# The start of sustainability in Amazonia? A new paradigm based on fertility for sustainable land management

*Tienne M. F. Barbosa[a], Jean-François Tourrand[a,b], Benjamin de Souza Nahum[c], Jonas Bastos da Veiga[c], Darcisio Quanz[c], Plinio Sist[b,c], Eric Scopel[b,c]*

*[a]University of Brasília, Center for Sustainable Development (UnB-CDS), Brasília, Brazil; [b]Cirad, Montpellier, France, Cirad, Brasília, Brazil; [c]Embrapa Amazonia Oriental, Belém, Brazil - tiennejo@yahoo.com.br*

***Abstract:*** *In the Amazon, slash and burn is the most common technique used by American-Indians, small farmers and even big ranches to transform forests into rural landscapes. The basis of food subsistence for diverse populations (rice, corn and bean), slash and burn is also a must for the plantation of cocoa, coffee, palms and pastures. The Amazonian rural landscape is currently dominated by pastures, occupying around 80 % of the deforested surface. Even if the nature of the plantation varies according to location, height, soil type and local traditions, slash and burn remains relatively the same in all regions. Agro-ecological intensification and the integration of livestock and agriculture is 2-3 decades old. Different alternatives have been tested, particularly the introduction of leguminous (covering the land or forming trees) to improve the soil and to build a bank of proteins for cattle. New techniques for the recuperation of pasture lands have become widely popular among ranches. The introduction of one or two annual plantations between two pasture areas allows re-establishing fertility through the injection of nitrates and, as a result, increases the pasture's productivity. However, being relatively high-cost because of its demand in terms of mechanization and inputs, this technique is almost unaffordable for small Amazonian farmers. This low level of mechanization, along with the increasing need of changing the production paradigm due to the closing of the pioneer space, has led to the elaboration of new farming techniques, as permanent food-producing plot, focused on land fertility more than on the exploration of natural resources. The first results are interesting from a technical, economic and social viewpoint. Revenues are as high as 4-5 t/ha for rice and corn, significantly surpassing the traditional 1.2-1.5 t/ha. Socially, these techniques have had a positive impact on comfort and work safety, food security, community empowerment and the involvement of youngsters in this new concept of farming. Besides this, the adoption of these new concepts paves the way for the reorganisation of the rural space at the property and community scales, especially through the implantation of agro-forest and pasture systems adapted to local conditions and through the reconstruction of forest areas in fragile zones (closeness to rivers, river sides, steep hills, etc.) Why did it take so long and why did we have to destroy so many natural resources before reaching this new paradigm?*

***Keywords:*** *agro-ecology, Amazonian frontier, alternative to slash and burn, landscape management, no-tillage and direct seeding*

## Introduction

For nearly three decades local authorities, scientists and environmentalist lobbies have been rallying to put an end to the advancement of deforestation in Amazonia, essentially because of its negative impacts on the environment. Depending on the region, the various causes of this deforestation, including local actors' land management strategies, the interests of agro-businesses and the financial groups supporting them, soil and sub-soil stakes, state land and territorial development policies, etc. (Sayago et al., 2003), are still being discussed.

Whatever the combination, deforestation nearly always leads to the transformation of a forested plot into rural space following three successive steps: slash and burn of the vegetation in order to enrich the soil with minerals contained in the ashes, then establishing of a cereal food crop such as rice or corn or bean or manioc. After this first crop, unless other inputs are added, the second annual crop is jeopardized due to a lack of soil fertility. Indeed the nutriments are used up by the first culture and an infestation of weeds, which the farmers have great difficulty in getting rid of. For these two reasons, after a first crop on slash and burn soils, the plot is usually left fallow, planted with a permanent culture or used as pasture land. In this latter case, failing strict management, the fodder cover gradually

deteriorates and the soil becomes less and less fertile. Thus, although nearly 80% of the deforested land in the Amazon has been established as pasture, the percent of this land that is usable and actually used for grazing by the farmers is significantly lower (Veiga et al., 2004).

The slash and burn technique is used by the American-Indians as well as by small farmers and big ranches. However, surface units involved vary immensely. In the American-Indian communities, crops growing on slash and burn soils do not stretch over a few hectares. Surface units are generally 2 to 5 ha in the case of small farmers and several dozen, if not hundreds of hectares a year in the case of the big ranches. Moreover, whereas the American-Indians usually leave the land fallow after a first crop, this is less true of the small farmers who are increasingly inclined to plant a permanent culture or pasture, and in the big ranches, this is nearly always pasture.

