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AGROFORESTRY SYSTEMS AS AN ECOLOGICAL APPROACH IN BRAZILIAN AMAZON DEVELOPMENT

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ABSTRACT

This paper discusses EMBRAPA's agroforestry systems experience in the Brazilian Amazon. The forestry species and fruit trees introduced in shifting cultivation systems had great success, particularly the wood species **Cordia goeldiana** and **Swietenia macrophylla** and the fruit trees **Musa** spp and **Theobroma grandiflorum**. In forestry plantations **Vigna unguiculata** was mixed with the trees **C. goeldiana**, **Jacaranda copaia** and **Bagassa guianensis** in the first two years to reduce costs of investment and cultural treatment. In this case, **Vigna unguiculata** did not affect survival of trees and incresed heigh and diameter tree growth. The introduction of wood trees in livestock pastures can represent formation of system more balanced and stable through the nutrient cycling than it is possible today. A silvopastoral system has been carried out in Paragominas region (Eastern of Para) using the forestry species **Eucalyptus tereticornis**, **B. guianensis** and **Schizolobium amazonicum**, the crop **Maiz** sp. and the forage species **Brachiaria brizantha**, **B. humidicola** and **Panicum maximum**. The forestry and forage species performance has been satisfactory and the corn yield was more than regional average. The cattle, at a low stocking rate, graze normally on the site and cause no harm to the planted trees.

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INTRODUCTION

The Brazilian Amazon has about 280 million hectares of dense forest representing 60% of the land cover of Brazil. The most frequent climatic types (Koppen classification) are Awi, Ami and Afi. Most soils are highly weathered, acidic and of low fertility.

The commom reasons for deforestation in Amazonia are to establish swidden agricultural plots, or tree plantations, or cattle ranches. In this paper examples are provided of how agroforestry techonologies can be useful to both farmers, plantation foresters, and ranchers in Brazilian Amazon.

THE SMALL FARMER AND THE AGROFORESTRY SYSTEM

Shifting cultivation is an important land-use practice in the Brazilian Amazon. The main crops used in this system are rice (**Oriza_sativa**), corn (**Zea_mays**), cowpea (**Vigna__unguiculata**) and cassava (**Manihot___esculenta**). Normally, a small forest area is felled and burned and cultivated for two or three years and then the area is abandoned. In the Bragantina Region (northeast of the State of Pará), where population densety is high, the land fallow time is about three years while in other places, where land pressure is lower, fallows can extend to ten or more years. It is estimated that in the North Region of Brazil over 300,000 hectares are been annualy let to fallow in shifting cultivation systems.

The major criticism of slash and burn agriculture is that it is an inefficient use of the land because new parcels of forest have to be cleared every two or three years to sustain the cultivator. Also, the crops produced are of low value. Hence, the farmers have little opportunity to accumulate capital and thereby better their lives.

In the Tapajós Region of the central Amazon, it was initiated a holder research towards helping small producers to adopt more environmentally sustainable farming practices, and obtain an additional source of capital. This means, specifically, the introduction of fast growing and high economic value forest species into farming areas. The tested system involved the combination of corn (**Maiz** sp), banana (**Musa** sp), freijó (**Cordia goeldiana**) and mahogany (**Swietenia macrophylla**). Corn and banana were planted in accordance with the traditional local pratice. The forest species performance is satisfactory because at eight years of age the wood volume are 31 m3/ha for freijó and 8 m3/ha for mahogany. Using this approach, the total gross production and net income per hectare per year of this system can, respectively, increase 6.2% and 1.8% (BRIENZA JUNIOR **et alii**, 1982).

The mixing of tree timber species with short-lived crops is still not an ideal solution because after crops senesce, there is still a wait of many years before the timber species are ready for harvest. The introduction of more long-lived fruit trees might solve this problem, providing steady production while the timber species grow fast.

In January, 1986, an experiment was initiated using a farming area of 1.5 hectares involving crops, fruit trees and forest especies. The objective was to study an agroforestry model adapted for small farmer conditions and which could function like a capitalization mechanism. The species involved were cumarú (**Dypterix odorata**), quaruba (**Vochisia maxima**), brazil nut (**Bertholletia excelsa**), tatajuba (**Bagassa guianensis**), cupuaçú (**Theobroma grandiflorum**), ingá (**Inga** sp), freijó, mahogany, banana and corn (MARQUES **et alii**, 1986).

According to MARQUES **et alii**, (1988) the crops and the trees showed good performance. The corn yield was about 1,400 Kg/ha in the establishment phase, when it was mixed with banana. This production is approximate the regional average of 1,500 Kg/ha. Besides providing shade for fruit and timber trees, the banana had good yields with low costs. In the second year of experimentation, the fruit production was about 1,900 Kg/ha or 500 bunchs or 22,820 fruits, which represented US$ 930.00/ha/year of gross income. One year after tree planting, the survival of the majority of species was good. Tatajuba, freijó, cumarú and mahogany showed 100% of survival and brasil nut 90%. Quaruba survival was low because the seedling quality was not good. Mahogany presented the best growth (2.20 m of heigth) and was not attacked by **Hypsiphylla grandela** till 12 months of age. Tatajuba, freijó and cumarú had shown heigths of about 1.30 m and 1.50 m, respectivelly, whereas brasil-nut presented 0.50 m of heigth, which is normal for this species.

