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PRIORITIES FOR FORESTRY AND AGROFORESTRY POLICY RESEARCH

REPORT OF AN INTERNATIONAL WORKSHOP

EDITED BY HANS GREGERSEN · PETER ORAM · JOHN SPEARS

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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Priorities for Forestry and Agroforestry Policy Research: Report of an International Workshop

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Preface

Recent international reviews of forestry and agroforestry research needs in developing areas (such as Bellagio II and the study conducted by the Technical Advisory Committee of the Consultative Group on International Agricultural Research [CGIAR]) have placed high priority on policy research, both because of the basic importance of policy constraints in the overall course of forestry development and conservation and because of the existing lack of research in this area. In order to better identify priority issues for policy research, the International Union of Forestry Research Organizations, Special Program for Developing Countries (IUFRO/SPDC), the International Food Policy Research Institute (IFPRI), and the Agency for International Development (AID), in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and the Forestry For Sustainable Development Program at the University of Minnesota, convened an international workshop on forestry and agroforestry policy research in Washington, D.C., July 9–12, 1991. It was hosted by IFPRI.

Forty participants from 21 countries were selected to represent regional and disciplinary expertise (a list of the participants appears at the end of this report). An additional 22 persons provided written comments on the first draft. Their help is gratefully acknowledged.

The focus of the workshop was on policy and economic issues associated with developing alternatives to slash-and-burn agriculture, since that form of land use is a major cause of tropical deforestation. Particular emphasis is given to the distribution and growth of populations in tropical forest areas, to the effects of shortened fallow periods, and to opportunities for addressing policy research needs in these areas.

It also should be emphasized that the workshop dealt with a broad range of issues and research themes. Specific, researchable problems still need to be defined and prioritized for a given theme area through regional, national, and local consultation and through the initiative of researchers working with client groups.

The first part of this paper is a summary report, which describes the findings that emerged during the workshop, synthesizes some of the priority areas and approaches identified, and discusses these areas in the context of future policy research initiatives. The summary discusses the context for forestry and agroforestry policy research and describes some of the common themes that have been designated as areas of critical importance. Then the views of five thematic working groups, organized as part of the workshop, are summarized. Finally, recommendations on implementation of programs of policy research to address the identified issues are presented.

Five papers prepared for the workshop provided the initial thrust for discussion. Part 2 comprises these papers. They explore priority research questions and describe the state of knowledge in a number of key areas of concern.

Hans Gregersen
Peter Oram
John Spears

Editors

PART 1

Summary Report of the Workshop on Forestry and Agroforestry Policy Research

CHAPTER 1

Forestry and Agroforestry Policy Research Needs

The Context for Policy Research

A recurring question is What types of studies constitute policy research? One can define three types that support the dynamic process of policy change in most societies. The first is research to improve understanding of the existing situation and the problems and opportunities associated with it. The second is research to identify desirable changes in the present situation. The third involves research on how to bring about these changes, that is, what policy instruments and other mechanisms can be used to achieve the objectives. In this report, all three types of research have been included in the scope of the discussion.

However, participants in the July 1991 international workshop on forestry and agroforestry policy research, which is the basis for this report, generally agreed that research designed merely to collect basic data and baseline information is not in itself policy research, though this type of information is often essential for the formulation of sound land-use policies. Further, the collection of data and the development of data bases are of little use unless guided by appropriate policies. The discussion on the role of baseline information at the workshops emphasized the iterative nature of policy formulation: policy is seldom developed independent of past experience. Rather, it builds on earlier policies and uses new information as it becomes available and as new development priorities emerge. Research priority-setting needs to explicitly recognize and take into account the dynamic nature of policy formation.

It was recognized that current forest policy developments should build on earlier sound policies and policy objectives, and that the policy process must have a mechanism to assess and reject outright policies that have conflicted in the past with the objective of optimizing land uses. It should be acknowledged that there is as much to learn from good policies as from bad.

The workshop identified the need to generate various types of information through research, depending on the stage in the policy development process. The prioritization of research needs must reflect different hierarchies, information requirements, and stages in the decisionmaking process, as well as the proven effectiveness of different policy instruments, such as legislation, direct investment, and incentives, which interact in both positive and negative ways to shape land-use decisions. The process of policy development, the questions asked in policy research, and the basic information requirements at different stages in this process are summarized in Table 1.1.

The workshop recognized that sometimes policymakers fail to act upon information that is made available to them through policy research. An understanding of why this happens, and how policy research can contribute more effectively to decisions of policymakers, is critical.

Finally, research priorities must in part reflect existing forestry and agroforestry policy research capacities in developing countries, which vary greatly in quality and quantity.

Table 1.1—Information requirements at different stages in the policy process

Questions at Each Stage Leading to Policy Changes	Information Requirements
1. What is the existing situation and what changes are desirable to achieve particular development objectives related to sustainable development and the environment?	Background information Needs and problem assessment Market information Technical information (biophysical, social, and economic)
2. What inputs into the local, regional, or national economy have to change to achieve these development objectives?	Research on the means for changing forestry and agroforestry activities, reflecting social and economic constraints and opportunities
3. What policies have been effective in achieving development objectives? What policy changes are required to alter the existing situation in a way that meets development objectives?	Policy research Studies of effects and opportunities for achieving development objectives through policy change related to incentives and regulations

Workshop discussion focused on the fact that many forestry and agroforestry policy issues are quite site- and situation-specific. Information at present is derived primarily from isolated case studies not designed for extrapolation. For all areas of policy research, a critical challenge is to design studies using standardized or comparable methods and carefully selected cases to provide rigorous empirical evidence that can be extrapolated to address broader policy concerns. Otherwise, research findings may appear to be contradictory, when in fact they reflect context-specific characteristics that are not generalizable. Because of this, the priorities identified by the working groups are generic in character (with the exception of research into methodological issues). They must be defined in the context of a specific site or situation in order to derive concrete, researchable problems. This also means that more time and effort needs to be devoted to properly identifying the various types of stakeholders or interest groups that will be affected by changes in policies in any given situation.

Common Policy Themes and Research Areas

Most of the themes suggested by the workshop participants fell into six crosscutting categories, listed here in no particular order of importance:

- macroeconomic and other macro-level studies;
- land and tree tenure issues;
- ways of optimizing land use and rural welfare;
- the effects of organizational reform;
- institutional support, services, and infrastructure; and
- markets, subsidies, and incentives.

The types of research needed in each of these categories are summarized in the following sections.

Macroeconomic and Other Macro-Level Studies

There was general agreement on the need for research to understand the dynamics of interactions between population, economics, and the environment. The types of research needed include the following:

- Research is needed to determine, first, how improved living conditions would reduce migrant outflows from source areas into environmentally fragile areas such as upland watersheds or forest-covered agricultural frontiers, and, second, whether buffer-

zone development can help to stabilize agricultural frontiers.

- Research is needed on the effects of structural adjustment programs on migration, agricultural expansion, and deforestation and on how the effects of macroeconomic shocks on potential migrants could be reduced to slow the processes leading to agricultural expansion. How can migrant populations on the extensive margin be stabilized?
- Existing national and local policies and regulations affecting incentives to plant or manage trees need to be assessed, as well as national forest policies and their effects. Which types of policy approaches and policy instruments have been found to be most effective and in what circumstances?
- Mechanisms for a balanced valuation of environmental benefits in national accounts need to be developed. There is also a need for analytical perspectives and empirical measures that link forests and trees with national planning variables. The role of natural resource accounting to evaluate losses to the national economy as a result of deforestation and forest degradation must be delineated.
- Mechanisms are needed for valuing trees and forests from a local perspective to complement national valuations for use in policy decisions.
- Research is needed on intersectoral effects of fiscal and employment policies, trade and protection regimes, agricultural pricing, and industrial policies on deforestation, forest use, and patterns of tree cultivation and management. How can multisectoral policies enhance natural resource management strategies? How can the negative impact of multisectoral policies be minimized?
- Research is needed on policy coordination at different levels of government.
- Finally, studies should be undertaken that examine the regional effects of policy change, reflecting the increasing globalization of natural resource issues.

Land and Tree Tenure Issues

- Empirical studies are needed to evaluate the effects of changes in tenure regimes or tenure rules on tree-growing practices. How do tenure arrangements act as a barrier to tree planting or as an incentive? How can contemporary land and tree management practices be built upon an understanding of customary tenure arrangements?
- Research is needed to identify policies to mitigate tenure-related constraints to tree growing, and to understand how the landless can be provided access to tree resources. How can equitable systems for access to trees and use of forest products be developed where they are not already in place?
- Studies should explore how tenure regimes in newly settled areas or in areas affected by land reform can provide or safeguard access to trees and tree resources, and the effects of land adjudication on tree tenure and usufruct.
- Research is needed on the relationship of gender to tree and land tenure and on the effects of policy changes on gender-related tenure issues.
- Research is needed on upstream and downstream land and tree tenure linkages and the management of upland watersheds.
- Research should be undertaken on common property or communal management to understand how macro-level policies may hinder or support these types of land management practices, as well as research on how patterns of access to communal and forest land affect management options and incentives.

Ways of Optimizing Land Use and Rural Welfare

Research is needed on the following topics:

- the complementarities of farm and forest activities by forest-fringe farmers in the tropics;

- demographics and the dynamics of land-use change and the adoption or abandonment of different tree-related land uses;
- synthesis of existing research on land-use strategies and decisionmaking behavior in intensively farmed areas, and on the extensive margin, as a response to policy initiatives;
- the evolution of land use from rotational fallowing systems to settled cultivation;
- the development of optimal land-use strategies, considering an improved and broadened valuation of on-farm forests and tree resources, off-farm local resources, and global resources; the role of trees and forest resources in food production and food security; and tree-related land uses compared with other land uses; and
- the relationship between urbanization, migration, and changes in land use, considering urbanization as a driving force for extensive and intensive land development at the frontier.

The Effects of Organizational Reform

This theme requires the following research:

- studies examining the impact of the devolution of land management from the state to the private sector; privatization of the supply of goods and services related to forestry, land use, and activities having an effect on land use; and the role of common property management systems;
- research into the comparative advantage of different organizational structures—local, regional, national, private, or public—for managing natural resources, promoting forestry and agroforestry, and decentralizing responsibility and its relationship to land-use change;
- research on the appropriate institutional mechanisms for fostering interinstitutional cooperation and coordination on intersectoral issues;
- studies of how institutions can more rapidly respond in the face of growing demographic pressures and of how institutions can mediate the effects of demographic change on the environment, both on-farm and off-site; and
- research on institutional responsiveness to the requirements of populations already resident in or making use of forested areas and studies of how institutions can address the constraints of these populations.

Institutional Support and Services

This theme includes the following research areas:

- research on the resource and institutional needs to undertake effective policy research and to strengthen these capacities in countries with critical deficiencies;
- research to compare the effectiveness of different types of extension strategies in different types of forest and agroforestry land-use systems to explore the role of indigenous knowledge in extension strategies;
- research into the cost effectiveness of different means for linking research with education and extension;
- research on how biophysical constraints can be alleviated in a way that encourages the adoption of sustainable patterns of land use and on policy options for introducing new technologies; and
- studies of the role and effectiveness of nongovernmental organizations in encouraging environmentally positive land-use changes and in managing and implementing extension programs for forestry and agroforestry.

Markets, Subsidies, Incentives, and Infrastructure

The following research is required:

- studies into market development, job creation, and income generation strategies that reduce the agricultural expansion pressures on forest areas (for example, by offering nonfarm and off-farm alternatives) and

increase rural welfare in source areas;

- research on the effectiveness of credit and tax policies to encourage the development of more appropriate and sustainable land uses and on the role of credit and subsidies for agroforestry development or for the management of natural forests;
- studies on the relationships between plantation forestry development, subsidized timber pricing, and rates of deforestation;
- research on ways to improve the functioning of markets for tree and forest products, to examine the role of middlemen as exploiters or facilitators, and to make public-sector involvement in marketing less problematic;
- research on pricing of forest and tree products, price responses to income, interproduct substitution, and rationalization of forest product pricing to more effectively reflect its economic value;
- studies of licensing and concession policies as options for improving resource management; and
- research on the effects of transportation and roads infrastructure on migration and forest clearance and the development of markets for forest products.

Priorities for Policy Research Addressed by Working Groups

As part of the overall workshop the organizers established five thematic working groups to discuss the following topics:

1. *Population distribution and growth, deforestation, and land use in wet tropical forest zones.* Particular emphasis was placed on means of addressing issues related to optimizing land use among small-scale cultivators (including those who shift cultivation), the distribution and growth of populations, shortened fallow periods, and opportunities for alternative land-use strategies that incorporate trees or other perennial crops.
2. *Options for the reclamation and utilization of degraded forest lands in dry regions,* focusing on common property issues, experience with wasteland management strategies, and the management of lands by public agencies.
3. *Intensive, sustainable land-use systems involving trees in upland watersheds and the preservation of woodlands,* giving special emphasis to the characterization of these systems, upstream/downstream effects, and how the quality of life of people living in or near upland watersheds could be improved by income generation through job creation.
4. *The role of trees in income and welfare security,* addressing social and economic issues related to the use of trees and tree products in farming systems, by communities, and by small-scale enterprises.
5. *Intersectoral policy issues affecting the forestry sector,* such as policies affecting agricultural expansion and intensification, structural adjustment programs, road development initiatives, and policies related to energy resource development.

The crosscutting issues described earlier evolved out of the thematic discussions by the working groups.

The resulting synthesis of ideas on prioritization of research in these five areas provides a starting point for discussion of regional and national issues. It is just a starting point, however. The task of priority setting is unfinished until priorities are defined at the national and regional levels. That remains to be done through local consultations and workshops, with researchers working closely with policymakers and policy implementors.

The main priorities identified by the working groups are summarized in Boxes 1-5.

[1] The workshop recognized that some shifting cultivation strategies are already optimal, in the sense that land and tree resources are not being seriously degraded in areas where fallow periods are long and population densities low.

Box 1. Priorities for policy research on population distribution and growth, deforestation, and land use in wet tropical forest zones

Research should be geared primarily toward reducing migration to agricultural frontiers and toward speeding the transition to more sustainable forms of land use. The following research areas should have high priority.

- research on *macroeconomic processes* that lead to migration from source areas to environmentally fragile lands; relationship of structural adjustment lending to migration;
- research on *institutional reforms* needed to strengthen tenure of individuals or of groups to trees and land; the devolution of responsibility for natural resources from government to others; the structure of tenurial arrangements; improvements in public-sector natural resource management; coordination between agencies;
- research on the role of *infrastructure* and its relationship to deforestation, on logging roads and the rate of migration to frontier areas, and on effects of market access on returns to rural land users;
- studies on the potential for *sustainable land-use technologies* to improve returns to land use;
- research on *subsidies and pricing policies* to understand how to reduce incentives for land clearance and to encourage the adoption of sustainable land uses;
- research on means for stabilizing the distribution and growth of rural populations through *off-farm employment and income generation opportunities;*
- studies on land-use potential and its relationship to population demographics and biological conservation priorities;
- research into methods for improving the *valuation of environmental services provided by forests and trees* such as soil erosion prevention, catchment protection, biodiversity, and so on; and
- research on the impact of *forest and agriculture-sector policies* on deforestation, particularly on policies regarding the development of buffer zones, licenses and concessions, and the relationship between plantation forestry, biological conservation issues and deforestation.

Box 2. Priorities for policy research on the reclamation and utilization of degraded forest lands and drylands. These areas are located primarily in the arid, semi-arid, and seasonally dry tropics, and in the subtropical semi-arid ecological region of West Asia and North Africa.

Studies of improvement of land-use to increase rural welfare should be undertaken to reflect the range of social and economic conditions that are often a function of ecological potential in dryland areas. These include

- research on *optimal land-use strategies*, and the policies necessary to encourage the adoption of these strategies, in dry-land areas; problems of reconciling local, regional, national and international points of view;
- reviews of *policies affecting trees and tree planting* that encourage the rationalization of national policies and traditional practices;
- studies of *tenure and customary rights to trees* to identify how tenure and usufruct act as incentives or barriers to tree management; and
- research on the improvement of *markets for tree products from dryland areas* to improve market access and returns to forest products.