Over the past two decades, agriculture in the Amazon region has changed due to mechanization. Indeed, when combined with additional inputs (fertilizers, herbicides and insecticides), mechanization allows a more intensive and sustainable exploitation of Amazonian soils. This type of agriculture, which is based on the recuperation and then the maintaining of soil fertility, allows farmers to plant crops on old plots, fodder or not, whose fertility had deteriorated and had therefore been left fallow. It is this type of agriculture that has led to the boom in the production of soybeans in the Cerrado and in Amazonia, making Brazil one of the biggest granaries in the world. Among the key techniques enabling to maintain soil fertility, one should mention no-tillage and direct seeding, permanent soil cover, as well as all the physical, chemical and biological processes limiting erosion and element loss.

However, to implement this type of agriculture based on mechanization and the input of fertilizers, the initial investment is high and up until now has only been affordable by large scale agro businesses and landowners. A farming equipment (a large and a small tractor, a planter and a harvester) is suitable for a surface area of 500-800ha/year and costs 80-120,000€ secondhand, plus approximately 15-20,000€ of inputs. As it only takes 3 or 4 years to pay off the investment the problem resides more in the fact that the small farmers are unable to raise the necessary capital or tend such large areas of land than in their lack of motivation. Renting land to regain fertility in one or two agricultural seasons is also restricted to large-scale production, at least up until now, due to the amount of land required to secure a return on the capital outlaid to buy the equipment. Sharing the management of the equipment has been tested in places, but the results have been unsuccessful, probably more because of the need for the equipment to be highly available so that the farmers may intervene quickly and at unforeseen times during the growth of their cultures than because of the complexity of technical path.

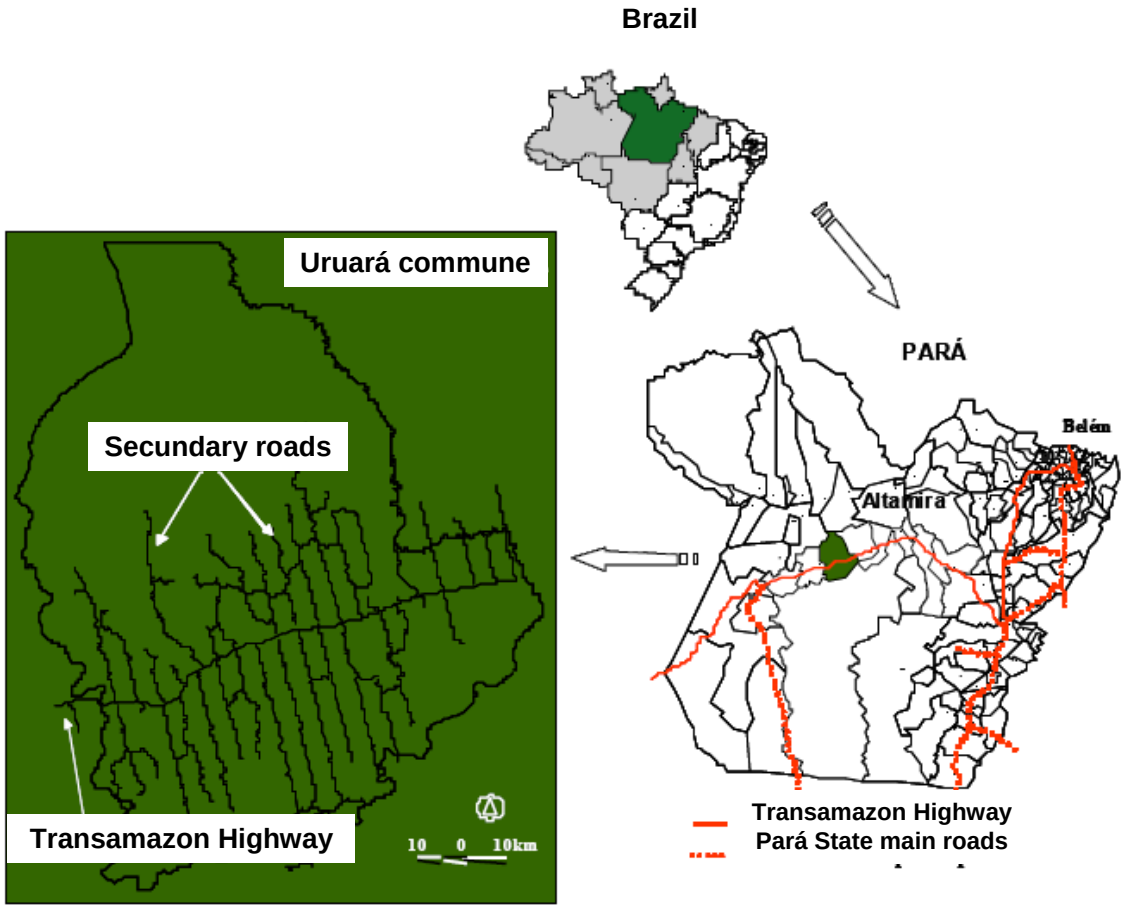
Thus, at a time when the Brazilian government is reporting a new rise in deforestation in the Amazon, partly due to slash and burn followed by pastures established by small farmers, this paper describes an unusual farming experience conducted with small farmers along the Transamazonian highway. The aim was to avoid the slash and burn technique and adopt techniques based on direct seeding, plant cover of soils and various ways to limit erosion while maintaining soil fertility at the heart of the agricultural process.

