Multi-strata agroforestry as an alternative for small migrant farmers practicing shifting cultivation in central Amazonian communities in Brazil[1]

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Key words: development, participatory research, adoption, colonization project

Introduction

To increase agricultural production and the farmers' socio-economic development is a challenge for the government and for institutions working in Central Amazon. Development programs in Brazil have been usually conceived within the frame of formal science and modern technologies. However, many proposed solutions for problems in rural communities have failed in taking into account the local knowledge. The land use system of the migrant population in the colonization projects is the slash and burn cultivation, in which the fallow period has been drastically reduced, what in turn decreases soil fertility status, thereby reducing crop productivity.

The understanding of local knowledge and farmers' perspectives is the key to planning and implementing research and development projects as innovative and longer term strategies (Hildebrand & Poey 1987; Fujisaka 1991; Sousa *et al.* 1992; Smith *et al.* 1998). This has led the authors to initiate an on-farm research project at Presidente Figueiredo municipality, Amazonas State. The overall objective was to test a participatory approach of farmers' involvement in research development, in order to implement some agricultural practices that could benefit farmers' production systems, and would contribute to income diversification, food security, sustainable land use, and consequently, social and economic development of rural communities.

Material and Methods

With the objective of eliciting farmers practices and knowledge through a combination of field observations and understanding of farmers systems, a diagnostic survey was addressed to resource poor farmers of government settlement communities. Using a structured questionnaire, a group of eight to ten persons visited five communities in the settlement and some independent farmers. Each team was constituted of two technicians, one a researcher from Embrapa, and one from the local extension agency (Idam).

As the inquest did not target effectively the understanding of interactions within farmers systems and external relations, the D & D method (Raintree 1987) was applied. Two teams of five-eight persons of different disciplines visited and interviewed 19 families during one week. Three to four visits were made per day. Farms were distributed over the entire municipality. The technique was an informal, interactive and structured interview, so as to enable the individuals to follow the line of inquiry according to each ones discipline, in order to facilitate the analyses and the understanding of the broad issues investigated. After analyzing the data gathered with the two methods of inquest, a participatory process of analysis of problems and systems identified with farmers was carried out.

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This analysis showed that the farmers' traditional land use system consisted of slashing and burning the forest, raising one or a maximum of two cassava crops in the fertile ash, followed by abandonment for soil fertility recovering. Harvests are initiated within 14 to 16 months after planting and the area harvested each time is just enough to prepare 2-3 bags of 50 kg of flour for family consumption and sale in the market. The same year or on the following year, the native fruit tree species are planted in the area. After the harvest of cassava or even before the end of cassava harvesting, the area is abandoned until the perennial crop starts flowering. The secondary vegetation is then cleared.

Based on the systems analysis, two agroforestry alternatives were discussed with farmers and four farm areas were selected to implement the research. The project was intended to be a means to provide researchers, extension workers and farmers themselves with a laboratory to learn and capacitate farmers and other groups involved in farmers development programs. In addition to be a process of technology testing, validating and developing, the project objective was to enhance farmers technological capability through training courses, group discussion and farmers organization, in order to facilitate adoption of new technologies.

The trials were, up to a point, researcher-managed, with farmers participation, as the researchers helped to implant the trials and supplied seedlings, seeds and fertilizers used in the treatments, while it was the farmers' responsibility to carry out all the field work such as, land clearing, weeding and harvesting. The migrant farmers living in this settlement project are constituted of different categories. Some are traditional farmers, others farm workers that became land owners and others had no agricultural experience. But all shared certain characteristics, such as the land use system and the lack of knowledge regarding the use of modern technologies, crops arrangements and improved germplasm.

The central experiment pretended to evaluate the potential of two low-input multi-strata agroforestry systems to be sustainable alternatives of land use. They were also seen as a prospect for a more permanent form of land cultivation than the traditional slash and burn agriculture. The strategies used were evaluating the annual food crops, cassava (*Manihot sculenta* L.) and rice (*Oriza sativa* L) varieties and cowpea (*Vigna unguiculata* (L.) Walp) in rotation and inter-cropped with perennial fruit trees, such as cupuaçu (*Theobroma grandiflorum* (Willd. ex Spreng.) Schum) and peach palm (*Bactris gasipaes* Kunth), a semi-perennial component, banana (*Musa* spp), and inga (*Inga edulis* Mart.) for fruit production, soil fertility improvement and firewood, in a temporal and spatial arrangement. The effects of some soil management practices on plant growth and grain, root and fruit production was also evaluated.

