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Summaries from the Natural Resources Systems Programme

A Strategy to Stabilise Slash and Burn Agriculture at the Forest Margin

Barry Pound, Farming Systems Agronomist, Natural Resources Institute, Chatham Maritime, Chatham, Kent, ME4 4TB, and Kate Warren, DFID Associate Professional Officer to project R6382 – Sustainable Agriculture in Forest Margins.

Slash and Burn Agriculture

Slash and burn agriculture as practised by indigenous forest dwellers is ecologically sensitive and sophisticated, and is able to support low population densities without long-term degradation of natural resources (Posey, 1985). In contrast, the directed and spontaneous migrations in Bolivia and Brazil into forested, or previously forested, tropical, humid lowland environments, has led to the use of aggressive slash-and-burn methods of agriculture resulting in the degradation of soil and forest resources over large areas, with long-term economic and environmental implications at local, national and international levels.

Pioneer colonist farmers have extremely limited capital and labour resources, and immediate requirements for food and cash. The fertility of the forest biomass is therefore rationally used as their start-up capital, which leads to the loss of large amounts of nutrients and organic matter through burning and erosion, the loss of faunal and floral bio-diversity and the loss of potential sources of income from timber and non-timber forest products (Peters et al, 1989; Godoy and Bawa, 1993). Further capitalisation accrues to the colonist farmer by the sale of land to satisfy the continuing demand for cleared land from ranchers, mechanised agriculturists or speculators. Cleared land has an immediate cash value, while forest may have none, especially where access to markets for timber and non-timber forest products is undeveloped.

'Smallholder' colonist farmers in Bolivia and Brazil often have relatively abundant land (30-50 ha), but other resources (cash and labour) are scarce, leading to extensive farming methods that are wasteful of natural resources, but require relatively low labour and minimal cash inputs. The situation is extremely complex and dynamic (the 'Moving Target' described by Richards, 1997) with farming households under different circumstances (e.g. soil, climate, road access, access to support services, ethnic origin, community cohesion etc.) opting for different routes through the capitalisation/stabilisation process, as described by Wachholtz (1996) for the project area in Bolivia. Each stage in this process has its own characteristics, and its own specific requirements for technical/institutional support (Muchagata, 1997). Addressing this complex situation requires the development and testing of a strategy, rather than the identification and validation of a solution.

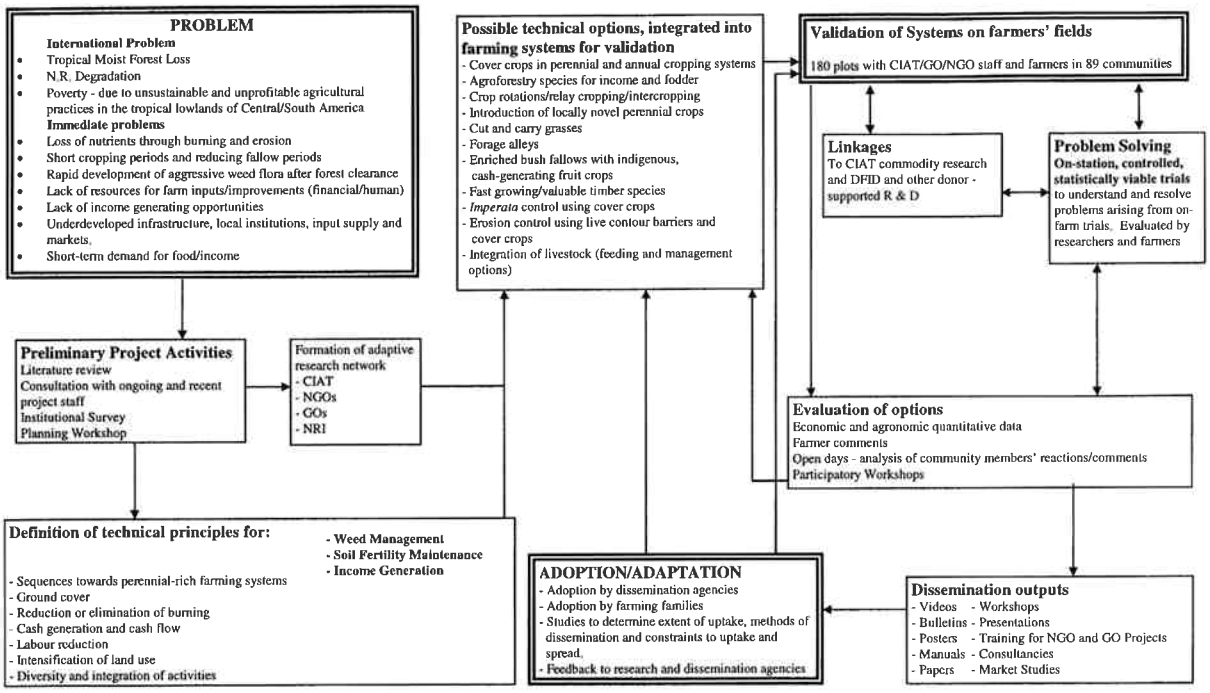
The Centro de Investigación Agricola Tropical, based in Santa Cruz Bolivia, received DFID bilateral support for agricultural research for some 19 years. Now CIAT is supported by a number of DFID strategic research projects. Three of these projects – R6382 Sustainable Agriculture in Forest Margins (DFID Natural Resources Systems Programme); R6008 Weed Management for Sustainable Agriculture in Forest Margins (Crop Production Programme) and R6774 Strategies for Integrating and Optimising Livestock Production in Forest Margin Farming Systems (Livestock Production Programme), are working alongside CIAT, and together with farmers and local NGOs in Bolivia, to identify practical options for soil fertility maintenance, weed management and income generating opportunities through integrated crop, tree, livestock production. Due to the degree of overlap and complementarity of the three projects, they are referred to in the following text as 'the project'. Figure 1 provides a flow diagram of the project, and the interaction between its components.