## Setting the research/ issues

The commune of Uruará in the Brazilian state of Pará in Eastern Amazon is not unlike the other pioneer fronts of the Brazilian Amazon. Until the 1970s, the region was entirely covered with forests and populated by a few American-Indian communities from the Arará group. The first settlers arrived in the region following the construction of the Tramsamazonian road which runs through the commune from east to west. The first twenty families settled in the area in 1972, but they were rapidly followed by other groups of migrants. In order to survive and make a success of their new lives, the new settlers immediately set out to transform the forested massif into agricultural space by means of the slash and burn process. At the rate of a few hectares per family and per year, used firstly for food-producing crops, then partly for cocoa and pasture, the landscape soon turned into a mosaic (i) of gradually decreasing forested land (ii) due to slash and burn farming, increasingly numerous fodder plots (iii), cocoa plantations, then during the course of the 1980s and 1990s, coffee and pepper plantations. Several families eventually gave up and went back to where they came from.

Currently, about one third of the 50,000 people in the region live in the town of Uruará sited in the middle of the commune. Employment is largely in the lumber industry (1,500), municipal administration (1,200) - especially education and healthcare – and services (600). The 6,000 rural families live along theTransamazonian road and byroads that lead off towards the north and south every 5 km.

*Map 1. The commune of Uruará in the state of Pará in Brazilian Amazonia (Bonaudo, 2005)*




100 ha of forested land were allocated to each family. A few families now own 2 or 3 lots but the 100 ha norm of the commune has by and large changed very little. However, as soon as the early days of colonization, several lots of 600 ha and even 3,000 ha were established with the view of developing ranches. While the number of big ranches with over 3,000 hectares has remained approximately the same as it was 30 years ago, the number of ranches with several hundred hectares has increased.

Jones et al. (2004) noted that forested land is perceived by both large scale and small farmers as a reserve of fertility to be used by slash and burn process, in the short, medium or long term in relation with communal, local and regional demand. This accounts for the inexorable advance of the agricultural frontier to the detriment of forested ecosystems and the gradual transformation of forested land into farmland.

Our research hypothesis, therefore, came down to wondering if there were any technical paths in keeping with small farms, in adequacy to Amazonian conditions, that could encourage small farmers to give priority to previously deforested zones to grow their food-producing crops and thus preserve the primary or secondary forest and even develop it as such.

## Materials and methods

Materials for our research consisted of farming communities based in the commune of Uruará, a sampling of farms representative of the commune's diversity and an innovating system called the permanent food-producing plot whose aim was 1 to replace the slash and burn culture plot in terms of food supply and 2 to serve as a tool to recuperate the soil fertility of the deforested plots. Methods were based on participative approaches for developing, implementing and evaluating experimentations in small farms.

## Settler communities

Our partner in this research team was a cluster of rural communities representative of the Brazilian Amazonian colonization over the 3-4 past decades. In total this amounted to about 200 migrant families of various origins. Using participative methods, soil-use maps and farming schedules were made up for about 30 farms presenting various agro-ecological and social economic situations.

## Farms representative of settlers' diversity

Experimentation of the permanent food-producing plot was conducted in six different farms representing the main types of farms in the region. Chosen farms were all motivated to establish a food-producing plot on their land. The six farms fitted with one of the following types:

- ***Diversified farm*** represented by a young farming couple with 4 young girls on two lots totaling approximately 200 ha, with forest covering two thirds of their land. The farmer is the youngest son of a family of 5 children. When he decided to remain on the farm, production was sufficient to provide for the livings of 3 or 4 families. The farm was diversified and included coffee, cocoa and pepper plantations, a dairy and beef livestock of about 40 cows, fruit trees, a food-producing plot and a poultry run. Part of the production was consumed by the family, the surplus was sold. The farmer learnt about animal traction from his father. Being the only worker on the farm, he has limited his activities to a dairy cow herd, a few coffee plants and, each year, a slash and burn forested plot used for food-producing crops (rice, corn, bean and manioc). Thanks to solar panels, the farmer is able to produce his own electricity.

