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**Participatory research to optimise agroforestry systems in Eastern Madagascar:  
Improved fallows and intensified orchards as an alternative to traditional slash-  
and-burn**

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**Abstract**

Intensified slash-and-burn entails forest destruction and declining yields. Analysing the farmers' perception shows that the satisfaction of basic needs encounters important difficulties and that thus they are interested in agricultural improvement. Suggestions are inspired by indigenous innovations elsewhere. Improved fallows might provide wood and accelerate soil fertility rehabilitation, while the intensification of orchards responds to farmers' financial needs: increasing yields for existing cultures, introduction of new cash crops and agroforestry species fulfilling both ecological and productive functions. All interviewed peasants agreed to participate in on-farm-trials to adapt these propositions to the local ecological conditions and their own needs and capacities.

**Introduction**

The Eastern escarpment of Madagascar, characterised by a hot, humid climate, a mountainous relief and originally covered with rainforest, is inhabited by the Betsimisaraka. They practise traditional slash-and-burn to produce rice, cassava and ginger and cultivate some bananas, coffee and fruit trees in mixed orchards. Population growth accelerates forest destruction (Brand and Zurbuchen 1997) and the shortening of fallow lengths entails soil and vegetation degradation with declining yields resulting finally in infertile grasslands (Pfund et al. 1997). A part from wet rice cultivation agroforestry represents a promising alternative to replace this practice by a more sustainable production system. According to Tomich et al. (1998) "all tree-based alternatives [to slash-and-burn] are agronomically sustainable". Integrating trees or shrubs in the agricultural surface results in several ecological advantages and provides a scale of products for consumption, sale and other uses.

But the identification of appropriate techniques means only one step towards a more sustainable management of natural resources, since for any agricultural improvement it is essential that the local farmers themselves recognise the danger caused by their present practices and accept to change them. Every external proposition must correspond to their needs, interests and capacities. Given the poverty of the region, ulterior questions concerning ecological sustainability or economic profitability remain without interest unless the family's food, housing and essential financial requirements are satisfied.

## Objectives and hypotheses

The objectives of this study are:

- to evaluate the local perception of the present production system, the difficulties the peasants face and their interest in agricultural improvement,
- to identify agroforestry methods which could solve or alleviate these problems,
- to adapt and apply these propositions to the local conditions: identify appropriate species and elaborate techniques corresponding to the farmers' needs and capacities.

The following hypotheses are emitted:

- The satisfaction of basic needs represents a primordial criterion in the peasants' perception and the consciousness of difficulties will motivate them to search and accept agricultural improvement.
- Agroforestry systems developed in other tropical countries, which already underwent the transition of slash-and-burn towards a more intensive agriculture, can provide models for a similar intensification in Eastern Madagascar.
- The participatory development of new agricultural techniques is an effective approach for their adaptation and diffusion because it combines scientific knowledge and local know-how and permits to realise planting trials under different ecological conditions and according to the real situation of the farmers.

## Methods

Traditional agroforestry models are studied by bibliography and a research stay in Indonesia. This country has been chosen in account of the numerous well-documented agroforestry systems found there and the cultural relationship between the two countries (the Malagasy people being partly of Indo-Malaysian origin), which induces a similar importance accorded to (upland or irrigated) rice cultivation (Göttert 2000).

The evaluation of the farmers' perception of the present production system and their interest in amelioration is realised during meetings of volunteers and through an individual survey with 24 households in two villages. The discussions focus on the satisfaction of basic needs like food, firewood, housing and essential financial income. The participants mention the most important species with their functions and trends of production during the last years as well as related problems and possible solutions. Potential improvements are discussed after the presentation of how Indonesians satisfy their daily needs with intensified agroforestry systems and irrigated rice cultivation. During the individual interviews system diagrams are elaborated following Lightfoot et al. (1993) "to identify farmers' practices and priority problems and, consequently, to help towards on-farm experimentation". The peasants are asked about the relations between basic needs, production items, difficulties and advantages. Afterwards the diagram is used to show where the proposed improvements could positively interfere. A special survey is realised about nutrition (Matejka 2001) in order to assess eventual deficiencies and raise consciousness for the diversification of nourishment.

