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Embrapa

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PROJECT COORDINATOR

ON-FARM TESTING OF AGROFORESTRY ALTERNATIVES TO SLASH AND BURN CULTIVATION BY MIGRANT SMALL FARMERS AT PRESIDENTE FIGUEIREDO - AMAZONAS.

EMBRAPA/UFAM/INPA JOINT PROJECT

FINANCED BY THE ROCKEFELLER FOUNDATION

FINAL REPORT

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Project Coordinator: GLADYS FERREIRA DE SOUSA

MANAUS - AMAZONAS - BRAZIL

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EMBRAPA/CPAA-(Empresa Brasileira de Pesquisa Agropecuária/Centro de Pesquisa Agrofloresta da Amazônia Ocidental)

UFAM-(Universidade Federal do Amazonas)

INPA-(Instituto Nacional de Pesquisas da Amazônia)

EMATER-(IDAM)-(Empresa Brasileira de Assistência Técnica e Extensão Rural)-(Instituto de Desenvolvimento do Amazonas)

INCRA-(Instituto Nacional de Reforma Agrária)

UTAM-(Instituto de Tecnologia da Amazônia)

IBAMA-(Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis)

FUNAI-(Fundação Nacional do Índio)

CNPMF-(Centro Nacional de Pesquisa de Mandioca e Fruticultura)

SENAR-(Serviço Nacional de Aprendizagem Rural)

PESACRE-(Grupo de Pesquisa Agropecuária do Acre)

CPAF/Acre-(Centro de Pesquisa Agroflorestal do Acre)

SHIFT-(Estudos sobre impactos humanos em floresta e várzea dos trópicos)

ESTABLISHMENT AND EVALUATION OF THE AGROFORESTRY SYSTEMS.

EMBRAPA

GLADYS FERREIRA DE SOUSA

ON-FARM TESTING OF AGROFORESTRY ALTERNATIVES TO SLASH AND BURN CULTIVATION BY MIGRANT SMALL FARMERS AT PRESIDENTE FIGUEIREDO - AMAZONAS.

INTRODUCTION

The government development programs taken place in the later 20 to 30 years in Brazil encouraged the occupation of the Amazon basin, by migrant small farmers coming from the northeast and southeast regions of Brazil. The lack of knowledge and capital of these migrants to occupy this environment, and the pressure on land for food production to sustain their food needs and the food supply of an escalating urban population led these migrant farmers to a devastating use of the environment, resulting in a rapid soil degradation of an already poor soil and depletion of natural resources.

In addition, little from government development programs have been placed on these migrant population. Considering the low income and the poor infrastructure available, farmers in this region appeared to be facing a bleak future in terms of ensuring the ecological and economical viability of their farms. Thus, the negative results coming from those poorly planned development that had excluded a large portion of the population are forcing government and local research institutions to search for more innovative and longer term strategies that would help farming communities sustain their food security.

Based on these premises and on results of a primary investigation data regarding problems identification and farmers land use systems taken place in 1991/1992 and considering the perspective of the agroforestry systems as alternatives to slash and burn agriculture, EMBRAPA/CPAA initiated, in 1993, an on farm participatory research project with farmers, in collaboration with INPA-Amazon National Research Institute, UFAM-Amazonas State University, and the financial support of the Rockefeller Foundation.

The project was conducted in four farmholdings at the settlement area on AM-240 Balbina road at Presidente Figueiredo municipality. They were located at: km 13, Marcos Freire community (farmer-Sr. Miguel); km 22, São Francisco de Assis community (farmer-Sr. Davi), km 28, Cristo Rei community (farmer-Sra. Cosma) and on São Miguel community at km 51, Sr Didi household.

The participation of EMATER, the official Extension Services in the project was searched for and it was very promising at the first year of the activities. However the problems encountered by the Institution with respect to reduction of field personnel and financial resources to accomplish institutional goals, prevented the permanence of the technicians in the project on subsequent years. That interfered considerably on dissemination of relevant results and technology transfer. It was expected from EMATER to attain the goal of community organization and establishment of some production processing mini projects. Some of these options would be cassava **(Manihot esculenta)** flour mill and cupuacu **Theobroma grandiflorum** processor plant, or other alternative project for income generating.

SITE CHARACTERISTICS

The Presidente Figueiredo municipality is located at 107 km of Manaus. Its economy is based on the secondary sector, with emphasis on mining, and the primary sector that involves wood mining, lake fishing and agriculture based on cassava, cupuaçu, sugar cane, guarana, banana and other crops. The municipality is very rich in natural resources, with many arqueological sites, caves, water falls, and besides two protected areas for conservation the Waimiris-Atroaris Indians reserve occupies significant part of its territory. The population of the municipality consists of over 7,000 habitants, and, from which, 54 % are rural scattered almost in the entire municipality, but the majority is concentrated on settlement areas, maintained by the town hall and by INCRA (Brazilian National Agrarian Reform Institute); others are distributed on independent communities and also in isolated farms.

The settlement maintained by INCRA, on the road to Balbina nucleus spreads from km 13 to km 36 and it is formed by five communities with approximately thirty six families each, totaling over 600 persons. Outside of this area, but on the other end of the Balbina road is located Sao Miguel community that extends from km 36 to km 60. Sixty four families, totaling approximately 360 persons were established in this community. As it occurs in the settlement, the members of the community are frequently migrant farmers coming from some other settlement areas, after going by some jobs on the industries in Manaus. At the beginning, when the project was proposed, the settlement was newly formed, and it had not gone through many interventions by institutions or government donations programs. Thus, it appeared to have an ideal condition to start a development research project with farmers participation.

The rural population lives mainly on slash and burn subsistence agriculture, which has a low productivity, and, consequently, a very low income. The land use systems are based mainly on **Manihot** and **Theobroma grandiflorum** crops, which are more adapted to the local soils conditions. Soils are heavy textured, with low native fertility, limiting considerably the options of plants to grow in the farming systems. The production is generally sold on two local markets at Presidente Figueiredo town and Balbina urban area, and some times in Manaus city.

PROJECT GOAL

The overall project goal was to test a model of research and development to be applied to small scale farmers of a colonization project on upland ecosystems at Presidente Figueiredo municipality, Western Amazon, with the purpose to improve the technical and economical level of farmers land use systems, as well as, to contribute to income diversification, food security, sustainable land use, and consequently, increasing family income. Therefore farmers participation was a priority in this project.

Specific Goals:

1. To validate technologies suitable to small farmers land use systems;
2. To determine sustainable alternatives of land use systems;
3. To develop technologies that could be incorporated to resource poor farmers' production systems;
4. To promote actions toward communities organization for welfare improvement and a more sustainable use of natural resources.

RESEARCH ACTIVITIES

To achieve these goals, a number of activities had to be pursued at local level and they consisted of:

1. Establishment and evaluation of two Agroforestry systems in four farmlands as pilot plots for demonstration, and/or research development, and technology validation.
2. Evaluation of secondary vegetation (weeds) influenced by systems plant components and crops successions - UFAM.
3. Evaluation of microorganisms infection on leguminous plants: cowpea, peanuts and mucuna- INPA.

1. Establishment and Evaluation of the Agroforestry Systems.

This activity represented most of the project and it consisted of establishment for a central experiment to evaluate the potential of two low-input agroforestry systems to be sustainable alternatives of land use for resources poor migrant farmers, and also as a prospect of a more permanent form of land cultivation than the traditional slash and burn agriculture. Thus, the strategies used were evaluating the annuals plant components in rotation, and intercroped with perennial and semi-perennial plants in temporal and spatial arrangement; monitoring the soil nutrients contents, crop yields and the effects of some soil management on plant growth and grain, roots and fruit production.

2. Evaluation of Secondary Vegetation (Weeds).

It is assumed that agroforestry systems are more stable forms of land cultivation, but weeds are important constraints to increase crop yields in any land use systems. In traditional land cultivation weeds are controlled by the extended fallows and brief periods of cropping. Thus this research activity consisted of weeds characterization and the influence of plants components, crops rotation and soil management on weeds composition and distribution.

3. Evaluation of Microorganisms Infection on Leguminous Plants.

Most of the available humid tropical soils are acid and infertile and are subject to nutrients losses by leaching and erosion during heavy rains. Therefore, to improve crops production in continuous cultivation in such environment several soil-related constrains must be overcome. Fertilizers and lime increase crop yields in the humid tropical soils. However the application of these technologies by those resources poor farmers have several limitations and must be first adapted to their economic conditions. On the other hand, the effect of microorganisms on improving crop growth and production particularly the leguminous plants is well reported. The activity consisted of evaluation of rhizobia infection in leguminous plants, and its tolerance to acidity.

PROJECT RESULTS

The following research results describe the four phases of the work, reporting the data for each year, during the project activities:

PHASE ONE

Report Of Primary Results (1994).

Research Activities

1. Establishment of the agroforestry systems.

The participatory research strategy in farming systems starts with the comprehension of the traditional agricultural systems. With this approach, the work was conducted in close collaboration with farmers, based on their own reality, and developed on their own land. Farmers were active partners in the whole process, including problems identification, technology generation and transfer.

Two agroforestry systems were discussed with farmers of five communities and implemented in two 0.55 ha farmland of a less than two year-old secondary forest fallow.

System 1. "Agroforestry alternative for improving the traditional system of cassava x perennial fruit trees". The perennial components *Theobroma grandiflorum*, *Bactris gasipaes*, *Inga edulis*, and the semi-perennial *Musa sp* were tested at the farm site in a spatial arrangement. The annual component, six cassava varieties (*Manihot esculenta)* recommended by research, was planted in the spacing between the trees species.

System 2. "Agroforestry alternative for improving the system of annual components x perennial fruit trees". The arrangement and the perennial components were the same as in system 1. Three rice varieties *(Oriza sativa)* tolerant to low P and high soil acidity were tested in the spacing between the fruit tree components. The rice varieties were subsequently, substituted by cowpea (*Vigna unguiculata)*, and, then, by *Manihot esculenta*.

The systems were tested on the first year with three treatments: (1) with fertilizer; (2) without fertilizer and (3) with leguminous ground cover crop. The treatments consisted of a judicious amount of chemical fertilizer (22.5 kg/ha of N, 17.68 kg/ha of P and 33.37 kg/ha of K) and organic matter (5 liters of chicken manure per plant). These were applied per plant and concentrated in a pit of 30 cm x 30 cm x 30 cm. Peanuts was the cover crop on the first year, followed by cowpea and then continuously *Mucuna sp.*

The studies carried out in the trials consisted of the characterization of soils texture and density, and chemical properties; weeds; quantification of above ground biomass before slashing and burning the secondary vegetation ("capoeira"), and after project implementation; and evaluation of the agroforestry components in terms of growth and yield. In addition, economical data and the social considerations of the agroforestry systems were accounted for.

2. Weed Evaluation and Microbiology Studies

The studies results on weed management, conducted by UFAM, and on soil microorganisms, carried out by INPA are reported subsequently.

3. Soil Characterization and Plant Component Evaluation

The primary results regarding the chemical analysis of the soil samples demonstrated some of the soils characteristics, that is, low native fertility, high acidity, high clay and low organic matter content (Tables 1 and 2). The amount of the above ground biomass of two year-old secondary vegetation ("capoeira") was not sufficient to restore the stock of soil nutrients in order to permit plant growth and production without fertilizer utilization. The fertilizer treatments increased significantly the growth of cassava, banana and inga, and cowpea grain production (Fig. 1 and 2).

4. Social Considerations (Participatory evaluation)

After the establishment of the on-farm agroforestry systems the project initiatives aimed at farmer organization. The first activity consisted of organization of a farmer's field day visit to the project area with the purpose to: (1). Informing community representatives and local institutions the status of the project; (2). Debate with farmers practical aspects of the project: farmers opinions, necessities, and interest in working together; (3). The importance of a global program involving other governmental institutions, the municipality and a larger number of farmers from neighboring communities. For this event representatives of 28 communities of Presidente Figueiredo municipality and 12 farmers from the communities of the settlement where the work was conducted were invited. Representatives of the following institutions were also invited: INCRA (National Agrarian Reform Institute), FUNAI (Indian National Foundation), EMATER and EMBRAPA. A representative of the town hall of Presidente Figueiredo also participated in the event.

CONCLUSIONS AND RECOMENDATIONS

The conclusions from this first phase were summarized as follow:

1. The initial resistance and suspicion of local farmers had given way to optimism and a genuine desire by many farmers to participate in the on-farm trials.
2. The introduction of better adapted varieties (*Manihot* and *Vigna*) in association with the judicious amounts of fertilizer had resulted in an immediate impact on yields of staple crops and significantly growth increase of perennial crops such as *Musa sp* and *Bactris gasipaes*.
3. EMBRAPA researchers gained a good appreciation of the difficulties faced by these farmers and the realities of adapting on-station derived technologies to farm conditions.

The results and experiences derived from this first phase permitted to make the following recommendations:

1. To establish a community cassava flour processor so as to add value to the basic food crop produced by all farmers in these communities. Converting the cassava tubers to flour in the community, meant that farmers had control of the produce and then to transport a more valuable product (flour instead of raw tubers) to market. It was intended to help the community to purchase the flour processor and training a group of farmers from the community on the operation and administration of the flour processor and its proceeds. However the difficulties encountered to developed some of those activities, forced the changes of the recommended proposals, and this being one of them.
2. To conduct two training courses for community on soil management (including inorganic nutrient additions), nursery and tree seedling preparation techniques, and crop rotations. The idea was to get more farmers to adopt agroforestry rotations as a means of protecting the soil, while producing staple and perennial crops.
3. To extrapolate results of on-farm work to date to a new community of farmers. This was in response to a strong demand from local communities that were not participating in the project, at the time.

4. To organize field visits by members of the communities to EMBRAPA research sites so as to provide feedback to EMBRAPA researchers on the technologies generated on-station.