- ***Planter farm*** represented by a farming couple aged about 50 years with two children studying agriculture, on a lot of approximately 100 hectares, with forest covering 60% of the land. About 30 hectares are used for cocoa plantations and one 5 ha plot is reserved for mechanized food-producing crops. Indeed, the farmer has an old tractor and receives agricultural season loans. The family has acquired a second lot of 100 ha, which is largely forested. The plan is to establish their son on this plot once he has completed his agricultural studies. The daughter plans to take over her parents' farm. Manpower consists of the farming couple and their two children when they are at home. The farm produces its own electricity thanks to a small generator.

**- *Subsistence farm*** represented by a farming couple with about ten adult and teenage children who work either locally or in town. The family lives on a mountainous lot of 100 ha. 60% of their land is covered by forest, 30% by pastures for a cowherd of about thirty heads. Each year a forested plot of about 2-3 hectares is slashed, burned and planted with a food-producing crop – rice, corn, beans and manioc. Surplus production is sold and combined with the revenue generated by the sale of calves; the money collected covers the family's rare expenses. There is a small cocoa plantation of a few hectares but production is low because the land is unsuitable. The father is the only source of labor on the farm with the exception of his wife who looks after the house and tends the poultry run. There is no electricity and no running water on this farm.

**- *Cattle ranching small farm*** represented by a farming couple aged about 50 years with their two eldest children, now married and established on the farm. Surface area of the farm is approximately 200 ha and nearly entirely deforested to the detriment of pastures and grazing land. An additional forested lot was acquired recently. There is a small cocoa plantation of a few hectares but it is still too young to be yielding a crop. The plan for 2007 is a slash and burn culture of about 10-12 hectares on the lot acquired recently and then establishing this land as pasture in order to increase fodder production and ultimately the number of livestock on the farm. Manpower on the farm consists of the father, his two eldest sons and a teenager. The mother and the spouses of the married children take charge of the domestic chores and the poultry run. There is no electricity on this farm.

**- *End of cycle farm*** represented by a farming couple with two married sons who work in town. A third son, who is currently studying agriculture, plans to follow his brothers and find work in town. The farm consists of a 100 ha lot, half of which is forested, about twenty hectares are fallow and a few hectares are planted with cocoa. Each year the farmer, who is the only source of manpower on the farm, slashes and burns a forested plot in order to plant a food-producing crop – rice, corn and beans. Surplus production is sold and combined with the sale of the cocoa production and calves, covers the family's expenses. There is no electricity on this farm.

***- Dairy farm*** represented by a retired farming couple, former dairy farmers, on a lot of 100 ha, pasture accounting for 85% of the land and secondary forest the remaining 15%. Dairy bovine livestock amounts to about 100 heads. The main source of revenue, except for their pension, is the sale of bullocks and heifers bred for dairy production by means of artificial insemination carried out by the farmer's spouse. The plan for 2007 was to plant corn on about 10 hectares of the secondary forest to provide food for their poultry farm. This production is sold on the market at Sao Paulo thanks to the lumber truck drivers who commute to and from the region. Until now the corn had been sold locally. Manpower on the farm consists of the farming couple who, from time to time, employ a temporary wage earning laborer to help maintain the fodder plots. As the farm is located near the Transamazonian road, it has electricity and a telephone line.

## An innovating technical system: a permanent food-producing plot

The aim was clearly to establish, with the help of local actors, an alternative system to the slash and burn technique for which the advantages and drawbacks, and especially the social constraints and environmental externalities, have been mentioned previously.

Subsistence requirements were evaluated for each of the six farms. The surface area of the permanent food-producing plot and the type of cultures were established in relation with subsistence requirements, available manpower and the motivation of the different members of the family. The model proposed to the farmers was a plot of 1-4 hectares, preferably flat and if possible within the vicinity of the house. Moreover, technical training sessions corresponding to the successive culture stages (seeding, fertilizing, fight against weeds, etc.) were arranged in the communes of the six farms so that the farmers and their neighbors could acquire the basic theoretical knowledge for the experimentations. An experimental schedule in 9 steps was established in conjunction with the farmers:

***Step 1: choosing a plot.*** The first step consisted in choosing and marking out the experimental plot. Then, 5-6 soil samples were taken from each of the pots to check pH and mineral contents so that appropriate adjustments could be made.

***Step 2: acquiring the equipment.*** In order to reduce the amount of the small farmers' initial investment, it was decided that on the occasion of the first year only the basic and minimal equipment would be acquired, namely one man-drawn insecticide/herbicide spreader for two farms as well as one fertilizer spreader and one animal-drawn rola-faca (roller-cutter) for the six farms. The total cost of this equipment amounted to approximately 1,800€, i.e., 300€ per farm, including transport.

