# SUSTAINABLE ALTERNATIVES TO SLASH AND BURN AGRICULTURE AND THE RECLAMATION OF DEGRADED LANDS IN THE HUMID TROPICS

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## ABSTRACT

Slash and burn agriculture (shifting cultivation) accounts for about 50 to 75% of the 14 million hectares of moist tropical forests currently converted every year. Tropical deforestation is responsible for 25% of current global warming, for most of the decimation of plant and animal genetic diversity, and threatens the stability of many watersheds. Rates of deforestation have doubled over the last two decades they are likely to continue increasing and to contribute a relatively larger proportion of global warming. Shifting cultivation is a consequence of complex socioeconomic factors that drive poor farmers and migrants into the forest margins. Sustainable alternatives to slash and burn would enable millions of poor farmers to make an adequate living without destroying additional forests. Research conducted at several humid tropical locations for many years shows hope; for every hectare put into promising alternatives, five to ten hectares of tropical rainforest can be spared from the shifting cultivator's axe every year.

Such alternatives must be thoroughly tested and validated so that they are accepted and adopted by farmers on a large scale. A concerted effort among socioeconomic, agricultural, ecological, and policy scientists and developers has started with partial funding from the Global Environmental Facility to assure that this happens. This effort involves farmer participation from the beginning, as well makers and decisions makers.

Several international centres and programs have joined efforts with national research system (NARS) as well as non-governmental organizations (NGOs) to formulate this initiative. The strategy focuses on two main targets: 1) reclamation of already deforested and degraded lands and 2) prevention of damage by deforestation itself. The strategy consists of three main components: 1) developing and testing alternative slash-and-burn technologies for small-scale farms, adapted to specific ecoregions of the humid tropics, 2) linking environmentally-oriented strategies with socioeconomic policies that provide incentives for such technologies and disincentives to further deforestation, and 3) enhancing the capacity of NARS, local NGOs, decisions makers and investment institutions to promote sustainable alternatives to slash and burn agriculture.

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## INTRODUCTION

Conversion of tropical rainforests is one of the world's major environmental concerns because of its negative effects on plant and animal biodiveristy, greenhouse gas emissions and on watershed stability. Deforestation rates in the humid tropics have increased from 7 to 16 million hectares per year during the decade of the 1980's and are expected to increase even more during the 1990's (Houghton 1987; Dale et al., 1993). Slash and burn agriculture, often preceded by logging, is the principal cause of deforestation. However, policies to mitigate deforestation seldom consider the needs of farmers and migrants who are placing land use pressures upon these forest margins.

Agenda 21, however, changed all that. Its chapter on combating deforestation explicitly recommended " to limit and aim to halt destructive shifting cultivation by addressing the underlying social and ecological causes (Agenda 21, Chapter II, Section 11.14j). This chapter also mentions the need to develop and apply environmentally sound technology and enhance human resource development in support of these activities. It also underscores the need for promoting buffer zone management and the rehabilitation of degraded lands through agroforestry, community and social forestry (UNCED, 1992)

Two years before, representatives of the United Nations Development Programme (UNDP) contacted leaders in the international agricultural research community to inquire about the advisability of a concerted international effort to develop alternatives to slash and burn agriculture. A global workshop was held in Rondonia Brazil in February 1992, which developed the broad guidelines. In December 1992 the Global Environmental facility agreed to fund the initial efforts. This paper describes the rationale and proposed activities of the Slash and Burn Programme which can be considered a direct response to agenda 21's recommendations and thus an integral part of this Global Forest Policy. This paper draws heavily from the programme working documents and projects briefs developed by the Steering Group.

## THE PROBLEM

### Environmental Context

Slash and burn (or shifting cultivation), the traditional farming system over large areas of the humid tropics for centuries, today remains the dominant land use practice in about 30% of the arable soils of the world it provides sustenance for an estimated 250 million of the world's poorest people and additional millions of migrants from other regions (Andriesse and Schelhaas, 1987).