To test and adapt the proposed agricultural techniques, on-farm trials are conducted by more than twenty farmers. Our role only consists in giving explanations and advice, supplying seeds as well as evaluating the choice of fields and observing the plantations and their maintenance, for which the farmers are entirely responsible. To identify suitable species, they choose among a scale of timber (*Albizia lebbek*, *Cassia siamea*, *Grevillea robusta*), fast growing trees (*Grevillea banksii*, *Mimosa scabrella*) and bushes (*Calliandra calothyrsus*, *Crotalaria grahamiana*, *Flemingia congesta*, *Leucaena leucocephala*, *Sesbania sesban*, *Tephrosia vogelii*). Different kinds of vegetable (cabbage, carrots, peas, tomatoes, zucchinis etc.) are also tested. The plants' development is monitored regularly and completed by the peasants' observations.

## Results

### *The farmers' perception of the present production system*

During the meetings the farmers state that among the principal food crops the production of rice decreases because of pests, soil infertility and frequent use of fallows due to population growth. Yet the peasants seem not worrying much about cassava and other supplementary food crops (mainly tubercles, leaf vegetables and pulses). The impact of cyclones and parasites, the diminishing numbers of *Albizia chinenses*, which formerly shaded and fertilised the orchards, in addition to the lack of maintenance and rejuvenation cause declining harvests for the traditional cash crops coffee and banana. Ginger as recently introduced short-term income source gains importance in surface and presently occupies the first rang although rats and insects also attack it. Sugar cane and fruit species represent promising cultures for those who produce local rum or know the ways of commercialisation. For housing construction forest trees remain the most appreciated materials although they have to be bought at relatively high prices, since as a result of slash-and-burn there are scarcely any left within the village territories.

Therefore the participants state the growing importance of reforestation, but complain about the low timber quality of *Eucalyptus* and *Pinus* and the difficulty to find seeds or plants of other species. The choice of firewood becomes restricted because of the low age of the fallows, their frequent exploitation and infertility.

During the discussions about alternatives the farmers declare that they cannot assure the high labour and financial investments necessary for the intensification of wet rice cultivation and that there are not enough appropriate surfaces for irrigation. But they state that all the propositions concerning the intensification of agroforestry are feasible under the condition that they are realised gradually. In an anonymous poll 90 % of the participants assert their will to enlarge, intensify and diversify their orchards. The same percentage is interested in the establishment of improved fallows.

In general the individual survey confirms the results of the meetings (Figure 1). While the production of supplementary food seems without difficulties, the main consumption and cash crops rice, cassava, ginger, bananas and coffee suffer from pest attacks and climatic incidents (cyclone or dryness). Numerous peasants state declining soil fertility plus lack of rejuvenation and maintenance as further causes for decreasing harvests on slash-and-burn fields and in the orchards. Irrigation represents a particular problem for the paddies. Though only every third recognises that natural resources are overexploited, 70 % of the farmers claim already planting leguminous species (mainly *Tephrosia vogelii*) to improve the soil. More than 80 % complain that forest disappearance forces them to buy timber for construction, which induces a negative feedback on their financial means. The instability of cash crop prices represents another obstacle for the security of income sources.

The survey about nutrition reveals that food supplies undergo big variations during the year and that generally carbohydrates (rice and tubercles) prevail while meat, pulses, vegetable and fruit as sources of proteins and vitamins are only consumed in small quantities (Matejka 2001).

Summarising the participatory research, the analysis of the farmers' perception shows that the satisfaction of basic needs encounters important difficulties caused by natural hazards on the one and agricultural insufficiencies plus degradation of natural resources on the other hand. This growing consciousness induces a certain interest in agricultural innovations.