The needs of smallholder farming families that are emerging as a result of experience in implementing the project include: (a) the development of practical options for soil fertility maintenance, weed management, and animal nutrition and management; (b) the identification of income-generating opportunities; (c) institutional restructuring and collaboration; (d) the development of improved support services to farmers, and (e) a more conducive policy environment. The project contributes to (a) and (b) above, and CIAT is actively reorganising its structure and activities.

Research Methods

The research approach adopted by the project is one of participatory on-farm research supplemented by researcher-managed trials and special studies, linked to conventional research. The implementation of the on-farm research programme has been considerably

Figure 1: Bolivia – Sustainable Agriculture in Forest Margins (DFID RNRRS Natural Resources Systems Programme)/Weed Management for Sustainable Agriculture in Forest Margins (DFID RNRRS Crop Protection Programme)



facilitated by the recent restructuring of CIAT to create a number of decentralised zonal research and technology-transfer teams, and its wholehearted support to the piloting of participatory research methods. In addition, the project has coincided with the national 'Law of Popular Participation', which decentralises government to the Municipalities. A GTZ-supported project has been assisting the municipal authorities in the project area to adopt a land-use plan (CORDECRUZ, 1994), which both depends on, and partly shapes, the research programme.

The substantial (200 trial) on-farm research programme is conducted by individual collaborating farmers and supervised by technicians from CIAT and local Governmental (GOs) and Non-Governmental Organizations (NGOs) and covers a wide range of technologies and combinations in order to provide a 'basket of options' from which farmers can choose. The implementation of the on-farm trials programme is shared in a collaborative effort between CIAT and local GOs and NGOs, which arose from recognition of the need for co-ordination of adaptive research in the area during a project survey on the agricultural research and development activities of institutions within the project area. Working directly with some 200 farmers (CIAT/NRI, 1997) has required the establishment of databases to record details of each farmer, their trials and results, and spreadsheet programmes to analyse economic and agronomic data.

The project has evaluated farmer-participatory workshops, field days and case studies, as different approaches to farmer participation and evaluation of technologies.

Technical Advances

The wide range of farmer circumstances in the project area has been categorised using a **Recommendation Domain** classification which provides a framework for the interpretation of information from on-farm research and the formulation of recommendations for intermediate and end users of the project outputs.

The on-farm trials incorporate a number of common principles:

a. **Diversity:** providing multiple income sources, and efficient use of labour, soil, water and sunlight resources.

b. **Soil cover:** for protection of the soil from erosion and high soil temperatures, control of weeds and maintenance of soil fertility and structure.

c. **Sequences** towards stable farming systems based on perennial species. These begin at different points: 1. From newly cleared land; 2. From bush fallow; and 3. From degraded pasture.

d. **Integration** of annual crops, perennial crops, forestry species and livestock activities in one programme.

e. **Simultaneous research and development**, with involvement of farmers, NGOs, grassroots and government extension agencies in the on-farm research programme.