Deforestation rates have almost doubled during the last decade: from 7.6 million hectares per year in 1979 to 13.9 million hectares per year in 1989 (Myers, 1989) to 17 million at present (Dale et al, 1993). After deforestation, soil organic matter may act as an additional source of carbon dioxide to the atmosphere or as a sink where carbon dioxide may be sequestered depending on how the land is managed. There is little reliable quantitative knowledge about fluxes of carbon dioxide, nitrous oxides or methane due to shifting agriculture. Hard data from well-replicated experiments and surveys are needed to determine the current extent of slash and burn agriculture, the process of change in land use and the extent and nature of the environmental impact of these systems. The contribution of tropical land use to global change is one of the uncertainties in current models. Deforestation rates are expected to increase in the next decades and the overall contribution to global warming is expected to equal or exceed that of fossil fuel combustion by the second or third decade of the 21st century. If this trend continues, much of the remaining tropical forest will be gone by the end of next century.

Deforestation is also decimating the world's largest depository of plant and animal genetic diversity (Wilson, 1988). Recent discoveries of rainforest plants as new sources of food, or as ingredients in chemotherapy for certain types of cancer, underscore the need to preserve rainforest biodiversity. Therefore, finding practical ways to preserve tropical rainforests is one of the principal global environmental concerns of our times.

## Equity Context

Tropical deforestation is also a major human equity concern, because slash and burn is largely practiced by the poorest, largely displaced rural populations of the tropics. It is driven primarily by population growth and by major externalities.

Population Growth as the Driving Force. The process of deforestation is driven by a complex set of demographic, biological, social and economic forces (see Figure 1). Population growth in developing countries continues at a high rate, while most of the fertile and accessible lands are already intensively utilized. Government policies often exacerbate land scarcity by allowing gross inequities in land tenure. These factors result in an increasing landless rural population that essentially has three choices: stagnate in place, migrate to the cities, or migrate to the rainforests that constitute the frontier of many developing countries. Although urban migration is spontaneous, national policies in key countries promote the occupation of tropical rainforests, notably via colonization programs.

Densely populated rural environments suffer from an ever decreasing farm size and overuse of steepland areas. This results in widespread soil erosion, siltation of reservoirs, and other adverse off-site effects to urban centers. Migration to the cities

by the rural poor searching for a better life results in bitter disappointments. It is coupled with limited urban infrastructure, and produces unmanageable cities with populations far exceeding their carrying capacity and infrastructure.

People migrating to the humid tropics seldom find a cornucopia. The equilibrium of traditional shifting cultivation, with its long forest fallows, is broken by the migrants, and in some countries by land speculators as well. The result is shifting cultivation in disequilibrium, which quickly turns into various forms of unsustainable agriculture. Traditional societies are disrupted, economic failures abound, and migration to urban centers increases.

Environmental degradation originating from deforestation often affects production and subsistence systems in rural areas. Erosion, flooding, ground water depletion and silting affect agricultural productivity, decreasing food availability, income and employment. Forests also serve as "food banks" for poor communities, and often are the main source of household energy for cooking.

Major externalities. Population growth and poverty are not the only causes of increased rates of deforestation. External forces or processes such as expansion of commercial plantations or farms, ranching, logging and mining attract or push migrants into slash and burn, causing considerable deforestation. In Africa the expansion of cash crops for export (e.g. groundnut, cotton, coffee, cocoa) has considerably reduced land availability for food crops, increasing forest encroachment and reducing the fallow period. Another important cause is the need for fuelwood, estimated to account for half of the wood harvested in the world (Grainger, 1990). Commercial exploitation for high-value logs accounts for much of the deforestation in Central America, Bolivia, Nigeria, Cote d'Ivoire, Indonesia, Malaysia and the Philippines, mainly to supply European,American and Japanese markets.

In Latin America, clearing the forest is a way for settlers to claim title to state lands, encouraging uneconomic forest clearing and land speculation. Construction of roads and other infrastructural facilities supporting development strategies have also contributed to accelerated rates. But it is the clearing of forest for pasture that may have been the main cause of deforestation. The remaining deforestation in the Amazon could be attributed mainly to commercial logging, plantations, speculation and mining, while population pressures by small peasant agriculturalists, clearing land a fraction for their own farms, accounts for only of total deforestation. However, a recent change in strategy led the Brazilian government to eliminate incentives to Amazon development, resulting in substantial reductions in deforestation areas.

