Secondary Forests and Fallow Vegetation in the Eastern Amazon Region: Function and Management.

(ENV-25)

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Period: September 1991 - August 1995

Project presentation and objectives

Agricultural activities in the eastern Amazon region have caused the replacement of tropical rainforest with secondary vegetation. This secondary vegetation plays an important role as fallow to restore the productivity of the slash-and-burn agriculture of the local small-holder farms (Fig. 1). However, because of increasing land-use intensity (e.g., population pressure, mechanized land preparation, etc.) the fallow vegetation is no longer accomplishing its function, resulting gradually in lower yields. Consequently fallow periods are shortened or cultivated areas are expanded in order to compensate for the low productivity. Since the period and vitality[2] of the fallow vegetation has a direct influence on crop yields, it is important to take into account agricultural practices that affect directly these parameters, as shown in Fig. 2. Considering the population growth in regions with small-holder farming, the question arises under which conditions can the local land-use systems maintain their productivity.

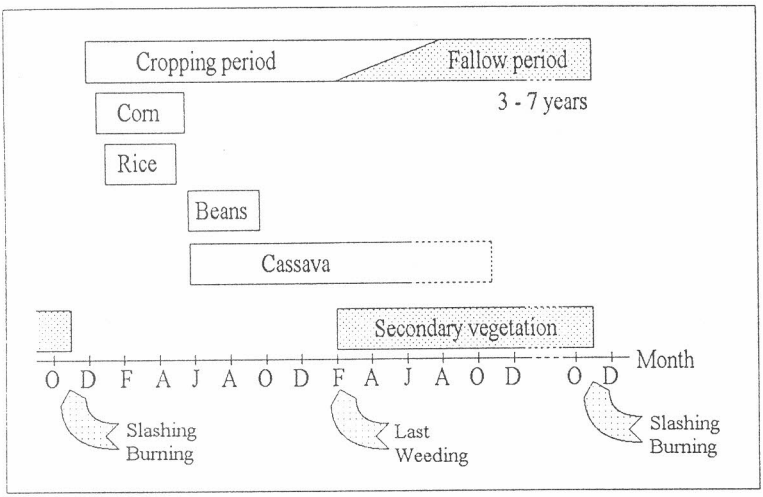

Fig. 1. The secondary vegetation in the land-use system

[2] Expressed by diversity, structural homogeneity, phytomass production, nutrient accumulation, regeneration capacity, and so on.

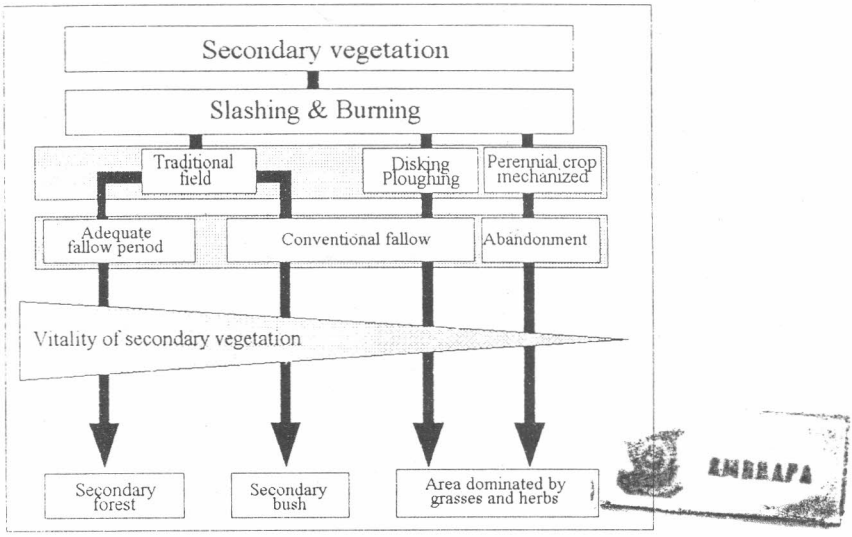

Fig. 2. The vitality of secondary vegetation: causes and consequences.

Based on the assumption that further development of traditional fallow systems could contribute to the ecological and economical stability of the small-holder's land-use system, the main objective of the project is to understand the ongoing ecological processes in the system (soil, plant community, microclimate and their relationships) during the fallow period, on the basis of which recommendations for subsequent vegetation management could be developed. The management techniques to be developed should contribute to the improvement of secondary vegetation either for its maintenance, or to shorten the period of fallow, without interfering with the productivity of the farming system on the one hand, or for long term utilization as a source of forest products on the other.