Box 3. Priorities for policy research on intensive, sustainable land use in upland watershed areas and woodland preservation.

Research in upland watershed areas should be designed to evaluate how the quality of life of people living in these areas can be improved, and how environmental conditions in upland areas can be maintained in a way that benefits populations both upstream and downstream. Research should include

- the development of better information about *externalities* related to upland watershed management, particularly identification of incentives to protect, plant, and maintain trees and forest cover; the measurement of social, economic, and ecological interactions between upland and lowland communities and land uses; and how production processes in these respective areas can be stabilized;
- the development of better *forest and tree management* through understanding of why farmers plant what they do when they do, more creative management systems, tenure and traditional management strategies, and economically viable management systems for extensive commercial forestry that do not compromise the protective functions of forest ecosystems;
- research into problems of *infrastructure, institutions, and marketing,* to identify ways to develop more effective market opportunities and new markets; research on how roads and transportation affect development and migration into upland watershed areas, and how local, regional, and national institutions could best work together to manage and protect forest, tree, and land resources.

Box 4. Priorities for policy research on the role of trees in rural income and subsistence security.

Proposed research priorities in this area focused primarily on the relationship of trees and forests to household income and subsistence security.

- research on *patterns of demand and use of tree products and services* in rural areas;
- studies of *markets, marketing, and pricing of tree products from rural households*, with a particular view toward more orderly development of tree product markets;
- *comparative analyses of alternative forestry and agroforestry systems in the stabilization of existing and new land-use systems*, particularly to investigate the evolution of these systems in response to increasing demographic pressures;
- research into aspects of *land and tree tenure and control* to clarify the relationship between changing land tenure relationships and tree rights;
- studies of *common property management* of tree resources by individuals, communities, and the state to identify where macro policies conflict with communal management objectives, to determine how these management strategies are affected over time, and to determine how greater local responsibility can be placed over local resources; and
- research about *institutional support and services*, such as the role of extension, research, and education linkages, and the role of credit and subsidies.

Box 5. Priorities for policy research on intersectoral policy issues.

Research in this area is needed to assess the effects on forests and on trees on farms and in rural areas, of policies in other sectors to evaluate how policy measures can reduce negative intersectoral effects and enhance positive intersectoral effects.

- research on *macroeconomic policies* affecting forests, such as structural adjustment programs, economic liberalization programs, agricultural and fiscal policies, and industrial development;
- *microlevel research on agriculture and forest interactions*, particularly to explore the relationship of policies to deforestation, and to identify how negative intersectoral effects can be reduced by stabilizing populations on the extensive margin through practices that increase household income;
- research on *institutional implications of intersectoral linkages*, such as the impact of restructuring institutional responsibilities to increase collaboration and coordination between institutions.

Recommendations for Implementing a Program of Forestry and Agroforestry Policy Research

The workshop participants realized that establishing a framework of priority issues and topics for research represents only a first step in developing research on policy issues at the national level. Recognizing issues at a generic level is one thing; it is quite a different matter to develop effective and efficient programs to implement those issues.

At present, forestry and agroforestry policy research is extremely weak in most developing countries. There is a need to expand training and information programs that will help build the capacity in developing areas to address critical policy issues. At the same time, considering the urgency of many of the issues identified and the time delays involved in building capacity, the workshop participants urged immediate, stopgap measures to expand policy research in high priority areas. For example, issues related to containing deforestation cannot be ignored until research capacity is built up. Policymakers need insights on the issues and their resolution now. With this in mind, the following recommendations are made.

Expansion of Policy Research Programs in Developing Areas

National decisionmakers in developing countries are currently at a disadvantage in formulating policies related to forestry and trees in land use because of the lack of capacity to do research on the likely effects and costs of implementing different policies. The workshop participants reached the following conclusions.

There is an urgency to many of the forest use and misuse problems facing developing countries. National policies, if properly formulated, can play an important role in reducing the negative effects of forest misuse, in containing nonproductive deforestation, and in taking advantage of opportunities for trees to make positive contributions in land use. Policy research, to be effectively used, should be carried out primarily within the countries in which the results might be applied; at the same time, an exclusive focus on top-down policy processes should be avoided. Forestry and agroforestry policy research is in its infancy in most developing countries, and, thus, national policy research needs to be given a major boost. To support such a buildup in research, international and developed-country organizations conducting policy research and training, such as IFPRI, the Food and Agriculture Organization of the United Nations (FAO), the World Bank, bilateral agencies, universities, and nongovernmental organizations need to become more actively involved in joint or collaborative policy research in developing countries.

Given these conclusions, the workshop participants strongly recommended the following:

- National institutions in developing regions, including universities, government departments, research organizations, and nongovernmental organizations, should, in the short run, initiate or expand significantly collaborative research programs to address a range of key forestry and agroforestry policy issues such as those identified during the workshop.
- Concurrently, in order to assist national institutions, regional workshops should be initiated at an early date, with donor support, to delineate more specifically the problems and priority areas for research. These workshops could lead to the establishment of research networks on problems common to several countries, the results of which would have broad applicability. They could also help determine where action might be needed by international or regional organizations to deal with issues that transcend national boundaries, or where to find solutions to methodological problems beyond the resources of individual countries.
- In support of these recommendations, donors and research groups (including IFPRI, FAO, the International Centre for Research in Agroforestry [ICRAF], and other international groups) should develop improved mechanisms for funding and

providing technical assistance and collaborative support for this type of research.

Intensification of Training and Information Programs

Development of policies for optimal land uses in developing countries is frequently hampered by either a lack of relevant information or access to it. Although policies can and will be formulated in the short run without such data, a significant longer-term expansion of information gathering could help reduce the uncertainty surrounding policy decisions and could, eventually, lead to more effective and sound policies.

Weaknesses in policy analysis and development have been identified repeatedly in sectoral surveys in developing countries. One reason for these weaknesses is the lack of researchers and analysts who are trained in the techniques of policy analysis, and who are working in an environment where such analysis might be productively applied. Training and institution building are needed to overcome these weaknesses.

Given these conclusions, the workshop participants recommended the following:

- More effort should be devoted to building standardized and comparable data on the potential outcomes of various land-use decisions in different policy contexts. This includes paying more attention to the development and use of integrative systems for data management, such as Geographic Information Systems (GIS) and the agro-ecological zoning methodologies developed by Centro Internacional de Agricultura Tropical (CIAT) and FAO.
- In light of the difficulty and often high cost of carrying out extensive site-specific studies, more attention should be given to the evaluation of existing data and case studies. This approach calls for the development and use of comparative and comparable techniques for analyzing case study data. It also calls for the use of off-site data for filling gaps in local knowledge and use of bibliographic data bases, which increasingly are becoming available at reasonable cost.
- The narrow spread of disciplines customarily recruited into national forestry services should be broadened to include skills in, for example, sociology, anthropology, economics, agronomy, and geography. Training should improve abilities to collect and analyze relevant land-use data and to present more effectively to political decisionmakers the arguments from different perspectives for and against different land-use options.
- All of this information is needed by policymakers and could help improve the policy process for forestry and agroforestry in developing countries.

Given these conclusions, the workshop participants recommended that developing countries, with strong technical and financial support from the international donor and research communities, should move aggressively into training and information generation programs that can help to build an expanded and more effective capacity for policy research. Such programs could form components of the country capacity projects to be carried out through national forestry action programs.

PART 2

Papers Prepared for the Workshop

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CHAPTER 2

Policy Issues Related to the Role of Trees in Rural Income and Welfare Security

J. E. M. ARNOLD

Large numbers of rural people still live in or adjacent to a wooded environment, where the forests and its components are of great spiritual, cultural, or economic significance. This paper focuses on the material outputs of forests and managed trees of subsistence or market value to the rural household. The broader attributes of the forest are examined only where these influence the supply and use of these outputs.

The products of forests and trees enter widely into rural household and economic use—principally as food, medicines, fuel, fodder, construction and storage materials, soil nutrients, protection, and sources of employment and income. Rural people obtain these inputs by taking them from nearby wood stocks on public land, and by incorporating trees of value into their farm or livestock systems. Supply is still largely obtained through own production or collection by the user household, but increasingly it is obtained—at least in part—through sale and purchase.

The role of trees in rural income and welfare security is discussed in this paper in two parts. The first part explores the nature of the links between trees and rural households, with particular reference to the effects of changes that are altering people's access to or dependence on forest-based goods and services. The second part examines the production and management systems that supply these outputs, the changes that are taking place in these systems, and the lessons to be drawn from recent attempts to intervene to strengthen them.

Trees, Income, and Household Food Security

At the risk of considerable oversimplification, as the categories overlap, rural usage of forest products can be grouped into three categories—products or activities that provide employment and income; inputs to agriculture such as fodder, soil nutrients, and raw materials for agricultural implements; and direct use by the household as food, medicine, fuel, construction timber, and so forth.

Income and Employment

Rural people gather, produce, and trade a wide range of forest products in order to derive income. Gathered products include fuelwood, rattan, bamboo, fibers, medicines, gums, and wild foods. As more and more tree products are traded as commodities—fruit, fuelwood, and poles, for example—a growing share of the supply in some areas is coming from trees grown within the farm system (Falconer and Arnold 1989). The main groups of traded products that first undergo simple processing at the household or small-enterprise level are furniture and other products of wood; baskets and mats and other products of canes, reeds, and grasses; and handicrafts (Fisseha 1987).

Small, forest-based gathering and processing enterprises provide one of the largest sources of nonagricultural employment and income to rural people—at a time when rural

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households are having to look to nonfarm employment and income for a growing share of their total livelihood (Kilby and Liedholm 1986). In most countries small, forest-based processing enterprises alone (excluding gathering activities such as collecting and sale of fuelwood) constitute one of the three largest, rural, nonfarm economic activities (FAO 1987). In Africa as a whole, these enterprises are estimated to be the second largest (Page and Steel 1984).

Many people depend on sales of such products as fuelwood and rattan to supplement their farm income year round. Others engage in such activities seasonally, to exploit raw materials or markets available only at particular periods, to employ labor available in slack agricultural months, or to meet seasonally induced cash needs such as agricultural loan payments or school fees. Others resort to these activities to tide them over emergencies, with more people becoming involved in gathering and sale of fuelwood, for example, in years when agricultural conditions have worsened.

The seasonality of some activities is dictated by the availability of the product or raw material and of others by the demands of other activities such as agriculture. For example, in northern Brazil, Babassu palm kernels are gathered and processed during the agricultural slack period. During this period the income earned from these activities represents more than a third of the family's overall budget (May et al. 1985). Because the markets for many locally processed forest products are dependent on rural people's purchasing power, they too are tied to the cyclic nature of agricultural incomes.

Income earned from forest-based activities is often critical to the agricultural cycle, providing funds for establishment of the new season's crop. Forest-based income and employment opportunities are particularly important to the poor, because of the ease of access and the very low thresholds of capital and skill needed to enter and engage in most of these activities. For forest or forest-fringe populations, they can account for the greater part of their income. The level of participation is high for poor women, who often dominate activities such as mat and basket making, which may be performed in or near the home, allowing them to combine these income-earning activities with other household tasks. However, returns to labor from many of these simpler forest-based activities are marginal; markets for their products may be penetrated by lower-cost, factory-made substitutes, and their raw material base is vulnerable to depletion or loss of access.

The poor are therefore especially threatened by a deterioration in the supply of forest materials. It is difficult to discern overall patterns of response to such changes, which can vary widely even within a single area. Stocks of the species that provide some products can decline, while those that provide others remain abundant within the same forest. When faced with raw material problems, producers of some products may persist in the face of declining returns to their labor and some may concentrate on the more profitable of their activities, whereas others may shift out of forest-based activities altogether (De Beer and McDermott 1989). For many, however, the change means a deterioration in their income.

Inputs to the Agricultural System

Many agricultural systems rely on tree cover to restore nutrients to the upper layers of the soil. Where rotational cropping with a period under fallow has given way to continuous cultivation, the nutrient recycling input of trees may be maintained either by intercropping suitable tree species with the farm crops or by gathering green mulch from trees off-farm. Crop cultivation in the Himalayas, for example, is dependent on access to a substantial area of forest from which to cut and carry leaf mulch to maintain soil fertility and to obtain fodder for livestock kept in large part for the manure they produce.

Off-farm forest grazing or arboreal fodder can also be a key component of systems where the numbers of draft animals needed are considerably higher than can be sustained from feed produced within the farm system—dryland

systems, for example, where holdings can be large, and plowing and sowing have to be compressed into a short rainy season. Forest grazing and arboreal fodder are often particularly important seasonally and in times of drought.

Changes in the role of such forest inputs to agriculture can again vary widely from situation to situation or over time. Agricultural trends, such as putting land previously under dryland crops or pasture under irrigation, or shifting to short-stemmed, high-yielding grain crops, or shifting away from cereal crops, can reduce on-farm fodder supplies and increase dependence on off-farm sources of livestock feed. The alternatives to off-farm grazing—such as irrigated fodder crops, stall feeding, and substituting tractors for animals—tend to require more intensive use of capital or labor and are therefore unlikely to be available to the poor. Consequently, shortages of forest grazing or fodder often force the poor to dispose of livestock. On the other hand, trends in livestock management to upgrade quality tend to require a shift to better, cultivated pasture, which reduces the role of forest sources and arboreal fodder.

A wide variety of agricultural implements are made from wood, and many storage and packaging containers are made from leaves, grasses, and other forest materials. They provide low-cost, locally available sources of supply, readily adapted to changing local needs. They tend to be displaced as rural markets become more accessible to outside supplies and to changes in agricultural practices requiring use of standardized equipment and materials. Their role is therefore likely to be affected by policies bearing on development of rural infrastructure and the modernization of agriculture.

Inputs to the Household

For most rural people, foods derived from forests, or from trees they maintain in their farming system, add variety to diets, improve palatability, and provide essential vitamins, protein, and calories (Falconer 1989). The quantities of forest foods consumed may not be great in comparison with the main food staples, but they often form an essential part of otherwise bland and nutritionally poor diets. Forests also provide the greater part of rural people's medicines and other health treatments.

In addition to these supplemental roles, forest and farm tree foods are extensively used to help meet dietary shortfalls during particular seasons of the year, bridging hunger periods when stored food supplies are dwindling and the next harvest is not yet available. The third main role of forest foods in the overall nutritional system is their use during emergencies such as floods, droughts, famines, and wars.

Where people have relatively unrestricted access to forests, forest food is often particularly important for poorer groups within the community. While forest gathering activities are not restricted to the poor, they depend on these activities to a greater extent. They are therefore most likely to be affected by a reduction in the availability of such foods as the forest resource is reduced, degraded, or becomes inaccessible to them. However, reduction in forest cover does not necessarily mean reduced food availability. Bush fallow or farm bush may produce as much, if not more, food. People may adapt by drawing on a wider range of edible plants and animals or trees valued for food may be protected or planted as the forest is removed. People also display considerable adaptability in their use of forest medicines, continuously experimenting with health practices to reflect new needs and the changing availability of medicinal products (Falconer 1990).

Changes in the role that forest food plays in household nutrition may also reflect penetration of rural markets by new food products or changing tastes, rather than decreased availability. Some studies indicate that emergency uses of forest resources are dwindling as people rely to a greater extent on purchased food. In many areas, forest food is no longer consumed, and knowledge about its use is vanishing. In other areas, in contrast, markets for forest foods have grown rapidly—for example, the market for

bush meat in West Africa. However, even where consumption is not declining the nutritional diversity of the gathered food may have decreased.

The impact of declining consumption of forest food is not clear. In some cases these changes have led to a poorer quality diet, most notably as greater reliance on purchased food reduces dietary diversity. Perhaps the worst effect is the progressive reduction of poorer people's food options, especially during seasonal and emergency hardship periods (Falconer 1989).

