not inoculated with spores of mycorrhizal fungi
+ myc. = inoculated with spores of mycorrhizal fungi

Table 4:
Layout of the four mixed cultivation systems

System I:

```
  4    2,5   2,5   2,5   2,5   2,5   2,5   2,5
-----S-----M-----P-----M-----C-----M-----P-----M-->
   4|    3|    2|    3|    6|    3|    2|    3|
    S     M     P     M     C     M     P     M
 + Pueraria as cover crop
```

System II:

```
  4     4     4     4     4     4     4     4     4
-----B-----U-----C-----P-----B-----U-----C-----P-->
   7|    4|    7|    2|    7|    4|    7|    2|
    C     U     B     P     C     U     B     P
 + Maniok between the rows + Pueraria as cover crop
```

System III:

```
  4     5     5     7     6     5     5     7     4
-----S-----C-----CP----Z-----S-----C-----CP----Z--->
   4|    7|    8|    5|    4|    7|    8|    5|
    S     PC    CP    Z     S     PC    CP    Z
 + Maniok, maize, Cowpea, + Pueraria as cover crop
```

System IV:

```
  4       10       10       10       10       4
-------S--------MG-------PC-------A-------S-------->
     4|       7|       4|       7|       4|
      PC       A        S       MG       PC
 + spontaneous vegetation between the rows
```

Legend:

---- distances between the rows [m]
___ distances between the plants in a row [m]

Abbreviations of the plant species:
S = Seringueira, C = Cupuaçu, P = Pupunha, B = Castanha-do-Brasil,
U = Urucum, K = Cocos, Z = Citros, PC = Paricá, Mg = Mogno,
A = Andiroba, M = Mamão

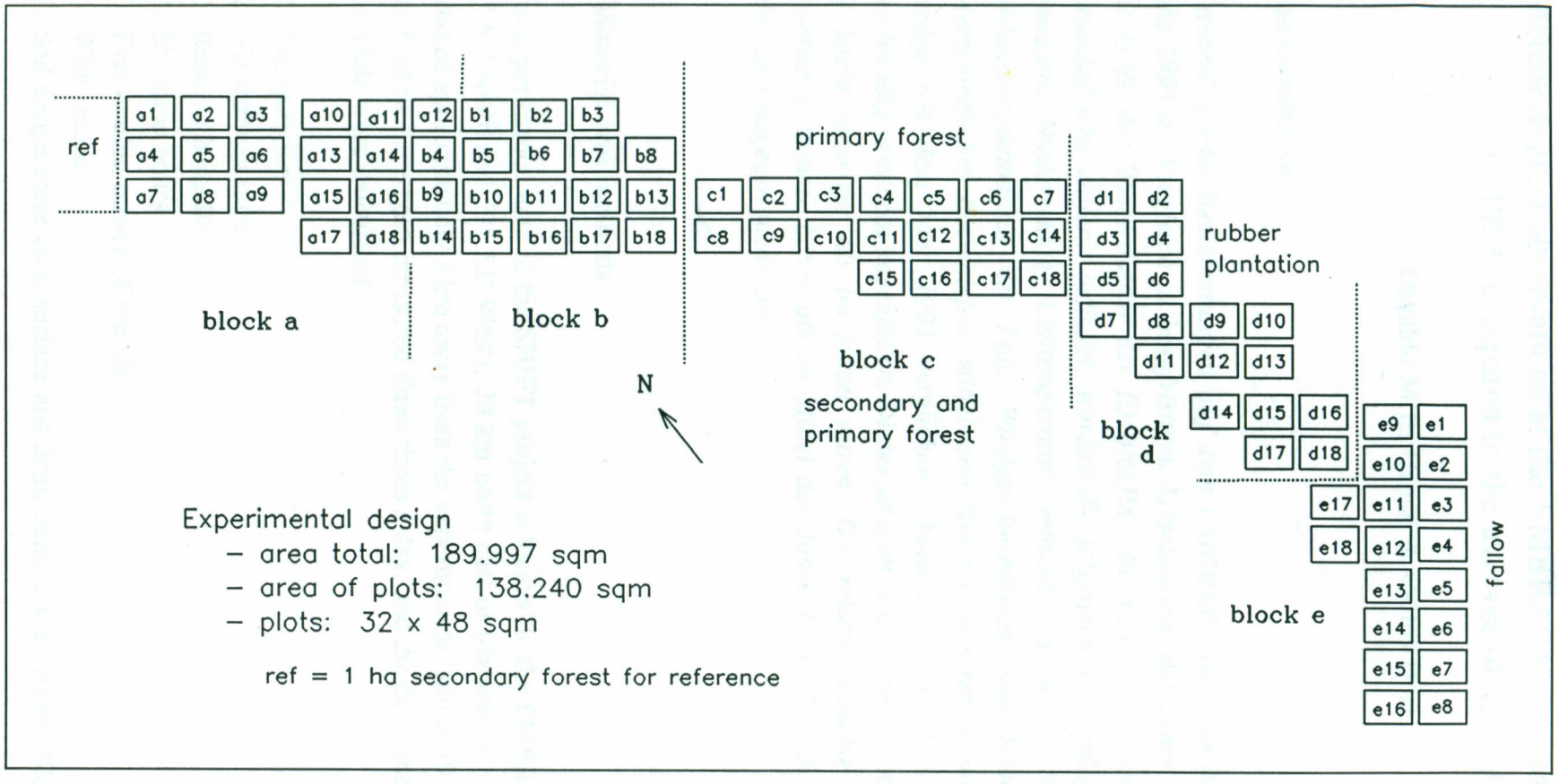

Fig. 2:
Blocks, plots and adjacent sites of the experimental area