Vegetation management means influencing or intervening in the process of secondary succession, which is defined as sequences of vegetation development on previously vegetated and disturbed areas. Changes on abandoned cultivated land are also considered secondary succession.

Concerning the management of the fallow period two different paths are proposed:

1. cutting short the successional development of the fallow vegetation by planting desirable species, or life/growth forms of later successional stages, and

2. directing the successional development by agronomic and/or silvicultural interventions, which depend upon the desired characteristics of the envisaged plant community or stand structure.

The latter offers three options influencing the development of fallow vegetation such as: designed disturbance, controlled colonization, and controlled species performance (Luken, 1990), which are based on Pickett et al. (1987), who stated that vegetation development is dependent on three causes of natural succession: site availability, differential species availability and differential species performance.

To test the above-mentioned options, several interventions are being carried out to evaluate the effect of these practices on plant growth and vegetation development (Table 1).

Table 1. Several agricultural interventions being evaluated under different categories according to Luken (1990).

Designed Disturbance	Controlled Colonization	Controlled Species Performance
Slash and burn	Weeding	Shading
Slashing, no burning	Mulching	Fertilization
Stump removal	Fertilization	
Ploughing	Enrichment with trees	
Discing		

Considering that management options have a direct environmental influence on the ecology of the agricultural landscape, with their contributor indirectly to reducing the pressure on the primary forest by the agricultural activities, three major questions need to be answered:

1. What kind of effects does the land use system impose on floristic composition and development of secondary vegetation (farmland, landscape diversity, and economically speaking) ?

2. What is the importance of the secondary vegetation regarding the stability and productivity of the small-holder land use system ?

3. What are the mechanisms and regeneration capacity (sexual and vegetative), and expansion ability of woody secondary vegetation into deforested areas ?

Description of the study site: The municipality of Igarapé Açu, Pará.

The municipality is located east of Belém, between 1° 7' 41" south latitude and 47° 37' 15" WGr longitude. The geographic area is 783 km^2, with a population of 31,965 inhabitants (51 % in rural areas) and a demographic density of 40.8 hab/km^2 (IDESP, 1990).

The mean annual temperature is 24.9 °C and the mean annual precipitation is 2.442 mm. A dry season occurs in the region between the months of September and November.

The predominant soils are oxisols/ultisols. Considered as a whole, the values observed for these soils for acidity (pH in KCI 4.0 -4.8), organic matter (0-10cm: 1.42 %; 30-60cm: 0.72 %; all mean values for 25 samples), macro-nutrients (N 0-10cm: 46mg/100g of soil, 30-60cm: 28mg/100g; P 0-10cm: 0.20mg/100g, 30-60cm: 0.09mg/100g; K 0-10cm: 0.03meq/100g of soil, 30-60cm: 0.02meq/100g)

and effective cation exchange capacity (0-10cm: 1.70meq/100g; 30-60cm:1.16meq/100g) must be classified as low to very low. Only calcium reaches average supply values (0-10cm: 0.82meq/100g; 30-60:0.17meq/100g) in comparison with other Amazonian soils. Saturation of aluminum is average to high, justifying the expectation of losses in agricultural yields due to Al. In depths below 30cm, the soils have saturation levels of Al capable of indicating a phytotoxic effect (76-87 %).

The potential zonal vegetation of the municipality of Igarapé Açu is tropical rain forest or more precisely an evergreen Amazonian forest. A majority of the vegetation types of the region - terra firme primary forest, Várzea and igapó forest, terra firme and inundated grasslands - occur very sparsely at present, and are limited to only a few locations. The most important natural vegetation are the residual forests along the streams, but even these are heavily exploited. Today, 95 % of the vegetation in the municipality is considered transformed in comparison to its original state. The natural forms of vegetation and their typical floristic compositions with respect to the geographic aspect have been substituted by secondary vegetation originating from human actions.

Igarapé Açu was founded in 1897 as a colonization pole, favored by the construction of the railway between Belém and Bragança, with the objective of promoting settlement in the region for the supply of food goods for Belém. Due to competition with road transport the railway was halted in 1966.

Agriculture has been practiced for approximately 90 years in some parts of the municipality. Today, agriculture occupies 86 % of the agricultural area. In the municipality small holders predominate (97 % of the farm properties). Small holders are defined according to their socio-economic situation, even though they may own up to 100 ha of land. Small farms cover 74 % of the total usable area, while large farms (properties with more than 100 ha) occupy 26 % of the total usable area and represent only 3 % of the farm properties.