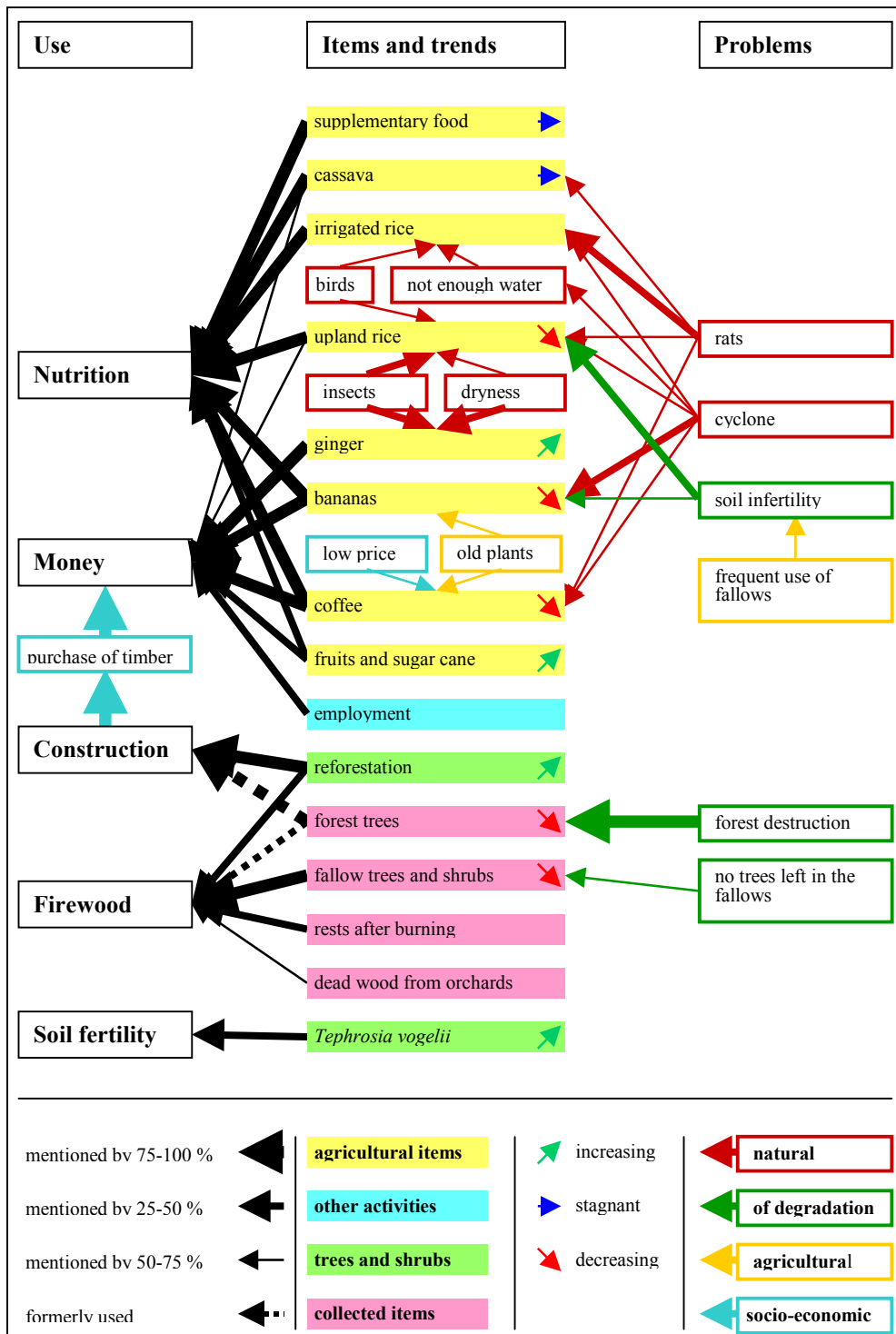


Figure 1: System diagram showing the relations between basic needs, cultivated or collected items and related problems cited by the interviewed farmers

### Agroforestry models as response

#### IMPROVED FALLOWS

The problems farmers in Eastern Madagascar are faced with are the typical symptoms of unsuitable intensification of slash-and-burn. According to Levang et al. (1997) "any attempt of continuous cultivation [to replace slash-and-burn in the tropics] collides with the triple problem of the multiplication of weeds, the infestation by parasites and the decline of soil fertility". In shifting systems fallow periods ensure the rehabilitation of

soil fertility and provide food, fodder and fuel, but due to growing population pressure their length often becomes insufficient to restore fertility and crop yields decrease. Under these conditions "households have developed indigenous management strategies to manipulate and modify the fallow vegetation [by protecting or planting certain perennials]" (Burgers 1999). The author explains that according to the socio-economic and social conditions, either species accelerating soil rehabilitation to enable intensified food cropping, or perennials with economic value to increase household cash income are selected. Examples found in Indonesia show that slash-and-burn loses importance, rice being more cheaply cultivated in irrigated paddy fields or purchased, and the productive fallows can even become the main source of income (Götttert 2000). Though these systems developed under specific conditions and cannot be directly transferred to Eastern Madagascar they inspire promising concepts. Corresponding to Burgers' (1999) statement that "in early stages of intensification, we usually find combinations [...], where a degree of biophysical, social and economic benefits from the fallow may be accrued", the planting of agroforestry trees together with or after the annual crops might solve several of the above mentioned problems:

- Reduced erosion in combination with higher biomass production and eventual nitrogen fixation might accelerate soil fertility rehabilitation.
- Increased wood production improves firewood availability and provides timber for light constructions.

Moreover fast growing species might impede the infestation by *Rubus mollucanus* and *Lantana camara*, two introduced spiny shrubs dominating a lot of fallows. As they are very difficult to remove mechanically, peasants name them as one reason why they have to burn before cultivating a slashed fallow.