In many cases, changing the strategy may, however, not be enough. Forestry programs assume that rational exploitation in suitable areas, on a sustained basis, using appropriate technologies, should lead to economic benefits. Their assumptions about social institutions, markets, costs, alternative land uses, agroclimatic conditions,

and available technologies have often been erroneous. Also they sometimes neglect to consider the rates "beneficiaries" use to discount uncertain future costs and benefits. Equally they may disregard local social, economic and cultural relationships and constraints, ignoring the way introduced activities compete with others vital for the family livelihood. On the other hand, forestry activities that make complementary use of farmers land, time and other resources in a manner integrated with other agricultural activities, may be more readily adopted.

## Characteristics of Slash and Burn Agriculture

Throughout the world, traditional shifting cultivation practices are remarkably similar. Small forested areas are cleared by axe and machete during periods of least rainfall and are burned shortly before the first rains. Without further removal of debris, crops such as corn,rice, beans, cassava, yams and plantains are planted in holes dug with a planting stick or in mounds for root crops in Africa. Intercropping is very common, and manual weeding is practiced. After the first or second harvest the fields are abandoned to rapid forest regrowth. The secondary fallow may grow for 10 to 20 years before it is cut again (Jurion and Henry, 1969; Nye and Greenland, 1960).

Traditional shifting cultivation is almost entirely based on nutrient cycling. Burning releases half of the nitrogen and most of the sulphur and carbon into the atmosphere, thus contributing to greenhouse gases. The remaining nutrients are transferred to the ash, which acts as a quick release fertilizer. Furthermore, the accelerated organic matter decomposition caused by soil exposure releases additional nutrients but increases carbon loss and the higher nutrient availability can increase gaseous nitrogen emissions.

These factors provide high nutrient availability for one or two years to grow food crops, depending on the fertility status of the soil (Nye and Greenland, 1960; Sanchez, 1976, 1987). But as nutrients are removed by crop harvests or lost to leaching, overall fertility declines. Nutrient deficiencies as well as increasing weed pressure impeded further cropping, and the fields are abandoned to a secondary forest fallow. The secondary forest grows rapidly, tapping nutrients remaining in the soil, including those released slowly by unburned decomposing forest biomass, accumulating them above ground for 10 to 20 years, until the cycle begins again (Scott and Palm, 1986).

The fallow period, therefore, does not improve soil fertility per se. Except for some reaccumulation of carbon in the soil organic matter and fixation of atmospheric nitrogen, fallows mostly accumulate nutrients in the plant biomass, most of which can be tapped by future crops as ash after slash and burn.

There is considerable art involved in traditional shifting cultivation, including the selection of tree sprouts allowed to grow and form the forest fallow. The traditional system is ecologically and environmentally sound but guarantees perpetual poverty. Traditional shifting cultivation systems, however, are being rapidly replaced by shifting cultivation in disequilibrium, which is practiced by migrants from other regions who are unfamiliar with the humid tropics and ignorant of the sophisticated practices of indigenous cultures that make shifting cultivation a sustainable system, albeit for low population densities with low incomes and low crop yields.

Soil erosion is seldom a significant problem in traditional shifting cultivation, because the land is always covered by some sort of vegetative such as fallen logs, ash, crops, weeds or forest fallows. When shifting cultivation is practiced by newcomers to the humid tropics, the land is often devoid of soil cover for considerable time. This can lead to major erosion and siltation of rivers, particularly in hilly areas and where land is deforested with bulldozers.

Shifting cultivation is definitely not sustainable if significant increases in land productivity are required to support higher human population densities and increased demand for food and fiber. Recent increases in population growth, as well as in colonization, have placed great pressure on farmers to increase the productivity of limited land resources by expanding the length and intensity of the cropping period and decreasing the fallow period.

As the time available for secondary forest fallow growth decreases, the fertility and productivity of these soils, which are mostly low, continue to decline. Furthermore, when the fallow period is shortened, it generates a disequilibrium of carbon input-output ratios and intensifies nutrient mining. Complex and often adverse ecological changes occur, such as invasion of Imperata grass and reductions in the number of viable native seeds left for regrowth. Re-establishment of secondary forest fallow vegetation is slowed or stopped, some soil becomes bare, and erosion begins. This situation is typified by the so-called "derived savannas", which occupy more than three-fourths of the previously tropical moist forests of West Africa and 40 million hectares of Imperata grasslands in Southeast Asia and in Madagascar.