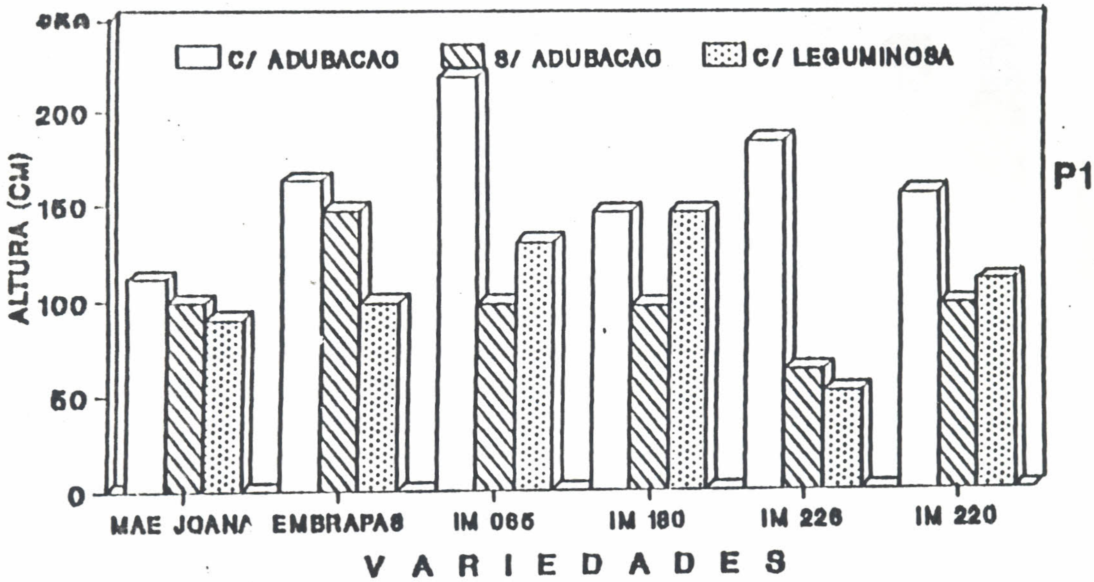
Table 1. Chemical characteristics of soil samples of two farmholdings - farmer P_1 and P_2 in systems S_1 and S_2, in three different soil depths, before burning.

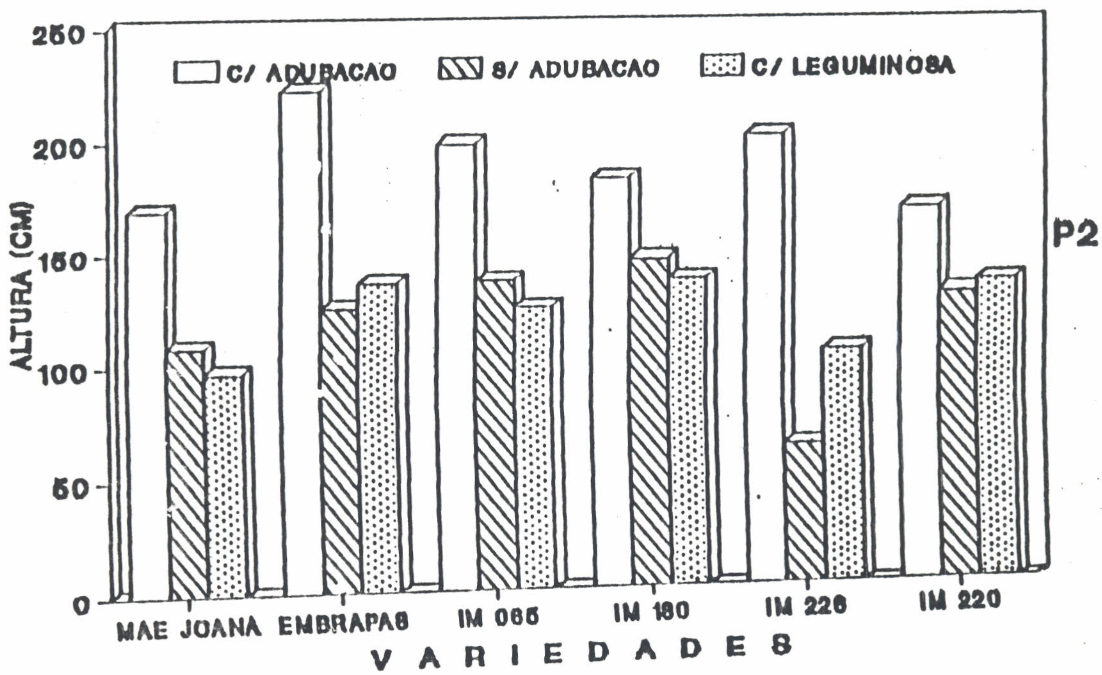
Farmers/ Systems	Depth (cm)	pH	P	K	Ca	Mg	Al	S	C	V	Al
			---ppm---		-----------me%-----------				---------%---------		
P_1/S_1	0-20	4,9	2	42	0,87	0,38	1,2	1,36	2,65	8,75	46,9
P_1/S_2	0-20	5,3	4	68	1,74	0,62	0,4	2,53	2,47	19,83	13,7
P_2/S_1	0-20	4,5	2	24	0,57	0,24	1,7	0,87	2,37	6,35	66,2
P_2/S_2	0-20	4,9	2	90	1,37	1,1	1,1	2,70	2,39	18,11	29,0
P_3/S_1	0-20	4,5	3	44	2,08	0,65	1,2	2,84	3,71	-	29,7
P_3/S_2	0-20	4,4	1	30	0,52	0,22	2,0	0,81	3,59	-	70,9

Table 2. Physical characteristics of soil samples (texture), in three soil depths and two farmholdings – farmer P_1 and P_2.

Farmers	Soil Samples Texture (%)				
	Depth (cm)	Coarse Sand	Fine Sand	Clay	Silt
P_1	0-20	3,45	1,50	79,74	15,33
P_2	0-20	4,27	1,75	82,14	11,86
P_3	0-20	8,98	5,38	78,20	7,45

FIG. 1.- ALTURA MEDIA DE SEIS VARIEDADES DE MANDIOCA NOS SISTEMAS DE MANEJO DE SOLO E PRODUTORES (P1 E P2).





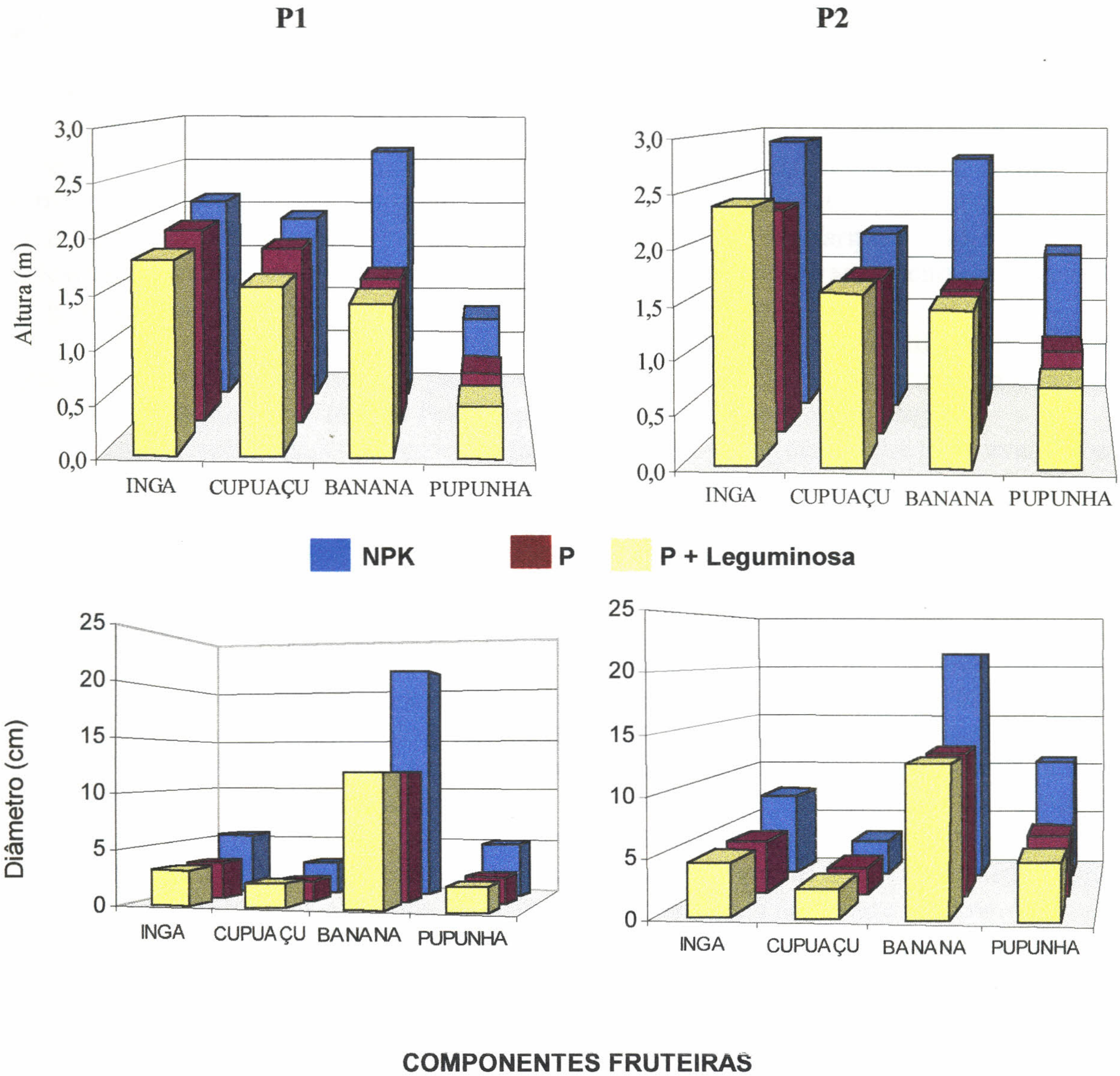


FIGURA 2. ALTURA E DIÂMETRO DOS COMPONENTES FRUTEIRAS AOS 18 MESES DE IDADE NAS ÁREAS DOS PRODUTORES (P1 E P2).

PHASE TWO

Results (1995).

1. Technological Considerations.

The interest raised from the first phase motivated the implementation of a new experimental plot in a third community of the settlement, on the second year of the project activities. The systems and the plants arrangement were the same as the preceding areas. To understand the global aspects of the systems established in the farmers land, a process of following up was set up which consisted of observation of plants arrangements, data collecting on growth, production and acceptance of the systems by farmers.

In this context a strong farmer participation, not only on the identification of farmers goals and problems, but also in a partnership between researchers and farmers in conducting and in evaluating the trials in their fields was an important demand of the project.

The technical results discussed at this phase, then, were mainly the trials evaluation by farmers. In general, farmers evaluated the spatial arrangement of plants in the agroforestry systems a better option for producing the food crops, mainly due to labor effectiveness. With these arrangements, the weeding of the staple food such as cassava, rice or beans implied also on the weed control for the fruit trees in the systems, like *Musa sp, Theobroma grandiflorum*, *Inga edulis* and *Bactris gasipaes*.

The search for sustainable production systems for the fragile upland soils required also the efficient use of inputs such as fertilizer application. The influence of fertilizer inputs on crops growth and production was one of the most important results accomplished by the project Farmers evaluation recognized that harvesting of crops, other than cassava, in a land like the one used for the establishment of the trials was unlikely to occur. As they reported, a land cleared after two to three years fallow was abandoned because it was unproductive for crops with higher fertility requirement such as *Musa sp*. Even in a newly burned secondary forest land, production of corn, rice, or beans was impossible. Yields were too low.

The yield of beans was very high as farmers evaluated. In a small plot of 18 m x 24 m with the small amount of fertilizer, band application, 45 kg of grains were produced while in the other two plots, double the size of the first one (18 m x 48 m), and where fertilizer was not applied the harvest was only 6 kg.

The cassava varieties recommended by research was evaluated by farmers just bearable. They believed the farmer variety with the same fertilizer treatment would produce more than the ones in the trials. In reality, the comparison was not done at the first crop because farmers did not plant their plot at the time the project initiated. That was due to the fact that farmers worked in the field, according to the working force available at the time was needed. In addition, farmers cassava crop was harvested only 16 months after planted, and one of the purpose of the trials was to shortening the harvesting time to 12 month or less. Thus, time for harvesting of both, trial and farmer plot, was unrelated.

Farmers planted their parcel only after the trials were established and they began to use some of the agricultural practices recommended by research, such as the spacing between the fruit trees, and the application of chemical fertilizer. This particular practice was used by one of the farmers who had some fertilizer acquired through a governmental credit program on preceding years, which he had never used, and as he learned from the project, he decided to apply the fertilizer in his crops. In case of the other farmer that had no fertilizer at his disposal, he collected all the residues (ashes, pieces of charcoal) resulting from the burning of the vegetation (trunk, branches and leaves) and applied them into the pit he planted *Musa sp* seedlings. The use of organic matter was also one of the practices used and recommended for the research managed trial. These invalidated possible comparisons.

Nevertheless, from farmers point of view, the cassava variety EMBRAPA 8 was considered the best among the research materials in test, due to higher starch production and flour quality. In addition, this variety had the highest root production when the crop was harvested with 11 months old, and in the total production when harvested at 15 months old.

Regarding the production of banana fruits, farmers showed their great satisfaction with the first year harvest on fertilized plots treatment. In fact, after 15 months of harvesting, just one farmer was discouraged with the crop, due to disease incidence on plants. However, the results reinforced the fact that banana was a temporary component and did remain in the system during the time the perennial components were not in production. What had to be considered was the income generating from the plot that received fertilizer application as compared with the two plots without fertilizer, that had no production. Besides, the crop was harvested every week during almost one year. The other two farmers, however, were so much satisfied with this crop, that they adopted the agroforestry practices with banana, as one of the components of the systems.

The results derived from these trials showed the direction some on-station research priorities should be taken. Alternatives of fruit species, food crops varieties or other permanent plant species had to be introduced into the farming systems used. On the other hand, the results showed that information reaching the farmers were very limited and possibly one of the major causes of low production, thus preventing life improvement of those resource poor communities.

2. Economics Considerations.

Information about cost of production, yield and income generated with the agroforestry systems were collected during the two and half years the trials were established. The cost of labor and inputs for each one of the activity as land preparation, fertilizer and application, sowing, weeding, harvesting and so on, were collected from the beginning of the project for the different treatments. Evaluations then were made by farmers and also by researchers.

Evaluation of the trials after 18 months of crops growth showed a significant difference between treatments. The fertilizer treatment showed the highest production. Over 700 kg/ha of grain for the first cowpea crop was obtained with the fertilizer application, against approximately 100 kg/ha on the treatment without fertilizer. The cassava varieties yielded on fertilized plots almost twice as much as the yield of tuber on the unfertilized plots. However the variety EMBRAPA 8 reached the highest production (27 t/ha of roots-11 months old) in plots with fertilizer treatment, while all varieties growing in plots without fertilizer had the lowest tuber production. Nevertheless, cassava was the only staple crop yielding reached the Amazon's average tuber production, 10 t/ha.

Banana yield was over 2,000 kg/ha on the treatment with fertilizer application, as with the unfertilized plot the production was approximately 60 kg/ha.

The total average cost of production of the experimental area was US$ 5,024.00. The cost of labor and inputs for the treatment with fertilizer was US$ 2,062.00 and the income generating by this treatment was approximately US$ 3,863.00. The results up to the second year of planting, showed a cost return on the agroforestry systems established with the reduced amount of fertilizer applied. At the same time, it raised on farmers of the communities, the expectation and the desire to adopt some agricultural practices, such as fertilizer application, and crop management. However, the adoption of such practices create the demand for products that should be available at the local market, to be used in the farming systems, for crops production improvement.