#### INTENSIFICATION OF THE ORCHARDS

Usually the orchards are composed of bananas and coffee under the shade of some scattered *Albizia chinensis* and a few fruit trees. Cash crop production being their main purpose they correspond more or less to the orchards found in Indonesia. Yet the later comprehend several interesting aspects which could be imitated to improve the profitability of the Malagasy ones. A high diversity of mainly perennial cash crop species guarantees a great ecological and economic stability providing regular returns, some trees bearing fruit all year round (banana, papaya, coconut) while others have distinct harvesting seasons (coffee, pepper, fruit). At least during the first years annual cultures (maize, taro, chilly etc.) are associated to the trees, making the new orchard already profitable. Moreover the presence of timber trees (teak, mahagoni etc.) or cinnamon, which can be harvested and sold at any time there is an urgent need of money, constitutes a kind of financial assurance (Götttert 2000).

In comparison the Malagasy orchards lack diversity and maintenance; they neither comprise annual crops nor timber trees, and the returns they provide depend on a few species, which moreover undergo severe price fluctuations. Their intensification, inspired by the Indonesian models, could respond to the farmers' financial needs by several ways:

- increasing the yields of existing cultures by better planting and maintaining techniques and means of pest management,
- ensuring a regular income from the beginning of the plantation and during the whole year by enlarging the scale of cash crops with new perennial and annual species,
- encompassing a kind of long-term capital reserve in the form of timber trees.

The integration of agroforestry species providing shade for the coffee trees, biomass to improve the soil and firewood would support these approaches.

### *On-farm research to test and adapt the proposed agroforestry intensification*

First planting trials concerning the diversification of perennial species have been realised by Razafiniaina (2001); she recommends *Tithonia diversifolia*, *Crotalaria grahamiana* and *Tephrosia candida* for hedgerows, *Cassia siamea* as timber producing shade tree and sweet sop, sour sop, rambosteen and papaya to diversify fruit production for further testing.

To deepen and widen these experiences, on-farm-trials about the integration of agroforestry species into the existing production system are currently carried through. All the peasants interviewed during the individual survey about basic needs agreed to participate. They install improved fallows, hedgerows along contour lines or future shade trees by direct sowing into upland rice or ginger fields. Half of them also want to integrate additional trees into existing fallows or orchards, even though that requires a higher labour input for the preparation of seedbeds and later transplantation. More than 80 % of them choose timber trees, 70 % are interested in fast growing species and every second likes to plant hedgerows. The surface of the trial fields varies between one are and several hectares with an average of 0.5 ha per farmer.

Concerning the integration of annual crops, Lehavana (2001) found that a lot of species develop well in a newly planted orchard, while some others (i.e. chilly pepper) even thrive under the heavy shade of an established one. A market survey of the same author shows that the local demand offers an interesting potential, since up to now nearly all vegetable have to be imported from the Highland.

Motivated by the survey about nutrition (Matejka 2001), 29 households take part in planting trials introducing new vegetables in order to diversify their alimentation and alleviate shortage periods. During the cooler months, when there is less work to do for the traditional cultures, they cultivate species of the temperate zones (cabbage, carrots, peas etc.), which could also be sold on the local market. For many farmers it is the first time they practise fertilising techniques like mulching or composting. Continuing the trials of Bongartz (2000) different preparations on the basis of soap, ginger, turmeric or other locally produced ingredients are tested to prevent pest infestation.

A part from newly introduced species, the integration of ginger into the orchards would be of particular interest, since its present form of cultivation (shifting around the slopes) causes very high erosion rates (Brand and Rakotovoao 1997). According to Jayachandran et al. (1998) and the observations made in Indonesia (Götttert 2000) this Zingiberaceae should also thrive under the trees of an existing orchard. First trials are being executed in a demonstration field and the development up to now seems with good prospects.

### **Conclusion**

Though research has only begun and appropriate species as well as technical details still have to be identified, the optimisation of agroforestry systems seems promising to solve important problems the peasants are faced with: declining soil fertility, scarce wood supplies and insufficient income sources. The participatory development of agricultural techniques offers the possibility to respond to the needs and capacities of the local population since it starts from the present production system and improves it gradually. The farmers' engagement for the field trials confirms their interest in new vegetable, fruit and agroforestry species.

Complementary to the continuation of the field trials, further studies concerning marketing possibilities for the commercialisation of the new products (Raharilantsoa 2001) and about the perpetuation of the innovations after the end of the project are indispensable.

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