Few foods can be digested properly uncooked, and cooking is necessary to remove parasites and bacteria. If there is less fuel or time for cooking, consumption of uncooked or reheated food may increase, which could cause a serious rise in disease. A decrease in the number of meals provided may have a particularly damaging effect on child nutrition, as children may be unable to consume enough of the often overstarchy staple food in one meal (Cecelski 1987). However, many other factors are associated with changes in dietary customs, which should not be attributed to fuel shortages alone. In many situations, the lack of food is so great that fuel shortages play only a minor role in determining diets.

Nor does decreasing availability of wood necessarily lead to shortages of fuel. People respond spontaneously to decreases in fuelwood supplies by making a number of adjustments that enable them to cook their food. For those with land, the adjustment process may include using more of the woody material grown on their own land as fuel and changing cropping patterns to include more trees or crops such as pigeon pea (*Cajanus cajan*), which provide woody residues that can be used for fuel. Another response is the oft-cited one of collecting fuelwood from resources further afield. Others include more careful and economical use of available supplies and shifts to other readily available biomass fuels such as crop residues and dried dung (Dewees 1989; Leach and Mearns 1988).

Where rural fuel shortages do exist, the issue may be less one of physical scarcity than of labor shortages, constraints on access, or culturally determined patterns of behavior (Dewees 1989). Thus, the task of obtaining fuel may become a greater burden when women have more to do, as is widely reflected in fluctuations in gathering that coincide with seasonal cycles in agricultural or other pressures on their time (Cecelski 1987). This makes it no less a burden or problem, but makes it less clear that tree planting is a sufficient, or even appropriate, solution.

Policy Issues

A considerable amount of information now exists about local patterns and magnitudes of rural use of forest and tree products. However, most of this information has been collected in the course of village or household studies, which usually had a focus other than forest products. Though some widespread patterns emerge, such as the seasonal role of forest products, this fragmented and disparate information base does not readily lend itself to aggregation and extrapolation. Nor does it provide a satisfactory basis for identification of policy-related problems and appropriate solutions.

Much remains to be learned about the factors that influence people's use of forest products, and about the factors of change that cause them to increase or reduce their use of and dependence on these products. In the absence of sufficient understanding of the dynamics of the interrelationships, there has been a tendency to plan interventions on the assumption that the relationships are static, concentrating on preserving or strengthening the status quo or a situation that obtained in the recent past. Programs and projects to create fuelwood supplies in situations where people have spontaneously shifted toward alternatives that meet their needs at lower cost than interventions to maintain tree-based supplies is but the most notable example of an incorrect choice of response based on insufficient information about the dynamics of change. Shifts toward greater dependence on

forest products, which can happen very rapidly and for a wide variety of reasons, can just as easily be overlooked or misunderstood.

Information about patterns of supply tends to be even less satisfactory than that about use. The recent debate about "extractive reserves" in the Amazon—areas to be set aside exclusively for local people to gather nontimber products—has underlined some of the uncertainties that exist. Though some studies have been interpreted as showing substantial sustainable income-generating offtake, in excess of what could be obtained from alternative uses of the forest (Peters, Gentry, and Mendelssohn 1989), others have argued that such low input-low output activities can never generate more than marginal levels of household security, are easily undermined by institutional as well as market forces, and compare unfavorably with even the simplest alternatives (Browder 1989).

Recent evidence from areas in West Africa indicating that the greater part of the output of most nontimber forest products comes not from the forest, but from bush fallow and farm bush, has drawn attention to the lack of information about patterns of supply. Without more information about which tree-bearing vegetation types and which components of tree stocks are more important as sources of supply, and about differential patterns and rates of depletion, it will continue to be difficult to define what needs to be done to incorporate nontimber forest products into forest and fallow management (Falconer 1990).

Definition of policy agendas dealing with forests and rural welfare thus calls for considerably more research into the nature of the linkages between the two, with particular reference to the following:

- understanding the factors influencing people's use of these products in different situations, and the reasons for changes toward or away from dependence on them;
- understanding the consequences of declining access to forest inputs and the choices between these products and alternatives that constitute people's spontaneous adaptations to diminishing supplies;
- identifying the categories of forest or tree resources that are the most important actual or prospective sources of supply.

Production Systems

Production of forest products for rural use has two main components. One is the management of neighboring forest, woodland, and scrub resources to provide inputs needed in order to complement what is available from on-farm resources. The other is the incorporation into its farming system of planted and managed trees of value to the farm household. With the decline and degradation of nearby forests and common land in most populated parts of the developing world, and the increase in demand for fuel, fodder, and other forest products, there is a general trend toward greater reliance on on-farm resources. However, as is evident from the review in the preceding section, the greater part of what is used at present still comes from off-farm sources. This part of the report looks first at these common pool resources, then at trees within farming systems, and finally at processing and marketing.

Forest, Woodland, and Scrubland Systems

The forest products that rural people draw from nearby areas of forest, woodland, and "waste" land often constitute a major component of their overall agricultural system, filling gaps in the resource and income flows from other resources and providing complementary inputs often critical to the continued functioning of agricultural and household systems. In the past, where rural populations depended on forest resources in such ways, forest use was traditionally subject to local control. In systems of rotational agriculture, management of tree stocks was integrated with fallow, range, and crop management. In settled agricultural systems, areas adjacent to the cultivated land were managed as common property.

The decline in local control. These traditional production and management systems have

nearly everywhere been subject to a long period of state intervention, which typically has progressively eroded people's rights and access to forest resources. Particularly during the colonial era, appropriation as state forests of areas of "unused" forest or of woodland areas within extensive rotational agriculture, seasonal grazing, or food and material gathering systems severely undermined local livelihoods. At best people were left with usufruct rights, application of which was subject to the whim of the state and its officials.

In recent times the reduction in availability of common property resources has nearly everywhere been massively accelerated. Privatization, encroachment, and government appropriation have been the main processes taking resources out of common use. Increasing pressures on what is left have frequently led to its progressive degradation. This process is now so heavily entrenched in policy and practice in many countries as to make further privatization or appropriation seem either inevitable or desirable or both.

The erosion of the extent and quality of the resources on which people draw has been accompanied by a weakening or breakdown in local control and management. In his study of common-property resource management in the dry regions in India, Jodha (1990) found that, of the communities that in 1950 had exercised controls such as rotational grazing, seasonal restrictions, and watchmen, only 10 percent had such controls in 1980, while use of fines, taxes, and fees had ceased altogether. Most common property resources had become open-access types. Privatization, increasing population pressure, greater commercialization, and technological change had all contributed to this breakdown. Possibly the most important factor in undermining communal control, though, has been the replacement of local leadership and authority with centralized political control—"the ever increasing tendency of the State to expropriate the initiatives and activities which belong to people" (Jodha 1990).

Comparable patterns of change have been occurring in other regions. In forest communities in Southeast Asia, traditional methods of access control, usufruct allocation, and conflict resolution have widely become ineffective or have disappeared, undermined by political, economic, and social changes in villages and nations. State assertion of control, first over the resource, then over the land, reduced access and rights of usage. Differentiation within the community and inmigration of outsiders claiming the right to use the resources have widely thwarted efforts to maintain or reestablish local control systems (Poffenberger 1990).

In Africa, large areas of land have been transferred from communal to national control. Management has changed from use rights based on clan membership to the exercise of state-granted privileges and management by restriction and exclusion. The authority of the traditional kin group has been undermined, allowing an increasingly unregulated exploitation of land. With government legislation having become necessary for any change to established practice, groups are discouraged from organizing to manage their local resources (Shepherd 1990).

Despite these negative pressures and trends people still widely depend on common property resources, with the poor usually more heavily dependent than others. Even in the heavily reduced and degraded dryland communal areas of India, it was found that the poor obtained the bulk of their fodder and fuelwood and from 14 to 23 percent of their income from common property resources (Jodha 1990). The poor were also found to benefit considerably from the employment created by common-property resource management activities.

Communal, private, or state management. Recognition of the continuing importance of common pool resources to many rural populations has stimulated much of the recent reexamination of policies and practices that lead to their erosion. The case for bringing use of common resources under either private or government control stems from arguments that common property resources are likely to become degraded because of one or more of the following conditions.

- Absence of individual ownership and man-

agement results in unpriced access and hence overuse.

- Each person gains by increasing his or her level of use, while the costs of that increase are borne by the group as a whole (the "tragedy of the commons" argument).
- Individuals lack assurance as to the outcome for themselves of competing within a management system that would benefit all (the "prisoner's dilemma" argument).

Consequently, it is argued that current circumstances no longer permit effective control by user groups or, more fundamentally, that the changing environment within which individuals must operate induces behavior patterns inimical to collective cooperation. However, these arguments fail to take into account the factors that encourage collective action, even where there is increasing stress on the common resource and its users, and the self-regulating capabilities of groups of users.

They also overlook reasons why the alternatives to communal management may themselves not be sustainable. Because exclusion from a common property resource is difficult, it may not be feasible to privatize it. Private use can also lead to overuse and degradation. Equally, the government may not be able to control, manage, or prevent degradation to a resource it has expropriated (Berkes et al. 1989). Furthermore, privatization tends to shift control away from common property resource users, so that it does not improve the efficiency with which the needs of the latter are met. Privatization—by transferring control of the resource to a limited number of individuals who thereby acquire the social and legal sanction to exclude others—in fact is likely to exacerbate the problems of those without access to private property (Bromley and Cernea 1989).

The thrust toward expropriation also tends to ignore the fact that breakdowns in common property systems may reflect deficiencies in policy or policy implementation rather than deficiencies in the property regime. Common property may not have the same degree of support in law, or elicit the same response when threatened, as private property (Bromley and Cernea 1989). A breakdown may thus reflect neglect of the institutional underpinnings of common property resource management.

Strengthening local management. There are, therefore, strong reasons for questioning the discrimination against collective management and the attempts that have been made to reverse it. However, interventions to this end have had limited success. In what is by far the largest, the social forestry woodlot program in India, the woodlot projects managed by forest departments have inadvertently shifted use of communal land from products for local use to higher-valued wood products for sale outside the community. In practice, the benefits will be transferred from those who earlier used the common land to those who will gain from the income accruing to and spent by the community as a whole. A combination of forest management prescriptions more closely tailored to foresters' than to villagers' skills and experience, uncertainties about access to the benefits, use rules set by governments that are not always compatible with local needs and possibilities (and that are not open to change locally), and planning and control systems centered in local government bodies rather than in user groups has meant a widespread lack of local confidence in the outcome. The planned transfer of responsibility for management of woodlots on common land from the forest department to the community is consequently seldom taking place, so that the programs run the risk that in effect they are unwittingly converting common property resources into state-controlled resources (Arnold and Stewart 1991). Though successful in increasing the productivity of the sites used, the interventions have not been well adapted to the institutional situation of the region (Jodha 1990).

In common with most other "woodlot" programs and projects, the social forestry interventions in India are predominantly on land outside the forest. More promising potential for success seems to exist where the interventions seek to effect joint management of forestland, building on the mutual benefits to

be obtained from greater access to forest products by local people and reduced protection costs for the forest department. Features of positive experiences in a number of areas in north India and Nepal include the existence of substantial amounts of government land available for common property resource use, and similar patterns of use of forest products throughout the community. The most successful examples seem to occur in areas where the technical knowledge already existed at the village level, and the missing ingredient was an effective agreement between village institutions and local representatives of the government. Experience suggests that such institutions and working arrangements can mature in a relatively short period.

However, progress is still the exception to the rule. A survey of experience in Southeast Asia reports two main impediments (Seymour and Rutherford 1990). One is the reluctance, or inability, of forest departments to proceed with or implement devolution of responsibility to the local level, particularly where they perceive that this will threaten their control over a timber resource. Improved access to use of forest products therefore tends to be concentrated in degraded forest. The other constraint arises from pressures within the community, such as inmigration of outsiders, that undermine or overwhelm agreed systems of local control.

Problems tend to be more pronounced where access to forest products is combined with rights to cultivate land—tree *pattas* (leases) in India, stewardship contracts in the Philippines, STK land entitlement certificates in Thailand, and forest management agreements between the State Forest Corporation and groups of farmers practicing *taungya* (*tumpang sari*) on forestland in Java, Indonesia, for example. Additional problems with these arrangements include concern on the part of governments or government departments that a concession allowing temporary use of forestland for cultivation will lead to permanent transfer of the land from forest to agriculture. Such schemes may also founder because participants lack the resources to bring the degraded land assigned to them into productive use. Allocation to individuals of land that previously was available for common use may also raise problems of choice between and exclusion of previous users.

A problem common to nearly all of these experiences, both promising and unpromising, has been weaknesses in the legal framework. Effective local or joint control requires that government be both willing and able to legitimize and empower the local controlling institutions and to help them enforce their rights. Even the most promising approaches tend to be undermined by failures to do so. Governments are commonly slow to amend laws or to implement them. Thus in India even the most robust recent initiatives have been threatened by their uncertain legal status (Chambers, Saxena, and Shah 1989). Interventions may be at variance with existing legislation, or the implementation of enabling legislation, where it exists, may be neglected. More widely, forest departments fail either to honor their own obligations or to enforce those of right holders (Seymour and Rutherford 1990).

It has been argued that, given the constraints to legal reform, priority should be given to making progress within the existing framework, exploiting gaps in existing law, and clarifying the position of right holders within the law by getting forest departments to enter into contractual agreements with them. However, experience in Southeast Asia suggests that this can be counterproductive because the poor are usually at a disadvantage in legal cases. Clarifying their position can make the situation of existing right holders worse, putting even their existing de facto rights at risk (Seymour and Rutherford 1990).

Policy issues. The identification of interventions to strengthen local access to forest products has benefited from the recent upsurge in research on common property resource management. However, as Campbell (1990) has pointed out, in practice, most, if not all, land—especially forest, grazing, and fallow land—is subject to overlapping de jure or de facto property rights. The development of

policies and strategies based on the assumption of clear-cut distinctions between private, state, communal, and open-access tenure situations may therefore be of limited use.

In addition, most research on communal management to date has been concerned with resources—fish, water, range—which, unlike forests, can only be sustained if their use is controlled collectively by the users. The incentives to secure collective management of those resources are therefore more compelling, and success with an approach to collective management in other sectors will not necessarily be relevant to the forest-based sector. It also has to be recognized that the past is likely to provide only a partial guide to the future. The lessons learned from study of surviving systems now under stress and in decline may yield only limited information about conditions favoring successful introduction of new and contemporary forms of common property management. This is particularly likely when, as is often the case in forestry, the new management initiative seeks not to strengthen control over existing resources but to create a new and different resource.

Research into policy and other issues related to management of forest resources for local use is essentially still at an early stage. At least three areas of concern that require further research can be identified.

The first concerns the generally unfavorable policy environment for local control that characterizes the present situation in many countries. The low returns and high social costs associated with trying to control common property resources in the face of progressive intrusion by the government may prove unacceptable to users to the point where they prefer to leave management to the government or to privatize. Unless a more positive policy framework emerges, the future supply of nontimber forest products seems likely to move predominantly toward trees grown within farming systems or toward public resources exploited through open access or under rules laid down by the forest department or some other arm of government.

The second relates to the potential for joint management of resources on state land by users and the forest department. As Shepherd (1990) has pointed out, there is a tendency for this to be seen as a cheap option for under-resourced forest departments, in which control and ownership is retained by the government and local people take on the responsibilities of management. Though the potential of more genuine and sustainable partnerships has attracted attention in the last few years, little has emerged that enhances understanding of which institutional mechanisms are most likely to effectively respond to the particular strengths and weaknesses of rural user groups and forest departments, operating with imperfect information (Stewart 1990).

The third concerns the internal institutions within the community using the resource. When local institutions have broken down under the pressures of change, it is not to be expected that new village institutions capable of controlling resource allocation and use can be created easily. Recent review studies have stressed the difficulties that all but small, relatively homogeneous and isolated collective groups are likely to encounter when faced with market, demographic, and political pressures. Some authorities have rejected the likelihood that communal tree resources can be managed effectively at all in such circumstances. But viable systems do exist—often quite complex and involving substantial market transactions—and they have been shown to be capable of evolving quite rapidly.