3. Sociological Considerations.

The project was an interactive process in which the farmers' needs were to improve over time. However, at first, the concern was mainly over the technological problems and not on political participation. It was considered, at first, the political conditions were exogenous to the process, but the researchers involved recognized the need to improve farmers empowerment and, also the involvement of other government institutions.

The perspectives of success visualized as results of the project were enhanced by the adoption, or awareness, or even interest of other farmers and communities for the technologies and practices developed in the trials. That was highlighted by the farmers involved reports. Evidence was also shown by the amount of land planted with bananas in Presidente Figueiredo municipality over the last years. Some income generated in the trials came from the sale of banana seedlings.

Senhor Davi, one of the project collaborator, reported that, as he was at the farmers' market selling his products he almost had no time to work as others farmers were asking him for information in how he planted, what he used, and many other questions of interest. Even farmers on more fertile soils came to get information from him. He also mention that his better quality products were usually sold faster. Those farmers were triggered by the fact that Senhor Davi' bananas, grown on a dry land could had such quality. So, farmers concluded that Senhor Davi' soil and crops agricultural practices were probably the reason for the better quality of banana fruit produced.

Senhor Miguel, another project collaborator, said he wished he could have more labor to increase the production of his area, as consumers at the farmers' market were usually looking for his products, and they were sold out.

Our third farmer Senhora Cosma, mentioned how neighboring farmers stopped at her land to ask for information, and also for some of the plant materials she had in the plot. She was happy with the project. She had never harvested so much in such small piece of land, she reported. Her husband planned to expand the planted area with an agroforestry system, using banana in association with other trees as components of the systems.

Two other communities demanded and organized meetings with the research group to discuss their needs, searching for information on land production and produces quality improvement. They also showed interest on having training programs in agricultural practices, and discuss other alternatives for their communities.

One farmer reported, that if he knew he could make his living from 3 ha, he would never had cleared twenty as he did over time, as he saw the return on the investment, the possibility for food and cash production and savings in labor with the agroforestry systems.

Senhor Davi also reported his youngest son conclusion, that they should not plant cassava any more because production was so low that what they had harvested all those years were only enough to survive. Then, at the father's argument that cassava was their main staple food his son said: "then, we should plant like EMBRAPA showed us to do, because from a piece of land like the one the trial was set up a high production was harvested".

PHASE THREE

Results (1996).

1. The concepts used

In the context of research and development the project aimed, of several targets besides technologies testing. Important areas were to implement a training program that would capacitate farmers to improve their working conditions in addition to improve their production systems. So, a more efficient land use system would be the farmers objective.

By using a participatory approach it was necessary to take into consideration the farmers' characteristics and their goals in order to formulate new proposals. In this regard all new decisions of what to plant were presented first to the farmers for discussion, before implementation. But farmers did decide what should be done and the research team, through observation and based on the farmers' reality, and the knowledge accumulated, organized the ideas and then suggested a better technical adaptation to the farmer's conditions.

1. The follow up process

A process of following up to understand the global aspects of the systems established on farmers land was set up. This process consisted of observation of plants arrangements, data collecting on growth, production and farmers acceptance of the systems. The data on plants production were taken on a parcel that was selected as the sample for each treatment in observation

The data were collected mainly on technical and socio-economical levels and the variables consisted of crops yield (rice, beans, cassava roots and bananas), soil fertility improvement, nature of the cultural practices, labor and inputs spent. Farmers satisfaction was another variable measured by observation of farmers intentions.

2.1. Feedback to farmers

Farmers and researchers were responsible for data collecting, and after the information was processed by the researchers team, the results were presented individually to each farmer and collectively discussed with farmers in the communities. A visit to the agroforestry systems areas of other farmers from the communities involved and other communities in the municipality were then organized. As part of the Research and Development process and for the establishment of a real partnership among researches and farmers, there was discussions regarding the needs and ways to improve the communities capability.

Courses and meetings were organized by the communities themselves and the results obtained in the on-farm research project were discussed. The objective of those meetings was to bring information and to carry on more farmers into the process of improving their production systems as well as to get them into a more effective community organization. In this regard, farmers were not only talking but also using similar crops arrangements in their new plots. However the researchers team was unable to identify or quantify the impact of the project in improving the agriculture systems at Presidente Figueiredo municipality communities. They could not measure these effects. But it was visible what occurred in the area over the years this program was in development. Changes such as the increase in areas planted with bananas and new collaborative research initiatives.

2. Technical and economical results

The land use system of farmers in the upland ecosystem and particularly in the areas of the settlement were quite similar and with very few variation. Thus, the initial agroforestry systems tested were equal, and had the same species components as the traditional farmers land use systems, except the crop differentiation incorporated by the farmers own decision.

Some technical results regarding crops production in the systems in the areas of the three collaborator farmers including total costs (inputs and labor) and income generated in the system were summarized in Tables 3, 4 and 5.

As observed on Table 3 the results of **Manihot** tuber production in the trials was high. It ranged from 13,900 to 24,100 kg/ha with NPK (first crop and average of two harvest date) considering the average yield in the state of Amazonas of 10,000 kg to a maximum of 12,000 kg of tuber per hectare. The fertilizer application had a positive effect on yield of any of the varieties, even when just a small dosage of P-phosphorus were applied. However the evaluation of the varieties by farmers was not what researchers were expecting. The farmers preference and acceptability of new varieties lied on profitability regarding flower production and consumption aspect, such as color of flower produced, while researchers preference focus on high tuber yields, and above ground growth to better fit as component of an agroforestry system. This was the reason for the preference of the farmers variety, the color instead of yield.

On the second **Manihot** crop the tuber production decreased significantly to approximately a third or even fourth of the first year yield (Table 3). The reduction was higher on fertilized plots than unfertilized ones. Nevertheless the tuber yield was approximately the same on all three treatments. This was probably due to above and below ground competition, since the growth of the perennial plants in the treatment with fertilizer were higher than on the treatments without fertilizer and apparently the amount of fertilizer applied was not sufficient to overcome those effects. It has been reported also the increase of problems on the second year **Manihot** crops due to higher insects incidence and rooting reduction of the cuttings.

The cowpea beans as shown by the results increased considerably with fertilizer treatment even with just a small amount of P-phosphorus application. It was not observed decreasing of cowpea yields over the years, even after the third crop. It showed a strong evidence that cowpea is good crop to grow in the central part of the alleys of the agroforestry systems, as in association or in rotation for food production.

The high response of *Musa sp.* fruit trees to fertilizer application (4,800 to 5,600 kg/ha with fertilizer) showed not only to researchers but also to farmers the importance of a minimum use of a technology to improve crop productivity and profitability as more marketable products meeting consumers demand were produced. The results also showed that even a judicious amount of P-phosphorus was enough to produce a higher yield of banana fruit (6.273; 3.433 and 2.538 kg/ha with NPK+ MO; P; and P + leguminous, respectively) in the first year as compared with results of the third farmer (P_3).

Production costs (labor and inputs) and income generated with the agroforestry systems summarized in Table 4, for farmers P_1 and P_2 showed return over the years when fertilizer was applied (US$ 3,311.00/costs and US$ 5,875.00/income). In addition, when analyzed the production of the third farmer that had equal plants arrangement in the agroforestry system, but with all plants receiving a judicious amount of NPK + MO or P-phosphorus, the yields obtained in the system for the first year was relevant when compared with the others farmers. Production was represented by rice, beans, cassava and banana fruit. The costs of labor and inputs, in this case, were not so different from the one spent on the other two farmers.

Farmers innovations were also some of the important results observed. Farmers selected new alternatives as components for the systems, such as vegetable production on the rows of the perennial plants, grown on the time the staple food crop was not suitable to grow. Knowing the effect of the organic matter applied on crops, particularly on *Musa sp.*, farmers started a compost production which was applied on the next year crop fertilization.

The researchers motivated other farmers to prepare compost for their own fields. The collaborator farmers were showing them the process. Farmers themselves were innovating. Instead of preparing a large pile of compost, they had chosen to make small piles spread on different places in the field, preferably, close to the parcel to be applied.

Other crops arrangements farmers were incorporating into their new plots were also observed. The word-of-mouth communication in the area, during the period this project was conducted, generally promoted by farmers was the major source for results dissemination.

Therefore, the identification and analysis of the progress on farmers' technological improvements as the incorporation of new priorities into the arrangements of their systems were considered highly important. Also, the evidences increasingly indicated that these systems, though not considered stable, at this time, seemed productive, ecologically sound, sustainable and tuned to farmers' social and economic situation.

4. Plan for action at community level

The improvement of a research and development process required the involvement of farmers from the communities for participatory technology development. With regard to further action in the community level emphasis was given to field results feedback. Farmers engagement at the community level, occurred through periodical meetings. In these meetings matters of common interest were discussed, and some of them changed into new possibilities and opportunities.

As part of these interests and opportunities, courses were given, visits to the project areas, and a new area was implemented by the initiative of a farmer from a community outside the settlement area. He worked through the involvement of other members of his community in the process of technology development. The plants components in his agroforestry system were **Manihot, Theobroma grandiflorum,** and **Euterpe oleracea**. But pineapple and passion fruit were also introduced subsequently.

This farmer organized a meeting with the members of his community where the knowledge accumulated with the project was discussed. The adoption of improved agroforestry practices could be observed in his plot and in neighboring farmers land, with new production systems established with government loan.

TABLE 3. - Average yield of crops in the systems up during three years growth in areas of farmers P_1, P_2 and P_3 , in three soil management.

CROPS	SOIL MANAGEMENT								
	NPK			P			P + Leguminous		
	P_1	P_2	P_3[2]	P_1	P_2	P_3	P_1	P_2	P_3
	kg/ha								
RICE[1]									
Ita 257	-	-	1,308	-	-	2,175	-	-	1,296
Xingu	-	-	706	-	-	2,975	-	-	2,362
Guarani	-	-	2,631	-	-	2,225	-	-	2,750
Araguaia	-	-	1,400	-	-	2,637	-	-	1,987
COWPEA									
Year-1	686	724	840	105	155	672	89	72	671
Year-2	564	732	635	361	370	1,040	487	387	440
Year-3	807	822		850	602		515	945	
CASSAVA									
Year 1									
IM 065	18,525	14,154	20,720	5,314	9,530	12,947	9,310	8,348	19,883
IM 180	18,314	14,659	22,840	5,133	4,875	6,989	12,815	22,267	19,258
IM 220	17.808	10.976		4.760	6.480	7.225		7.925	29.793
Milagrosa[3]	-	-	7,742	-	-	12,109	-	-	13,281
Mãe Joana	14,725	13,948	5,400	4,313	6,590	8,083	6,440	10,090	9,883
Embrapa 8	24,121	22,594	8,500	10,564	12,083	12,853	8,840	13,551	7,611
CASSAVA									
Year 2									
Mãe Joana	6,810	6,441		7,584	9,005		2,568	4,221	
Embrapa 8	4,312	6,774		11,023	5,221		7,044	5,867	
BANANA									
Year 1	4,853	5,694	6,273	325	509	3,700	158	570	2,716
Year 2	663	822	+	84	61	+	35	216	+

1. No rice production on the first year, in areas of farmers P_1 and P_2.
2. Yield for the first year of planting, including bananas.
3. Farmers variety.

- The variety was not planted.

+ The yield was not collected

TABLE 4. Costs (labor and inputs) and income generated per hectare with the systems, areas of farmers P_1 and P_2 in three soil management, during three years of continuous cropping.

DISCRIMINATION	SOIL MANAGEMENT						TOTAL	
	NPK		P		P+Leguminous			
	P_1	P_2	P_1	P_2	P_1	P_2	P_1	P_2
	--------	--------	--------	US$	--------	--------	--------	-------
COSTS (labor and inputs)	2,550.1	2,550.1	1,886.6	1,886.6	1,982.2	1,982.2	6,418.9	6,418.9
INCOME[1]	5,875.7	5,828.7	1,144.2	1,516.1	898.1	1,861.9	7,918.2	9,206.7

1. Income from 2nd cassava crop and cow-pea on year 3 not included.

Table 5. Average productivity (Farmer: P_1 and P_2) of two agroforestry systems on two smallholdings during the first 38 months of continuous cropping on fertilized plots.

Crops	Planting date	Grain/Tubers/Fruit/Pulp Yields	
		System I	System II
		----------------- t/ha	--------------------
Cassava	Dec./93	23.4	
Rice	Feb./94		1.30
Cowpea beans	June/94		0.76
Cassava	Dec./94		5.50
Cowpea beans	June/95	0.6	
Cowpea beans	July/95		0.65
Cassava	Dec./95	5.5	
Cowpea beans	June/96		0.82
Cassava	Jan./97	3.3	
Banana	Feb./94	5.3	5.30
Cupuaçu	Feb./94	0.24	0.29
Total grain			**3.5**
Total tuber		**31.2**	**5.5**

PHASE FOUR

Results (1997).

The results of the on-farm agroforestry alternatives to slash and burn cultivation indicated high potential of sustainability by modest fertilizer application. Relatively to the traditional farmers cropping systems the yields on the continuous cropping with rice, beans, cassava and bananas on the plots that received minimum amount of fertilizer (22.5 kg/ha of N, 17.68 kg/ha of P and 33.37 kg/ha of K annually, and 5 liters of chicken manure per plant at the first year) were considered very high. Table 5 summarizes the yield (average of two experimental areas) of four and five continuous crops harvested in System I and System II, respectively, within three and half years after the experiments had begun. It was observed that improved practices enhanced the diversity of food crops available to the family, and increased income through higher productivity.

The comparison, however, should be made with the traditional farmers systems. From the information gathered at the initial phase of the project through the diagnostic survey at the household level for the upland ecosysstems at Presidente Figueiredo municipality it was concluded that farmers land use systems consisted of slashing and burning the forest, raising one or two cassava crop in the fertile ash, following abandonment for soil fertility recovering.

The results for the agroforestry systems with the levels of fertilizer used, indicated that productivity of the area exceeded significantly that of the traditional farmers shifting cultivation. In four years of continuous agroforestry systems in an Oxisol, and considering the land use history, four annual crops on System I and five on System II were harvested. The average yield, in the treatment with a judicious amount of fertilizer, and without application of lime, in soils with pH 4.9, in average, and 40% Al saturation, was over 30 t/ha **Manihot** roots, for three crops; 3.5 t/ha of rice and cowpea grain in four crops (average of two trials). The area with fertilizer treatment yielded 5.3 t/ha banana fruit in 18 month production. After that, due to the disease problems, the plants were eliminated and new varieties tolerant to disease were planted on the same space, at the begin of the fourth year. The plants started flowering and fruiting and a good yield is expected.

The harvest of the first **Theobroma grandiflorum** production occurred within three years of planting and the second one had started. Apparently the production is going to be very high taking into consideration the number of fruits formed. If comparisons were made with the farmers traditional farming system, the **Theobroma grandiflorum** fruit production on the third year after the experiments began, was a good result as in the farmers land use systems it generally initiates after the fourth year growth and sometimes on the fifth and up to the seventh year.