***Step 3: preparing the plot.*** This step consisted in manually clearing the vegetation and adjusting, if necessary the pH by adding lime, between 1-2tonnes/ha, and a phosphorous-based fertilizer designed to last 3-4 years. This process was carried out directly by the farmers who were guided by the research team. The different inputs were acquired by the research team from local traders at the going market price. Quantities and costs of these inputs, as well as dates were logged in a book that was left on the farm to allow the farmer to note down his comments, suggestions, questions, concerns, doubts, etc.

***Step 4: seeding.*** This step was carried out during the rainy season, a priori in December and January. For the first year, the entire plot was seeded at once. For the second year, the plan was to spread out the seeding season in order to reduce the climatic risk factor.

***Step 5: tending the culture.*** This step involved the different operations carried out during the culture : fertilizing, spreading herbicides and insecticides, etc. These tasks were carried out by the farmers themselves following the guidance of the research team.

***Step 6: intermediary evaluation.*** The intermediary evaluation was carried out in two stages: farmer by farmer in conjunction with the technical support team of the project, then collectively by the six farmers and the different communities on the occasion of an evaluation day of experimental plots. An estimation of crop yields was performed. During this step, the second crop and possibly even the third crop were chosen in relation with agro-climatic conditions, available manpower, the first crop yields and the needs and wants of the family

***Step 7: harvesting.*** This crucial step allowed to evaluate crop yields, gross and net profit margins, the pay of family labor and to compare results with those obtained by neighbors tending slash and burn plots, etc.

***Step 8: maintaining soil fertility.*** Unlike the slash and burn technique which is temporary, the permanent food-producing plot is an on-going process requiring attention. Indeed, even if the farmer does not want to or cannot plant a second culture, it is necessary to plan a cover plant in order to have the vegetation material for a future culture, protect the soil, continue the fertilizing process initiated during the first culture and possibly add nitrogen with a leguminous plant.

***Step 9: final evaluation.*** In this step the results from the first year of culture in the permanent food-producing plot were evaluated, in economic as well as social and ecological terms. This step was also used to plan the next experimental social, technical, economic and public policy experimentations, as well as the decision or not to include new farms, etc.

# Results

Results are in relation with the evaluation criteria retained for the study. They are of agronomic, technical, social, economic and political nature and relate to the individual, the family and the community.

## Satisfactory agronomic results

Crop yields were above average, with a mean of 5-6t/ha for corn and 4t/ha for rice. Beans were not grown during this first farming season. These crop yields were similar to those obtained by the large agro-business plots.

The farms are, however, still in need of a considerable amount of technical support to help in establishing itineraries, especially in relation with locally available seeds and climatic conditions. Indeed, during this last agricultural season the weather was disastrous. At the beginning of December rainfall was as per usual, but then in January and February there was no rain at all. In March rainfall resumed but only for a short time. The result was that only one crop was produced, whereas initially two crops had been planned. Moreover, the quality of the rice seeds was not good – extremely low germination rate – and the plots had to be re-seeded. This probably led to lower crop yields. Furthermore, as yet we have little information concerning the amounts of herbicides and insecticides used on the plots. Results were satisfactory although, according to the experts consulted, the doses used were minimal. Appropriate doses, therefore, will have to be reassessed during the next agricultural seasons.

All the farmers except the one that was mechanized noted a radical change in the superficial part of the soil on their plot, and this was noted as soon as the second season of direct seeding. A layer of fine and granulated earth appeared on the topsoil. For the farmers, this was the sign that the soil was less compacted and more “domesticated”. It should be noted that this externality, which was considered positive by the farmers and the technicians, actually complicated matters when direct seeding the second agricultural season. Indeed, the earth stuck to the traditional manual planter and, consequently, it took considerably longer to carry out the direct seeding. As a result of this problem, two farmers decided to acquire animal-drawn planters.

## Guaranteed food supply

This is a major evaluation criterion within the communities and as it turns out, in spite of disastrous climatic conditions, crop yields were good whereas they were very low (less than 1t/ha), or nil on the slash and burn food-producing culture plots. The farmers considered that the system was satisfactory in order to counteract the effects of both low and badly distributed rainfall since these two events occurred during the first year.

During the first agricultural season, the permanent food-producing culture varied from 1 to 2 ha depending on the farm. One only of the farmers did not harvest his rice because he didn’t want to replant following the failure of the first seeding. On the five other farms, crop yields were sufficient to cover the family’s food supply needs. Due to climatic conditions, such crop yields would not have been attained in slash and burn cultures. It could be noted that one of the farmers planted corn on a neighboring slash and burn plot. The crop yield was 5-6 times higher for the direct seeding corn.