Cutting across these three essentially institutional areas requiring policy attention is a fourth concerning policies that distort the values and uses of the resources on which rural people draw. Many of the policy measures that restrict local access to public forests stem from the priority attached to timber over nontimber products, and to urban/industrial users over rural users. As was noted in the first part of this paper, exploration of the potential for changing this imbalance is severely hampered by lack of information about these values and about how to incorporate management for locally valued products into timber and environmental management.

Rural users tend to be further discriminated against by the widespread practice of making forest products available at heavily subsidized prices. These encourage use well in excess of what would be efficient. As urban markets grow, supplies previously available to rural users are increasingly diverted to urban users. In addition, maintaining prices at levels well below replacement costs inhibits investment in creating or managing tree stocks.

The main policy-related actions surrounding supply to rural users from existing forest resources may be summarized as follows:

- within a policy environment that is generally unfavorable to local control and management, identifying those resource, institutional, and user circumstances in which local control could be usefully pursued;
- defining policy and other changes that would facilitate joint management of state forestlands by forest departments and local user groups;
- defining the appropriate role of the government in supporting and facilitating viable user-group mechanisms of different kinds; and
- identifying changes in forest policies and administrative practices that would create a better balance between local, industrial, and environmental values in the management of reserved forests.

Trees in Farming Systems

As common property resources disappear or are degraded, farmers everywhere have sought to shift the production of outputs of value on to their own land by protecting, planting, and managing trees of selected species. In recent times the process of adding trees to farming systems has been accelerated or transformed in some areas by the growing commercialization of fuelwood and other tree products, and the consequent emergence of the growing of trees as a cash crop.

Not all intensification of forest product and land use leads to increased incorporation of trees into agriculture. Some of the changes in agricultural land use may result in the elimination of trees from farming systems rather than their retention or establishment. Prominent among such pressures are competition with crops for light, water, and nutrients on intensively cropped land; new agricultural techniques (use of tractors, for example); broader land use practices (burning, free grazing); changes in control of the land (privatization, nationalization); and reduction in the rotational cycle to the point at which desirable trees are no longer able to be reestablished.

Other changes tend to reduce or eliminate the need for trees. Irrigation of dryland, for example, is likely to reduce the need for draft animals, and hence for fodder, and is also likely to create new and more productive sources of fodder than could be provided by fodder trees. Alternatives may be available that present a lower opportunity cost to the farmer than creating supplies of tree products—hence the widespread use of dung and crop residues in place of fuelwood. Other economic options available to the farm household—off the farm as well as on it—may offer a better use of its resources than adding or intensifying tree management.

The balance between supplies from tree stocks off-farm and from stocks managed and planted on-farm varies widely with the agroecosystem and the patterns of land use, population pressure, and level of activity associated with different agroecological situations. Within a particular agroecosystem, farmer involvement in tree growing appears to be largely related to changes in the availability and employment of land, labor, and capital, and to the progressive emergence of markets for tree products such as fuelwood and poles. Variations in tree growing patterns within this framework seem to reflect, among other things, variations in the efficiency of operation of factor markets, different stages in the process of agrarian transition, and different patterns of tenure.

Factor availability. Where agroecological conditions favor vertically structured joint tree-crop-livestock systems as potentially the most productive use of the site, farmers may respond

to declining land availability through more intensive intercropping of trees and other perennial and annual crops. Such an evolution has been quite widely observed in the humid tropic belt in Asia and Africa, where home gardens are an important part of farming systems (Falconer and Arnold 1989).

Where labor resources are limited, forcing farm households to turn increasingly to off-farm employment, low-input tree crops may be used as a way of keeping land productive. This is more likely to happen where poorly functioning labor markets prevent the adoption of more productive labor-intensive uses, and where leasing out the land consequently withdrawn from crop production is not attractive to farmers. Tree crops may also be used as a means of reducing labor supervision problems (Srivastava and Saxena 1991).

Tree growing may also be adopted where lack of access to capital prevents farmers from adopting more capital-intensive crops. In highland areas in Kenya, for example, this appears to be one of the principal factors determining a farmer's choice between tea and woodlots (Dewees 1990). Farmers may also grow trees as a way of building up a flexible reserve of capital.

Trees as cash crops. Growth in markets for short-rotation wood products have often stimulated substantial tree growing by farmers. This response has been most pronounced in areas where wood is in short supply, where site and tenure conditions are favorable for tree growing, where land uses requiring low labor input are favored, and where there has been a transition from predominantly subsistence-oriented agriculture toward greater involvement in commodity markets.

The expansion of the growing of trees as field cash crops has aroused concern, notably in India, that it is diverting land from production of essential foods and is reducing rural employment. This argument tends to overlook the factors that are causing farmers to withdraw land from coarse grain production and to find less labor-intensive forms of land use, as well as the features of tree growing that make it a logical response to these pressures. The shifts into tree growing therefore appear to be as much, if not more, a response to policies related to crop and input prices and minimum wages as to policies that provide subsidized tree-planting stock.

Some of the concerns expressed about use of arable lands for tree growing are those that apply to all cash crops—namely, that it may undermine the household's capacity to meet its essential food needs. The suitability of crops of trees such as eucalyptus, which could put household food security at risk, can be questioned on this count. Because these trees produce only a single product, income from them is potentially vulnerable to market fluctuations; moreover, they provide income in "lumps" followed by periods with little or no income. Multipurpose trees and multispecies systems such as home gardens are more likely to contribute to a household economy with a sound mix of subsistence and cash crops. Tree monocropping is likely to be an appropriate option only if the household has access to other sources of income or food and if there are reasonably stable markets for the tree products (Falconer and Arnold 1989).

Trees are also grown to help diversify farm production, to provide products and income in the period between the main harvests, and to help bridge the peaks and troughs in seasonal demands for labor. Farmers also use trees to help manage risk where repeated drought threatens other crops (Chambers and Leach 1987).

Tenure. The presence or absence of trees is widely associated with rights to land. Trees are often employed to mark the boundaries between one property and another. The main focus, though, has been on the impact of security of tenure on the tree-growing decisions of farmers. It has been assumed that sharecropping and other forms of tenancy, systems of customary tenure wherein land is a common pool resource, and customary and legal rights associated with the presence of trees all constrain or inhibit tree growing, because of the uncertainties they create about

access to benefits from production activities with a relatively long time lag between investment and harvest.

However, the relative importance of security of tenure may have been overstated. In customary land-use systems in Africa, for example, rights, in particular grazing rights, appear to be more important than tenure. Customary tenure may already provide the necessary assurances of returns to capital and labor, so that tree-growing decisions are determined more by considerations of profitability (Cook and Grut 1989; Shepherd 1990).

The tendency to focus on the need to increase security of tenure to the individual in order to encourage investment in a relatively long gestation crop such as trees is therefore probably often misplaced. Changes in both formal and customary tenure are usually difficult to accomplish, so that it can be unrealistic to design project interventions that require such changes. Indeed, it has been argued that attempts to change tenure can be counterproductive. Past changes stemming from the colonial era have often engendered a strong distrust of government intervention. As was noted earlier, moves to individualize common pool resources can disenfranchise large segments of the local population. The prospect of change can itself introduce uncertainty and so inhibit investments in long-term activities such as tree growing.

Policy issues. In the first generation of projects designed to stimulate and support private tree growing by farmers, there was a widespread tendency to develop projects as though they were effectively isolated from many of the key influences on them—particularly economic forces. The assumption that farmers plant trees to meet subsistence or environmental needs and that these are not bought or sold in the market place was reflected in projects designed as though they were divorced from and immune to market forces. Some even attempted to prevent participants from selling their produce on the grounds that this was contrary to the service function assumed to be the goal of community or social forestry. This reflected the priority that was given in the late 1970s and early 1980s to increasing supplies of fuelwood, in response to what was perceived to be widespread shortages in the subsistence sector (Arnold 1991).

The perception that this was an urgent problem, requiring action on a massive scale, often resulted in pressures being placed upon forest services to achieve overly ambitious planting or seedling distribution targets —pressures that all too often resulted in priority being accorded to quantity rather than quality (or appropriateness). Many tree-planting support programs have consequently been characterized by poor technical prescriptions and practices, with implementation being forced to run ahead of capability to provide adequate extension and technical packages.

The emphasis on meeting subsistence needs tended to be accompanied by an underestimate of the influence of market demands for wood products. As forest products such as fuelwood, fodder, and fruits become progressively commercialized, and with the growing dependence of farm households on income to meet at least part of their needs, the distinction between production for subsistence or for sale has progressively less meaning. A producer will not only sell what is surplus to his or her subsistence needs but will sell a commodity needed in the household if the opportunity cost of doing so is advantageous—hence the widespread phenomenon of households short of fuelwood selling wood.

One result of promoting tree growing as though it were outside the forces of the market system has been failure to match project production to market possibilities or to link producers to markets. The collapse of prices of poles in northwest India, as large quantities of farmer-grown material entered the market in the late 1980s as a consequence of social forestry support programs, reflected a lack of market information and a lack of attention to the functioning of this emerging market. Most states still have in place restrictions on harvesting and sale of wood products by private producers that severely hinder the efficient functioning of these markets (Chambers,

Saxena, and Shah 1989; Saxena 1990). In addition, farmers had to compete with fuelwood supplied to urban markets from state forests at subsidized prices. As they experience these adverse developments, many farmers are now withdrawing from tree growing in the areas affected (Saxena 1990).

Similarly, projects have generally neglected to put producers in touch with sources of higher inputs, such as credit available to those seeking to produce for the market. Indeed, provision of credit, which has featured prominently in government programs to encourage tree-crop cultivation, has been notable for its absence in most farm forestry projects.

Project interventions have instead centered on provision of subsidized planting stock or cash payments or both to offset establishment and maintenance costs. Originally intended to encourage pursuit of essentially social and environmental goals, in practice these interventions are generally supporting production for the market. Recent evaluations of projects in India suggest that there is a danger that this type of intervention is encouraging cash cropping of trees in situations where it is unlikely to be profitable. In Bihar, farmers appeared to be planting in response to the short-term returns from the cash payments provided rather than the longer-term returns from investment in trees, leading to undesirable distortions in land use—such as displacement of sharecroppers and reduction in small-farmer subsistence production to the point where household food security could be adversely affected (SIDA 1990).

The main policy-related issues affecting the incorporation of tree stocks and outputs within agriculture are the following:

- understanding the potential of and constraints to tree growing in different agricultural land management systems;
- matching agroforestry interventions and targets to farmers' needs, capabilities, resource availability, access to markets, and so forth;
- more accurate targeting of subsidies and other policy and economic interventions to meet these needs and targets.

Processing and Marketing

As was noted in the first part of this report, small rural enterprises that process and market forest and tree products play an increasingly important role in the household economy. They provide many of the products that farm households require at lower cost than the modern sector. Most are operated in conjunction with farming and provide supplementary income often critical to the functioning of the farm, helping to smooth out seasonal production-income cycles.

Small processing enterprises predominate where there are factors that favor local processing, such as dispersed raw materials, small markets, or high transport costs; where there are economies of small scale, such as in handicraft production; or where subcontracting is more efficient than are integrated operations. The large component of small-enterprise operations in the forest sector reflects the size of rural markets for forest products and the dispersion of these markets across large areas with a relatively poor transport infrastructure, so that they are more effectively supplied locally (FAO 1987).

Small enterprises tend to be eroded, however, by competition both within the small-enterprise sector and between small and large enterprises. Because of the very low capital and skill requirements for entry into many forest-based activities, it is all too common for many more production units to exist than can be supported locally. This results in high failure rates and prevents the generation of profits that can be plowed back into the business.

Improvements in rural infrastructure that enable products from outside to be placed in rural markets at less cost put small rural enterprises under further pressure. Factory made furniture tends increasingly to replace the local artisanal alternative, and plastic mats and basketware displace similar products made from vines, reeds, and grasses. The seasonal nature of rural demand, tied to the availability of agriculture-based income, further disadvantages small units, which are less able to meet these surges in purchasing than larger enter-

prises with sufficient working capital to be able to hold stocks.

The sheer smallness of most enterprises not only renders them vulnerable to competition but hampers their transition to larger, more viable size. They depend heavily on inputs from the entrepreneur and his or her family. Too small to be able to draw on most rural credit facilities they are seldom able to absorb the costs of moving from the household to larger separate premises and powered equipment. Those that do make the transition tend to find themselves confronted with a policy environment that compounds many of their problems, because it is oriented toward large modern-sector industry. Thus small enterprises often face higher import tariffs, tax concessions, and subsidized credit restricted to or directed at large-scale firms. Even where such overt restrictions do not occur, licensing and other burdensome bureaucratic procedures tend to exclude them from access to available incentives or assistance.

Diminishing forest stocks are a particular threat to small enterprises, as they are seldom able to create or conserve their own tree resources. Their forest raw material problems are often worsened by unfavorable harvesting controls, exclusive allocation to large users, complicated licensing or auctioning procedures, plus demands for heavy deposits or other insurmountable preconditions, high prices due to state monopolies, and monopoly distribution systems (FAO 1987). Access to raw materials can be further restricted by the impediments to private production and sale and by poorly functioning timber markets, discussed in the previous section.

There appears to have been little in the way of intervention programs specifically designed to support small-scaled, forest-based enterprises. A number of possible strategies have been identified, based on the experience of other enterprise sectors that have evolved successfully. These include concentrating on activities where small enterprises continue to have a competitive advantage, such as niche markets, specialization in products such as handicrafts not amenable to factory production, and subcontracting.

However, more needs to be known about the differing potential of the various types of activity within the forest-based total before it is clear what the relevance of each might be to this group of activities. The little empirical evidence that is available suggests that while wood-based enterprises such as carpentry, which is usually organized on a workshop scale, can compete quite robustly, single-person enterprises based on materials such as grasses, reeds, and vines—mat making, for example—show only marginal returns to labor and would not survive competition or the emergence of alternative employment for those engaged in them (Kilby and Liedholm 1986).

The main policy actions may be summarized as follows:

- securing a policy environment that is neutral to scale and location between modern-sector and small rural enterprises;
- identifying those small-scale, forest-based rural enterprise activities that have the potential to continue to be viable and competitive in the face of change and those that do not, and devising support strategies for those that do;
- developing policy measures to improve the access by small enterprises to forest-based raw materials and to incorporate nontimber outputs into forest management.

Conclusions

Awareness that forest and tree outputs are important components of most rural household economies has increased substantially in recent years. But this awareness has not yet been matched by an information base that allows identification and execution of interventions with reasonable confidence. There is a continuing priority need for research into the social and economic functioning systems of supply and use of forest products within the rural economy.

Although supplies of products of local value come overwhelmingly from existing resources, interventions have been concentrated on

creating new resources through planting. Even communal programs have usually given higher priority to creation of woodlots than to management of existing tree stocks. Such attention as has been given to natural resources has been concentrated on nontimber products from forests. However, it is becoming apparent that fallow, farm bush, scrubland, and other formations where the wooded cover has been altered by human intervention are often more important sources of supply of these products than the forest, and therefore warrant more attention in research and intervention programs.

Recognition that improved management of resources for local use would be more readily achieved through increased local involvement is by now widely accepted. There is as yet less recognition in the design of interventions of the constraints to local control imposed by the generally negative policy environment created by the progressive intrusion of the authority of the government, and by land allocation and other policies that undermine common property. The potentials for reversing counterproductive policies and practices and the negative bureaucratic attitudes that such a policy environment induces are probably best where increased local involvement could be achieved on forestland within the state domain. Joint management systems and small gathering and processing enterprises are particular components of the rural forest-based economy that could benefit from a more supportive forest policy framework.