Bactris gasipaes was another crop component, and it was included in the systems to meet the need to fruit production for human and small animal feeding. Thus, the young **Bactris** growth were always eliminated, at the first years of the project. The understanding that palm hart could be also one of the project outputs, the first palm heart yield was harvested only within 42 months of continuous growth, when fruit production had also initiated. Farmers, however, were keeping the seeds for seedlings for further plantations or sale. It should be highlighted that **Bactris** palm heart is usually harvested within 14 to 16 month old.

TECHNOLOGY TRANSFER

Adoption of improved technologies to achieve project' goals and preventing further deforestation of primary forest are determined by various factors including farmers participation, support services, and technology appropriateness. The participatory research methodology automatically facilitated technology transfer.

In Presidente Figueiredo Project, the technology transfer was occurring slowly, but in a progressive manner, as the dissemination of results had relied primarily on word-of-mouth communication, promoted by farmers instead of the official extension service. However, the procedures used apparently were reliable as the farmers' collaborators and other farmers were trying to incorporate the technologies into their farming systems.

The project emphasized the training of farmers through courses, visits to EMBRAPA Experimental station to observe and discuss agroforestry systems experiments, undertaken at EMBRAPA's field, and others technologies that could be of farmers use. Other activities included farmer's field day to inform about project development, meetings to discuss results and new strategies of work, and seminar on co-op as a process to improve farmers knowledge on communities organization.

TRAINING PROGRAM AND INTERNATIONAL EXCHANGE

Among the main results accomplished by the project are the conclusion of the first stage of the work. The results identified at least three lines of research interest. The first two lines, soil fertility improvement and successional vegetation in agroforestry systems will be addressed in a Doctorate dissertation. The third line rural development will be further explored in a Master's thesis to be initiated in 1998. Two new project with innovative contents were proposed in major areas of activities. The first one proposed to disseminate agroforestry systems as conservation units in which forest species of economic importance and in process of extinction respectively, Brazil nuts (*Bertholletia excelsa*) and pau rosa *(Aniba rosaeodora* Ducke), would be included as plant components of the systems. The second project included the establishment of a mini unit for processing and conservation of farm produces, to aggregate value and to favor the farmers income improvement. Other accomplishments involved human resources development capabilities through participation in courses, training events, national and international congress, and seminars.

It is worth mention, the training given to the Local Extension Technician Aldair Oliveira in one of EMBRAPA' research center, (CNPMF) National Cassava and Fruticulture Center, located in Cruz das Almas municipality, Bahia State, in 1995. This practitioner was able to broaden up her knowledge on important tropical plants, the major crops systems components.

The project gathered much interest among researchers. During the year of 1996 a subproject was conducted by a German student of Kassel University at Witzenhausen, Hubert Weidner: "Ergonomy and labor requirement analysis for socio-economic assessment of agroforestry systems in Western Amazon". This proposal was part of a Doctorate dissertation, but could not be continued due to student's personal reasons. The preliminary results of this study are presented subsequently.

As part of the interest among researchers is also the ongoing study of Ms. Martina Skatulla on the farmers areas on "Evaluation of strategies of secondary vegetation regeneration in cultivated farmers land". These observation will be a complement of her Doctorate dissertation that is being developed at EMBRAPA' field.

Mention also should be made to the ongoing Doctorate dissertation of Gladys Ferreira de Sousa, as student at INPA, Manaus-Brazil: "Effect of soil management, composition and biomass of weeds on growth of cupuaçu plants *(Theobroma grandiflorum* (Willd. ex Spreng.) Schum) in agroforestry systems at Presidente Figueiredo, AM".

Several visits were organized. Visits of students from Technical School of Manaus (two visits) close to fifty students; visits of farmers from two communities in Manaus; visits of the technical staff of IDAM; visits of Post–graduate students and professor from INPA; visits of undergraduate students and professor from UTAM; visits of others researchers of EMBRAPA/CPAA; researchers and students from project SHIFT, researchers from EMBRAPA-CPAF/Acre and PESACRE-Acre and so on.

A video for the television broadcaster was prepared and a farmer interview to the New Scientist Magazine was given.

FARMERS TRAINING PROGRAM

One priority of this project was to enhance farmers capability and opportunities for self help. Four courses were given with the support and the organization of SENAR (National Rural Education Service). They were: (1). Topical fruit production; (2). Grain and Oil production; (3). Agricultural pesticides, and (4). Fertilizer application. After the strong participation of farmers, both men and women, in these training activities, the farmers demanded other courses that were given subsequently.

Thus, the project researchers team with the technical support of the Fruit Crops Project group organized three courses in which ninety five farmers were trained. These courses were: (1). Management and agricultural practices for citrus fruit production; (2). Management and agricultural practices for banana fruit production; (3). Pupunha palm heart production and processing.

The training program for farmers also included three field days. The purpose of these field days was to demonstrate and to discuss results from the systems. One of these days counted with the participation of representatives of 28 communities of Presidente Figueiredo municipality, besides 12 farmers from the settlement where the work was been conducted. In the two events there were also participation of the following Institution representatives: INCRA, EMATER, FUNAI, Representative of the Town House, IBAMA, IDAM and EMBRAPA' researchers. Other events consisted of farmers' visits to the project areas (2) and visits to EMBRAPA Experimental Stations (2) in which over 70 farmers participated. It should be highlighted that, during the time of development of the project, meetings were organized by the communities directly involved, by other communities and by the researchers to discuss results, possibilities for the project to cover further areas and future activities that would strengthen the resource-poor farmers.

NATIONAL AND INTERNATIONAL MEETINGS CONTRIBUTIONS

The project accomplishment go beyond the innumerous local meetings the research team were invited to participate to discuss the methodological process and the results. It also included the participation on some national and international congress and meetings:

Paper presented on the I National Agroforestry Systems Congress and the I Meeting on Agroforestry Systems of Mercosul Countries held on Porto Velho, Rondônia State in July 1994.

Paper presented on the 10th National Meeting on Soil and Water Management held on Florianopolis, Santa Catarina State, in July/August 1994.

Paper presented on the XIII National Fruitculture Congress, held on Salvador, Bahia State, in October 1994

Paper presented on the III Latin American Ecology Congress held in Merida, Venezuela in 1995.

A lecture presented on the Post Graduate Course in Agroforestry Systems, M. Sc. level, at the University of Amazonas State (UFAM), on Farming Systems Characterization and Diagnostic Methods in 1995.

Paper presented on the XIV National Fruitculture Congress, held in Curitiba, Paraná State, in October 1996.

A lecture presented on the 1st Seminar on Forest Polices held in Roraima, on October 1996, about Familiar Agriculture.

Participation on the Meeting FORUM BELÉM Roads to a Sustainable Development held on Belem, Para State, in November 27 to 29, 1996.

A lecture presented on the Post Graduate Course in Agroforestry Systems, M. Sc. level, at the University of Amazonas State (UFAM), on April 23, 1997, on Farming Systems Characterization and Diagnostic Methods.

Lecture presented on the 1st. International Meeting of Amazonians Agroforestry Researchers in Leticia - Santa Rosa/Tabatinga, Colombia/Brazil, in June 1997.

A lecture presented to the Forest Engineering undergraduate students of UTAM-Amazonian Technology Institute, on Methodology and Research Perspective on Integrated Farming Systems with emphasis in Presidente Figueiredo study, in November 20, 1997.

CONCLUSIONS

It was recognized that on-farm test of agroforestry systems was an important device used in the process of research and development in which researchers and farmers were, according to reality, observing, analyzing, and identifying practices that were more suitable to farmers requirements and permitted a better performance of the farming system. The participatory approach was useful as a mechanism for making technology development more relevant to farmers' needs. However, the process required good information transfer among different production units and communities as well as farmers acceptance of new technologies or ideas. In this context, farmers responsibility in the management of their trials and in setting their own innovation in the farming system made this a valuable and creative process of capability and opportunities to help them choosing their own solutions to their problems.

The results indicated that the agroforestry systems designed had potential to enhance the diversity of food crops available to the family, increased income through higher productivity, while maintained the integrity of natural resource basis. The farmers seemingly aware, the systems proposed just tried to make some improvement on traditional practices and plant components of their production systems. On the other hand, the on-farm agroforestry system although not considered stable, at this time, but is considered a promising transition technology from the traditional shifting cultivation to a more permanent land use system.

Realistically, it is recognized also that in the Amazonian environment the search for a sustainable agriculture models will have to combine traditional adapted local practices with some modern agriculture technology. In this regard, a sustainable production system for the fragile upland soils requires the efficient use of inputs such as fertilizer application, which in the case was used in amounts only enough to support the plant nutrition requirement without degrading the environment.

From the results of this project, several gaps in knowledge emerged which require the development of new research addressed to the farmers' new situation. Some suggested priorities to overcome those knowledge gaps include further research on soil fertility management, soil organic matter, nutrients cycling, and plant components arrangement to permit higher production per unit area. Determination of a more effective extension method for the transfer and adoption of improved technologies was also another important priority.

The preliminary results obtained on the *Rhizobium* inoculation of beans were very promising and they indicated one of the research priorities as a measure to increase crop productivity. The studies on weeds up to now indicated that much needs to be learned about how to control the weeds economically by hand labor as is done now or else.

In the process of participatory technology development and transfer, difficulties were encountered in involving others institutions. The dissemination of results, in the case studied, relied primarily on word-of-mouth communication, and was totally promoted by farmers instead the official extension service. For a more efficient dissemination of results, new projects proposals were prepared and financial support is being searched. It consists of disseminating of agroforestry systems as conservation units in which forest species of economical importance would be included as components of the systems.

The on-farm research development and technology testing was a learning process for the researchers group as well. It was a challenging process of technology testing and development. The close contact with the resources poor farmers in the project provided valuable opportunities for increasing the level of interaction between researchers and small farmers. It raised communication capability, researchers awareness of the difficulties encountered by the resources poor farmers to overcome the innumerous problems, and offer opportunities for creating more demanding technology results. However, to only recognize the power and validity of these approach it is not enough, but it is also necessary to create conditions within the institutions for projects of this nature to be developed.

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FINANCIAL DEMONSTRATIVE FROM PROJECT (in US dollars)

ITEMS DISCRIMINATION: EMBRAPA/UFAM/INPA PROJECT	TOTAL VALUE	% EXECUTION
PERSONNEL	28,237.60	28.2
SUPPLIES -(Fertilizer/Manure/Equipment)	14,942.80	15.0
TRAVEL–(Farmer visits/Training/Supplies)	23,008.20	23.0
VEHICLE(Parts/Services/Fuel)	33,832.10	33.8
TOTAL	**100,020.70**	**100.0**

Scientific registration nº : 2247
Symposium nº : 14
Presentation : poster

Integrated agroforestry system for small migrant farmers of shifiting cultivation, Presidente Figueiredo-AM., Brazil

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The low nutrient content on major Amazonian humid ecosystems soils affects considerably agriculture practices in the region. With the objective to develop alternatives of land use for migrant small farmers of shifting cultivation, two agroforestry systems proposals were conducted in two smallholdings at Presidente Figueiredo, Amazonas State. The systems consisted of crops arrangements in which annual plants: manioc (*Manihot esculenta* L.), cowpea beans (*Vigna unguiculata* L.) and rice (*Oriza sativa* L) varieties were interplanted in sequential arrangements in the rows of perennial plants: cupuaçu (*Theobroma grandiflorum* (Willd. ex Spreng.) Schum), pupunha (*Bactris gasipaes* Kunth), inga (*Inga edulis* Mart.); and semi-perennial: banana (*Musa sp*). The system I followed the sequence of manioc, cowpea and manioc, while system II had the sequence of rice, cowpea, manioc and cowpea. Three fertilizer treatments were tested: (1). NPK + Organic Matter; (2). P and; (3). P+ leguminous ground cover crop. The results suggested that the productivity of the area at the levels of fertilizers used, have been maintained longer than the traditional slash and burn systems. After three years of continuous agroforestry systems and with a land use history, in which up to five annual crops were harvested, and yielding a total of over 30 t/ha manioc roots, 3.5 t/ha of rice and cowpea grain and 5.3 t/ha banana fruit during, 38 month of continuous crop without application of lime, in Oxisols with pH 4.9, in average, and 40% Al saturation. In traditional agriculture system, the possible yield would be one manioc crop, averaging 6 t/ha. The soil samples analysis reinforced the soils' low natural fertility. Burning of above ground biomass of two years old fallow improved slightly the topsoil nutrient content. However, that increase did not promote fruit trees development and annual crops grain production. Fertilizer application had a positive effect on crops yield and topsoil nutrient content. The results indicated this low-input agroforestry systems although not considered stable yet but it looks as good strategy to a more permanent land use system.

Key words: Agroforestry systems, shifting cultivation, soil fertility, Amazon Region.

Scientific registration n° : 2247
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Integrated agroforestry system for small migrant farmers of shifiting cultivation, Presidente Figueiredo-AM., Brazil

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INTRODUCTION

The small scale farmers at the Amazon State appeared to be facing a bleak future in terms of ensuring the ecological and economic viability of their farms due to factors that range from the complexity of the production systems they use to the precariousness of the available infrastructure. In addition, the pressure on land for food production to sustain their food needs and the food supply for an escalating urban population led these migrant farmers to a devastating use of the environment, resulting in increasingly rates of cleared land every year, without an increase in production or farmers welfare improvement (Fernandes, E.C.M. & Serrão, E.A.S., 1992; Fearnside, P.M., 1993).

The recognition that in agricultural sciences a vast amount of technical knowledge has been accumulated in research institutions which have not been used by farmers and the realization that resource poor farmers gain very little from the process of development and transfer of technology of governmental programs motivated CPAA to develop a participatory research project at smallholdings of a government settlement at Presidente Figueiredo, Amazonas, Brazil.

Thus, a central experiment was established to determine the potential of low-input agroforestry systems to be sustainable alternatives of land use for resources poor migrant farmers. Therefore, considering the low natural fertility of major Amazon basin soils which can not sustain a continuous cropping the present study concentrated in some soil fertility management and monitoring of soil nutrients, to determine how long the system would remain productive.

METHODOLOGY

Two agroforestry systems were discussed with farmers of five communities and, then, implemented in two 0,55 ha farm areas of less than two year-old secondary forest fallow. The areas were cleared by traditional slash and burn system, except the long trunks were cut, piled up and burned in order to increase the available planting area and also to improve initial soil fertility through ash addition. The systems were formed by perennial components: cupuaçu (*Theobroma grandiflorum* (Willd. ex Spreng.) Schum), pupunha (*Bactris gasipaes* Kunth), inga (*Inga edulis* Mart), and semi-perennial component: banana (*Musa sp.*), distributed in a spatial arrangement. The annual components of system I consisted of manioc varieties (*Manihot esculenta* L.) which were evaluated in the space between the trees species. In system II rice varieties (*Oriza sativa* L.) tolerant to low P and high soil acidity were tested and substituted subsequently by cowpea (*Vigna unguiculata* L.), following manioc and cowpea, continuously.