## Labor safety and comfort

This was viewed very positively by all farmers, both men and women. Being able to work near the house is a big advantage which, obviously, the slash and burn technique does not allow. Being able to stop work for a moment and drink a coffee at the house without having to go right across the farm, being a being able to come home for lunch with the family and then go back to work again if need be in the afternoon, being close to the house when visitors come or in the case of emergencies,… these are all major advantages of the permanent food-producing plot. Moreover, in this alternative system, farmers and laborers are less exposed to accidents since it does away with the slash phase of the forest. On the other hand, it should be noted that herbicides and insecticides need to be handled adequately.

## Promising economic results

The fact that the initial investment of slash and burn cultures is low is considered by many authors as a key asset. However, the analysis could be more complex. Indeed, not everyone is able to slash a forest plot and then burn the land in such a way that it ensures a production within the range of 1.2-1.5 t/ha. A chain saw is required and farmers need to know how to use it. For this reason, many farmers hire professional experts to fell the trees and these men have to be paid after the harvest. There is a cost, therefore, to slash and burn cultivation, which varies considerably in relation with various factors. It is, however, usually in the range of 150-200€/ha.

Our estimation is that in the case of a permanent food-producing plot of 2 ha, the initial investment is 400-500€ and this includes the equipment. Results obtained during the first year of experimentation show that the minimum income, given average climatic conditions, at the end of a 6 month agricultural season, with 2 successive cultures, one cereal -rice or corn – followed by a crop of beans, would amount to approximately 1,000-1,200€. On top of that, farmers have a plot that is ready for a second and then a third crop due to the fertilizer input realized during the first agricultural season. This represents an investment of 4 calves and a return on investment at 6 months of 10 calves.

This promising return on investment will need to be confirmed during the next seasons. However, banks in charge of regional development have shown great interest in financing such operations by offering loans to the farmers that want to start a permanent food-producing plot. We hope that public policy will follow suit in the near future thanks to the participation of public and private institutions in charge of technical support in agriculture.

## Promising environmental impact

Prior to planning the establishment of a permanent food-producing plot, the six farms had planned to slash and burn a forested or fallow plot to cultivate a food-producing crop, four plots to feed the family, one for the poultry run and one for a cocoa plantation. The experimentation did not mean that the farmers had to stop slash and burn cultivation since the research team wanted each family to be free to make their own choices in relation with their own interests. Given the crop yield prospects, three farmers, *Diversified*, *Subsistence* and *Dairy Farm* decided not to cultivate on slash and burn plots, *Diversified* having chosen to slash and burn a small plot merely to compare, as mentioned previously (cf. 3.2). Planter maintained his plan to slash and burn a plot to plant cocoa on a plot he was keeping for his son. The *End of Cycle* farmer also established a cocoa plantation, encouraged by his second son who was back on the farm. It should be noted that this farm, which was initially ranked as being *End of Cycle* has now, thanks to the return of the two sons, more in common with the *Diversified* farm.

The *Cattle Ranching* farm is the only farm to have maintained slash and burn cultivation along with the permanent food-producing plot. This may have affected the farmer's choice not to replant his rice after the failure of the initial seeding. It should be noted that at the end of the first year, the six farms said they wanted to rely on several permanent plots for their food-producing crops. The farmers are even envisaging an increase of fodder surface using one or several permanent food-producing plots. These plots could be used during several years for food-producing crops, then established as pasture, with a theoretical animal load 1.5 to 2 fold higher than on slash and burn plots. The only time deforestation was planned was for new cocoa plantations.

### New perspective, especially for the young

The positive technical, economical and social results obtained as soon as the first agricultural season, in extremely difficult climatic conditions, has paved the way for new perspectives. Thus, on the *End of Cycle* farm, we rapidly noted how interested the youngest son was when he was about to look for a job in town. Then, a few weeks later, we noted the return of another son who had already left the farm and moved into town. The same thing happened on the *Subsistence* farm. At the beginning of the agricultural season, the father tended his permanent food-producing plot alone. Then he received the help of his son. Then encouraged by his family, he proposed to establish two other permanent food-producing plots for his other sons. Even in the case of the *Cattle Ranching* farm, the married sons showed an interest in the permanent food-producing plot.

The fact that these farmers' sons showed an in interest in this alternative system, combined with the possibility for these young people to get loans to establish their crops, led us to set up as soon as the second year a demonstration unit at the commune's agricultural college. The cost of this unit was financed by the agricultural college – purchase of equipment and students' labor – and by the municipality – purchase of inputs.

The *Diversified* and *Dairy* farmers, the farmers that showed the greatest interest in the system right from the start of the experimentation, decided to invest in animal-drawn equipment as soon as the second year, especially for seeding and spreading fertilizers and herbicides so that they could expand their cultivation surface area without having to recourse to wage earning labor.