As forests and common land resources decline or deteriorate, tree stocks on farms will become progressively more important. Interventions in support of farm forestry have in the past tended to be overly narrowly focused, underestimating, first, the economic dimensions of farmer decisions and, subsequently, factors that enter into the balance between supply and demand of marketed products. It should be recognized that trees in farming systems usually perform multiple functions. Adoption of approaches to research and intervention design that draw on lessons of experience with tree crops and other agricultural crops on access to markets, credit and other services, and subsidies, could contribute to more accurate targeting of policy and other interventions in farm forestry.

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CHAPTER 3

Population Pressures, Deforestation, and Land in the Wet Tropical Forest Zones: The Technical Dimensions

JOHN K. COULTER

Deforestation has been a cause of concern for centuries. A statute passed in England in the 16th century ordered that there "should be left in every acre twelve standels or stores or oak," and a statute also forbade felling to make charcoal for iron smelting. Among the attempts to protect tropical forests was an edict issued about 1800 in Madagascar forbidding the felling of forest (Oxby and Boerboom 1985). Such decrees have had little impact; many so called forest reserves are now nothing more than lines on maps and, as this paper will show, the annual rate of deforestation appears to be increasing.

The demand for tropical timbers, the incentives to exploit "cheap" land for pasture, and the inexorable increase in the number of small farmers that depend on low-input, low-output agriculture for survival provide the basic economic reasons for the pressures on these tropical lands. Farming systems depend on land rotation, whereby forests or secondary woodland are felled and burned; crops are established for one or a few years; and the land is then abandoned to natural regeneration for varying periods, determined by the availability of unused land. Where land is relatively abundant from the farmers' viewpoint, the return per day of labor is of primary importance. As Ashby (1985) points out, small farmers faced with a choice between maximizing present income in the short term or making an investment in long-term benefits will usually opt for maximizing present income, even if this implies destruction of the natural resource base in the long run.

The detrimental effects of deforestation are well publicized, and governments are becoming increasingly concerned about the problems, particularly the long-term aspects of environmental degradation. Although much attention is being paid to the causes of deforestation and its potential effects, little attention is being directed to technical innovations that could replace present systems and provide farmers with livelihoods at least equal to today's.

Technical solutions must of course be combined with policies that encourage the farmer to invest in his land—to move away from the short-term strategy of maximizing today's income at the expense of the rural resource base. However, because of the complexity of the problems and the number of people affected, there are no simple answers. Indeed it is likely that small farmers will continue to clear available forestland for agriculture at the present rate into the foreseeable future. If the growth in the number of people dependent on low-input, low-output farming continues, expansion of the rate of forest clearing seems likely.

The Physical Environment

From a biological point of view the use of land is determined by soils, climate, and topography. Hence present use—for example, tropi-

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cal forest—and potential use—retention or replacement of forest—are related to these factors. In many cases the soils may be so poor, the climate or topography so adverse, that the land should obviously remain a forest; small farmers will recognize this and avoid such lands except under extreme economic pressures.

Climate

Wet equatorial climate occurs mainly within 5° north and south of the equator, where heavy rainfall is frequent, averaging 2,000-3,000 millimeters per year (Webster and Wilson 1980). Some months may be drier, but rain usually occurs in every month. As there is little variation in the high temperatures throughout the year, the climax vegetation is evergreen rainforest. Myers (1989) defines tropical forests as areas receiving not less than 100 millimeters of precipitation in any month in two years out of three and annual temperatures in excess of 24° centigrade. This definition includes areas north and south of the equatorial belt in which some of the trees will be deciduous.

This type of climate is important for agriculture because temperature is never limiting to crop growth and there is usually adequate moisture, though short, dry periods can affect yields, particularly of cereals. Pests and disease are active throughout the year.

Soils

In the humid tropics there are important areas of volcanic soils, which have a good structure and large reserves of plant nutrients, but these areas have nearly all been developed for agriculture. There are also substantial areas of alluvial soils, either of marine or riverain origin. These may be covered with peat or contain pyrite, which produces high acidity on drainage. Otherwise, they are also rich soils and widely cultivated.

Because of the nature of the topography, parent materials, climate, and age of the landscape, vast areas of soils in tropical rainforest are highly weathered and leached. These conditions generally give deep reddish or yellowish acid soils. In the various tropical soil classifications, they are classified as haplorthox, paleudults, tropepts, ferralsols, ferric acrisols, and arenosols. The soils are characterized by a large amount of clay with low activity, very little silt, low exchangeable bases, and high saturation with aluminum, so that only aluminum-tolerant crops will flourish on them. Within these soils are areas with massive lateritic concretions that render cropping difficult. The total area of highly weathered and leached soils in the low-altitude, humid tropics can be estimated from small-scale soil maps. These would indicate that about 70 percent of the area is covered with these soils.

The forest cover usually appears to be quite uniform over large areas of these soils, but more extreme nutrient conditions are reflected in the vegetation. Highly alkaline soils will carry a distinct forest type, as will those derived from ultrabasic rocks. The high level of heavy metals in the latter will produce a type of xerophytic vegetation, which usually grows where there is little moisture, even in high rainfall areas.

Soil Mapping

Many areas of tropical forest have been soil mapped, but mostly at a very small scale. In a review of data on soils in the Amazon Basin, Sombroek (1989) found that some mapping had been done at a 1:250,000 scale, but a large program designed to produce 1:1,000,000 maps was based on limited field data. Only about 6 percent of the soils in the Amazon are of good fertility, though this represents some 25 million hectares. Other fertile soils include varzeas, the use of which is dependent on the local flooding regime. A larger percentage of the soils are haplorthox and paleudults, relatively well-structured soils with low plant nutrients. However, about 25 percent of the Amazon (120 million hectares) has extremely poor soils, which are unsuited for agriculture and should remain under the existing (general-

ly poor) vegetation.

A land-use survey and maps of Indonesia at a scale of 1:250,000 have recently been published (Indonesia, Republic of, 1990). The huge area (1.9 million square kilometers) to be covered in a short time meant that there was limited ground control for much of the mapping, done mostly by interpretation of remote sensing data. (Ninety-five percent of the time was spent on interpretation, and only 5 percent on fieldwork.)

A substantial amount of soil mapping has been done in humid West Africa, and schematic mapping at a small scale has been done in Zaire. It is worth noting that, although soil classification has evolved over the years, the methods of describing and analyzing soils have changed rather little, so that older soil maps still retain their value. In Malaysia, a schematic soil survey at a scale of 1:500,000 covered the country. This work was supported by a substantial amount of field sampling (Coulter 1972). Table 3.1 gives some analytical characteristics of these soils.

These analyses illustrate some of the basic properties of soils in the humid tropics. Weathering for long periods under hot, humid conditions results in highly acidic soils, mostly with highly exchangeable aluminum (Al). Only aluminum-tolerant crops, such as rubber, oil palm, cassava, upland rice, and cowpeas, will flourish on these soils, except where there is a large amount of soil organic matter—after felling forest, for example.

The activity of the clay, as determined by surface area, means that some soils, the Serdang series, for example, would require rather little lime to raise the pH level, whereas the Selangor series would require much more. The Kuantan series is illustrative of soils with high iron and aluminum oxide content and a capacity to adsorb large amounts of phosphate.

Topography

Topography also affects plant growth because of its influence on soils. Steep slopes often have shallow soils, but these will normally be higher in plant nutrients because of the regenerative effects of erosion. Slopes up to 100 percent are often cleared for cultivation; where most of the stumps and logs remain, as in small-scale shifting cultivation, soil loss is greatly restricted.

Exploitation of Forestlands

The term "deforestation" has been used by Myers (1989) to describe the complete destruction of forest cover. Remote sensing is now the

Table 3.1—Chemical and physical characteristics of some important soils in Malaysia (0-15 centimeter horizon)

Soil Series	Parent Material	pH(CaCL2)	Percentage of Aluminum Saturation	Surface Area
				(grams/square meter)
Rengam	Medium granites	4.0	65.5	111
Kuantan	Basalts	4.3	34.2	248
Serdang	Sandstones	3.8	86.2	68
Selangor	Marine alluvium	3.6	77.7	188

Source: John K. Coulter, "Soils of Malaysia: A Review of Investigations on Their Fertility and Management," *Soils and Fertilizers* 35 (1972): 475-498.

most widely used method for measuring its extent. Other records, for example, government forestry department figures, can be misleading in some countries, where areas recorded as forest reserves are totally devoid of trees.

The American LANDSAT series and the French SPOT are the major satellite systems used in remote sensing. LANDSAT 4 and 5 provide complete coverage of the entire globe every 16 days, whereas the cycle of SPOT is 26 days. Frequent monitoring in the humid tropics is not possible, however, because of cloud cover: cloud-free scenes of larger sections of the tropics have still not been obtained from LANDSAT and SPOT, according to NRI. NOAH AVHRR satellites 10 and 11 are currently operational. Together they provide four passes over a particular ground station during a 24-hour period. However, resolution at the nadir is only 1.1 kilometers. Satellite-borne synthetic aperture radar (SAR) has been used for land use classification. It is not affected by cloud cover, but the resolution of the radar images is poor at high altitudes, though this can be improved with special techniques (Skidmore, Wood, and Shepherd 1987). Westman, Strong, and Wilcox (1988) used LANDSAT multispectral scanner images, derived from two periods 15 years apart, to measure deforestation in an area of Uganda. They calculated that the net reduction in forest cover, counting regrowth as forest cover, was 28 percent over this period. They expressed the annual rate of geometric decline by the equation $b/a = Xn$, where a is the total forest cover initially, b is the forest cover including regrowth at the end of the measurement period, and n is the number of years between measurements. The annual rates for Africa, thus calculated, are shown in Table 3.2.

Iverson, Graham, and Cook (1989) report on studies in the Amazon Basin, using AVHRR imagery, which show that the deforested area in Rondonia increased from 4,200 square kilometers in 1978 to 27,000 square kilometers in 1985 and 35,000 square kilometers in 1987.

Table 3.3 gives the results of a recent detailed study of land cover in Indonesia, using a variety of remote sensing techniques (Indonesia, Republic of, 1990). About 30 percent of the area in Sumatera is under extensive land use and 18 percent is under intensive land use; in West Kalimantan, on the other hand, 36 percent of the territory is used extensively and only 4 percent is used intensively.

Table 3.2—Annual rates of geometric decline of forest cover, Africa

Country	Annual Rate
	(percent)
Congo	0.1
Gabon	0.1
Zaire	0.2
Sudan	0.6
Tanzania	0.7
Uganda	1.3
Ghana	1.3
Kenya	1.7
Rwanda	2.7
Nigeria	5.0
Cote d'Ivoire	6.5

Source: W. E. Westman, L. L. Strong, and B. A. Wilcox, "Tropical Deforestation and Species Endangerment: The Role of Remote Sensing," *Landscape Ecology* 3 (1989): 97-109.

Myers (1989) in his summary of rates of deforestation gives the total for 26 countries as approximately 140,000 square kilometers per year, equal to 1.8 percent of existing forest. He gives annual percentages that vary from 14.3 percent in Nigeria to 0.3 percent in Gabon and 0.4 percent in Zaire. However, Brazil with 50,000 square kilometers of annual deforestation accounts for more than one-third of the total area deforested each year.

While these figures provide useful guidelines for the extent of deforestation, they tend to become hallowed by frequent repetition. Like many statistics for the tropics, they are probably not very accurate. Westman, Strong, and Wilcox (1988), for example, quote threefold differences in rates of tropical forest clearing from two studies, one showing 7.4 million hectares per year, the other 22 million hectares

Table 3.3—Land cover in major regions of Indonesia

Land Cover Type	Irian Java		Kalimantan South		Kalimantan East/North		Kalimantan West		Sumatera		Indonesia Total	
	Area[a]	Percent	Area[a]	Percent	Area[a]	Percent	Area[a]	Percent	Area[a]	Percent	Area[a]	Percent
Forest	349,583	84.0	115,144	76.0	196,710	84.0	87,006	59.0	233,235	49.0	1,197,005	63.0
Intensive Use												
Upland	43	<0.1	34	<0.1	0	0.0	0	0.0	17,073	3.6	53,215	2.8
Wetland	739	0.2	2,236	1.5	5,601	2.4	1,464	1.0	21,558	4.5	76,664	4.0
Tree crops	145	<0.1	418	0.3	1,160	0.5	4,245	2.9	35,494	7.5	75,577	4.0
Agroforestry	0	0.0	0	0.0	0	0.0	0	0.0	5	<0.1	5	<0.1
Reforestation	0	0.0	0	0.0	239	0.1	124	0.1	0	0.0	1,288	0.1
Settlements	794	0.2	17	<0.1	971	0.4	300	0.2	13,592	2.9	38,415	2.0
Extensive Use												
Shifting cultivation	12,873	3.1	24,860	16.2	8,889	3.8	20,847	14.1	34,286	7.2	116,988	6.1
Grassland	32,135	7.7	2,706	1.8	8,143	3.5	3,398	2.3	27,593	5.8	102,753	5.4
Bush/scrub	3,376	0.9	5,053	3.3	9,708	4.1	28,463	19.3	76,750	16.1	188,749	9.9
Other												
Water	8,409	2.0	68	<0.1	2,265	1.0	1,660	1.1	4,652	1.0	21,815	1.1
Unvegetated	3,975	1.0	0	0.0	0	0.0	4	<0.1	116	<0.1	5,705	0.3
No data	2,328	0.6	2,068	1.3	1,014	0.4	19	<0.1	10,995	2.3	30,872	1.6
Totals	414,800	100.0	153,604	100.0	234,700	100.0	147,530	100.0	475,309	100.0	190,905	100.0

Source: Republic of Indonesia, *The Land Resources of Indonesia: A National Overview* (United Kingdom: Republic of Indonesia, 1990).

[a] Area is in square kilometers.

per year. Apart from the problems of government reporting and remote sensing estimates, the definition of what constitutes "deforestation" varies. Commercial logging may be very selective, removing only 10-15 trees per hectare. Logging may cause variable damage to the remaining forest, but this will not normally be detected by remote sensing. Cleared areas, exceeding 50 hectares can be detected, but fast regrowth where climates are humid can cause misinterpretation.

The Causes of Deforestation

The major causes of deforestation are timber and fuelwood extraction, including wood for charcoal and clearing for farming by an ever-increasing rural population, already present or moving into the forest zones.

The value of fuelwood in the developing countries is enormous. TAC (1990) places the annual gross value of nonconiferous fuelwood at approximately US$46 billion, second only to rice and well above the values of maize and wheat. Nonconiferous sawlogs, a large proportion of which are from the humid tropics, are almost equal in value (US$44 billion). The magnitude of these figures indicates that the livelihood of large numbers of people are involved in one way or another with tropical timbers. Whether timber and fuelwood extraction maintain, degrade, or destroy the forest depends on how they are extracted; for example, Myers (1989) states that in Malaysia logging destroys the forest to such an extent that it can be regarded as deforestation rather than degradation. Where properly controlled, logging need not lead to such extensive degradation.

Clearing for agriculture is the most important cause of deforestation. Three main forms of agriculture can be distinguished. The first is the high-input, high-output system that has been developed for tree crops such as rubber and oil palm in Malaysia and Indonesia. Common practice involves removing the underbrush, felling trees by chain saw and axe, burning, stacking, and reburning. After the burn, leguminous cover crops are established, which will be shaded out in three-to-four years (Bevan, Fleming, and Gray 1966). Under this system, soil loss is minimal, and organic matter and nutrients added to the soil from mineral fertilizers are substantial. Average yields from such systems have more than trebled over half a century, rising from 500 kilograms per hectare to 2,000 kilograms per hectare of dry rubber (Webster and Watson 1988).

The second form of agriculture—pasture production—is mainly confined to Latin America. The forest is felled and burned and upland rice is sown as the pioneer crop; thereafter pasture is established. Use of tropical forests for pasture has come under severe criticism. Murgueitio (1990) states that much of the pasture is poor, production is inefficient, and major social problems arise when poor smallholders sell out to larger landholders. He suggests that the land should be used for intensive production of sugarcane (which on these poor soils would require large amounts of mineral fertilizer) and forage trees for intensive livestock production. However, the situation is summarized in a more balanced way in a report by Tropsoils (1987), which points out that pastures can be either good or bad depending on how they are managed. Well-managed they protect soils, require relatively few cash inputs, make good use of soils unsuitable for food crops, and recycle most of the nutrients used by the grazing animals. However, poorly managed pastures are "an economic and ecological liability". The use of pasture species that are badly adapted to the local environment leads to poor productivity. As a result, many thousands of hectares of former rainforest have been abandoned.