THE FORESTRY AND AGROFORESTRY SYSTEM

Forestry could also be combined with crops in its phase of establishment as an agroforestry technology. At present, tree plantations are most common in the State of Pará and Amapá Federal Territory which include about 170,000 hectares of plantation area. The main species used are gmelina (**Gmelina arborea**), pinus (**Pinus caribaea** var. **hondurensis**) and eucalyptus (**Eucalyptus urophylla** and **E. deglupta**). Recently, experiments have been undertaken to mix plantation tree crops with annual food crops. One obvious advantage is economic because food crop associated with tree species can reduce forestry plantation costs, as well as decrease the frequency of crop treatments and it is favorable to tree growth. In 1980 an experiment at Belterra (State of Pará) was initiated. Tatajuba (**Bagassa guianensis**), parapará (**Jacaranda copaia**) and freijó were mixed with cowpea (**Vigna unguiculata**). According to BRIENZA JUNIOR **et alii**, (1985) in the third year, the tree species freijó, tatajuba and papará had an average height growth of 3.6 m, 4.5 m and 4.8 m, respectively. The cowpea yield was 645 kg/ha in 80% of 1 hectare at this time. Cowpea has also shown satisfactory results with other tree mixtures in others areas of the Amazonia. According to UEPAE-MANAUS (1980) cowpea yielded 780 and 900 k/ha in separate mixtures with rubber tree and guaraná (**Paullinea cupana**), respectively and when cowpea was mixed with freijó its production was 805 kg/ha (UEPAE-MANAUS, 1981). The results are indicating that cowpea is a good option for mixing with

forestry species because it offers a good yield and does not seem to suffer from the presence of trees during the early years of plantation development.

Although crops mixed with forestry species does not affect survival of the trees, increases its height and diameter growth and may reduce costs of reforestation, the adoption and implementation of these systems will depend on economic factors, specially availability of capital (BRIENZA JUNIOR et_alii._1985).

THE CATTLE RANCHER AND THE AGROFORESTRY SYSTEM

Since the early 1960s, large areas of Amazonia have been cut to establish cattle ranches. Pastures are established after the forest is cut and burned.

Pastures grasses grow well during the first few years following clearing, but then a progressive decline in productivity generally occurs due to loss of soil fertility and poor management pratices. At present about 8 million hectares of cultivated pasture exist with perhaps half of this area in some stage of degradation (SERRAO, 1988).

Agroforestry techniques and concepts can also be incorporated into livestock operations in the humid tropical region. For example, in 1985, Brazilian Agricultural Research Coorporation (EMBRAPA), initiated a silvopastoral experiment in Paragominas (State of Pará). The work began by planting a mix of corn and tree crops. In the third year, after two crops of corn had been harvested, forage grasses were introduced with a final planting of corn. Now, in the

fourth year, the swaths of grass with 12 m of large, between the trees rows, are periodically grazed.

The tree species in this experiment are paricá (**Schizolobium_amazonicum**), eucaliptus (**E._tereticornis**) and tatajuba (**Bagassa_guianensis**). The forage specie are marandú (**Brachiaria_brizantha**), quicuio-da-amazônia (**B._humidicola**) and colonião (**Panicum_maximum**).

Preliminary results of this research are very interesting. According to MARQUES **et_alii**, (1986), AGUIAR **et alii**, (1987) and VEIGA **et_alii**, (1988) the corn production in the first, second and third years was about 1,100, 700 and 400 kg/ha, respectively. These yields are satisfactory when compared with the regional average. The forestry species performance has been satisfactory. At four years the average plant height and diameter growth was, respectively, 15.7 m and 14.3 cm (paricá), and 12.9 m and 11.0 cm (eucalyptus). Tatajuba experienced problems with deer grazing during the first year but at present it is growing well with an average height of 6.5 m and an average diameter of 5.8 cm. Of the forage species used, marandú had the grestest yields 11,100 Kg of dry matter/ha. This performance allowed a stocking of up two steers per hectare in a rotational grazing system. The cattle, at a low stocking rate, graze normally on the site and cause no harm to the planted trees.

CONCLUSIONS

Agroforestry systems may not necessarily be an ideal solution for all Amazon conditions. However, there is a growing consensus that these systems can constitute a rational land-use strategy in many cases because they maintain the integrity of the forest landscape and provide moderate yields.

For the small holder, it can be suggested that the goverment establish incentive programs for agroforestry systems. This money could be used to establish nursuries to produce the seedling necessary for these agroforestry systems. In this way, small producers will have a chance to improve their incomes while using the land in a more ecologically sustaineble manner.

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