Component technologies that are incorporated into the on-farm research programme include the following:

a. **Cover crops:** these annual or perennial legumes cover the ground to smother weeds, provide nitrogen where nodulation is effective and improve soil structure. Different species are appropriate to different stages in the sequences mentioned above, when growth habit and aggressiveness, longevity, rooting system, shade, drought and temperature tolerance are all considered. Promising species are: *Mucuna* spp. for maize-based cropping systems, pasture regeneration and perennial fruit orchards; *Pueraria phaseoloides* (tropical kudzu): for pasture regeneration and perennial fruit orchards; *Calopogonium mucunoides:* for relay cropping or rotations with rice and for perennial fruit orchards; *Arachis pintoi* (forage groundnut): for perennial fruit orchards (although there are problems of slow establishment and poor competitiveness with weeds); *Canavalia ensiformis:* versatile annual legume for rotations with annual crops and ground cover in perennial crops; *Cajanus cajan* (pigeon pea) and *Crotalaria* spp for intercropping with annual crops and early stages of perennial orchards; *Desmodium ovalifolium:* shade-tolerant perennial legume for later stages of perennial plantations.

b. **Perennial and semi-perennial species:** in order to reduce migration (both towards the cities and towards the forest frontier) it is important for farmers to have cash-generating activities. To date these activities have been predominantly confined to the sale of cleared and de-stumped land, the production of cattle (for meat, milk and cheese) and rice. All of these lead to land degradation and the loss of forest or bush fallow. Perennial crop mixtures with good ground cover do little to combat the loss of biodiversity, but can provide comparatively stable incomes without further natural resource degradation. Perennial species require careful testing against the agro-ecological and socio-economic conditions, and the simultaneous development of processing and marketing facilities. The project has concentrated on: **Citrus** and **Macadamia**, **Pineapples**, **Bananas**, and **Peach palm** *(Bactris gasipaes).*

c. **Bush fallow enrichment:** A series of on-farm trials is looking at methods for the transition from 5-10 year old bush fallow to productive plantation **without burning** through enrichment planting with shade-tolerant local species such as **Achaichairu** *(Garcinia macrophylla)* an indigenous fruit for making juice, and **Mahogany** *(Swietenia macrophylla)* and **Cerebó** *(Schizolobium amazonicum)* as long-term timber species.

The gaps in the combined technical/local knowledge base identified by working closely with farmers and NGOs in the on-farm trials are being investigated in four sets of formal researcher-managed trials.

- A major problem is the short period (one to two years) that rainfed rice yields can be maintained after forest clearance and burning due to weed infestation and fertility decline. Two researcher-managed trials are investigating the **intercropping, relay cropping and rotation of rainfed rice with leguminous cover crops and a winter legume food crop** (local varieties of indeterminate cowpea) and **the strategic use of herbicides for the management of weeds** and maintenance of fertility.

- Cover crops have a critical role to play in the transition from resource-degrading, extensive migratory systems to low-external input, semi-intensive, stable systems of agriculture. Formal trials are looking at the **potential of a range of winter (dry season) cover crops**, and their management.

- Peach palm (*Bactris gasipaes*, locally known as 'tembe' or 'pejibaye') is a plant indigenous to the moist tropical lowland forests of Bolivia but with little commercial exploitation in Santa Cruz Department. Formal trials have been designed to **identify low external-input methods for reducing peach palm establishment costs while ensuring strong growth, early production and long-term productivity**.

Uptake

Practical results resulting from the project have been partly responsible for the establishment or planning of substantial agricultural support projects in the area, leading to excellent potential for uptake of the project outputs. Uptake pathways are shown in Figure 2. An interesting aspect of this is the initiative that has been taken by CIAT in forming commercial agreements with development projects, in which they are clients for CIAT products (consultancies, training, advisory services, genetic materials and dissemination media).

