A Global Focus on Alternatives to Slash-and-Burn

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Need for A Global Approach to Slash-and-Burn Agriculture

Slash-and-burn is as old as agriculture itself. But it was not until recently that it was considered to be a global problem. As with so many of mankind's activities today; however, the aggregate magnitude of slash-and-burn agriculture has created enormous stress on natural resource systems in most parts of the tropical world. Slash-and-burn agriculture is one of the principal activities associated with the conversion of tropical forests. 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 hectares at present (Dale et al, 1993). They are expected to accelerate even more in the future.

The conversion of tropical forests is rapidly affecting three major aspects of the global environment: biodiversity, greenhouse gas buildup, and watershed degradation. Deforestation is eroding the world stock of irreplaceable plant and animal biodiversity. Some 5,800 higher plant species are lost annually. The burning of forest biomass that takes place every year is estimated to contribute about 23% of the global carbon emissions to the atmosphere. Watersheds that are deforested often experience greatly accelerated rates of soil erosion and nutrient depletion. This trend toward degradation tends to impoverish local inhabitants, as well as to contribute to downstream siltation, flooding hazards, and reduced continuity of water yields.

The environmental effects are serious, but the impoverished people who practice slash-and-burn agriculture are an equally critical global concern. Currently, shifting cultivation is the dominant land-use practice on perhaps 30% of the world's arable soils. It provides sustenance for an estimated 250 million of the world's poorest people (Hauck, 1974). These are generally the poorest rural populations in the tropics.

The process of deforestation is driven by complex demographic, biological, social, and economic forces. Populations are expanding rapidly in many developing countries, but the most fertile and accessible lands are already intensively utilized. Government policies often exacerbate land scarcity by fostering inequity in land tenure. These and other policy distortions foster the occupation of state forest lands.

The humid tropical forest areas are not often a conducive environment for smallholder agriculture. The more modest populations of past generations could sustain a stable agriculture by short periods of cropping followed by long intervals of fallow land. This

equilibrium has been broken in most shifting cultivation areas because of decreasing amounts of land per family. The result is an unsustainable agriculture that degrades the local soil resources, and forces local inhabitants to start fresh in another forest area. Clearing forest land may also be a way for settlers to claim title to state lands. Where this is tolerated or encouraged, there is fierce activity in land speculation. Policies to mitigate deforestation seldom, however, consider the situation and needs of farmers and migrants who are placing land-use pressures upon these forest margins.

Slash-and-burn agriculture is a problem that nations across the tropics are grappling with in the context of their local circumstances. Countries are addressing their slash-and-burn agriculture problem in a variety of ways. Success has been limited, however, as evidenced by the approximately 10 million hectares of forest now cleared every year. A global effort to address the problems may provide a means of building a knowledge base on the driving forces behind the problem, and enable a more coordinated approach to identify and share solutions. This coordination will help build the capacity of scientists and policymakers to more effectively address the issues in their local and national contexts. These are the propositions that provide the basis for the development of the Alternatives to Slash-and-Burn (ASB) Program.

A Global Effort

In 1992 several international centers and programs joined efforts with national research systems (NARS) and international and local non-governmental organizations (NGO's) to formulate a research and development initiative aimed at developing viable alternatives to slash-and-burn agriculture on a worldwide basis (GEF, 1993). The Alternatives to Slash-and-Burn (ASB) Program is based on the principle that deforestation can be reduced by diminishing the need to clear additional land through improved methods of agroforestry land-use. The strategy has three main components: (1) developing and testing alternative technologies to slash-and-burn agriculture for small-scale farms on the forest margins, (2) identifying suitable policies that provide incentives for such technologies and disincentives to further deforestation, and (3) enhancing the capacity of NARS, NGO's, decision makers and investment institutions to support sustainable alternatives to slash-and-burn agriculture. The program is targeting the reclamation of already deforested and degraded lands, and prevention of further deforestation.

ASB involves interdisciplinary research and dissemination at global, regional, and local levels. The consortium operates through a joint strategy pursued at six benchmark sites in partnership with NARS and NGO's. The benchmark sites were identified at a workshop held in Rondonia, Brazil in February 1992. The 8 benchmark sites encompass the range in biophysical and socio-economic conditions in the humid tropics where slash-and-burn agriculture is important. Sites are located in all three tropical regions. In Africa, one site in Cameroon represents the equatorial Congo rainforest in a zone of rapid social and environmental change, and the other site in Zambia represents the dystrophic Miombo woodlands, where chitemene systems are practiced. In Latin America, two sites are found in the Amazon including one in Rondonia/Acre, Brazil characterized by semi-deciduous

rainforests with very rapid development, and another in the humid rainforest of Peru with poor infrastructure and migration from the Andean region.

In Asia, the site in Indonesia will represent the equatorial rainforests, where both primary forest clearing and *Imperata cylindrica* grasslands are abundant; another site is in the ethnically diverse hill country of northern Thailand in an area of extremely rapid deforestation and rapidly eroding slopes.