The systems were tested on the first year under three treatments: (1). with fertilizer NPK + organic matter; (2). without fertilizer and (3). with leguminous ground cover crop. On the second year the treatments were: (1). NPK + organic matter; (2). P and (3). P + leguminous ground cover crop. The fertilizer consisted of 22.5 kg/ha of N, 17.68 kg/ha of P and 33.37 kg/ha of K and 5 liters of chicken manure per plant, applied locally. The chicken manure was applied only on a perennial and semi-perennial components, on the first year. The NPK fertilizers were applied annually on the permanent and on the annual components. Peanuts was the ground cover crop on the first year, followed by cowpea and continuously by mucuna (*Stizolobium aterrimum*).

Relevant soil chemical properties were monitoring at the initiation and yearly, during the three and half years of the experiments, for the two areas studied. The influence of subsequently soil management treatments were also measured by the production of all crops.

RESULTS

Soil Properties

Topsoil chemical properties (Table 1) improved slightly during the period 6 to 18 month after clearing, on treatment with fertilizer, what was apparently in response to fertilizer application, rather than to the fertilizer value of the ash. This was indicated by increased base status. From the period 18 to 38 month, there was decrease in base status, increase in aluminum saturation, little change in available P, and a sharp decrease on soil organic matter. It is noteworthy that soil organic matter decreased sharply on continuous crop of System II than on System I. Apparently this was due to the annual component on System I. Manioc is a more permanent crop, stays on the field as long as one year without disturbing the soil. In the case of System II, the frequency of crop rotation in the experimental plots, together with the high temperature and rainfall in the area may have influenced on the rapidly organic matter decomposition.

The declining soil fertility on the plots with only P fertilizer showed a different pattern from the fertilized treatment. In general, there was a continuous decrease in nutrients status during the period 6 to 18 month and, then, an increase in nutrients what was due, apparently, to the application of P through chemical fertilizer. The topsoil nutrient levels in the unfertilized treatment were much lower than in the fertilized ones. Possibly, this was also due to low inputs from ashes, crop residues, or addition by chemical fertilizer.

The levels of Al saturation, on the other hand, were much higher on unfertilized plots. In general, the values were more favorable to plant growth during the first 18 months, and, mainly on fertilized plots. This was in contrast with results obtained by other continuous cultivation research work (Benites, Nureña & Sanchez, 1986). Available P was always very low, much below the critical level 10 ppm of P for soils in the area. The small N, P and K addition on fertilized treatments apparently were sufficient to improve production but not enough to construct a nutrient budget for topsoil vegetation systems.

Crop Yields

Relatively to the traditional farmers cropping systems the yields of rice, beans, manioc and bananas on the plots that received minimum amount of fertilizer were considered very high. Table 2 shows the yield of four and five continuous crops harvested (average of two experimental areas) in System I and System II, respectively, within three and half years after the experiments began. A total of 3.5 t/ha of rice and cowpea grain was produced during this period, with the judicious amount of fertilizer N, P, K and chicken manure. The yields on unfertilized plots approached zero, at the first year and were close to 50% of the yield obtained on fertilized plots on the second year, when 17.68 t/ha of P were applied. The production of cowpea on three subsequent years of fertilized plots showed always the same higher level of grain yield, indicating that cowpea is a good crop to grow in similar cropping systems. It is assumed that cowpea beans are possibly more tolerant to above and below ground competition. This is in accordance with results obtained by Torquibeau & Akyeampong (1994) that showed cowpeas as a more favorable crop than corn and banana to support lower level of shade. A little change in grain production was obtained during the three crops and an increase was observed on the third crop.

A total of over 30 t/ha manioc roots were produced on System I. There was a sharp decrease in production of manioc on the second and third crop on all treatments. This yield reaction may be related to a decline in soil fertility. Alternatively, it also may be explained, possibly, by above and below ground competition, because yields on both fertilized and unfertilized plots on the second and third years were at the same levels, that means, 5 to 6 t/ha manioc roots on the second crop and 3 to 4 t/ha for the third crop. It was assumed the problem was mainly related to competition since the permanent crops on the unfertilized plots were less developed than the fertilized ones.

A total of 5.3 t/ha of bananas was produced during the 18 months the crop was grown in the systems. The yield, then, decreased sharply due to diseases, which induced the elimination of the crop from the experimental plots.

On the third year after the experiments began the cupuacu crop started the fruit production what was a good result as compared with the farmers traditional farming system. The cupuacu production in the farmers land use systems begins after the fourth year growth and sometimes on the fifth and up to the seventh year.

Table 1. Topsoil (0 - 20 cm) fertility status within the first 38 months of the agroforestry system at two farmholders (P_1 and P_2) under three soil management and two crops arrangements.

Months after Clearing	Fertilizer treatment	Total exchangeable base System I	Total exchangeable base System II	Al saturation System I	Al saturation System II	Organic mater System I	Organic mater System II	Available P System I	Available P System II
		------- c mol/l --------		------------------------- %	-----------------------		-------- mg/kg ------		
				Farmer 1 (Sr. Miguel - P_1)					
6	NPK+OM	3.17	3.43	18.10	16.90	2.23	2.79	4	3
18	NPK+OM	2.60	3.69	21.20	15.14	2.75	3.31	1	5
38	NPK+OM	3.31	2.41	17.85	21.65	3.30	2.37	5	4
6	P	2.46	3.86	32.80	15.40	3.03	3.35	2	3
18	P	1.84	2.63	37.40	16.00	3.51	3.35	3	1
38	P	3.14	3.38		14.59	3.45	2.49	8	5
6	P+Leg.	2.79	2.57	50.20	25.90	2.47	2.75	2	2
18	P+Leg.	2.46	2.66	20.90	15.80	2.83	2.87	1	1
38	P+Leg.	1.50	2.92	48.30	12.00	3.28	2.73	4	4
				Farmer 2 (Sr. Davi - P_2)					
6	NPK+OM	1.04	3.11	57.40	16.60	2.35	1.56	3	3
18	NPK+OM	1.74	3.30	19.51	44.59	3.27	3.71	5	2
38	NPK+OM	0.93	1.63	22.19	61.79	2.65	2.17	9	3
6	P	0.50	0.81	80.00	42.60	2.63	2.27	2	3
18	P	0.42	0.43	84.25	82.64	2.99	3.15	1	1
38	P	0.65	0.49	75.85	72.30	2.13	2.62	3	3
6	P+Leg.	0.97	2.45	66.20	31.00	2.75	2.27	3	3
18	P+Leg.	1.83	0.75	78.26	32.97	3.03	3.71	1	1
38	P+Leg.	0.58	0.49	82.61	74.48	2.09	2.87	2	2

Table 2. Average productivity (Farmer: P_1 and P_2) of two agroforestry systems on two smallholdings during the first 38 months of continuous cropping on fertilized plots.

Crops	Planting date	Grain/Roots/Fruit/Pulp Yields	
		System I	System II
		------------------ t/ha	---------------------
Manioc	Dec./93	23.4	
Rice	Feb./94		1.30
Cowpea beans	June/94		0.76
Manioc	Dec./94		5.50
Cowpea beans	June/95	0.6	
Cowpea beans	July/95		0.65
Manioc	Dec./95	5.5	
Cowpea beans	June/96		0.82
Manioc	Jan./97	3.3	
Banana	Feb./94	5.3	5.30
Cupuacu	Feb./94	0.24	0.29
Total grain			3.5
Total roots		31.2	5.5

CONCLUSION

The low natural fertility of the soils in the Amazon region can be assumed to be the crucial limiting factor to the lack of sustainability of continuous cropping systems. Therefore, results are promissing for the agroforestry systems with low-input strategy as a transition from traditional slash and burn farming systems to a more permanent system of management. With relatively simple practices, such as, intercropping with perennials and semi-perennial species, farmers can grow four to five food crops. Where farmers were able to grow only one manioc crop, they have been given the chance to produce high yield of banana and one cupuaçu. The system can not be considered stable at this time but it looks very promissing as a transition technology. The limited information that reaches the farmers was also another major limiting factor to the farmers welfare improvement.

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ERGONOMY AND LABOR REQUIREMENT ANALYSIS FOR SOCIO-ECONOMIC ASSESSMENT OF AGROFORESTRY SYSTEMS IN WESTERN AMAZON.

Hubert Weidner

Summary

A questionnaire was conducted in September and October 1996 in Presidente Figueiredo municipality. Eight farmers participated at these interviews. These farmers were from four different states of Brazil. Six out of them have already worked in agricultural related enterprises, two worked as a miner or as a primary school teacher. They owned in average 80,5 ha but only 3,5 to 4,0 ha were cultivated. The farms are in the Terra firme (upland ecosystems) and the soil types are called Yellow Latosol. Only five out of eight farmers have access to agricultural information. The information is provided by EMBRAPA-CPAA, Manaus. Lack of money and low prices at the local market were the two principal problems which farmers faced.

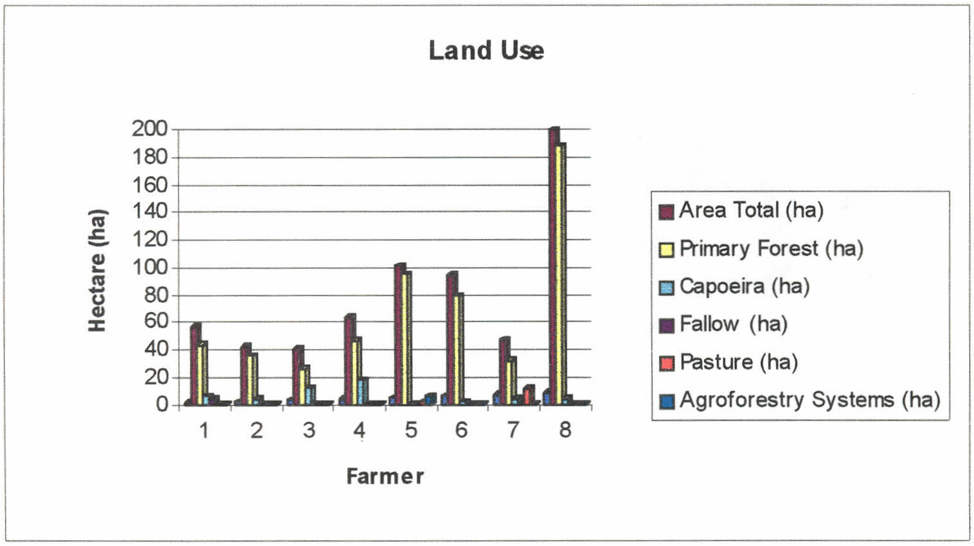
The peasants plant mainly cupuaçu (*Theobroma grandiflorum*), bananas (*Musa sp.*), pupunha (*Bactris gasipaes*), ingá (*Inga edulis*) and cassava (*Manhiot esculenta*) with usually no use of fertilizers and pesticides are planted. Chicken and ducks are the animals raised and consumed on the small farms. The main expenditure are for food and for transport. While they spend far less money on cloths, domestic articles and agricultural equipment. The agricultural equipment is hand tools such as shovels, machetes, hoes and axes. One farmer owns a motor saw for cutting wood.

The main field activities are slashing, burning, planting, weeding and harvesting. Food processing is all around the year, for instance, preparing flour. Food storing does not exist and therefore selling of fruits and corps occurs every week at the local market. Normally only the peasant himself is working on the fields meanwhile the wives are doing all the domestic stuff. The farmers are working five to six days on the field for up to six hours a day. The wives are working seven days a week for more than ten hours a day.

Description:

The eight farmers have an average age of almost 50 years and are from four different states of Brazil. The states are Amazonas (5), Piauí (1), Ceará (1) and Paraná (1). They have already worked in agricultural enterprises, for instance, as farmer itself or agricultural worker. The former profession of two out of them was mine worker and primary school teacher respectively. All of them own land titles and the average total area is 80,5 ha, it range from 40 ha up to 200 ha. Only 3,5 to 4,0 ha are cultivated at each property, because of lack of labour and planting material. The land proportions are illustrated in figure 1.

Figure 1: Percentage of land to each use of households investigated.



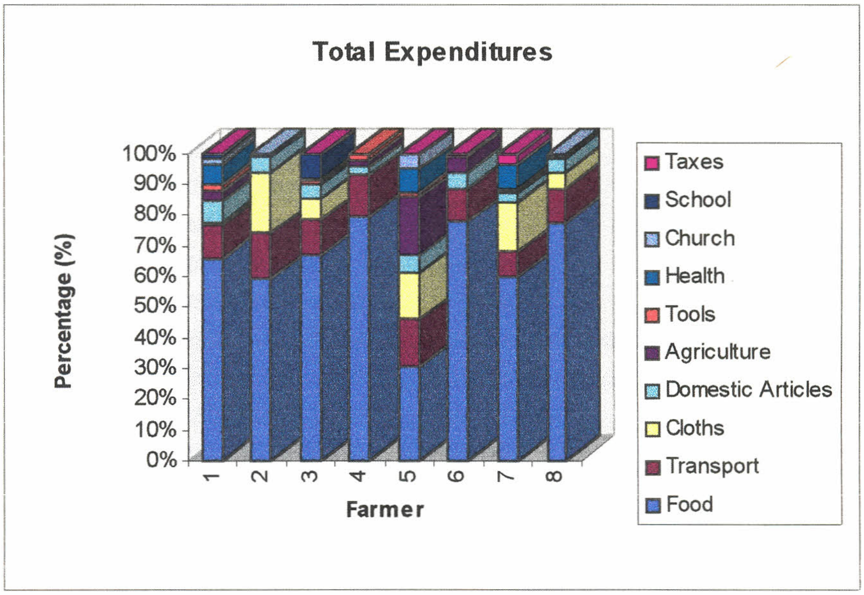
The soil types are called Yellow Latosol and they are located at the terra firme (upland) ecosystems. All cultivated land is at the road to Balbina. Because of the high age of four peasants they are receiving pension monthly, worth of R$ 112. At date of the interview none of them was involved in a credit scheme. The critical period of expenditure is in the dry season from the end of July to the beginning of November. Lack of labour is mostly at the beginning of the rainy season because of all planting and weeding has to be done. Four of the small farmers are provided with regularly agricultural information by the staff of EMBRAPA-CPAA. One has occasionally access to this information and the other three have more or less no access to regular agricultural information. According to the interview partners an extension service is existing but not working and cooperation are also not functioning. All farmers agreed in the principle problems of their living. These are the lack of money and the low prices at the local market in Presidente Figueiredo and Balbina, despite local prices for consumer goods are as double as much as in Manaus, capital of the state of Amazonas. With the shift to agroforestry systems the farmers can produce almost all around the year and therefore, he can get income every week and the critical periods of expenditures can be reduced.