## WHAT WE KNOW

Fortunately, the search for alternatives to slash and burn does not have to start from a zero baseline. There is considerable knowledge about the biophysical and socioeconomic determinants of shifting cultivation.

### Technologies

Research on shifting cultivation has been conducted since the 1950's in Africa with

the pioneering work of Jurion and Henry (1969) in Zaire, and Nye and Greenland (1960) in Ghana. The anthropological basis of shifting cultivator cultures have been widely studied in Asia, Africa and Latin America. Agronomic research on a long-term basis has been conducted since the 1970's primarily, but not exclusively, by four groups: at Yurimaguas, Peru and Manaus, Brazil by North Carolina State University (Seubert et al 1977; Sanchez and Benites, 1987; Szott et al 1991); at Ibadan, Nigeria by IITA (Juo and Lal, 1977; Kang et al 1990; Lal et al 1986); in northeast India by Ramakrishnan and associates (Ramakrishnan, 1984, 1987); and in Sumatra by AARD and associated institutions (McIntosh et al 1981; Wade et al 1988). These efforts have provided several kinds of information:

- They have quantified the nutrient transfer process from biomass to ash and into soil, and monitored the changes in soil properties upon cropping.

- Analysis of the dynamics of soil organic matter have shown that judicious management of inputs, vegetation cover and harvest residue can result in a sustainable level of soil organic matter.

- They have determined that bulldozer clearing is inferior to traditional slash and burn in providing suitable physical and chemical soil properties for planting. Detrimental effects of bulldozer clearing include topsoil carryover, soil compaction and the absence of ash as a nutrient-transfer process. Several major colonization projects are no longer based on bulldozer land clearing.

- They have determined that the weed population shift from broad-leaved species to grasses is one of the principal causes of land abandonment and often surpasses soil fertility depletion.

- Low-input systems have the highest potential for sustainability in acid, low fertility soils if they are based on the use of aluminum-tolerant germplasm of annual crops, pastures or trees. Systems based on this principle have shown sustainable production for more than 10 years at research stations, with evidence of improvement rather than degradation of physical, chemical and biological soil properties.

- Keeping the soil surface covered at all times is a key principle for sustainability in the humid tropics. Soil erosion can be checked with the use of agroforestry systems, including alley-cropping on slopes, live fences in pastures, annual crop-tree crop systems, and managed forest fallows. The presence of perennial vegetation further promotes nutrient cycling by litter and root turnover. This is particularly effective in pastures and agroforestry systems.

- Current research indicates that shifting cultivation can be replaced by alternative systems that meet the food and fiber needs of the humid tropical

farmer while providing for additional income by producing high value-low volume crops for export. For these crops (including rubber, palm oil, heart of palm, tropical fruits, pepper, medicinals) the humid tropics have a comparative advantage. Changing consumer values in the First World toward more nutritious and ecologically-friendly products may increase this comparative advantage.

- Research on plantation forestry shows that many of the soil principles applicable to agricultural systems are also appropriate for soil conservation, fertility, weed control and crop selection in forest management.

- Current research also indicates that for every hectare put into these sustainable systems, 5 to 10 hectares of rainforest can be saved from the farmer's axe every year to produce the same amount of food or fiber.

The research synthesis shows that some alternatives are possible; there definitely is hope. But, research has been conducted at an insignificant scale and primarily at research stations. Such a knowledge base needs to be expanded geographically, adapted to specific climate, soil and socioeconomic constraints with different market opportunities. Research needs also to expand from experiment stations to farmers' fields.

Policy

None of these technologies, however, is likely to be applied without significant policy changes that provide adequate market and infrastructure development and at the same time protect the remaining rainforests from being cut. Deforestation is a relatively new field in the policy sciences, but some of its underpinnings are beginning to emerge.

The environmental community generally cites four major policies to decrease tropical deforestation. These are: 1) economic development and more equitable land tenure in densely populated areas, 2) encouraging migration to less fragile areas such as the Cerrado of Brazil; 3) preserving the remaining forests by a vast network of well-protected national parks; and 4) sustainable use of the production forests. While policies that promote these four strategies should be definitely pursued, all are necessary but insufficient to mitigate deforestation rates. The second strategy is clearly insufficient in deflecting migration. The third is unrealistic in preventing hungry people from clearing land. And the fourth is likely to support only a small segment of the humid tropical population.