The areas were cleared according to the traditional slash and burn system, except that the long trunks were cut, piled up and burned in order to increase the available planting area and to improve initial soil fertility through ash addition. The three soil management were: a) use of organic and inorganic fertilizer; b) application of P only and, c) P plus a leguminous cover crop. Peanut (*Arachis hypogaea* L.) was the cover crop in the first year, followed by cowpea and mucuna *(Stizolobium aterrimum)*. Relevant soil chemical properties were monitored. Yields of all crops, income and costs during the first two years of the project development were collected.

Results and Discussion

The results were evaluated by farmers as well as researchers. According to the farmers evaluation, the multi-strata arrangement was a better option for food crops production than the traditional system, mainly due to labor effectiveness. With these arrangements, the weeding of the staple food such as cassava, rice or beans implied also a weed control for the fruit trees, which are usually left in fallow until production begins.

Farmers recognized that with the traditional systems, harvesting of crops other than cassava in a land as 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 unproductive for crops with higher fertility requirement such as banana. Even on newly burned secondary forest land, production of corn, rice, or beans was impossible. Yields were too low. The perspectives of success visualized as results of the project were enhanced by the adoption of some technologies by the farmers themselves as well as the awareness and interest of other farmers and communities for the practices developed in the trials. This was highlighted by the reports of farmers involved.

According to the researchers' evaluation, the productivity of the areas has been maintained longer than in the traditional slash and burn system. Yields of all products were higher than in the traditional system, which would possibly yield one cassava crop, averaging 6t/ha. The average yield of the first cassava crop with one of the soil management treatments was over 20 t/ha cassava roots. After four years of continuous agroforestry, the products harvested included five to six food crops in addition to banana and cupuaçu fruits and peach palm fruit and palm-of-heart, with inputs of N, P, K fertilizer and chicken manure (Table 1). Yields of cowpea grain on fertilized plots was high on the three harvests, indicating that cowpea was a good crop to grow in similar cropping systems. Results obtained by Torquibeau & Akyeampong (1994) showed that cowpea was more favorable crop than corn or banana to support low level of shade. Possibly cowpea is more tolerant to above and below ground competition than other annual crops.

The results also indicated that the multi-strata agroforestry system tested during this project has the potential to enhance the diversity of food crops and to increase income through higher productivity as seen by the costs and generated income (Table 2).

Table 1. Average productivity (t/ha) of two agroforestry systems (mean of three locations), during the first 46 months of continuous cropping on fertilized plots.

Crops	Planting date	Grain/Tubers/Fruit/Pulp Yields	Crops	Planting date	Grain/Tubers/Fruit/Pulp Yields
	System I			System II	
Cassava	Dec./93	20.2	Rice	Feb./94	1.30
Cassava	Dec./95	6.6	Cowpea	June/94	0.75
Cassava	Jan./96	4.1	Cassava	Dec./94	5.50
Cassava	Jan./97	3.3	Cowpea	July/95	0.65
Cowpea	June/95	0.6	Cowpea	June/96	0.82
Banana	Feb./94	5.3	Banana	Feb./94	5.30
Cupuaçu	Feb./94	0.24	Cupuaçu	Feb./94	0.29
Total grain		**0.6**	**Total grain**		**3.5**
Total tuber		**34.2**	**Total tuber**		**5.5**

Table 2. Costs (labor and inputs) and income (US$/ha) generated with the systems, (mean of three locations) in three soil management, during three years of continuous cropping.

Discrimination	Soil Management			
	NPK	P	P + Leguminous	Total
Costs (labor and inputs)	2,550.1	1,886.6	1,982.2	6,418.9
Income[1]	5,852.2	1,330.2	1,380.0	8,562.5

[1] Income from 2nd cassava crop and cowpea on year 3 not included.

Conclusions

The adoption of agroforestry practices which promote social, economic and environmental benefits was limited by the amount of information that reaches farmers, the lack of physical and financial resources, and farmers organization.

To achieve the goals of improving farmers welfare, their participation in all phases from problems identification until technology development and implementation is necessary.

The agroforestry systems designed had the potential to enhance the diversity of food crops available to the family and to increase income through higher productivity, while maintaining the integrity of the natural resource basis.

The search for models of sustainable agriculture in the Amazonian environment will have to combine traditional local practices with some modern agricultural technology, such as the efficient use of fertilizer, in sufficient amounts to support the plants nutritional requirements without degrading the environment.

The on-farm agroforestry system, although not considered stable at this time, is seen as a promising transition technology from the traditional shifting cultivation to a more permanent land use.

The close contact with the resource poor farmers in the project provided valuable opportunities for increasing the level of interaction between researchers and small farmers. It raised the communication capability, the researchers' awareness of the difficulties encountered by the resource poor farmers, and the opportunities for creating more demanding technologies.

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