The area occupied with cupuaçu (*Theobroma grandiflorum*) is in average 2,5 ha, bananas (*Musa sp.*) with 0,5 ha, pupunha (*Bactris gasipaes*) with 0,3 ha, inga (*Inga edulis*) with 0,25 ha and cassava (*Manhiot esculenta*) with 1,3 ha respectively. For all cultivation no fertilizers (organic and chemical) and pesticides are use. One exception is the area with agroforestry systems at the land of four farmer. EMBRAPA-CPAA provides a small amount of fertilizer (NPK, P and chicken manure) for these systems.

The peasants have usually no pigs or cattle but own chicken and ducks. Only one small farmer raises four cattle and their calves. The animals are sold at the farming gate to neighbours and friends.

More than 60 % of the income is spend on food and about 12 % on transport. The figure 2 shows this in more detail.

Figure 2: Percentage of total farmers expenditures.



About their income no precise information could be obtained. Often in the months of July to October (dry season) occur a shortage of money. The agricultural related decisions are always taken from the head of the family. The domestic decisions are taken by the person who is responsible for the household, in most cases the spouse of the farmer. The majority of the peasants are participating on different cultural or religious events, for instance, seven families take part of "Party of Cupuaçu" in Presidente Figueiredo (to be held in April or May) and three families are involved in the religious events such as the anniversary of the church or Christmas.

All farmers have shovels (up to two), machetes (up to two), axes (up to two) and hoes (up to four). One farmer operates with a motor saw and is paid for cutting wood. Other tolls as hand tools are not in use because of lack of money and knowledge of handling them. All tolls are quite old and worn. Maintaining of the equipment is done by the farmers themselves, for instance, sharpening. The range of prices of these hand tools is between R$ 5,00 to R$ 12,00.The field operations are done in the following months (see table 1):

Food storing does not exist and food processing is all around the year, mainly producing of flour (cassava flour). This is sold with as fruits and crops every day at the farmers gate or every Saturday at the local market in Presidente Figueiredo or Balbina.

According to the farmer they are spending from Monday to Friday up to six hours in the field. The women are working up to ten hours per day in the household. Saturday is normally reserved for selling the goods at the local market. Sons are sometimes helping in the fields and also the daughters in the house. But this is very irregular. Lack of labour usually occurs in the dry season from July to October/November.

Table 1: Distribution of field operations by month during the year.

Months:	Field Activities:
January	Weeding, harvesting
February	Planting, weeding, harvesting
March	Planting, weeding
April	Slash, harvesting
May	Harvesting
June	Slash, planting, weeding
July	Weeding, slash, burn, planting
August	Slash, burn, planting, weeding
September	Slash, burn, planting, harvesting, weeding
October	Slash, burn, planting, harvesting, weeding
November	Slash, burn, planting, harvesting
December	Planting, weeding, harvesting

Discussion:

The main problems of the farmers are the lack of capital and the low prices at the local market, also the poor equipment in the fields. The labour force is limited and therefore, the area cultivated is only 5 % of the total area. To get a higher output of the area the mayor of Presidente Figueiredo has to put more money to free transport and better local market conditions. But so far the involvement of the administration of Presidente Figueiredo in agricultural improvements is very poor and has to be amplify. Also the farmers have to get informed to use organic manure and to breed own planting material. Consultation from of EMBRAPA-CPAA staff should be obtained by the farmers although there is a need for a more active participation of the Local Extension Service in maintain technological information available to farmers.

EVALUATION OF SECONDARY VEGETATION (WEEDS).

UFAM

JOSE FERREIRA

AVALIAÇÃO DE ERVAS INVASORAS NOS SISTEMAS AGROFLORESTAIS EM ÁREAS DE PEQUENOS PRODUTORES EM PRESIDENTE FIGUEIREDO

Jose Ferreira
Milene Barbosa

INTRODUÇÃO

Um dos sérios problemas enfrentados pelos pequenos produtores de agricultura familiar na condução de seus sistemas de produção consiste da infestação das plantas invasoras dos cultivos, as quais, geralmente mais adaptadas às condições de baixa fertilidade dos solos desenvolvem com maior vigor que as plantas cultivadas, prejudicando consideravelmente a produção e produtividade das culturas agrícolas.

Resultados de pesquisa tem mostrado que a composição da vegetação secundária pode ser influenciada pelas espécies agrícolas cultivadas.

O estudo portanto, desenvolvido pela Universidade do Amazonas – UFAM consistiu do levantamento da composição florística e do banco de sementes em duas áreas experimentais onde dois sistemas agroflorestais foram estabelecidos e se encontravam em desenvolvimento no campo. Os sistemas foram implantados em duas áreas de pequenos produtores de um assentamento do INCRA, na Estrada de Balbina, no município de Presidente Figueiredo no Estado do Amazonas. As propriedades pertenciam aos produtores Sr. Davi e Sr. Miguel, que no presente relatório são identificados como local 1 e local 2, respectivamente.

As coletas das plantas daninhas foram realizadas na cultura do arroz nos meses de abril e junho e, na cultura da mandioca nos meses de abril, junho e julho.

A amostragem foi feita em 1% de cada área da parcela. Após a coleta das plantas estas foram identificadas e herborizadas.

A primeira coleta foi efetuada em setembro de 1993, antes da implantação dos sistemas agroflorestais. Em cada área foram escolhidos 10 locais de coleta correspondendo cada local a 0,5 m^2. Em uma folha própria de coleta de campo foram anotados o número de plantas no local, a espécie e a família a que pertenciam, sua altura e estádio de crescimento.

As amostras foram realizadas a cada 30 dias, e os resultados são mostrados nas tabelas seguintes.

RESULTADOS

Os resultados iniciais demonstraram que o número de espécies identificadas nas áreas (entre 12 e 20) foi relativamente pequeno quando comparado com o número de sementes de cada espécie (171 a 523).

QUADRO 4. Número de sementes e espécies nos 10 locais de amostragem das áreas 1 e 2.

Profundidade (cm)	Áreas			
	Local 1		Local 2	
	NS*	NE**	NS*	NE**
0 – 5	4644	13	8375	16
5 – 20	2214	12	3417	20

* Número de sementes.

** Número de espécies.

QUADRO 5. Número total de plantas e altura média na primeira e segunda amostragem nos 10 locais das áreas 1 e 2.

Discriminação	Primeira amostragem		Segunda amostragem	
	Local 1	Local 2	Local 1	Local 2
Número total de plantas	81	178	38	269
Altura média (cm)	66,16	47,6	25,26	21,16

QUADRO 1. Número médio de espécies de plantas daninhas amostrados na cultura do arroz e da mandioca

Plantas daninhas	Feijão			Arroz			Mandioca		
	Adubação			Adubação			Adubação		
	Com	Sem	Legum	Com	Sem	Legum.	Com	Sem	Legum.
Amaranthus sp.	0	0	0	0,71a	0,71a	0,74a	0,72a	0,71a	0,76a
Ambelania sp	0,77a	0,71a	0,71a	0	0	0			
Ambrosia sp.	1,31a	0,79b	0,94ab	1,76a	0,78b	1,2ab	1,65a	1,12b	1,63a
Arrabidaea sp.				0,71a	0,71a	0,74a			
Bactris sp.	0,71a	0,80a	0,71a	0,71a	0,74a	0,76a	0,72a	0,71a	0,71a
Borreria latifolia (Aubl.) K. Schum.	0	0	0	0,73a	0,74a	0,71a	0,76a	0,82a	0,71a
Borreria sp.	0,77a	0,71a	0,71a	0	0	0	0,71a	0,71a	0,71a
Cecropia spp.	0,88a	1,03a	1,34a	0,95a	0,96a	1,10a	1,17a	1,24a	1,10a
Chronolaena cf. *mucronata* (Gardn) K. & R.	1,38a	0,96a	0,80a	1,11a	1,37ab	0,74b	0,91a	0,72a	0,89a
Chronolaena laevigata (Lam.) K. & R	0,71a	0,71a	0,77a	0,85a	0,79a	0,74a	1,28a	0,96b	0,87b
Clidemia rubra (Aubl.) Mart.	0,71a	0,71a	0,86a	0,71b	0,94a	0,81ab	0,76a	0,82a	0,80a
Conyza bonariensis (L.) Cronquist.	0,71a	0,71a	0,80a	0,73a	0,71a	0,71a	0,71a	0,71a	0,71a
Croton chamaedryfolius Griseb	0,88a	1,09a	0,71a	0	0	0	0,73b	0,86ab	0,93a
Cyperus sp.	0	0	0	0	0	0	0,71b	0,71b	0,89a
Dalbergia sp	0	0	0	0	0	0	0,72a	0,74a	0,71a
Emilia sonchifolia DC	0,71a	1,3a	0,80a	0,71a	0,71a	0,76a	1,08a	1,04a	0,88a
Erechtites hieracifolia (L.) Raf. ex DC	1,35a	1,04a	0,86a	0,73a	0,80a	0,74a	1,12a	0,97a	0,96a
Homolepis sp.	2,20a	1,72a	3,18a	2,22a	2,93a	2,93a	2,34a	2,14a	1,93a
Irlbachia alata (Aubl.) Maas.	0,71a	0,71a	0,84a	0,73a	0,71a	0,72a	0,93b	1,31a	0,92b
Memora flaviflora Pulle	0	0	0	0,78a	0,71a	0,71a	0	0	0
Nephrolepsis sp.	0,71a	0,71a	0,74a	0,75a	0,74a	0,74a	0,71a	0,78a	0,74a
Oldelandia corymbosa	3,64a	1,80ab	1,56b	2,81a	3,71a	4,91a	3,42ab	2,33b	3,85a
Panicum rudgei Roem et Schult.	0.71a	0,83a	0,71a	0	0	0	0,94a	0,98a	0,99a
Paspalum conjugatum Berg.	2,48b	5,13a	1,66b	6,69a	6,27ab	2,80b	4,48a	2,99b	Arroz
Paspalum multicaule Poir	0	0	0	0,71a	0,80a	0,82a	0,71a	0,88a	0,85a
Phyllanthus cf. *minutulus* Muell. Arg.	0,80a	0,80a	0,71a	0,81a	0,71a	0,71a	0,75a	0,72a	0,72a
Phytolacca rivinoides Kunth & Bouche	0	0	0	0	0	0	0,71a	0,71a	0,71a

Porophyllum ellipticum (L.) Cass.	1,32a	1,19a	0,75a	0,85a	0,80a	0,73a	0,84a	0,72a	0,82a
Portulaca oleracea L.	0	0	0	0	0	0	0,71a	0,71a	0,75a
Pothomorfe peltata (L.) Miq.	0	0	0	0,73a	0,71a	0,71a	0,71a	0,71a	0,71a
Ptirogramma sp.	0	0	0	0	0	0	0,71a	0,71a	0,71a
Solonum amaricanum Mill.	0	0	0	0	0	0	0,90a	0,73a	0,85a
Solanum rugosum Dun.	0,90a	1,22a	1,46a	1,27a	1,57a	1,56a	1,50a	1,48a	1,31a
Solanum subnerme Jacq.	0,71a	0,71a	0,83a	0,76a	0,71a	0,71a	0,73a	0,77a	0,71a
Swartzia sp.	0	0	0	0	0	0	0,71a	0,71a	0,72a
Trema micrantha (L.) Blume	0,71a	0,71a	0,74a	0,71a	0,71a	0,77a	0,86a	0,74a	0,74a
Unxia comphorate L.F.	*0*	*0*	*0*	0	0	0	0,71a	0,71a	0,72a

Observações. As médias apresentadas foram transformadas para raiz de x mais 0,5.
As médias seguidas de letras iguais na mesma linha e na mesma cultura não diferem entre si, a 5% de probabilidade pelo teste de Tukey.

QUADRO 2 Valores médios do número de plantas daninhas por cultura e local

Plantas daninhas	Feijão		Arroz		Mandioca	
	Local 1	Local 2	Local 1	Local 2	Local 1	Local 2
Amaranthus sp.	0	0	0,72a	0,71a	0,75a	0,71a
Ambelania sp	0,71a	0,75a	0	0	0	0
Ambrosia sp.	0,81b	1,22a	1,49a	1,01a	1,79a	1,15b
Arrabidaea sp.	0	0	0,72a	0,71a	0	0
Bactris sp.	0,71a	0,77a	0,74a	0,72a	0,72a	0,71a
Borreria latifolia (Aubl.) K. Schum.	0	0	0,72a	0,73a	0,82a	0,71a
Borreria sp.	0,71a	0,75a	0	0	0,71a	0,71a
Cecropia spp.	0,98a	1,19a	0,98a	1,03a	1,17a	1,17a
Chronolaena cf. *mucronata* (Gardn) K. & R.	1,39a	0,71b	1,33a	0,71b	0,98a	0,71b
Chronolaena laevigata (Lam.) K. & R	0,71a	0,75a	0,74a	0,89a	0,71b	1,36a
Clidemia rubra (Aubl.) Mart.	0,81a	0,71a	0,88a	0,71b	0,88a	0,71b
Conyza bonariensis (L.) Cronquist.	0,71	0,77a	0,72a	0,71a	0,71a	0,71a
Croton chamaedryfolius Griseb	1,08a	0,71b	0	0	0,98a	0,71b
Cyperus sp.	0	0	0	0	0,83a	0,71b
Dalbergia sp	0	0	0,76a	0,85a	0,72a	0,73a
Emilia sonchifolia DC	1,12a	0,75a	0,71a	0,75a	0,77b	1,24a
Erechtites hieracifolia (L.) Raf. ex DC	1,32a	0,85a	0,79a	0,71a	1,11a	0,93a
Homolepis sp.	1,5b	3,23a	2,88a	2,24a	1,76b	2,51a
Irlbachia alata (Aubl.) Maas.	0,80a	0,71a	0,78a	0,71a	1,10a	1,0a
Memora flaviflora Pulle	0	0	0,71a	0,78a		
Nephrolepsis sp.	0,71a	0,73a	0,74a	0,75a	0,73a	0,75a
Oldelandia corymbosa	1,49b	3,18a	3,4a	4,18a	3,33a	3,07a
Panicum rudgei Roem et Schult.	0,71a	0,79a	0	0	0,85a	1,09a
Paspalum conjugatum Berg.	3,07a	3,10a	7,63a	2,05b	4,0a	2,5b
Paspalum multicaule Poir	0	0	0,81a	0,71a	0,92a	0,71b
Phyllanthus cf. *minutulus* Muell. Arg.	0,83a	0,71a	0,77a	0,71a	0,74a	0,7[illegible]
Phytolacca rivinoides Kunth & Bouche	0	0	0	0	0,85a	0,71b
Porophyllum ellipticum (L.) Cass.	1,41a	0,77a	0,79a	0,81a	0,79a	0,79a
Portulaca oleracea L.	0	0	0	0	0,73a	0,71a
Pothomorfe peltata (L.) Miq.	0	0	0,72a	0,71a	0,71a	0,71a
Ptirogramma sp.	0	0	0	0	0,71a	0,71a
Solanum amaricanum Mill.	0	0	0,74a	0,71a	0,95a	0,71b
Solanum rugosum D[illegible]	1,11a	1,28a	1,63a	1,19a	1,54a	1,33b

Solanum subnerme Jacq.	0,79a	0,71a	0,74a	0,71a	0,74a	0,74a
Swartzia sp.	0	0	0	0	0,71a	0,72a
Trema micrantha (L.) Blume	0,71a	0,73a	0,74a	0,71a	0,82a	0,75a
Unxia comphorate L.F.	0	0	0	0	0,71a	0,72a

Observações. As médias apresentadas foram transformadas para raiz de x mais 0,5.
As médias seguidas de letras iguais na mesma linha e no mesmo local não diferem entre si, a 5% de probabilidade pelo teste de Tukey.