Activities were initiated in Brazil, Indonesia, and Cameroon in 1994. Peru and Thailand were added in 1995. The first two years have focused primarily on characterizing of the slash-and-burn system, developing common methodologies to analyze the driving forces of deforestation, and setting research priorities. The work is currently moving into the identification and refinement of prototype alternatives to slash-and-burn agriculture.

Traditional shifting cultivation practiced by indigenous populations with low demographic pressure is not the focus of this initiative. The concern is with disrupted systems and environmentally destructive practices to humid tropical forest areas used mainly by migrants. Locally adapted traditional systems are providing valuable sources of knowledge on the principles and practices of sustainable agriculture. They are being carefully studied by project researchers for the guidance they offer.

Methodologies to examine alternatives to slash-and-burn agriculture are being standardized across the sites through a collaborative and iterative process. Results from research in each country are synthesized at regional and global levels for extrapolation to the appropriate eco-regional zones, and for linkage to policymakers, the global change community, and investment decision makers.

Characterizing Slash-and-Burn Systems

To understand slash-and-burn systems pro-actively, it is necessary to conduct analyses at macro, meso, and micro levels. Land-use change is characterized with secondary data and mapped in a geographic information system (GIS). Household surveys are being conducted to characterize farming systems and resource flows in sample villages at the benchmark sites. At the field level researchers are determining the extent and type of soil degradation associated with slash-and-burn practices. The dynamics of soil organic matter and the cycling of carbon, nitrogen, and phosphorus are being elucidated. 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. Greenhouse gas emissions from slash-and-burn systems are receiving special attention. The results will be applied in global models relating land-use change to global warming.

The impact of land-use change through slash-and-burn agriculture on biodiversity is also being assessed, particularly on the viability of isolated natural plant and animal populations. This is important since forest remnants of various sizes often are left behind after the process of slash-and-burn. The loss and change in soil fauna biodiversity associated with deforestation and changes in land-use will also be evaluated. In addition to GEF-funded activities, research conducted at the sites provides a valuable framework,

through support facilities and staff, for the Global Change and Terrestrial Ecosystems Project (GCTE) work on global warming and biodiversity.

Global Hypotheses

Three general hypotheses have been identified as the basis for research to identify alternative land-use systems. The first is that agroforestry and agropastoral systems that accumulate biomass quickly and produce greater reservoirs of soil carbon will increase carbon sequestration, thereby decreasing carbon dioxide emissions. The validity of this hypothesis depends on what land-use systems the agroforestry systems will replace. Agroforestry is usually not superior to natural forest regrowth or plantation forestry in terms of carbon sequestration. However, agroforests may sometimes approach or exceed the biomass of these other systems. Agroforestry systems that replace short cycle annual crop-fallow can significantly increase above- and below-ground carbon storage.

The second hypothesis is that alternative technological interventions that maintain or enhance soil fertility and diminish weed invasion will prolong the productivity of recently cleared land, thereby reducing the need for further forest clearance. In addition, interventions that enable farmers to grow a wide range of products to diversify their agroecosystems' output will increase household food security, improve nutritional status, and reallocate labor within the farm or more productive activities. This proposition is controversial. Successful alternatives will enable higher family incomes on less land, thereby increasing land productivity and reducing the need for new land and forest resources per family. However, more productive practices will increase the value of land; they may thus attract more migrants to the forest margins and could even accelerate forest conversion. New agricultural/agroforestry practices will have to be combined with better enforcement of forest boundaries. Agricultural intensification cannot do the job alone. This points to a clear linkage between the ASB program and the integrated conservation development project (ICDP) approach to natural park management. The ICDP approach assumes that enforcement ought to be linked with development opportunities for the communities affected by the presence of the protected area (Wells and Brandon, 1992).

The third hypothesis is that the development of sustainable alternatives to slash-and-burn agriculture consisting of the productive use of an increased number of plant species will bring benefits to farmers and society at large and at the same time reduce biodiversity loss by minimizing further deforestation. This proposition is also controversial. Increasing the number of plant species in a farming system may increase its agrodiversity (ie. the diversity of cultigens employed). However, this does not *a priori* increase the natural biodiversity of the system. It may help do so, but only if the management practices are conducive to the colonization of natural forest species. This is quite evident in some agroforest systems, such as the 'jungle' rubber systems of Sumatra.

Where there has been a history of tree crop cultivation in the vicinity of a protected area, the environment of the farmed zone develops ecologically favorable characteristics for protection, even extension, of the natural biodiversity of the park itself. One case exemplifying this is the Damar agroforest systems found on the boundaries of the Barisan

National Park in Lampung, Sumatra (de Foresta and Michon, 1994). During the preceding decades, local populations have extended the cultivation of the Dipterocarp tree *Shorea javanica* which is tapped to yield a commercially marketed resin. This man-made agroforest now extends scores of kilometers along the western boundary of the park. It harbors a major fraction of natural rainforest flora and fauna species and effectively acts as an extension of biodiversity from the park itself.