## Discussion

In spite of the lack of hindsight and the fact that several results are still missing, the four following points are worth discussing: the farmers' interest in the social advancements of the permanent food-producing plot, the developing of a tool to redesign the forested and rural space of the farm and the community, the developing of a social, technical and political basis upon which to plan new forms of colonization in forest, and lastly the possible explanations as to why it has taken so long to adopt appropriate environmentally friendly farming methods.

### Primacy of social advances

During the intermediary and final evaluations, the surprise was to discover the farmers and the communities' interest in the social advances of the permanent food-producing plots, especially in terms of comfort and safety for the manpower, as well as the renewed perspectives for the young. This led us to reconsider our vision of the slash and burn technique, the settler and the pioneer community by confronting our own certainties with the perceptions of local actors. It would appear that for the settler, slash and burn is not only a matter of economic choice. It is more a matter of adopting a technique by obligation and/or for lack of real alternatives. It is clear that slash and burn is profitable in certain conditions: good slash allowing a good distribution of the organic matter to be burnt + burn enabling a significant and well distributed input of ashes + good climatic conditions allowing a satisfactory development of the plant + limited impact of pests +… All this amounts to many prerequisites for a good crop and consequently a high risk factor, especially as it is a hard job, which at times can even be dangerous. Thus, it is obvious that a technique that reduces the agronomic risk, is less dangerous and less hard in terms of labor, should be perceived positively. The fact that this technique should be profitable, very profitable or moderately profitable is of lesser importance. Moreover, even if during the 3-4 decades of colonization, slash and burn has enabled thousands of migrants to survive, and even to capitalize, it remains a technique for those who have no other means. For many, including peasants, no know-how is required. It is merely a matter of work force. Because if this, it is not particularly rewarding, be it socially or in terms of the community. In this day and age, in a world in which people are bombarded with news, in which Brazil is growing economically and is politically stronger, in which the revenue from agro-businesses enables the Brazilian state to finance its social policy, slash and burn is by no means a rewarding technique for the young. On the other hand, mechanization, however minimal, and applying a technique – direct seeding – which is the pride and glory of agricultural Brazil, gives the impression of taking part on an individual basis in the history of a winning Brazil. Not to mention the individual and family satisfaction of being a pioneer within one's community in implementing a new technical system. When one combines these viewpoints, it is easier

to understand why the farmers, and especially the young, were interested in the economic results of permanent food-producing plots.

## A land management tool within the farm and the community

One may assume that once the permanent food-producing plot has been adopted by the farmer, he will not go back to slash and burn cultivation. In partnership with the farmers taking part in the experimentation, the research team attempted to set up a model that used the different advantages of the permanent food-producing plot as a tool for the redevelopment of land management.

Thus, during the first year, since fire was banned, young trees could be planted on the plot. Eventually, these trees would undeniably increase the commercial value of the plot, either because of the lumber, the fruit crops or any non-woody product or environmental services. These same trees will provide shade for the livestock. Indeed, it makes sense to think that the same plot will sooner or later be established as pasture, once the trees have grown high enough for them not to be broken by the cattle (3-4 years). Moreover, the results obtained in the ranches that recuperated pastures using similar techniques, show that the animal load can be multiplied by 1.5 to 2 fold by comparison with a fodder plot resulting from a slash and burn plot. Also, on the scale of a farm, one can envisage successively recuperating various fodder plots, thus allowing a significant increase of the animal load and therefore of productivity, whilst preserving the forest lot.

Another possible use of the permanent food-producing plot is the recuperation of permanently protected areas (PPA) consisting of riversides, springs, steep slopes and any other space where it is unadvised to deforest. By planting young trees in the permanent food-producing plot, it only takes a few years to reconstitute a secondary forest, which may then serve as an APP. In the same way, a 3-4 year old permanent food-producing plot can be used to rejuvenate a cocoa or a coffee plantation. Thus, the permanent food-producing plot constitutes a genuine land development tool for the farm and the community so long as it is managed on the scale of a group of neighboring farms, and particularly so for reconstituting fringing forests and afforesting steep slopes.

Moreover, once the deforested surface has been cultivated and farmed in a rational manner, the forested surface no longer constitutes the fertility reserve it represented in the case of cultivation on slash and burn plots. The farms' forested plots, as well as the afforested plots can therefore be managed either directly by the farmer, or by the community, or even entrusted to a logging business, using for example low impact forest management techniques.