QUADRO 3. Espécies e Família das plantas daninhas encontradas nos sistemas agroflorestais, em Presidente Figueiredo-AM

Espécie	Família
Amaranthus sp.	Amaranthaceae
Ambelania sp	Apocinaceae
Bactris sp.	Arecaceae
Ambrosia sp.	Asteraceae
Chronolaena cf. *mucronata* (Gardn) K. & R.	Asteraceae
Chronolaena laevigata (Lam.) K. & R	Asteraceae
Conyza bonariensis (L.) Cronquist.	Asteraceae
Emilia sonchifolia DC	Asteraceae
Erechtites hieracifolia (L.) Raf. ex DC	Asteraceae
Porophyllum ellipticum (L.) Cass.	Asteraceae
Unxia comphorate L.F.	Asteraceae
Arrabidaea sp.	Bignoniaceae
Memora flaviflora Pulle	Bignoniaceae
Swartzia sp.	Caesalpiniaceae
Cecropia spp.	Cecropiaceae
Cyperus sp.	Cyperaceae
Nephrolepsis sp.	Davalliaceae
Croton chamaedryfolius Griseb	Euphorbiaceae
Phyllanthus cf. *minutulus* Muell. Arg.	Euphorbiaceae
Dalbergia sp	Fabaceae
Irlbachia alata (Aubl.) Maas.	Gentianaceae
Clidemia rubra (Aubl.) Mart.	Melastomataceae
Phytolacca rivinoides Kunth & Bouche	Phytolacaceae
Pothomorfe peltata (L.) Miq.	Piperaceae
Homolepis sp.	Poaceae
Panicum rudgei Roem et Schult.	Poaceae
Paspalum conjugatum Berg.	Poaceae
Paspalum multicaule Poir	Poaceae
Portulaca oleracea L.	Portulacaceae
Ptirogramma sp.	Pteridaceae
Borreria latifolia (Aubl.) K. Schum.	Rubiaceae
Borreria sp.	Rubiaceae
Oldelandia corymbosa	Rubiaceae
Solanum americanum Mill.	Solanaceae
Solanum rugosum Dun.	Solanaceae
Solanum subnerme Jacq.	Solanaceae
Trema micrantha (L.) Blume	Ulmaceae

Conclusões

As plantas daninhas da família Asteraceae apareceram em maior frequencia (23,68%), enquanto Poaceae (10,53%), Rubuaceae e Solanaceae com 7,89% cada uma .

Poucas foram as espécies de plantas daninhas, que apresentaram diferenças significativas, quanto ao número de indivíduos nos tratamentos com e sem adubação e leguminosas.

Dentre as cultivares de arroz e mandioca não foram encontradas diferenças significativas, quanto ao número de plantas daninhas.

O número de plantas daninhas, em geral, foi afetado pelo local(produtor)

EVALUATION OF MICROORGANISMS INFECTION ON LEGUMINOUS PLANTS.

INPA

LUIZ ANTONIO DE OLIVEIRA

TOLERÂNCIA À ACIDEZ DE ESTIRPES DE BRADYRHIZOBIUM SPP. DA AMAZÔNIA.

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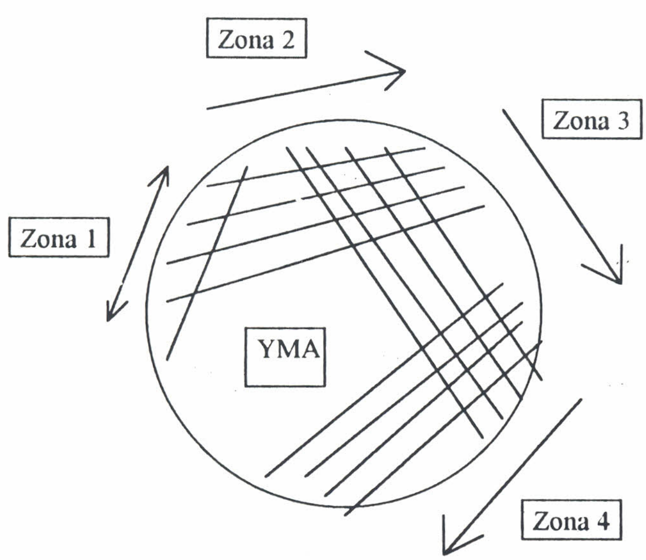
Palavras chave: Sobrevivência de rhizobia, crescimento de rhizobia, leguminosas.

Cerca de 90% dos solos de terra firme da Amazônia são deficientes de nitrogênio, fazendo com que plantas com potencial de fixação do nitorgênio, como as leguminosas, sejam utilizadas para aumentar o teor deste elemento no solo. No entanto, uma série de fatores bióticos e abióticos podem interferir no processo simbiótico planta-rizóbia, impedindo a expressão adequada da fixação do nitrogênio. Como a maioria dos solos de terra firme da Amazônia apresenta baixa fertilidade e elevada acidez, a sobrevivência das estirpes de *Bradyrhizobium* spp. em ambiente ácido é um aspecto muito importante a ser considerado para que a simbiose leguminosas-rhizobia seja efetiva nestes solos. Com o objetivo de avaliar a tolerância de estirpes de *Bradyrhizobium* spp. à acidez, foi realizado um experimento de laboratório.

O método consistiu em avaliar as estirpes de *Bradyrhizobium* em placas de Petri contendo o meio YMA com dois pHs (6.5 como controle e 4.5 para as avaliações de tolerância), usando o método de riscagem de placas segundo as figuras 1 e 2. Pontuações de 1.0 (sem crescimento visível) a 4.0 (máximo crescimento) foram adotadas, usando-se quatro repetições por estirpes em cada pH. As estirpes foram repicadas de placas de Petri na fase logarítmica de crescimento. A figura 1 apresenta o procedimento geral de riscagem nas placas, enquanto que a figura 2 apresenta o sistema de pontuações de crescimento nos pHs 4.5 e 6.5. As pontuações foram dadas a intervalos de 0.25, aumentando assim, a precisão do método.

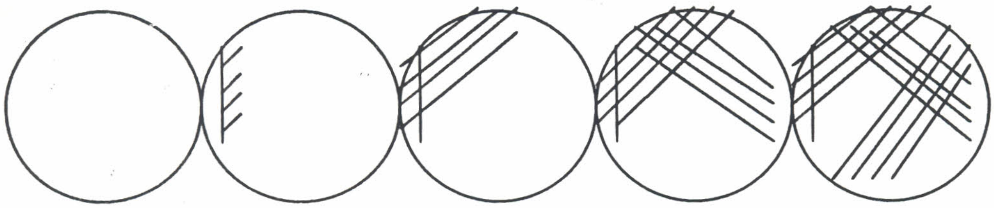


Zona 1. Uma linha. Riscagem de uma alça de platina diversas vezes em ambas as direções indicadas pela seta. A alça deve ser esterilizada para cada zona de de riscagem.

Zona 2. Quatro linhas de riscagem , usando-se um risco por linha, na direção indicada pela seta.

Zonas 3 e 4. Como na zona 2.

Figura 1. Procedimento de riscagem das placas de Petri com meio YMA (pH 4.5 e 6.5) para as avaliações das estirpes de *Bradyrhizobium* spp.



Nota 1.00 Nota 1.25 Nota 2.00 Nota 3.00 Nota 4.00

Figura 2. Pontuações (notas) para o crescimento de *Bradyrhizobium* spp. em placas de Petri com meio YMA e pHs 4.5 e 6.5.

Tabela 1. Espécies hospedeiras das estirpes usadas.

Estirpes*	Espécie hospedeira	Procedência
INPA 029	*Vigna unguiculata*	V r. do Aria£/Solimäes
INPA 044	*Vigna unguiculata*	FUCADA/PVA
INPA 046	*Vigna unguiculata*	FUCADA/PVA
INPA 048	*Vigna unguiculata*	V r. do Ariaú/Solimões
INPA 055	*Vigna unguiculata*	V r. do Ariaú/Solimões
INPA 078	*Vigna unguiculata*	FUCADA/PVA
INPA 511	*Ormosia excelsa*	Viveiro do INPA/DCA
INPA 520	*Pithecellobium saman*	Est. Ecol. Maracá/RR
INPA 522	*Clitoria* sp.	Est. Ecol. Maracá/RR
INPA 526	*Platymiscium paraensis*	Est. Ecol. Maracá/RR
INPA 550	*Inga edulis*	Lago do Calado/AM
INPA 558	*Pithecellobium latifolium*	Est. Anavilhanas/AM
INPA 562	*Pithecellobium latifolium*	Est. Anavilhanas/AM
INPA 563	*Acacia multipinnata*	Est. Ecol. Maracá/RR
INPA 565	*Rhynchosia minima*	Est. Exp. Ariaú/AM
INPA 568	*Dalbergia inundatum*	Est. Anavilhanas/AM
INPA 576	*Galactia jussiaeana*	Est. Ecol. Maracá/RR
INPA 602	*Enterolobium maximum*	Est. Anavilhanas/AM
INPA 609	*Swartzia laevicarpa*	Est. Anavilhanas/AM
INPA 624	*Swartzia laevicarpa*	Est. Anavilhanas/AM
INPA 630	*Pithcellobium latifolium*	Viveiro do INPA/DCA
INPA 632	*Centrolobium paraensis*	Viveiro do INPA/DCA
INPA 641	*Pithecellobium inaequale*	Viveiro do INPA/DCA
INPA 642	*Cassia mimosoides*	Est. Anavilhanas/AM
INPA 649	*Dalbergia inundata*	Est. Anavilhanas/AM
INPA 650	*Clitoria amazonum*	Ponta Negra/AM
INPA 657	*Entada polyphylla*	Viveiro do INPA/DCA
INPA 658	*Entada polyphylla*	Viveiro do INPA/DCA
INPA 671	*Inga edulis*	Viveiro do INPA/DCA
INPA 673	*Abrus tenuiflorus*	Est. Ecol. Maracá/RR
INPA 678	*Andira riveriana*	Viveiro do INPA/DCA

* Fonte: Setor de Microbiologia do Solo da CPCA/ INPA

As estirpes de rizóbios foram coletadas de várias espécies hospedeiras (Tabela 1). Após os 18 dias de crescimento em laboratório, os rizóbios foram classificados como sensíveis, medianos e tolerantes à acidez, conforme a Tabela 2.

Tabela 2. Classificação quanto ao grau de tolerância à acidez.

Graus de tolerância	intervalos de pontuação
Sensível	1,00 - 2,00
Mediano	2,06 - 3,00
Tolerante	3,06 - 4,00

Os resultados apresentados na Tabela 3 indicam que do total de 31 estirpes de rizóbia utilizadas no experimento, 23 apresentaram-se tolerantes à acidez aos 18 dias de crescimento no meio com pH 4.5 (notas superiores a 3.0). Maior precisão na avaliação pode ser obtida, analisando-se o crescimento das estirpes num menor período. Assim, pode-se observar que apenas a estirpe INPA 078 apresentou um alto grau de tolerância à acidez aos seis dias de crescimento. Aos nove dias, apenas esta estirpe e as 055, 511, 576, 632, 649 e 671 apresentaram crescimento com notas superiores a 3.0, demonstrando que estas apresentam graus maiores de tolerância à acidez que as demais. O meio com pH 6.5 serviu muito bem como controle, podendo-se observar que aos 18 dias, apenas a estirpe INPA 01-673 apresentou crescimento inferior a 3.0, demonstrando que este período de avaliação (18 dias) foi suficiente para avaliar praticamente todas as estirpes. Pelos dados, pode-se observar que o período mínimo de avaliação com uma boa precisão foi aos 12 dias, quando a maioria das estirpes (26 de 31) apresentou crescimento superior a 3.0 no meio com pH 6.5.

Portanto, o método mostrou-se adequado para selecionar inicialmente, as estirpes de rizóbia INPA 055, 078, 511, 576, 632, 649 e 671, que apresentaram elevada tolerância à acidez já aos nove dias de teste. Estas estirpes serão utilizadas em testes posteriores, podendo ser no futuro, úteis à agrosilvicultura em solos ácidos.

Tabela 3. Crescimento das estirpes de *Bradyrhizobium* spp. em meios de cultura YMA com pHs 4.5 ou 6.5. Médias de quatro repetições.

Estirpes INPA	Dias após a inoculação nas placas de Petri									
	6 dias		9 dias		12 dias		15 dias		18 dias	
	pH 6,5	pH 4,5	pH 6,5	pH 4,5	pH 6,5	pH 4,5	pH 6,5	pH 4,5	pH 6,5	pH 4,5
029	1,25	1,25	2,00	2,00	4,00	3,50	4,00	4,00	4,00	4,00
044	1,75	1,75	4,00	2,00	4,00	4,00	4,00	4,00	4,00	4,00
046	1,31	1,25	2,56	1,63	2,56	2,06	3,19	3,00	3,75	3,50
048	1,00	1,00	2,00	2,00	4,00	4,00	4,00	4,00	4,00	4,00
055	2,00	2,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00
078	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00
511	2,00	2,00	3,19	3,25	4,00	4,00	4,00	4,00	4,00	4,00
520	1,00	1,00	2,00	1,25	4,00	3,50	4,00	3,50	4,00	3,50
522	1,75	1,25	3,00	2,00	4,00	4,00	4,00	4,00	4,00	4,00
526	2,00	1,50	2,75	1,75	3,38	2,06	4,00	2,88	4,00	2,88
550	1,75	1,13	2,54	1,94	3,56	2,19	4,00	3,25	4,00	3,75
558	0,75	0,00	1,44	0,94	2,38	1,75	3,75	2,25	3,75	2,25
562	0,56	0,25	1,00	0,81	3,00	1,81	3,75	2,00	3,75	2,00
563	2,00	1,25	2,44	2,13	4,00	3,25	4,00	3,25	4,00	3,25
565	1,00	1,00	2,19	2,00	4,00	4,00	4,00	4,00	4,00	4,00
568	1,50	1,81	2,63	2,00	2,63	2,00	3,13	2,00	3,38	2,00
576	2,25	2,25	3,69	3,25	4,00	4,00	4,00	4,00	4,00	4,00
602	1,00	1,00	1,50	1,00	3,75	3,75	3,75	3,75	3,75	3,75
609	1,25	1,00	3,00	2,00	4,00	4,00	4,00	4,00	4,00	4,00
624	2,00	1,00	3,00	2,75	4,00	4,00	4,00	4,00	4,00	4,00
630	1,44	1,19	2,00	1,38	2,75	1,94	3,94	2,13	4,00	2,13
632	1,88	2,25	2,63	3,25	4,00	4,00	4,00	4,00	4,00	4,00
641	1,25	1,13	2,09	1,13	3,00	1,13	3,75	1,19	4,00	1,19
642	1,38	1,81	2,88	2,00	3,38	2,25	4,00	2,50	4,00	2,50
649	3,06	2,25	4,00	3,25	4,00	4,00	4,00	4,00	4,00	4,00
650	3,00	1,25	3,25	2,50	3,75	3,25	4,00	3,75	4,00	3,75
657	2,00	2,00	3,00	3,00	4,00	4,00	4,00	4,00	4,00	4,00
658	1,25	1,25	2,63	1,75	3,50	3,50	3,50	3,50	3,50	3,50
671	2,00	2,00	3,13	3,25	4,00	4,00	4,00	4,00	4,00	4,00
673	0,25	0,00	1,88	0,81	2,69	1,56	2,88	1,75	2,88	1,75
678	2,69	2,19	3,75	2,69	4,00	3,00	4,00	3,63	4,00	3,38

QUANTITATIVE EVALUATION OF BRADYRHIZOBIUM SPP. TOLERANCE TO ACIDITY.