Linking environmentally oriented strategies with economic ones provides a practical, realistic approach. New efforts in this direction are beginning to emerge (Spears,

1991; World Bank, 1991), and have resulted in lively dialogues. A few deforesting countries have developed policies to contain deforestation primarily in response to national and international environmentalist pressures. Some of them are far too radical to be workable and in some cases backfire, with negative effects on the economy, and they may trigger deforestation in neighboring countries.

The need for solid policy research on tropical deforestation is as important as biophysical research.

## THE ALTERNATIVE TO SLASH AND BURN INITIATIVE

Several international centres and programs have joined efforts with national research systems (NARS) as well as international and local non-government organizations (NGOs) to formulate a research and development initiative that provides viable alternatives to slash and burn agriculture on a worldwide basis. The strategy focuses on two main targets: 1) reclamation of already deforested and degraded lands and 2) prevention of damage by deforestation itself. The strategy consists of three main components: 1) developing and testing alternative slash-and-burn technologies for small-scale farms, adapted to specific ecoregions of the humid tropics, 2) linking environmentally-oriented strategies with socioeconomic policies that provide incentives for such technologies and disincentives to further deforestation, and 3) enhancing the capacity of NARS, local NGOs, decision makers and investment institutions to promote sustainable alternatives to slash and burn agriculture.

Traditional shifting cultivation, practiced by indigenous populations with low demographic pressure is not the focus of this initiative. We are concerned with environmentally destructive practices practiced mainly by migrants to the humid tropics. Traditional systems are a valuable source of knowledge and a point of departure for this initiative.

The First Global Workshop on Alternatives to Slash and Burn, partly supported by UNDP, was held in Porto Velho Rondonia, Brazil in February 1992 to determine the feasibility of developing a global, coordinated effort on alternatives to slash and burn agriculture in tropical rainforest areas. Participants consisted of 26 environmental policy makers and research leaders from 8 tropical countries and representatives from 5 NGO's, 6 international centres and 6 donor agencies. A consensus was reached that a collaborative global effort is necessary. The conclusions of that workshop provided the objectives and framework for this global initiative.

The overall goal of this project is to reduce global warming, conserve biodiversity, and alleviate human poverty by promoting the development of alternatives to slash and burn agriculture that are ecologically sound, economically viable and culturally acceptable.

The overall objectives are:

- To identify, evaluate and, where necessary, modify and develop, land-use systems and technologies which lead to sustainable alternatives to slash-and-burn agriculture and reclamation of degraded lands.

- To identify, evaluate, and design those policies and the tools and methodologies with which they are implemented that will protect the environment by reducing the area deforested by the practice of slash-and-burn, and that will promote the establishment of sustainable systems.

- To enhance the human resource capacity for informed policy decision making and the dissemination and application of research results.

## Scope of Work

The Alternatives to Slash-and-Burn Initiative involves multidisciplinary research and dissemination conducted at global, regional and local levels. The proposed mode of operation is a joint strategic effort by several institutions at 8 benchmark sites in partnership with NARS and NGOs.

The constituent institutions of the consortium are:

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| • AARD | Agency for Agricultural Research and Development, Indonesia. |
| • AFRD | Agency for Forestry and Development, Indonesia. |
| • CIAT | Centro Internacional de Agricultura Tropical, Cali, Colombia. |
| • DENR | Department of Environment and Natural Resources, Philippines. |
| • EMBRAPA | Empresa Brasileira de Pesquisa Agropecuaria, Brasil. |
| • FUNDEAGRO | Fundacion para el Desarrollo del Agro, Lima, Peru. |
| • ICRAF | International Centre for Research in Agroforestry, Nairobi, Kenya. |
| • IFDC | International Fertilizer Development Center, Alabama, USA. |
| • IITA | International Institute of Tropical Agriculture, Ibadan, Nigeria. |
| • INIAA | Instituto Nacional de Investigacion Agropecuaria e Agroindustrial, Peru. |
| • INIFAP | Instituto Nacional de Investigacion Forestal y Agropecuaria, Mexico. |
| • IRA | Institut de Recherches Agronomiques, Cameroun. |
| • IRRI | International Rice Research Institute, Los Banos, Philippines. |
| • MOAFF | Ministry of Food and Fisheries, Zambia. |
| • MOAC | Ministry of Agriculture and Cooperatives, Thailand. |
| • TSBF | Tropical Soil Biology and Fertility Programme, Nairobi, Kenya. |
| • WRI | World Resources Institute, Washington DC. |