Pasture establishment is also severely criticized on the emotive issue of whether resources in developing countries should be used to raise beef for hamburgers for developed-country populations, instead of subsistence crops for local people. Yet it should be pointed out that milk and beef are important parts of the diets of poor people in Latin America, representing 20-33 percent of the family food budget of the urban poor (TAC 1990). Indeed the

value of milk and beef in that region equals the combined value of maize, sugar, wheat, rice, and cassava production. It seems inevitable that beef and milk products and the pastures on which they almost entirely depend will continue to be a very important part of the farming system in Latin America.

There is virtually no clearing of tropical rainforest for pasture production in Asia or Sub-Saharan Africa. In Africa, control of trypanosomiasis by a vaccine or eradication of the tse-tse fly would alter the picture dramatically.

Arable rainfed farming accounts for the largest proportion of felled forestland devoted to agriculture. This takes many forms under many names; at its simplest it is a low-input, low-output system using only labor and seeds for inputs. The period of cultivation may be short and the resting or fallow period may be very long, depending on population pressures, soils, the age and status of the cultivator, and cultural traditions. Because these farming systems have excited the interest of agriculturalists and social scientists for many years, there are a number of publications detailing the many facets of the system (see, for example, Allan 1965; Conklin 1957; Jurion and Henry 1969; Newton 1960; Nye and Greenland 1960; Philipps 1966; Sanchez 1977; de Schlippe 1956; and Webster and Wilson 1980). As early as the 1940s, some of these authors began expressing concern about the effects of shifting cultivation and the growing shortage of land in some areas. Whatever its form, this method of farming can be described by the general term "slash and burn". The vegetation—whether short fallow, secondary bush, or virgin forest—is cut down, the material allowed to dry, and then burned, for the farmer has no other means of disposing of woody debris. Much of the organic matter is lost, together with its nitrogen and sulphur, while the ash retains the other plant nutrients; however, burning destroys little of the soil's organic matter. Following disposal of the vegetation, there may be virtually no cultivation if seeds are planted by dibbling, or there may be substantial cultivation with hoes or other tools.

Many attempts have been made to assess the number of farmers dependent on this system of shifting cultivation, but these numbers rely entirely on how the system is defined. Broadly there are three types of farmers. First are the small, scattered groups, who fell and burn small, scattered areas, the farming of which, combined with hunting and gathering, provides a livelihood that is in ecological balance with the environment. Wills (1962) defines this activity as "shifting cultivation". It is carried out by a family or group of families who occupy temporary settlements. The land within walking distance of the settlement is cleared patch by patch over a few years, and the settlement then moves to a new site. The number of people involved in this is relatively small. As a system, it has disappeared from many parts of Africa. In India, tribal groups have expanded so much that the forest on which their livelihood depended has now disappeared. It is still practiced in isolated areas in Asia, the South Pacific, and Latin America.

The second and much larger type is the settled farmers who practice land rotation. Tiffen (1982) defines this as the technique of restoring soil fertility by leaving the land fallow after a period of arable cultivation. The cultivation period is usually short and the restoration period relatively long. Webster and Wilson (1980), who also call this "shifting cultivation," describe it as the dominant form of rainfed arable farming over a large area of the tropics.

The third type, sometimes termed "shifted cultivators," includes those who migrate into forestlands from nearby or distant areas and often from different farming systems. These are "the vast throngs descending on the forests" (Myers 1989). The incentives to move are economic—landlessness and general poverty. Such movements may be sponsored by government schemes or spontaneously encouraged, perhaps by new road systems. Farmers move from overcrowded areas—from Java to Sumatera, for instance—or from inhospitable and impoverished areas—from the Altiplano to the Amazon Basin, for example—or from drought-prone areas. They will usually introduce several elements of their own farming systems, but will

often adopt, rather quickly, elements of any farming system already practiced in the area.

These different forms of farming demonstrate how difficult it is to define the number of people in shifting cultivation. However, the area cultivated per family seems fairly constant around the world. In Indonesia, for example, a family will utilize about 7 hectares (World Bank 1989), clearing about 1 hectare per year. Wiersum et al. (1985) report that in a district of Sierra Leone, an average of 1.3 hectares is cleared and planted. This requires about 210 person-days per hectare. In the southwest of the Côte d'Ivoire, the same authors report that 2 hectares have to be cleared for enough upland rice to support a family. Immigrants clear more land because they wish to establish a right to "ownership". In Papua New Guinea, Wood (1979) reports that a family will use about 1.3 hectare each year. Taking an average figure for land clearing of 1.2 hectare per family per year, and using a figure of 140,000 square kilometers per year for deforestation, 60 percent of which is the result of small-farmer activities, the 8.4 million hectares being cleared annually for agriculture suggests that perhaps 7 million families—35-40 million people—are involved in new clearing of forestland each year for farming. This represents only about 10 percent of the 300-500 million forestland farmers suggested by Myers (1989), most of whom are practicing land rotation.

The Effects of Deforestation

Debate on the impact of the loss of forests has received much publicity, because it touches on deep-rooted anxieties about the future. Concerns about the detrimental effects center around increasing carbon dioxide and methane in the atmosphere, increasing runoff, decreasing rainfall, loss of genetic diversity, and loss of soil fertility.

Climatic Effects

Carbon Dioxide. When the felled forest is burned, carbon dioxide (CO_2) is produced. Houghton (1989) reports that tropical forests contain 20-100 times as much carbon in their vegetation and soils as do crops and pastures. The carbon content of soils in evergreen forests in different regions is as follows (Brown and Lugo 1987).

Forest Area	Carbon (tons/hectare)
Latin America	176
Africa	210
Asia	250

The release of CO_2 from organic matter in soil is much slower than that released when timber is burned, as the former contains several fractions, only a portion of which is an active fraction with a decay period of 1-3 years. Deforestation is calculated to account for 25 percent of global CO_2 emissions (2,400 million tons), compared with 5,600 million tons emitted by the burning of fossil fuel. However, the figures for deforestation are subject to wide margins of error because they depend not only on the area of forest felled and burned, but also on the amount of biomass in the forest and the actual proportion that is burned. Typically in burning felled primary forest, the larger logs and most of the stumps remain to decay over several years.

If the land is abandoned before grassy weeds take over, rapid growth of woody species takes place. Some information on the amount of dry matter produced in different types of forest is found in the literature. Kyuma and Pairintra (1983) summarize a number of measurements showing that the net productivity of a tropical forest ecosystem (dry matter in the living vegetation plus litter fall) is about 20 tons per hectare per year. Of this, the annual litter fall is about 10 tons per hectare per year, which decays to return CO_2 to the atmosphere, thus the system would sequester about 5 tons of carbon per hectare per year. Myers gives a figure of 10 tons carbon per hectare per year during periods of active growth.

These rates of dry-matter production are well below both the theoretical levels (Table 3.4) and the levels recorded for plantation

crops (Table 3.5). The rate of 34 tons per hectare per year is more than 70 percent of the potential amount given by Webster and Wilson. This figure would be equivalent to about 17 tons per hectare per year of carbon, much higher than that recorded for forest ecosystems. At this rate of accumulation, a well-managed oil palm plantation would sequester all of the carbon released by felling and burning an equivalent area of rainforest in 17 years. These figures also illustrate the difficulty of calculating accurate records for the net contribution to atmospheric CO_2 through farming activities.

Table 3.4—Potential dry-matter production under different climatic conditions, assuming a 3 percent conversion of light energy

Region	Total Input of Radiation Energy	Potential Dry-Matter Production
	(kilocalories/ centimeter/year)	(tons/hectare/year)
Temperate	84-115	26-37
Subtropical	145-170	46-54
Wet tropical	130-160	41-51
Drier monsoon tropics	150-180	48-57

Source: C. C. Webster and P. N. Wilson, *Agriculture in the Tropics* (London: Longmans, 1980).

Table 3.5—Rate of dry matter accumulation in oil palm in Malaysia

Age of Planting	Amount
(years)	(tons/hectare/year)
0.0 - 1.0	1.01
1.0 - 2.0	8.58
2.5 - 4.5	22.90
4.5 - 8.5	31.20
8.5 - 17.5	34.00

Source: S. K. Ng, *The Oil Palm: Its Culture, Manuring, and Utilisation* (Berne: International Potash Institute, 1972).

Methane. Tropical grasslands used for cattle grazing are estimated to produce, by rumen fermentation, 0.8 ton of methane for each ton of carcass meat (Preston 1990). According to Houghton (1989), molecule for molecule, methane is 25 times more potent as a greenhouse gas than carbon dioxide. These data would suggest that the large ruminant population on the poor tropical grasses of tropical Latin America could have an impact on atmospheric levels of methane.

Rainfall. Apart from the influences of rising amounts of carbon dioxide and methane on climatic behavior, there is also much discussion about whether deforestation can generate climatic feedback effects. It has been suggested, for example, that 90 percent of the Amazon's moisture is derived from within the regional ecosystem (Myers 1989). Deforestation and land-use conversion affects the reflectivity or albedo values for moisture fluxes. Several feedback mechanisms have been proposed (Farmer and Wigley 1985), suggesting that reduced soil moisture implies less evaporation and therefore less rainfall. Penman (1963) argues, however, that the fundamental problem is that it is not feasible to compare the behavior of natural surfaces at the same time and in the same place, so that hydrological proof is impossible. However, using a general circulation model, it can be shown that changes in albedo and soil water capacity as a result of deforestation lead to reductions in rainfall outside the deforested area, mainly due to increases in albedo (Rowntree, Wilson, and Sangster 1985).

Runoff. While it is not possible to measure directly the effects of changes in vegetation on rainfall, the effect on disposal of rainfall can be measured, and many such measurements have been recorded. Crown cover, under-forest, litter, and high organic matter are all important in increasing infiltration and decreasing runoff (Jackson 1989).

Loss of Biological Diversity

This too has become a subject of much debate. The Amazon area is reported to contain 80,000 plant species (Elisabetsky and Nunes 1990), but knowledge of their spatial distribution is limited because access was mainly by rivers until the recent development of a road system. Only a few species from the tropical rainforest—cacao and rubber—have been exploited on a large scale by agriculturists. However, while cacao collections have existed in Trinidad since 1938, only a small proportion has been exploited for plant breeding programs. Indeed much of the cacao, rubber, and oil palm grown commercially has a very narrow genetic base.

By contrast, large numbers of local plants have uses in traditional medicine, and, according to Elisabetsky and Nunes (1980), 74 percent of the chemical compounds used in drugs in industrialized countries can be found in the plants used in traditional medicine. Moreover, 25 percent of all prescriptions in the United States contain active ingredients extracted from higher plants.

Madagascar exports six medicinal plants for pharmacological purposes, the best known of which is the Malagasy periwinkle, *Catharanthus roseus* (Rosoanaivo 1990). It is estimated, however, that the chemistry of more than 99 percent of the Malagasy plant species is not known. The loss of potentially valuable medicinal plants has become an emotive issue. It must be emphasized, however, that the demand from the industrial world is small. Madagascar exported US$750,000 worth of medicinal plants in 1986, but exports had already fallen to US$100,000 by 1988 (Rosoanaivo 1990). Furthermore, the enormous cost of bringing a new drug to market in the industrial countries mitigates against widespread exploitation. On the other hand, traditional medicines are an important form of treatment for poor people, so that the disappearance of medicinal plants has serious implications for this group.

In summary, there are three problems associated with genetic erosion: (1) the loss of genetic diversity through the demise of plant species that could be used to widen the genetic base of well-established commercial crops; (2) the loss of plant species with unknown but potentially valuable uses; and (3) the loss of species that are used both locally and for export as sources of food, medicine, and income.

Degradation of the Physical Resource Base

Forests preserve soils through the influence of their moisture-giving canopy on rainfall and their roots on soil stability. But forests do not prevent geologic erosion, and even in virgin rainforest, runoff carries away soil particles during heavy rainstorms. Comparable soil loss ratings are given for different systems in the Philippines in Table 3.6 (O'Sullivan 1984). In addition to erosion of the soil, there is, of course, the loss of organic matter and loss of plant nutrients. Many measurements have been made of the changes in soils after tropical forest is cleared (Wood 1979; Nye and Greenland 1964). Plant nutrients and soil organic matter are both reduced. However, the level of plant nutrients varies greatly in different soils when cropping is abandoned. Abandoned land in one area may have soils with much higher levels of plant nutrients than those in newly opened land in another area; it is the amount of active organic matter, particularly in acid soils, that appears to be most important.

It is apparent from these figures that any form of cultivation leads to substantial soil losses compared with natural forest. It should be pointed out, however, that most of the evidence for soil degradation is from experiments. Lal and Okigbo (1990) state that very little if any research has been done on the rate, extent, and distribution of soil degradation on farmers fields, and much of the existing information is anecdotal, related to yields. Indeed, the systems evolved by farmers are often not as destructive as those designed by researchers to test various hypotheses on soil losses.

Table 3.6—Erosion susceptibility of areas under different cropping patterns and conservation practices, the Philippines

Rate of Soil Loss (percent)	Land Use Option
0.1	Natural rainforest
9.1	Upland rice and corn mix, conventional rice: zero-till planted corn and contoured *ipil-ipil*
13.4	Upland rice and corn mix: conventional tillage and contoured *ipil-ipil*
17.5	Upland rice and legume mix: conventional tillage and contoured *ipil-ipil*
18.9	Upland rice/legume: conventional rice and zero-till planted legume
29.1	Upland rice and cornmix: conventional tillage
56.6	Legume and corn mix: conventional tillage

Source: T.E. O'Sullivan, *Farming Systems and Soil Management: The Philippines/Australian Development Assistance Programme Experience in Soil Erosion Management*, ACIAR Series No. 6. Canberra: Australian Council for International Agricultural Research, 1984).

Note: *Ipil-ipil* is the local name for Leucaena leucocephala.

Degraded Vegetation

Pests, including weeds and soil-borne pests and diseases, build up under cultivation and have a serious effect on productivity. Rhizomatous weed grasses such as *Imperata cylindrica* and *Digitaria scalarum* are encouraged by continuing cultivation and particularly by fire, which destroys woody species. These grasses are difficult to eradicate with hand tools.

Imperata colonized extensive areas of former forest in Malaysia, following intensive cropping of cassava, but it was eradicated by cultivation and herbicides when these areas were developed for plantation agriculture. It has been reported that *Imperata* is increasing in intensely cultivated areas of Eastern Nigeria. A survey showed that fields abandoned b of this weed occurred in 31 out of 39 v Another noxious weed of increasing tance in the area is Siam weed (*Chrom ordorata*). There is evidence from both ments and farmers' fields that prolongi cultivation period beyond two years lea considerable increase in noxious grassy which make the reestablishment of species much more difficult. Little is l about increases in soil-borne pests an eases, although nematodes are encoura continuous cultivation.

Developments in Agricultural Syst

Ultimately the debate on deforesta about changes in land use, from forest s that have major ecological and eco benefits to systems that are regarded as d ing to the earth's resources, with imp major ecological, social, and economic quences. There are several participants debate, with a measure of agreement on is taking place but not on the solutions. ecologist, the solution would be to p forests from further human encroachme to restore deforested areas to forest p tion. To the economist, exploitation, alb a sustainable basis, would be the idea sustainability, forests need to be pro from people. To the anthropologist, mai ing the way of life of people who live forests in a state of ecological balance be the ideal. And for the farmer, whose v seldom heard, a better return to land and would be the solution. Of course, all a that there is no ideal solution. They agre there are several hundred million people in or near forested or formerly forested who are generally poor, living at a near-s tence level, and whose numbers are lik double in the next two-to-three decades. numbers and poverty mean that they will powerful incentives to move into forestl wherever accessible. On these new lands, present farming systems will give them a return per day of labor than do their ex

lands. For such people, opening up new land is preferable to using more inputs on existing farmland. Therein lie the economic, policy, and even the technical dilemmas.