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Key words: Rhizobia selection, rhizobia growth, Aluminum, Amazon.

Abstract

Tolerance quantification in the laboratory is the first step in rhizobia strain selection. The present method evaluated rhizobia in Petri dishes with YMA medium at pH s 6.5 (control) 4.5 and 4.5 plus Al, using scores of 1.0 (sensitive, "no" growth) to 4.0 (tolerant, maximum growth). This method permited selection of *Bradyrhizobium* spp. from the Amazon with statistical precision and low standard deviations. Among the 25 rhizobia strains initially tested, strains INPA 02-078, 02-055 and 01-576 scored 4.0 at pH 6.5 and 4.5. Strains INPA 01-046, 02-029, 02-055 were tolerant to pH 4.5 but sensitive to Al. Two strains, INPA 02-044 and 02-077 presented higher scores at pH 4.5 or 4.5 plus Al than at pH 6.5. The method also permits strain selection without statistical analysis. It is necessary only to chose those which grow well on the three mediums (scores > 3.0), such as the strains INPA 01-168, 02-007, 02-009, 02-029, 02-034, 02-044, and 02-055. Tolerant strains must be tested for effectiveness, competitiveness and soil persistence before inoculant recomendation.

Introduction

The majority of Amazon Basin soils are acidic and have low fertility. Phosphorus, N, Ca, K, Mg, are deficient in the plateau soils (terra firme) of the Amazon. It is estimated that P and N are deficient in 90% of the region's soils (Nicholaides et al., 1983). Agricultural, forestry and agroforestry yields suffer from these constraints. While liming and fertilization reach a few land owners, these amendments are expensive and difficult to obtain in the region, especially for small farmers.

Nitrogen fixation by legume-rhizobia symbioses may supply this nutrient to the ecosystem, but plants and bacteria must tolerate soil constraints. Legume nodulation under natural soil fertility is sparse or absent (Magalhães et al., 1982; Oliveira & Sylvester-Bradley, 1982), except when soil constraints are eliminated (Oliveira et al., 1992). *Bradyrhizobium* strain selection for tolerance to low pH and low soil fertility has been done (Keyser & Munns, 1979; Sylvester-Bradley, 1980; Souza et al., 1984). However, these methods cannot quantify the rhizobia tolerance to acidity. Colony counting from rhizobia grown in acid YM liquid medium is a possibility, but very difficult and expensive in terms of material and time for screening a large number of strains or isolates. To facilitate strain selection, it is necessary to use a fast, easy method to evaluate a large number of isolates, as well as to quantify the bacteria tolerance/sensitivity to these soil constraints. The objective of the present study was to test a laboratory method for this purpouse as the first step in rhizobia selection for acid soils.

Method

The present method evaluated rhizobia strains in Petri dishes with YMA medium (Vincent, 1970; Somasegaran & Hoben, 1985) using an adaptation of the second method for streaking rhizobia (Somasegaran and Hoben, 1985, fig.1.1, p.9) at two pH´s, 4.5 and 6.5 (control). Some rhizobia were also tested at pH 4.5 plus Al (0.5 ceq of Al^{+3}/L of medium as $AlCl_3$ added as a sterile water solution just before pouring in the plates). For adequate solidification, YMA acid medium (pH 4.5) was prepared with 25 g of agar/L, instead of the usual 15 g. Rhizobia isolates were streaked from a mother Petri dish with YMA at the log growth phase (between 3-6 days of growth) with a platinum loop. Four replicates were used for each rhizobia isolate in each pH medium. Figure 1 presents the general streaking procedure, which used only one loop from the mother Petri dish per replication. A dilution factor occurs when looping are done from one zone to the other. Figure 2 presents the scoring system: 1.00 - "no" growth (no visible growth); 1.25 - some growth only in the zone 1; 2.00 - maximum growth in zones 1 and 2; 3.00- maximum growth in zones 1-3; 4.00 - maximum growth in all four zones (1-4). Intermediate scores were also given at intervals of 0.25. Growth evaluations were done until score stabilization, which occurred 9-18 days after streaking in the plates. Statistical analyses of growth were done at 6, 9, 12, 15, 18 days after streaking, with 20 strains using the F test, and Tukey at 5% for mean comparisons. Five strains were not statistically analysed but only graphed.

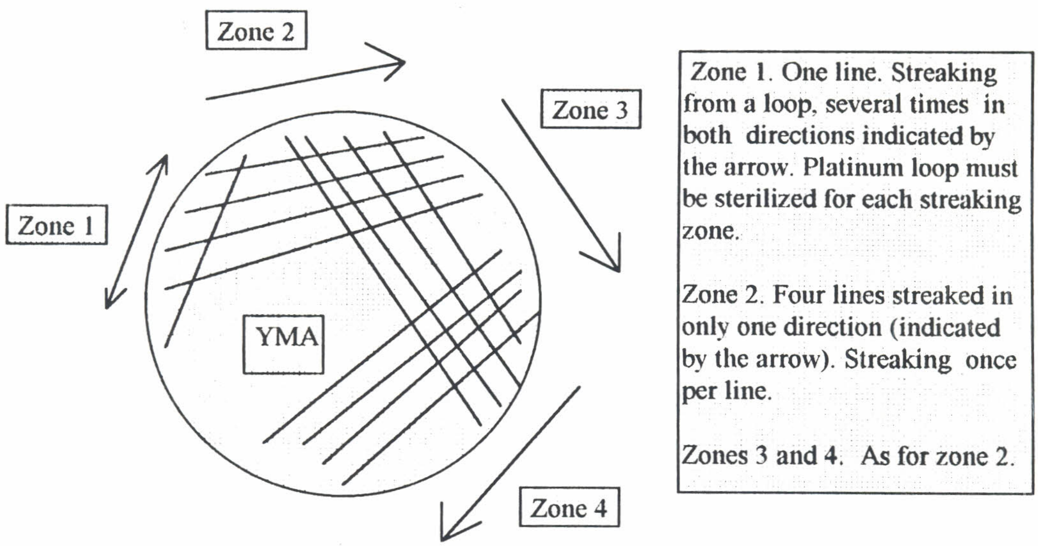

Figure 1. Streaking procedure in Petri dishes with YMA medium for rhizobia isolates evaluations.

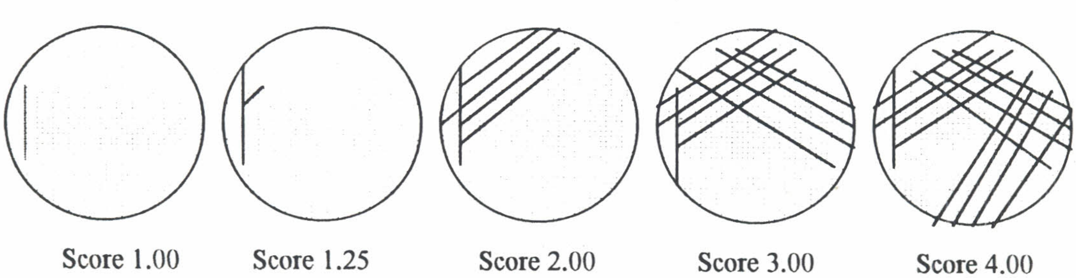

Figure 2. Scores for rhizobia growth in the Petri dishes with YMA (pH 4.5 and 6.5).

Results and Discussion

The method was succesful for quantitative evaluation of rhizobia tolerance to acidity. It was possible to separate rhizobia strains statistically, and with low variation among the four replicates for each strain at each pH (Table 1). The standard deviations, between 0.00 and 0.08, were very low.

Strains INPA 01-046, 02-029, 02-055 were tolerant to pH 4.5 but sensitive to Al. However, INPA 02-044 and 02-077 presented higher scores at pH 4.5, with or without Al, than at pH 6.5. All other strains were sensitive to both low pH and low pH plus Al. The strain INPA 01-055 presented poor growth even on the medium at pH 6.5, which may be a problem for it practical use.

The method also permits selection of strains without statistical analysis. It is necessary only to chose those which grow well on the three medium (scores > 3.0), such as the strains INPA 01-168, 02-007, 02-009, 02-029, 02-034, 02-044, and 02-055.

Figure 3 presents some examples of growth of *Bradyrhizobium* isolates at pH 4.5 and 6.5. Tolerant rhizobia (INPA 02-078, 02-055, 01-576) presented scores of 4 at both pH´s by 6, 9 or 12 days after streaking in the Petri dishes, while sensitive strains (INPA 01-641, 01-568, 01-526) never reached this score. Growth stabilization occurred from day 6 to day 15 after streaking in plates. These three strains presented different degrees of sensitivity, with INPA 01-641 the most sensitive.

Concluding comments

The method is useful for rhizobia quantitative evaluation at low pH and low pH plus Al. It is very simple, easy, and fast for screening a large number of rhizobia isolates under laboratory conditions. Statistical analysis may be used only when accuracy is necessary.

The method was used for more than 100 isolates of *Bradyrhizobium* (Oliveira and Magalhães, in preparation), as well as for *Rhizobium leguminosarum* bv. *phaseoli* strains (Oliveira and Graham, unpublished results) with a high degree of confidence and accuracy. However, it is only the first step of rhizobia selection. Tests for effectiveness, competitiveness and soil persistence (Oliveira & Vidor, 1984a,b,c,d) must be done before inoculant recomendation.

Aknowledgement

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Table 1. Growth of *Bradyrhizobium* isolates at different pH´s in YMA media at 9 days after streaking on Petri dishes.

INPA isolates	Scores [1] on YMA pH 6.5 Means(sd) [3]	pH 4.5 Means(sd)	pH 4.5 + Al [2] Means(sd)
01-046	3.84(.06)a	3.94(.02)a	1.31(.02)b
01-055	1.50(.00)a	1.00(.00)b	1.19(.02)b
01-080	4.00(.00)a	3.75(.00)b	3.44(.02)c
01-168	3.94(.02)a	3.75(.00)a	3.75(.00)a
02-007	3.88(06)a	3.50(.04)b	3.56(.06)b
02-009	3.31(.06)b	3.31(.02)b	3.62(.02)a
02-025	3.88(.06)a	1.94(.02)b	1.50(.00)c
02-029	3.88(.02)a	3.81(.02)a	3.50(.00)b
02-034	4.00(.00)a	3.50(.00)b	4.00(.00)a
02-038	3.00(.00)a	1.50(.04)c	2.00(.00)b
02-044	3.50(.00)b	4.00(.00)a	3.81(.02)a
02-046	3.87(.06)a	3.50(.00)b	1.31(.06)c
02-048	3.50(.00)a	2.25(.04)b	2.25(.08)b
02-053	3.31(.06)a	1.25(.04)c	1.50(.00)b
02-055	4.00(.00)a	4.00(.00)a	3.50(.00)b
02-065	3.56(.02)a	1.00(.00)c	1.50(.00)b
02-068	3.75(.00)a	2.50(.00)c	3.00(.00)b
02-073	3.50(.00)a	1.25(.04)c	1.50(.00)b
02-077	3.25(.04)b	2.06(.02)c	3.69(.06)a
CB-756	3.25(.00)a	1.00(.00)c	1.31(.02)b

1- Scores: 1.00 = "no" growth, 4.00 = máximum growth.
2- 0.5 ceq Al+3/L of YMA.
3- (sd) = (standard deviation)
Means followed by the same letter in each line are not statistically different by Tukey 5%.

Figure 3. Examples of growth of *Bradyrhizobium* isolates on YMA at pH 4.5 and 6.5.

SUMMARY OF THE FUNDS RECEIVED AND EXPENDITURES

TOTAL GRANT (US$): 100,000.00

Grant ref: RF 93024 # 2 US$ 40,000.00

Date	Amount received	Payments
1993 to March/1994	5,000.00	4,864.17
March to September/1994	10,000.00	10,134.24
October/1994 to September/1995 (May 8, 1995)	11,355.00	15,627.99
Vehicle Land Rover (direct - Land Rover of Brazil)	23,645.00	23,645.00
SUBTOTAL	50,000.00	54,271.40

Grant ref: RF 93024 # 3 US$ 60,000.00

October/1995 to September/1996 (Dec. 14, 1995)	15,000.00	
(May 08, 1996)	15,000.00	21,031.59
October/1996 to September/1997 (June 04, 1997)	17,635.50	24,717.75
(Jan. 05, 1998)	2,364.50	
SUBTOTAL	50,000.00	45,749.34
TOTAL	100,000.00	100,020.74

TOTALS

TOTAL RECEIVED (US$): 100,000.00
TOTAL EXPENDITURE (US$): 100,000.00

Agroforestry System with Cupuaçu, Banana, Bactris gasipaes, Inga edulis, after 43 months of planting. Passion fruit is growing on the spacing between the fruit trees, and the fourth cassava crop have been harvested.

Farmers participation on a training course in agricultural practices at EMBRAPA headquarters. Training focuses on adapting, rather then adopting technologies. Agricultural practices, such as citrus grafting and banana seedlings preparation were the focus of farmers training program.

System II: Annual crop, cowpea beans, growing on the spacing between the fruit trees: Cupuaçu, Banana, Bactris gasipaes and Inga edulis, 43 months after planting. The fourth cowpea crop growing with PK fertilizer application.

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