The 8 benchmark sites encompass the range in biophysical and socioeconomic conditions in the humid tropics where slash and burn is important. The sites are located in all three tropical regions. In Africa, a site in Cameroun represents the equatorial Congo rainforest which is a zone of rapid social and environmental change and one in Zambia represents the dystrophic Miombo woodlands, where chitemene systems are practiced. In Latin America, two sites are in the Amazon: One in Rondonia/Acre, Brasil is characterised by semidecidous rainforests with very rapid development, and another in the humid rainforest of Peru with poor infrastructure and migration from the Andean region. A third site in Latin America is in the remains of the Lacandona forest in Southeastern Mexico. In Asia, one site in Indonesia will represent the equatorial rainforests, where both primary forest clearing and degraded alang-alang are abundant, another in the tropical monsoonal forests of the Philippines, and a third in the hill country of Thailand in an area of extremely rapid deforestation and rapidly eroding slopes by hill tribes.

Methodologies used and data presentation will be standardized across all sites. Results generated at the sites will be synthesized at regional and global levels for extrapolation to the appropriate ecoregional zones, and for linkage to the global change community, farmers, policy makers and investment decision makers. A Global Steering Group was appointed at Rondonia to guide the project.

The activities fall into three categories: Biophysical research, socioeconomic research/policy options and enhancement of human resource capacity.

**Biophysical Research**

The primary activity of the biophysical research component is to evaluate existing and potential land-use alternatives to slash and burn agriculture and reclamation of degraded lands. The potential of improvements to enhance sustainability and productivity, and the principles governing their function will be evaluated through strategic process oriented on-station research. Such research is essential to provide the basic understanding required to predict performance and impact of improved technology over a wider range of environments. Then, systems will be evaluated on a long-term basis for their productivity, sustainability, environmental soundness and social acceptability. Systems research will be initiated at sites both on-station, where the emphasis will be biophysical monitoring, and on-farm where the focus will be assessing the social acceptability, potentials and constraints to adoption.

A major aim of this project is to determine the extent and type of soil degradation associated with slash and burn practices. Particular emphasis will be placed on understanding the dynamics of soil organic matter and the cycling of carbon, nitrogen and phosphorus through the system. Results from the studies will provide quantification of the losses and storage of carbon associated with deforestation and subsequent land use. Currently, only rough estimates exist. The results will be

applied in global models relating land-use change to global warming.

In addition to the GEF-funded activities, the research conducted at the sites will provide a valuable framework, through support facilities and staff, for the Global Change and Terrestrial Ecosystems Project (GCTE) work on global warming and biodiversity. GCTE will measure emission of greenhouse gases ($CO_2$, $CH_4$, $N_2O$) to the atmosphere, from slash and burn and alternative land-use systems. GCTE will also undertake research on the impact of land-use change through slash and burn agriculture on biodiversity. GCTE's program emphasizes research on the viability of isolated populations, which is directly applicable to slash and burn since forest remnants of various sizes often are left. The GEF project will also undertake a study of the loss and changes in soil fauna biodiversity associated with a deforestation and changes in land use.

### Socioeconomic Research and Policy Options

Socioeconomic and policy research will be carried out at micro-and-macro-levels and directed towards farmers, global and national decision makers, as well as investment institutions.

The assessment of slash-and-burn and its alternatives will provide knowledge on the economic, social and environmental benefits and costs associated with slash and burn and deforestation as opposed to more sustainable agriculture. Alternatives that are economically viable at the farm level and ecologically sound at a larger scale will be identified. This activity will also provide factual information on the economic value associated with the conservation of natural resources and biodiversity and the costs to society associated with the degradation of land resources.