Subsistence crops of prominence are beans (*Vigna unguiculata*), rice, maize and manioc. Manioc, besides being used to feed the family, is also the main source of income for the small holder in the form of sales of manioc flour. Among the permanent crops, only passion fruit and urucú (*Bixa orellana*) are cultivated on the scale of the small farm; while black pepper and oil palm are mainly cultivated by the medium and large scale farms.

In general terms, temporary crops have shown yields which are close to the averages for the state of Pará, except for maize and rice which have had lower yields. This fact may be attributed to the low fertility of the soils and the type of agricultural management. High yields of black pepper are attributed to the easy adoption of recommended technologies by the producers and its cultivation as a mono-crop. Low yields of oil palm are related to the recent introduction of this crop.

The small farms represent an important component of the rural economy of the Eastern Amazon (States of Pará and Amapá). They occupy only 20 % of the area, but offer most of the rural employment (82 %) and produce 68 % of the total production value of the agricultural sector (BURGER & FLOHRSCHÜTZ 1986).

Stage of Development

The project has been underway for about 15 months. Most studies are being carried out in the municipality of Igarapé-Açú, northeast of Belém, Pará State, Brazil, where the rural landscape is characterized mostly by secondary vegetation (66 % of the farmland). Taking into consideration the three major questions stated above, the ongoing studies can be grouped into three major topics:

1. Studies on Diversity of Secondary Vegetation.

- Floristic surveys of secondary vegetation with different ages and histories
- Multi-temporal studies of vegetation using TM-Landsat images
- Secondary vegetation as a source of wood

2. The Importance of Secondary Vegetation as Part of the Land Use Systems.

- Phytomass and nutrient stock as a function of the length of the fallow period
- Water and nutrient balances in the slash-and-burn systems
- Estimation of nitrogen input by nitrogen fixing species
- Chemical and biological changes in the soil throughout the cropping and fallow period

3. Studies on Secondary Vegetation Regeneration in Abandoned Areas.

- The impact of land preparation and agricultural practices on the vitality of the secondary vegetation
- Root dynamics in different stages of cultivation and fallow period
- Reproductive systems of secondary vegetation species
- Seed dispersal and soil seed bank
- Germination and survival of seedlings

The ongoing studies include several projects adapted to EMBRAPA's institutional research organization. With recent changes in the institutional research system, these projects will be tuned to the new Planning System at EMBRAPA (SEP). This system is based on the needs and demands of the clientele, and calls for multidisciplinary and inter-institutional teams of researchers, which fits this project's approach very well (Fig. 3).

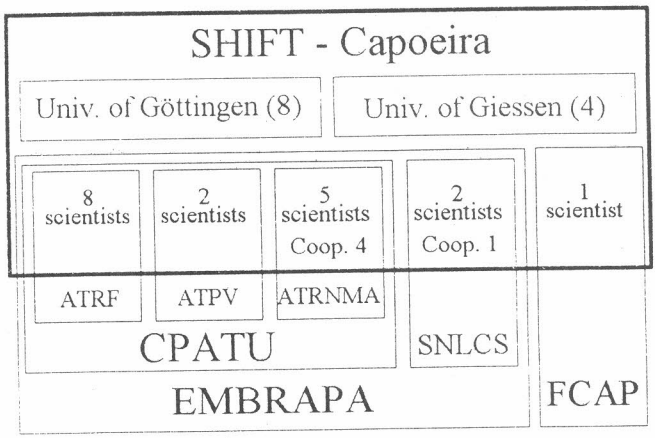

Fig. 3. Shows how the project is related with EMBRAPA and CPATU's Technical Areas as well as the other participating institutions.

Comments and future perspectives

The project as a whole is progressing very well. After 1 1/2 years the studies in the project have generated several preliminary results. In some cases those results will be used to generate dissertations which will grant the title of diploma and doctorate to several researchers. Although the physical infrastructure is still not adequate due to large demands from different studies, people's will and effort have been the key to the current progress.

For the near future, five more researchers (students) are planning to enter the project, and will be involved in different technical aspects that have been identified as gaps in the project. By November 1993, the project will have an internal evaluation in order to redirect the activities, wherever it is needed. By this time half of the whole period for the project will be completed, therefore it will be important to determine follow-up activities. The results being generated here will be used to design another applied project of Brazilian-German Technical Cooperation, after the Research and Development concept is completed.