Secondary forests and fallow vegetation in the Eastern Amazon region – a brief overview of the project approach

Paul L.G. Vlek[1], E. Adilson S. Serrão[2] and Horst Fölster[3]

[1] Center for Development Research (ZEF), University of Bonn, Germany
[2] EMBRAPA Amazônia Oriental, Belém – PA, Brazil
[3] Institute of Soil Science and Forest Nutrition, University of Göttingen, Germany

ABSTRACT

The project history, the basic ideas of the project and the most important findings of the first project phase (1991-1995) are briefly summarized. An overview of the arising studies from the first phase to be carried out in the current second phase (1995-1999) together with the respective new results is given. Furthermore, the third project phase, at present in preparation, is outlined.

RESUMO

O histórico do projeto, as ideias básicas e os resultados mais importantes da primeira fase do projeto (1991-1995) são brevemente sumarizados. São resumidos também os estudos da segunda fase (1995-1999), resultantes das informações geradas na primeira, e os respectivos novos resultados são apresentados. Além disso, um esboço da terceira fase, atualmente em planejamento, é apresentado.

ZUSAMMENFASSUNG

Die Entstehungsgeschichte des Projektes, seine Grundideen und die wichtigsten Forschungsergebnisse der ersten Projektphase (1991-1995) werden kurz zusammengefaßt dargestellt. Weiterhin wird eine Überblick über die Untersuchungen der laufenden zweiten Projektphase gegeben (1995-1999), die auf den Erkenntnissen der ersten Phase aufbauen. Dazu werden einige neue Ergebnisse vorgestellt. Abschließend werden die Aktivitäten der geplanten dritten Projektphase umrissen.

PROJECT INITIATION

Contacts between EMBRAPA Amazônia Oriental, former CPATU, and the University of Göttingen date back to 1984 when collaborative work was undertaken in the context of a GTZ project on utilization and conservation of soils in the Eastern Amazon region. That collaboration made it clear that many questions relating to secondary vegetation and the shifting cultivation practices in the Bragantina region of the Eastern Amazon remained obscure thus hampering the intelligent modification of the land-use system in order to optimize its functions. A fundamental question was the necessity of burning, particularly in a

world where CO_2 accumulation in the atmosphere ranks among the top environmental concerns. Equally disconcerting remained the low and often decreasing productivity of the system with the resultant tendency of farmers to migrate and claim new territory by clearing primary forest. The birth of the SHIFT program was a golden opportunity to reactivate the above-mentioned collaboration and revisit the region with a more fundamental approach to analyzing the local agroecosystem. A joint proposal was formulated that aimed at a better understanding of a number of (agro)-ecological factors, both abiotic and biotic, that were recognized from the earlier studies to play a critical role in the functioning of the traditional fallow system. These involved:

1. The structure and species composition of fallow vegetation.
2. The regeneration process of secondary vegetation.
3. The water and nutrient balance of the fallow/cultivation cycle.
4. The role of biological nitrogen fixation in secondary vegetation.
5. The role of soil-nutrient limitations in regeneration.
6. The effect of burning on soil biological functions.
7. The effect of agricultural practices on crop productivity and fallow regrowth.

The project covered an initial period of four years during which this basic information was collected and first ideas were generated on what options might be available to modify the system in order to avoid burning and migratory movement. The project was approved by the Brazilian and German authorities and started in September 1991.

THE FIRST PROJECT PHASE

This phase covered 1991-1995 and involved a close cooperation with Prof. G. Gottsberger of the University of Giessen. The research was exploratory in nature and covered the areas described above. The overriding results of this phase were that the so-called *capoeira* plays an important role in maintaining biodiversity in the agricultural landscape. An extensive study documents that the biodiversity is a function of land-use intensity and makes a strong case to preserve this component of the traditional land-use system. Studies on the regeneration capacity of *capoeira* provide evidence that its root system is the key to its regeneration and that regarding this the seeds of trees and shrubs play only a minor role. It could be shown that the root system also plays an important role in supplying the vegetation with water from greater soil depth and helps prevent leaching losses of plant nutrients. In the same context the nutrient losses due to burning in the slash-and-burn system were quantified and a strongly suggesting elimination of slash burning, as considerable quantities the aboveground nutrient stocks can be lost in that process. Another study showed that the leguminous trees contribute to the regeneration of soil fertility through biological nitrogen fixation following the abandonment of the cropped land, a process that comes to a hold as the vegetation ages. Fertilizer trials demonstrated that phosphorus is the principal limiting element in the regeneration of the secondary vegetation, followed by nitrogen.