Current and alternative policy options, such as regulations on land use and tenure, pricing and marketing of agricultural inputs and products, and credit will be evaluated in terms of their impact on deforestation, economic growth and equity. This activity in conjunction with the assessment of farmer response to the implementation of various policies will provide guidelines for the design and implementation of policies that can effectively reduce the practice of slash and burn, curtail deforestation and the degradation of land resources, while improving the economic well being of small scale farmers in the forest margins.

A special activity will be dedicated to market development for the little fruits and other forest products of the humid tropical region for export. The focus will be on value-added products originating from the rainforests that meet changing values nutrition about and the environment in the developed world. By developing markets for these products the alternatives to slash and burn agriculture will become economically viable and, therefore, more stable.

Another activity will make assessments on the processes and means to effectively implement various policies. This will be carried out in conjunction with national and international programs already developing decision support systems for policy implementation.

### Enhancement of Human Resource Capacity

Capacity-building activities will be closely linked to the research agenda and to the needs of national research and development partners. Dissemination programmes will provide support in three main area: I) Strengthening of human resources through workshops and short-term training; 2) information and documentation; and 3) communications.

The information and communications support will include the development of data bases, reviews of research work on slash and burn agriculture and provision of journals and other relevant and specialized documentation. The harmonization of procedures to report on results and progress in the different will be discussed and established early in the network development.

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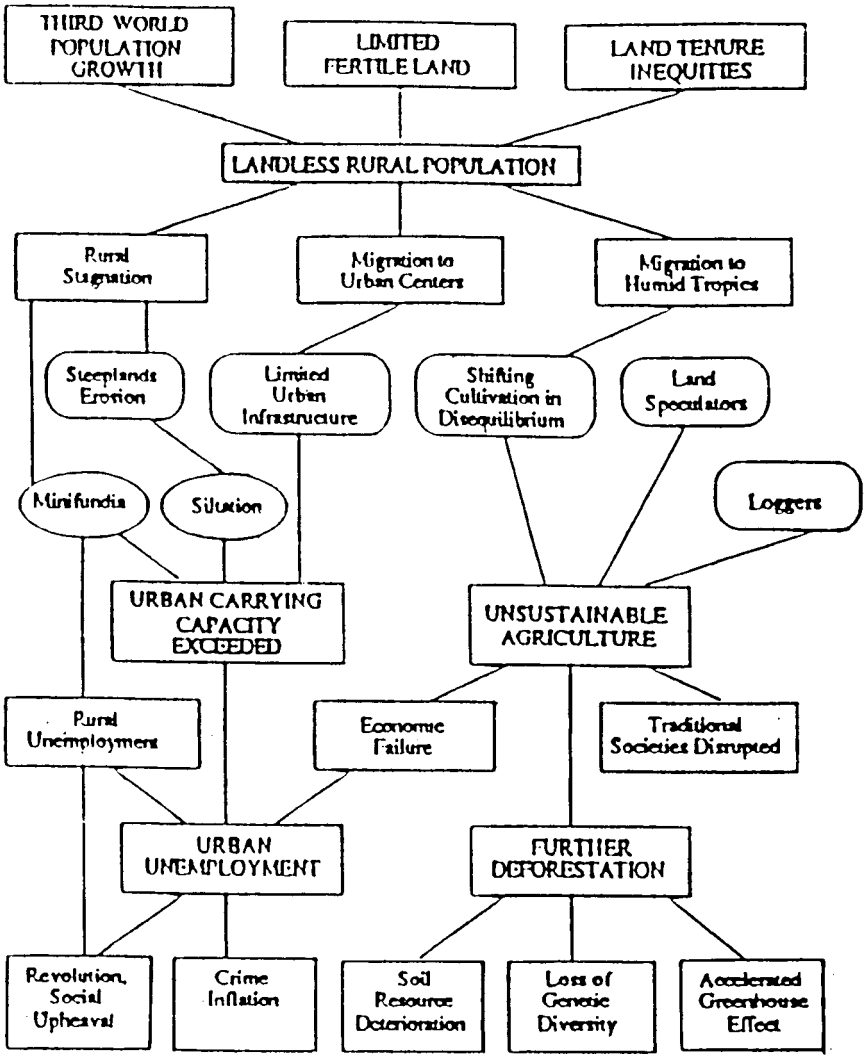


Figure 1. Causes and consequences of tropical deforestation in the humid tropics.