Evolution of Farming Systems

Jacks (1956) has described three stages in the coevolution of man and soils. The first is shifting cultivation, as defined by Wills (1960), wherein man's economic activities do not upset the ecological balance between vegetation and the environment, so that where populations are small, the fertility of the soil is maintained. But population pressures are now so intense that there is no chance of returning already deforested areas to this status.

The second stage is that of soil exploitation, whereby man, as a settled agriculturist, damages the environment by mining the soil without replacing plant nutrients. The land deteriorates to a lower level of productivity through loss of organic matter and plant nutrients, loss of top soil by erosion, increases in soil-borne pests and diseases and invasion of weeds. This is broadly the situation at present in much of the arable rainfed farmland in the formerly forested humid zone. Deterioration is expected to continue as more of this land is cleared for agriculture.

The third stage, according to Jacks, is the soil-conserving and fertility-improving stage, whereby there is sufficient wealth in a country—often produced outside the farming industry—to be able to afford to return to the land as much or more than is taken from it; this may be defined as good husbandry, rendering the land productive in perpetuity.

Since there are far too many people to return to the first stage, the following questions must be raised in the humid tropical areas: Where can farming be moved to the third stage now? How can it be done in the future? And what kinds of technology and economic policies are needed to promote that movement in the shortest possible time? Moreover, this movement must be accomplished in countries that are often poor, where population growth is much faster than in any developed country, and where soils, by their origin, are generally much poorer than in the developed countries.

At present, three major types of rainfed farming systems are being practiced in the humid tropics. These are monocrop systems with perennials, multicrop systems with perennials, and land rotation.

Monocrop Systems with Perennials. These are long-term, productive systems typified by plantations of rubber, oil palm, cocoa, coffee, tea, and coconut, as well as sugarcane. They are not only important in Asia, but also in Africa and Latin America. Although thought of as plantation crops, a larger percentage of the area planted in these crops is on small farms. In Malaysia small farmers operate 66 percent of the area under rubber and oil palm, and in Kenya smallholders farm 65 percent of the tea area (Tiffen and Mortimore 1990).

These industrial crops have benefited greatly from research, mostly paid for by the industries concerned. Yields where husbandry has been good have trebled during the past half century, often after several replantings on the same land. There are still substantial differences between actual and potential yields, especially for small farmers; narrowing these differences would supply most of the world's needs into the foreseeable future.

Multicrop Systems with Perennials. In a multicrop system, a variety of perennial tree crops and vines, together with some annual crops, are grown around the home and village. Such systems are referred to as home gardens, compound gardens, food forests, or *kandy* gardens. Fertility is maintained by adding refuse, animal manure, and mulches to the soil, all of which involve the transfer of material from more distant parts of the farm where arable cropping is practiced to the home area (Watson 1983). A survey of home gardens in Sumatera recorded 36 species of woody perennials grown for fruit, beverages, spices, green manures, fuel, fencing, medicines, and building materials. There were also 19 herbaceous

annual and perennial species producing fruit, vegetables, carbohydrates, and spices. In this particular area, home gardens accounted for 44 percent of the total agricultural production and between 28 and 60 percent of the total cash value of agricultural produce in the community (Fernandes and Fernandes 1986).

Watson (1990) also quotes records from the Philippines showing that the income from gardens of coconut, banana, cashew, and citrus is almost five times that for upland rice per unit of land; one laborer can manage 3-4 hectares of established oil palm or rubber. In southeastern Nigeria, compound gardens cover 28 percent of the cultivated area but account for 59 percent of the crop output (Lal and Okigbo 1990). Eden (1980) and Reategui (1979) have described similar kinds of production systems for Colombia and Peru.

The evolution of home garden systems is one of the major responses by farmers to population pressure, especially in areas with poor soils where home gardens are combined with a land rotation system. The transfer of materials to promote fertility from the cropped land, and the nea ly closed nutrient cycle within the home garden system ensure a degree of sustainability, though Lal and Okigbo (1990) claim that in southeast Nigeria even these show signs of deterioration under increasing population pressure and soil degradation.

Multicrop systems of the kind described above could be improved by upgrading some of the components: by planting improved varieties of fruit and other trees, by building better processing facilities, and by improving infrastructure, including facilities for marketing. Use of mineral fertilizer on the outer fields would improve the quantity and quality of feed for animals, such as fowl and small ruminants, which in turn would improve the productivity of the gardens.

Land Rotation. The farming system whereby soil fertility is partially restored by allowing plots of land to rest or fallow for a period between crops is the dominant form of arable rainfed farming in the humid tropics. Restoration of soil fertility in this context means not only restoration of plant nutrients and levels of organic matter but also suppression of noxious weeds and soil-borne pests and diseases. In the humid tropics, fallowed land is covered with woody vegetation; in drier areas grasses may be the dominant species. Woody vegetation will suppress noxious weeds like *Imperata* but only if fire is prevented.

Fallowing has been practiced by farmers in many different farming systems. Johnston (1987) described the system that existed in England down to the eighteenth century, wherein there was a fallow year after every two cereal crops to control weeds. The fallow period could only be dispensed with after the development of animal-drawn equipment for line sowing and weeding that allowed the cultivation of root crops. Because the grassy weeds that develop with extended cultivation lead to land abandonment, much attention has been given to the idea of planting fallow crops that would serve the same purposes as the natural fallow growth but restore the soil fertility at a faster rate and to a higher level. Leguminous cover crops and leguminous trees could serve this purpose. However, the farmer is unlikely to plant these because of the seed cost and the need for additional labor, unless he can obtain a direct return from them, by feeding them to livestock, for example.

Land rotation, with an adequate length of fallow ("adequate" being on average about 10 years in the humid tropics [Wiersum et al. 1985]), provides a low but sustainable level of production. (Sustainable is defined as a long-term trend in productivity that is stable or rising.) Under these conditions, land rotation is neither soil mining nor enhancing the productivity of the soil.

Unfortunately, in many areas the situation is no longer stable. Fallow periods are decreasing in length in most land rotation systems, affecting yields in many areas. Carr (1989) reports that in eastern Nigeria a comparison of three villages selected for uniformity of soil type and social organization showed that average yields of cassava were 10.8, 3.8, and 2.0 tons per hectare after fallow periods of

seven, four, and two years. Lal and Okigbo (1990) describe the changes that have taken place in the same region. These include reduction in the area and the complexity of species of secondary forest, increased colonization by the noxious weed *Chromolaena ordorata*, an increase in the area planted in cassava and a decline in the area planted in yams. Where markets and transport are available, cash crops such as vegetables and ornamentals are being grown. The picture is similar where upland rice is the staple crop. Watson (1983) states that in Sarawak, upland rice grown after clearing of virgin forest will yield 1,200-2,000 kilograms per hectare; with more frequent rotation and shortened fallows, yields drop to 700 kilograms per hectare with values as low as 300-400 kilograms per hectare on poor soils.

The conclusions to be drawn from this evidence is that land rotation per se is no longer a sustainable system in large areas of the humid tropics. Where new lands are available, farmers migrate. Where there are none, farmers grow more cassava, become more dependent on multicrop perennials, grow high-value cash crops if there are markets, rely on off-farm income, or—usually—combine several of these options.

The Research Agenda

The following kinds of research are needed to relieve the severe environmental damage from clearing and farming forestlands, according to IBSRAM (1985):

- knowledge of suitable land-clearing techniques and associated soil management practices;
- program of research testing and validating to identify viable cropping and farming systems;
- sociological studies of the people who farm these lands;
- clear appraisal of the land use after clearing; and
- restoration of the productivity of land degraded by man.

Other agendas for research have been suggested by foresters, sociologists, ecologists, and economists, and there is a need to reach agreement on research priorities. Innovations must provide the ecological advantages of forest vegetation, as well as opportunities to improve incomes of large numbers of people.

The International Institute of Tropical Agriculture (IITA) has been involved since its establishment in the development of soil and crop management systems for rainfed arable farming in the humid tropics. It has concentrated its efforts on alley farming, an agroforestry system with multipurpose trees as an alternative to fallows; mulches and cover crop systems; tillage methods, especially no-till farming; fertilizers, particularly regimes that do not cause acidification or toxicity problems; and improved fallows that would be more efficient in restoring soil fertility than unmanaged bush fallows. All of these systems have worked on the experiment station, and several are under trial on farmers land. All will require additional money or labor inputs or both.

Experiments to develop sustainable systems that are akin to developed-country agriculture have been under way for several years at Yurimaguas in Peru (Tropsoils 1987). This program was designed to demonstrate the sustainability of a fertilizer-based continuous cropping system with a rotation of rice, corn, and soybeans. Yields over more than 30 crops were stable.

Other research presents a different picture. For example, an IITA experiment with continuous maize crops with fertilizer showed that yields dropped from 5 tons to 1 ton over a seven-year period. The drop was attributed to loss of organic matter and nutrients (IITA 1990). The loss of organic matter is somewhat surprising, because a well-grown maize crop is reported to add up to 10 tons of organic matter per hectare through roots and stover (Parish 1988); crop residues from high-input systems can usually maintain levels of organic matter. While the type of soil and climate will determine the ease with which continuous annual cropping can be maintained, there are no physical or biological reasons why it should not be possible to design a high-input system

that will maintain yields. It is a matter of controlling soil erosion; soil nutrients; pests and diseases, including those that are soil-borne; and weeds. Nevertheless, rotations are likely to be better than monocropping. The problems of high-input systems are obvious: the lack of inputs or their unavailability at the right time, their cost, labor bottlenecks, lack of power, poor communications, and poor markets—all of these render high-input systems uneconomic in many areas.

Tropsoils has also been involved in experiments to develop low-input systems to form a bridge between the second and third stages of agricultural development referred to earlier—that is, from soil exploitation to soil conservation. These consisted of rice-cowpea rotations using acid-tolerant cultivars established after felling and burning forest fallow. No fertilizers were used, but all residues were returned to the soil. A total of five upland rice and two cowpea crops were harvested during a three-year period, but increasing weed pressure and decreases in available phosphorus and potassium in the soil system caused it to collapse. This work indicates that, although it is possible to obtain more than one crop of rice with the traditional system, it is not sustainable even under experimental conditions, and it leads to eventual mining of the soil and invasion of pernicious weeds.

Research on Pasture-Based Systems. In Latin America, pasture-based systems have been under study for some years, by Centro Internacional de Agricultura Tropical (CIAT) in particular. As indicated previously, grazing of cattle for beef and milk production is a major use for cleared rainforest in Latin America. The method for establishing pasture is usually felling and burning of forest, with an upland rice crop planted immediately afterward. Perennial pasture grasses are then planted, but these pastures often degrade due to poor management and unsuitable species. Research in Peru (Tropsoils 1986) showed that legume-based pastures, such as *Brachiaria humidicola/ Desmodium ovalifolium* or *Andropogon gayanues/Styloanthes guyanensis*, could sustain high animal production levels. Steep, degraded pastures could be reclaimed by establishing grass and legume species with minimum tillage and rock phosphate.

Highly productive pastures require more skilled management and cost more to establish initially. Their development depends on the economics of investing in their establishment and management, compared with investing in cheap land and spending less to establish pasture.

Agroforestry Research. A number of national programs are under way in collaboration with the International Council for Research in Agroforestry (ICRAF). In the humid regions, an experiment in Cameroon has included work on species trials and on intercropping maize with several species (ICRAF 1989). One year after planting, *Calliandra calothyrsus* produced the greatest yield of foliage dry matter—4.69 tons per hectare with two prunings. The nitrogen equivalent was 140 kilograms of nitrogen per hectare. However, *Leucaena* mulch provided the highest yield of maize, 4.11 tons per hectare, compared with 2.18 tons in the no-tree control. In a comprehensive review of agroforestry, Nair (1990) concludes that alley cropping as an agroforestry practice has some advantages, but some inputs are required. The relatively high labor requirement is a constraint, and economic data based on *ex post* analyses of field data are lacking.

This sample survey of ongoing research work illustrates the substantial efforts that are being made to develop systems of sustainable agricultural production for the humid tropics. However, this aspect of the work has received much less attention and less support than the work on the social, anthropological, and ecological problems of deforestation. The former is the key to finding the solutions for the latter.

Future Developments in Farming Systems

From a situation of land abundance less than half a century ago, more and more farm-

ers in the humid tropics now find themselves in a situation of land scarcity. As current practices show, farmers will open up new lands where available, with or without government encouragement. They will continue to practice one form or another of low-input, low-output agriculture because that is how they can maximize their income per labor day in the absence of infrastructure, capital, and power.

Where new land is not available—in parts of East and West Africa, South and Southeast Asia, East Asia, and Central America— farmers continue to practice land rotation with ever diminishing fallow periods and to develop plots with woody and herbaceous perennials. As land ratios become ever smaller, the return per labor day decreases, even on better soils, in spite of intensification of agriculture, and more of the income is from off-farm activities—about 77 percent in a study area in Rwanda (von Braun, de Haen, and Blanken 1990). In heavily populated areas of Asia's wet tropics and where soils are fertile, farmers long ago intensified their rice production and invested heavily in conserving and developing their resource base by building terraces as well as irrigation systems. Farmers in drier areas of Africa have also reacted to increased population pressures by terracing, which conserves both soil and moisture for rainfed farming, and by tree planting.

Where soils have a reasonable level of plant nutrients, farmers have been able to devise intensified farming systems that are more labor-intensive but conserve the soil. Recycling most of the plant nutrients through the use of organic matter, including animal and human wastes, provides a stable production system with modest yields of 1-2 tons per hectare of cereal equivalent. On the poor soils of the humid tropics, however, a stable production system would require 1 year of cropping and 10 years of fallow to produce 1-2 tons of upland rice. Thus about 11 hectares of land are required for the same annual level of production as from 1 hectare of good soil. The reasons for this are obvious: the plant nutrient levels, particularly of phosphorus and sulphur, are so low in these soils that even recycling of organic matter or animal wastes requires moving matter from large to small areas to build up soil fertility.

One can conclude, therefore, that increasing the productivity of many soils in the humid tropics will require inputs of plant nutrients. Some may come from recycling, but some must come from mineral fertilizers. Arable rainfed farming must continue to be a major farming enterprise in these areas, for it must still provide a major part of subsistence crops. This farming system will continue to be based on land rotation, but natural fallows may be replaced by planted fallows of legumes or other herbaceous or woody species. However, planted fallows must repay the additional costs of labor and seeds in increased production of food, feed, and fuel, and they must control grassy weeds and increase levels of organic matter in the soil. Indeed weed control and build up of organic matter will be key components in maintaining and enhancing productivity.

Farmers will undoubtedly continue, and even intensify, the process of planting more perennials. The configuration of these plantings will vary greatly depending on individual and cultural choices. Alley cropping is one possibility, but many other configurations are likely, with blocks close to homes, where soil fertility enhancement is easiest, probably preferred. The mix of species in the multicrop perennial plantings is likely to be great, in order to provide timber for fuel, fencing, and housing, as well as fruits, spices, and fodder. The emphasis on horticultural crops will increase, especially as markets develop, which means that fruit trees will command much greater attention in the agroforestry scenario. Indeed one of the features of perennials in the humid tropics is their wide adaptability, as demonstrated by the few commercialized species like rubber, oil palm, cacao, and tea. It is quite likely that many other useful species—at present used only locally—would be equally adaptable.

Where markets exist or can be developed, plantings of monocropped perennials, such as oil palm, rubber, and coconuts, may be developed. Small farmers on their own are more likely to plant mixtures or combine small

blocks of, say, rubber, with food crop production on adjacent areas. Massive increases in areas planted to traditional tree crops seem unlikely. The prices of such products have already fallen to half their 1980 value in terms of manufactured goods. Areas already under cultivation could produce considerably more, using existing, proven technology. However the demand for fruits is likely to expand both for domestic consumption and export. There is also increasing demand for meat, so that home gardens are likely to become increasingly important as sources of income through sale of fruits, herbs and spices, wood products, and small animal products. Such income can then be used for reinvesting in the whole farm system through the provision of plant nutrients and more intensive land use.