Building on this information, the agronomists initiated preliminary experiments in which the traditional land preparation system was modified by 1) eliminating the fire in land preparation, 2) the introduction of green manure crops, 3) enrichment planting of the fallow vegetation, and 4) different soil tillage methods. These experiments were used to assess their

effect on crop productivity, regeneration dynamics of the secondary forest, soil chemical and biological characteristics and carbon sequestration in the system. Using multivariate methods to analyze the soil characteristics, soil degradation following cultivation could be clearly demonstrated which was regenerated during the fallow phase. With enrichment plantings the regeneration process can be accelerated and the aboveground biomass reaches levels within two years equivalent to natural seven-year-old fallow vegetation. The carbon sequestrated in the soil (down to 6 m) and aboveground biomass strongly depends on land use, with rapid depletion of soil-carbon stocks under permanent crops. Fallow systems differ little from primary forests in this regard.

Halfway through the first phase it became obvious in our work, which largely took place on small holdings in the surrounding area of Igarapé Açu, that manipulation of the farming system would require a much better knowledge of the behavior and motives of the farmers. Contact with the Free University of Berlin and the Núcleo dos Altos Estudos Amazônicos (NAEA) in Belém led to the formulation of a socio-economic project that is being carried out in close cooperation with our project.

THE SECOND PROJECT PHASE

The second phase was elaborated in detail between the University of Göttingen and EMBRAPA- Amazônia Oriental over a period of one year. The objectives of this phase were to:

1. elaborate practical means of dealing with the secondary-vegetation biomass if burning of this material was to be eliminated;
2. identify suitable crop management systems with fire-free land preparation methods;
3. screen and identify suitable crop cultivars that are adapted to fire-free systems;
4. assess the effect of eliminating burning on the movement of water and nutrients through the soil profile;
5. screen and identify suitable leguminous trees for enrichment planting and assess their contribution, both in carbon sequestration and in biological nitrogen fixation.

The second phase, which will run until late 1999 has generated essential information already. It was rapidly evident that slashing and chopping the secondary vegetation – instead of burning - would lead to drastically reduced yields unless fertilizer was applied. However, with fertilizer such a mulch system could not only be made rather productive, but the conserved nutrients would permit the fallow period to be shortened and the cropping period to be doubled thus increasing considerably the land productivity. Weed pressures are reduced by mulching. Without fertilizer the mulch system was P starved and crop productivity is not economically feasible. Since manual chopping of the vegetation is impractical, contact was sought with the Institute for Agricultural Engineering at the University of Göttingen, leading to the development of a tractor driven prototype bush chopper. Initial trials have shown the concept to be functional and improvements are now being made to optimize the equipment. Cultivars of rice, maize, cowpea and cassava from around Latin America were screened for adaptation to the slash-and-mulch system in which no fertilizer is to be used, but, with the exception of cassava, little promising material seems to be available for these systems. With fertilizer, most of the existing material can be used.

Enrichment plantings carried out with different leguminous trees in the fallow vegetation showed that the chosen species had no difficulties establishing themselves in competition with the natural fallow. They rapidly contributed to biomass accumulation of the fallow, indicating that the options for enrichment planting are wide. The planting density of the introduced trees should not exceed a spacing of 1m x 2 m, so that the natural vegetation will not be suppressed and thus its biodiversity is maintained.

THE THIRD PROJECT PHASE

By the end of the second phase it is expected that a workable bush chopper will be developed and ready for pre-serial testing. Contacts have been established with a competent local machine/equipment producer who has shown interest in working with the project and the agricultural engineering department of the Federal University of Pará (UFPa) in order to prepare for serial production of this machine. A German Ph. D. student and several M. Sc. students from UFPa will work with the company on this aspect of the project.

Adoption of the technology by the farmers will require further work with the farmers in optimizing its deployment. Experiments will be conducted on-farm throughout the year in order to let farmers gain experience and confidence in the technology and design the best cropping strategies for slash-and-mulch agriculture. It is particularly of interest to verify the land productivity of the system and to assess the returns on labor investment in the various strategies farmers opt for. Leadership in this part of the third phase will be assumed by the Brazilian partners, particularly the EMBRAPA Amazônia Oriental. Agronomic and socio-economic aspects of the adoption process will be studied. One or two CNPq-sponsored Ph. D. students will be employed in the project and assisted by M. Sc. students, both from UFPa and Germany.

The last component of this final phase returns to the ecological aspect of the SHIFT program. The aim of the project was to minimize the environmental damage related to the slash-and-burn practices. The assessment of the benefits of slash-and-mulch agriculture will be based on comparative small watershed analyses. A series of small watersheds have been selected and will be instrumented in order to measure their water and nutrient balance as well as changes in the biodiversity of the fallow vegetation. We anticipate to be able to demonstrate that with slash-and-mulch agriculture the biodiversity can be maintained in the agricultural landscape and the water and nutrient cycles are better closed and thus, the system is more sustainable than the traditional system.