## A tool for new colonization projects

During the evaluation process of the permanent food-producing plots, the farming syndicate of the commune suggested that the system could be applied to new colonization projects. Currently this syndicate has 1,800 families on a waiting list for land, most of them young farmers who don't have enough money to buy their own land. The idea proposed by the syndicate was that the State could buy the commune's few currently non-producing ranches amounting to a total surface area of about 30,000 ha. Pasture land could be divided into lots of 20-25 ha and offered to the young farmers seeking land, in exchange for which they would contract to use the land as a permanent food-producing plot. Moreover, for each food-producing, pasture or perennial culture plot, the farmers would receive a forest lot of the same size that would be managed jointly using low impact methods. This idea would be a new way to develop the Amazonian area. It would appear to be a good idea to work on this proposal in order to have a more accurate idea as to what the technical, economic and social implications may be. Given that the proposal was made in the first place by a group of local peasant leaders who helped in the launching of permanent food-producing plots, one may logically assume that the proposal is set for a promising future.

## Why did it take so long for this change of paradigm to see the light?

The research team has been intervening in the Transamazonian region for over 15 years and two of the farms taking part in the experimentation have been followed for approximately 12 years. Soil use, farming practices, technical and economic performance have all been studied during this time. Moreover, on a community and regional scale, experimentations have been launched in various farming domains such as pasture and herd management, dairy production, cocoa plantations, soil tilling, the use of animal-drawn equipment, focusing on reducing the impact on the environment,

improved efficiency and greater social acceptance. Why did it take so long for a set of relatively simple techniques to be identified and developed on a larger scale, thus avoiding such a waste of natural resources? It is a mystery for all the members of the research team, as well as for several of the farmers. We have attempted to find a few elements of response. One of the first answers is the time it takes for a colonization process to be established and for a colonization space to gradually close up. Hence, today, 30 years after the onset of the colonization, our study region has gradually closed up. There is no available free land left for a new coming migrant. The price of land is relatively stable and lots, reserves big ranches and small farms are all being bought and sold. The space between and among the different actors is still being redistributed. On the other hand, there are no longer any big changes like there were a few years ago. Without actually being frozen, real estate transactions are now stabilized. The race to acquire land has ended, at least on the large scale and intensification logics such as the development of permanent food-producing plots now make sense, whereas they were not in fitting at the time of a young expanding pioneer front.

A second element of response is the current regional construction process. From a spatial point of view, the Uruará region is no longer such an active pioneer front, or at least nothing like it was two or three decades ago and socially speaking it has become a more mature community. Nowadays, the young are not prepared to accept the working conditions of their parents and the parents themselves would no longer accept the conditions they endured when they first arrived in the region. Access to electricity, healthcare and education are now deemed essential within the rural communities whereas before it was a demand merely in the urban communities. This demand within the rural community has brought television, the telephone, etc. into the farmers' homes. This would have been inconceivable even in town only 10-12 years ago when electricity was limited to 2-3 hours a day and there was only one telephone for an entire community. For young couples, the quality of life is a priority. They prefer, therefore, to move into a town and look for a job where they have access to education for their children, rather than stay in the rural community where they have no real perspective for the future.

# Conclusion

The abandonment of the slash and burn technique and the adopting of techniques aiming to maintain soil fertility – such as direct seeding and more generally cultivation systems under vegetational cover – would appear to constitute a real and sustainable alternative on the scale of small farms and communities because of their social, economic and environmental advantages. Results obtained during this first agricultural season are worth confirming. The technical aspects will have to be studied in further detail, as well as the impacts of these techniques on the medium and long term. The resolutely participative approach, although it is not particularly innovating in Amazonia, is worth developing, especially concerning the experimental system whereby the farmer and family are at the heart of the research.

From a social viewpoint, one can note an improvement in terms of comfort, work safety, food security and community empowerment. The work is also less hard and less dangerous. From an economic angle, one can note the guarantee of a food supply, even in unfavorable climatic conditions. This is a significant benefit. From an environmental viewpoint, one should mention the halt of deforestation and the possibility to reconstruct agro-forested landscapes by redeveloping the farms and communities, and particularly the re-afforestation of the more sensitive ecosystems, such as riversides, springs and steep slopes. This experimentation also highlights several social, psychological and identity factors among the young, which the conventional and technical-economic approaches tend to neglect. One big question remains: why did we have to destroy so many natural resources before reaching this new paradigm and implementing such measures, and why are these measures still but experimental?

# References

Bonaudo, T. 2005. La gestion environnementale sur un front pionnier amazonien. Doctorate Degree, AgroParisTech, Paris, France

Sayago, D., Tourrand, J.F., Bursztyn, M. (Eds), 2003. *Amazônia: Cenas e cenários*. Brasília, Brasil, Universidade de Brasília.

Veiga, J.B., Tourrand, J.F., Piketty, M.G., Poccard-Chapuis, R., Alves, A.M., Thales, M.C. (Eds). 2004. *Expansão e trajetórias da pecuária na Amazônia : Estado do Pará*. Brasília, Brasil, Editora da Universidade de Brasilia.