The technical experience of the project will be distilled into a series of dissemination materials (bulletins, posters, manuals and videos) that will be of direct use to intermediate users (Governmental and Non-governmental dissemination agencies) and to some final end users (farmers). Major clients for the materials will be development projects such as the DFID-supported Amboró and Pilon Lajas projects and the Belgian Aid extension and credit project. CIAT is in the process of negotiating commercial agreements with these and other projects to provide their staff with training in participatory methods and appropriate technologies and germplasm based on the outputs of the project. CIAT's consultancy capabilities in participatory research will also be enhanced by the influence of the project.

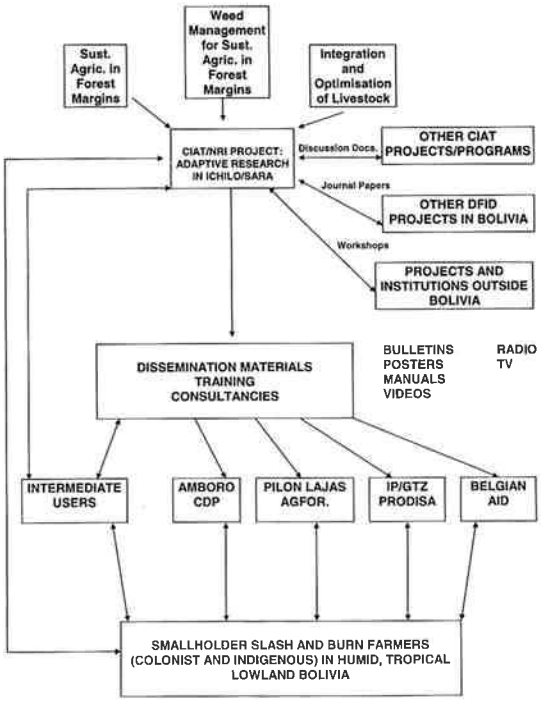
A different type of project output will be a **comprehensive critique of the project's methodology**. CIAT will be the direct beneficiary of this, but it is also hoped that other research and development institutions involved in adaptive research locally and internationally will find it useful.

During the second and third years of the project, an **adoption study** was carried out on a sample of communities, and for a sample of the farming systems under test

in the on-farm trials programme (Warren, 1997), to determine the factors affecting adoption and adaptation of the technologies under test by the project. Levels of adoption of technologies were high among those farmers directly involved in the trials programme, but low among non-collaborating farmers. Adoption was mainly of single component technologies, and not of the 'systems' under test in the on-farm trials.

The project has contributed to increasing the capability of CIAT (and local NGOs) to carry out farmer participatory research, but this process will require continued inputs beyond the life of the project. Of particular usefulness will be exposure to methods being used by other research and development projects in south and central America. In particular, it is suggested that closer liaison with CIAT, Colombia (for both technical and methodological interchange), and study of the Campesino-Campesino movement (Holt-Gimenez, 1996), would be of benefit.

Figure 2: Uptake Pathways



Conclusions

The strategy for developing and promoting sustainable agriculture in forest margins which is emerging from these ongoing projects has a number of components: a) The development and delivery with farmers and dissemination agencies of a wide range of technical alternatives to aggressive slash and burn techniques through participatory research, linked closely to conventional research; b) The identification of income generating opportunities, and the development of support services (inputs, advice, credit, marketing) necessary to enable these to be adopted; c) The evolution of appropriately structured and resourced formal and community-based institutions; d) The definition and implementation of a policy environment conducive to sustainable land use.

Policy conclusions

- Participatory research (linked to 'conventional' research) can address complex situations by testing and making available a wide range of options to farmers.
- Effective collaboration of formal research and dissemination institutions (GO and NGO) and the encouragement of local (CBO) institutions is vital for the widespread uptake of technologies.
- Policies need to be formulated that change the relative values of land under forest, non-mechanised agriculture, ranching and mechanised agriculture as seen by the smallholder producer.
- The different (and changing) agenda of donors, formal research and dissemination institutions, community-based organisations and individuals must be recognised, respected and catered for throughout the project cycle.
- Projects dealing with dynamic and complex situations, rather than discrete technical problems need to adopt a process approach which allows for an inception phase for training, team building ind an-depth understanding of the local institutional environment.

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Produced by: Systems Management Office, DFID, Room V226, 94 Victoria Street, London SW1E 5JL
Tel: 0171 917 0481 Fax: 0171 917 0249