Another example of the biological diversity protection role of an agroforest systems is the 'jungle' rubber system practiced on some 2.5 million ha in Sumatra and Kalimantan. Rubber seedlings are established as intercrops in a slash-and-burn system (Gouyon et al, 1993). After 1-2 years of cropping the plot is left alone. The rubber trees mature along with the secondary forest regrowth. The natural biodiversity may approach those of a natural secondary forest to a major degree (Thiollay, 1995). Since about 97% of the lowland primary forest in Sumatra has now been logged out, the rubber agroforests may be the major repository of lowland biodiversity in the future.

Identifying and Refining the Alternatives

Agroforestry is likely to play an important role in alternative land-use systems that balance economic growth and environmental protection in slash-and-burn agriculture. Agroforestry practices provide a variety of ways in which agriculture can be intensified, tree cover can be enhanced, and biological diversity can be protected, or extended, outside of protected areas.

Even in areas where smallholder agroforestry does not yield such striking levels of protection or extension of natural biodiversity as in the examples above, the benefits of increased tree cover on the landscape may nevertheless be important. Where trees are grown in reasonable densities for fruit, industrial, or timber uses, even on very small farms, the tendency for the family to collect fuelwood or timber inside the boundaries of an adjacent protected area may decline quite drastically (Murniati, 1995).

In countries such as the Philippines, Vietnam, and Thailand, which are experiencing extreme encroachment pressures on the remaining natural areas, there is a trend toward major increases in the value of farm-grown timber. Smallholders, even shifting cultivators on the frontier, are now engaging in farm forestry in large numbers, in response to strong price incentives.

Besides their attractiveness as sustainable land-use practices, agroforestry technologies have the potential to reclaim the secondary forest fallow and derived grasslands that often follow in the wake of slash-and-burn activities. However, little agronomic research has been conducted, and most of this has been on research stations. The current work will mainly be done on farmers' fields.

Policy Research and Intervention

No alternative technology is likely to be successful without a conducive policy environment that provides adequate market and infrastructure development, and provides

mechanisms for protecting remaining rainforests from being cut. The environmental community generally cites four major aspects in a successful approach to decrease tropical deforestation: 1) developing the economy and providing more equitable land tenure in densely populated areas; 2) encouraging migration to less fragile areas; 3) preserving remaining forests by a vast network of well-protected national parks; and 4) using production forests sustainably. While policies promoting these strategies are necessary and should be pursued, they are insufficient to mitigate deforestation rates.

Policies from various sectors (local, national, regional and international) affect farmers' decision making. The selection and testing of alternatives must consider the policy deterrents and incentives that are in place, and new policies must encourage the successful adoption of these alternatives. The effects of extension institutions, trade policies, and property rights on technology adoption and resource management at the farm level are being addressed. Other concerns are public finance, market performance, integration at the community level, macroeconomic policies, interregional flows of commodities, and migration on national and global scales.

The outputs of the policy work will indicate relative production -economic benefits and environmental consequences of the alternatives. Final selections could then be based on the balance of the farm, community, and global costs and benefits of the various alternatives given the objectives at the different scales. The use of ASB sites in six countries that range widely in socio-economic and biophysical circumstances facilitates the testing and validation of decision-support systems and assures that they are robust.

Current and alternative policy options, such as regulations on land-use and tenure, pricing and marketing of agricultural inputs and products, and credit are being evaluated to determine their impact on deforestation, economic growth, and equity. This activity, in conjunction with the assessment of farmer responses 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 agriculture, curtail deforestation and the degradation of land resources, and simultaneously improve the economic well being of small scale farmers in the forest margins.

Enhancement of Human Resource Capacity and Networking

Capacity-building activities are closely linked to the research agenda and to the needs of national research and development partners. Dissemination programs provide support in three main areas: 1) strengthening of human resources through workshops and short-term training; 2) information and documentation; and, 3) communications. Information and communications support includes development of data bases, reviews of research work on slash-and-burn agriculture, and provision of specialized documentation. Two training courses/workshops have been held in Indonesia to strengthen the scientific base of the work on carbon dynamics and greenhouse gas emissions and on participatory rural appraisal methods. Regional workshops are conducted on an annual basis to review progress and prepare plans for the next phase of work.

It would be desirable to have more countries participating in the ASB program. Because fund and management limitations currently prevent further expansion of the number of key countries, the program is developing mechanisms to network with other countries involved in their own research on slash-and-burn agriculture issues. The ASB Program support for this symposium in Kunming is part of that objective to reach out to scientists elsewhere in Asia. We also welcome the prospect of an ASB research network evolving in China. The ASB Program will be sharing its publications and outputs with Chinese scientists.

The ICRAF/ASB project in northern Thailand, based at Chiangmai University, will seek to expand on these contacts by building an international consortium of local institutions focusing on the issues of the mountain mainland region of southeast Asia, and to facilitate collaborative linkages with relevant international institutions elsewhere in the world. The Thailand activities will be gradually linked with those in YunNan Province and Vietnam through joint planning, methodology and training workshops, exchange visits, and similar activities.

The project, which is to be underway in 1995, will strive to build ever-closer relationships with slash-and-burn research activities going on in China.

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