It is likely that specialized farming systems will develop in certain parts of the landscape. Hydromorphic soils are used more intensely in Asia than in Africa and Latin America. Though generally less fertile than some of the alluvial and volcanic soils of Asia, they can still be developed for paddy rice, for example, where water control is possible; it should be noted, however, that paddy rice requires more labor per unit of output than upland rice.

More energy will be needed in farming enterprises. At present, human labor provides 89 percent of the total energy input into farming in Sub-Saharan Africa, compared with 68 percent in Asia and 59 percent in Latin America (Matthews 1990). The additional energy input could come from draft animals, mechanization of cultivation or transport, chemicals such as herbicides, or combinations of these. Again, increased farm income will be needed to support adoption of these inputs.

Protecting the Remaining Forests

Will these improvements in farming systems on already deforested land protect the remaining forests? The answer must be "no" because it seems highly unlikely that the potential improvements can take place quickly enough to stabilize existing farming populations and the predicted increases over the next decades. It has been proposed, for example, that the existing forests could support more people in "ecological balance" through the exploitation of forest products. This theory of "extractivism" has received much attention. A large number of people already manage a livelihood by collecting a variety of forest products including nuts, oils and essences, spices, flavorings, and fruits. However, the population surviving by these activities is very scattered. It seems unlikely that exploitation of nontimber products can generate more employment and income than the same areas developed for agriculture (*Cultural Survival* 1991). A rational appraisal of both domestic and export markets shows the limits of both (Green 1989).

There are proposals to develop buffer zones around forests, provide residents in these areas with incentives to protect the forest and regard it as a source of income for themselves. Such systems are likely to be successful in limited areas where population is not too great. Some of these areas have been studied in detail—the Korup National Park in Cameroon and the Oban Hills project in Nigeria—so that there is accurate information on the area and the number of people involved. However, there are no accurate figures on the areas of forest that could be so protected. A further question that must be faced is what happens in these areas as population pressures increase.

Research for the Future

Clearly new and more productive farming systems are needed for the deforested humid tropical lands—systems that will return as much or more to the land as the farmer removes. It is farmers and not scientists or economists who invent new farming systems. Nevertheless, no matter how innovative farmers may be, they cannot, by themselves, bring about change quickly enough to meet the needs of the unprecedented population increase. So researchers must provide better components with which they may build more productive systems. Such research will include studies to

identify the factors that cause productivity to deteriorate and cost-effective ways of counteracting these. Research will also be needed on perennials that can be combined with annual cropping systems to provide increased returns; on ways of augmenting energy inputs; on inexpensive ways of establishing fallow systems with legumes; on improved systems of processing and storage; on improved varieties; and on the use of mineral fertilizers and soil amendments. Such long-term research requires as much political and popular support as the more emotive issue of deforestation has received, but this support will have to be maintained over many years.

Policy Issues

For the large area of formerly forested land that is now being farmed at varying degrees of intensity using land rotation, policies are needed that will encourage investment by governments and farmers in resource-conserving farming systems. Policies for development of perennial crops, improvement of income for investments, and provision of infrastructure so that inputs become economically feasible are all needed. That farmers or scientists can develop sustainable farming systems that will increase productivity without using inputs is wishful thinking. Such systems will need more, not fewer inputs.

If farmers can achieve a better return per labor day by clearing forest, they will surely do it. Therefore knowledge and policies to help farmers settle the most suitable land are needed. Good land can make all the difference between a sustainable farming system and an ecological disaster. A project on the land resources of Indonesia provides the kind of information necessary and is a model on how to do it at a low cost (US$2.50 per square kilometer) (Republic of Indonesia 1990).

Ease of access is one of the most crucial factors in the protection of forests. Large areas of Southeast Asia and the Amazon have until recently been accessible only via their river systems. In their lower reaches, these rivers pass through swampy land that offers easy travel and plenty of opportunity for hunting and gathering but little for settled agriculture. In the higher reaches, land is more suited to agriculture, but access by river is more difficult. Roads for timber extraction, settlement, or other purposes always follow the higher ground and thus generally the land more suitable for agriculture.

Policies that will relieve population pressure in rural areas and increase rural income are surely the most important. Health measures such as eradication of guinea worm and control of malaria and bilharzia will greatly increase the work capacity of the rural population.

Finally, policymakers, pressure groups, and scientists must recognize that forestry, agroforestry (in the wider sense of providing income from perennials), and agriculture in the humid tropics are inextricably linked together; for one to prosper all must prosper.

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CHAPTER 4

Key Forestry Issues Facing Developing Countries: A Focus on Policy and Socioeconomic Research Needs and Opportunities

HANS M. GREGERSEN

Forests and trees will play an increasingly important role in sustainable development and environmental protection in developing countries during the second century of the International Union of Forestry Research Organizations (IUFRO).[1] Policy and socioeconomic researchers will have to make major progress in order to help decisionmakers in the public and private sectors avoid serious problems and take advantage of opportunities to increase the contributions of forests and trees to human welfare.

Growing Concern About the Role of Forests in Sustainable Rural Development

By the late 1970s, many world leaders had come to realize that forests and trees often play a critically important role in sustainable rural development and in resolving some major environmental concerns; trees contribute much more than lumber and paper. This increased concern with social and environmental issues is reflected in the fundamental shifts that have been taking place in official development assistance (ODA) for forestry.

First, there has been a dramatic increase in such funding in recent years, to a level of more than US$1.2 billion by the late 1980s. In the case of the World Bank and three regional development banks, for example, ODA for forestry more than tripled from about US$150 million in 1978 to US$496 million in 1988.

Second, the emphasis placed on different topics within forestry has shifted. For example, during 1967-76, only about 5 percent of World Bank support for forestry went to social and environmental forestry activities, the other 95 percent going to commercial plantation and forest industry activities. This 5 percent has now increased to 75 percent of total World Bank support for forestry. Overall, including both bilateral and multilateral donors, 55-60 percent of the total 1986 ODA for forestry went to social forestry, watershed management, and other environmentally related areas (FAO 1987).

The increased support indicates a recognition on the part of the donor community that

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the roles forests and trees play in sustaining rural development and in maintaining environmental quality and stability are important. These roles also need to be given priority attention by researchers.

To focus on the forestry-research-related aspects of four major social development and environmental issues that developing countries and their researchers will be facing over the next years, the challenge for research is to develop technologies and institutional options for

- containing unproductive deforestation in the humid tropics and improving the sustainability of use of remaining forest lands and lands that are cleared;
- reducing forest destruction and land deterioration in dryland regions and improving productivity and use of wastelands;
- reducing the rate of forest destruction and degradation of upland watersheds and improving their productive capacity and use; and
- improving the ways in which trees on farms and in communities contribute to household welfare and income stability.

These four areas deserve priority attention by physical/biological researchers, as well as by researchers in the policy, management, and social sciences.[2]

Deforestation and Inappropriate Land Use in the Wet Tropics

The closed forests of the wet tropics are being destroyed at a rapid rate. More than 40 percent of the original closed tropical forests have been cleared, logged, or degraded (World Resources Institute 1985). Whereas logging and other nonagricultural pursuits are responsible for a significant portion of the deforestation, the major cause is conversion to what in most cases are unsustainable agricultural and livestock uses. This problem involves both planned, large-scale conversion to ranching, as in the Amazon Basin, and conversion by smallholders in search of new lands for farming, as in West Africa, Southeast Asia, and parts of South and Central America.

With mounting population pressures, this problem is getting worse. In fact, preliminary indications are that the actual rate of tropical deforestation and degradation today is significantly greater than the rate of 11 million hectares per year estimated in the early 1980s by the Food and Agriculture Organization of the United Nations (FAO) (Lanly 1982).

A number of researchers have been concerned with various aspects of tropical forest management and the policy and socioeconomic issues associated with deforestation.[3]

Economic and Social Issues Associated with Tropical Forest Use and Conservation

To move ahead, socioeconomic and policy researchers need to address at least the following questions.

- How can the stocks and flows of the great array of actual and potential outputs from the tropical forests be better valued and considered in decisions related to forest land use and conservation?
- What are the economics of multiple use management? Do extractive economies make sense economically and socially?
- What is the economic and social importance of preserving the biodiversity of the tropical forest?
- What are the economics of timber management to sustain yield in the tropical forest?

[2] There is a strong overlap between these issues and the major thrusts of the Tropical Forest Action Plan (TFAP), sponsored by IUFRO and FAO, in the areas of trees in farming systems, upland watershed management, fuelwood and energy, and conservation and management of tropical forests. The basic issues being addressed by TFAP still remain, for the most part, the critical issues that will be faced in the next century.

[3] See, for example, Spears 1988; Repetto and Gillis 1988; Repetto 1990; and Harvard Institute for International Development 1988, and works cited in these.

What are the opportunity costs involved?

- What are the externalities associated with deforestation?
- Where and under what conditions does conversion of tropical forest to other uses make sense? (Is all deforestation bad?)
- What are the technical and economic opportunities for farmers to grow tree crops rather than unsustainable, annual agricultural crops on converted forestland?
- What are the economic and social facts concerning the often suggested roles of tropical forests in oxygen production and carbon storage, the role of fuelwood gatherers in tropical deforestation, the "hamburger connection," developed-world exploitation of tropical forests to save their own forests, and other popular beliefs concerning the role of tropical forests in today's world?

Government Policies and Programs to Contain Deforestation

Questions in this area include the following.

- What policies (inside and outside the forestry sector) affect conversion of forestland to other uses, and how should they be modified to help contain deforestation and forest degradation (policies related to differential treatment of subsidy and tax levels for certain activities involving forest conversion, and policies related to tenure, and buffer zones, for example)?
- What policy improvements could be made with regard to forest revenue systems and concession agreements (policies related to timing, extent, royalty levels, fees, bidding procedures, regeneration policies, and harvest methods, for example)?
- How can policies for promotion and protection of domestic wood processing industries be rationalized (policies related to taxation, incentives and subsidies, trade, and timber contracts, for example)?
- Should governments develop policies and incentives to encourage establishment of forest plantations as a means of taking pressure off the natural forest in areas of heavy timber production? Would such policies make economic sense?
- What can be done to make existing policies more effective—to develop more efficient policy instruments and tools to implement policies?

Deterioration of Dryland Forests and Wastelands

Degradation of dryland forests and wastelands is becoming increasingly critical in many parts of the world. More than 1.3 billion hectares have been degraded in the developing countries; many of those lands have become desertified. More than 300 million people are estimated to be affected by this process (World Resources Institute 1985). Countries such as India, Pakistan, Bangladesh, Ethiopia, Kenya, and the Sahelian/Sudanian zone have major areas of already degraded dry-zone woodlands and significant areas that are moving in that direction.

The main causes of the degradation are overgrazing by livestock, fuelwood gathering, and expansion for unsustainable agricultural production. All are likely to increase in importance in the future, due in part to population increases.

Compared with the policy and socioeconomic research on destruction of tropical moist forests, little has been done on dryland forests or on tree-related issues associated with wasteland development.

Management and Use

To improve their understanding of the issues involved, socioeconomic and policy researchers need to address the following questions.

- What are the potentials for management of dryland forests and wastelands? What types of multiple use patterns can be developed and sustained?
- In what situation is privatization the most appropriate strategy for managing degrad-

ing, open-access common lands? Government control? Communal management (common-property management)?
- When common-property management is deemed to be the most appropriate form, how can sustainable regimes be maintained on common lands?
- To what extent are dryland forests and wastelands associated with food security issues? How could they contribute to better food security?
- What role do trees play in containing desertification? Could that role be expanded?

Government Policies and Programs

- How do government policies related to agricultural mechanization, irrigation, energy, livestock, and settlement (such as conversion from nomadic to settlement living and use of public wastelands by the landless) affect management and use of dryland forests and wastelands?
- What government policies could be introduced to expand the role of trees in containing desertification and to increase productivity of dryland food production?

Upland Watershed Deterioration

More than 1 billion people are affected by what happens on upland watersheds in the developing world. The productivity of many of these lands is rapidly deteriorating due to overuse and misuse. An estimated 160 million hectares of upland watershed has been seriously degraded in Africa, Asia, and Latin America. The result is increased poverty at the site and increased problems downstream as a result of sedimentation in rivers and reservoirs. In many areas, the land simply will not support expanding populations on a sustainable basis. Alternative sources of livelihood have to be found (World Resources Institute 1985).

Land-Use Rationalization

Socioeconomic and policy researchers need to address the following questions.
- What are the economic and social implications of the upstream-downstream relationships associated with different land-use patterns? In other words, what is the economic impact of upland deforestation leading to downstream flooding in different parts of the world?
- What is the economic role of upland forests and woodlands in household economies, in terms of fodder, mulch, and other nontimber outputs and fuelwood?

Government Policies and Programs

- What infrastructure policies open up access to markets and alternative forms of employment, and what are their affects on deforestation in upland watersheds?
- What is the role of policies that affect tenure and communal management of forests (such as common property resource management issues and local versus national management)?
- To what extent should government policy focus on upstream-downstream relationships as opposed to focusing mainly on designing and implementing the most effective and efficient development strategies for the upland regions themselves?
- How are payments to upland land users to carry out soil conservation activities rationalized in terms of benefits to downstream landowners and users?

Trees and Security of Household Welfare

Food security for poor farmers is being increasingly threatened by deteriorating farm productivity and changes in farm tenure and size of holdings. Diets and incomes are also deteriorating as natural forests are depleted and can no longer provide traditional forest foods and products to be sold. In some areas, rural energy crises have developed due to decreasing availability of cheap or free biomass fuels. On-farm tree growing can help reverse

these trends. Significant opportunities are being missed to increase family income through tree growing and processing in small-scale rural enterprises.

A fair amount of research has dealt with the policy and socioeconomic issues associated with community and farm forestry (see, for example, Arnold 1991; Gregersen, Draper, and Elz 1989; and FAO 1987). However, socioeconomic and policy researchers need to address the following questions.

Role of Trees in Household Welfare

- What are the economic and social implications of the various roles of trees and tree products in family welfare, both for meeting basic needs and as sources of income? What roles do trees play in seasonal complementarity, in security of income and welfare, and in risk diversification?
- How do trees enter into farming systems as factor availability and prices shift—for example, as availability of on-farm employment diminishes?
- What are the economics of use of trees as substitutes for investments in farm management and improvement, including investment in fertilizer, livestock feed, fuels, soil conservation structures, and other capital inputs?
- What is the role of trees planted on farms in meeting basic fuel and energy needs in different parts of the world and in meeting commercial needs?
- Does increasing commercialization of tree products act as a stimulus to tree growing?

Small-Scale Enterprise (SSE) Development

- What is the economic importance of forest- and tree-based SSEs in rural employment and income?
- What is the role of trees (mainly as fuel) in other SSEs, such as potteries, bakeries, and foundries?
- What economic issues arise with declining access to raw materials in forest and tree-based SSEs?
- What are the efficiency and long-term sustainability prospects for different types of forest and tree-based SSEs? What are the dynamics of evolution of such SSEs into more modern and larger enterprises?

Government Policies and Programs

- What subsidies and incentives play roles in smallholder tree growing?
- What are the effects on tree growing of subsidies and incentive payments in other sectors, such as agricultural price supports and subsidy programs?
- What is the role of credit, and what are the effects of changes in access to credit?
- What are the tenure issues that are critical for tree growing by smallholders?
- What are the market-access issues related to government policy and programs?
- What are the effects of government-sponsored education, training and extension programs and policies?
- What are the effects of infrastructure policies and programs on tree growing and on gathering and processing activities, in opening up rural market areas to competition from the modern sector, for example?
- What are the effects of subsidized fuel prices on tree growing for fuel?
- What is the role of the informal sector in forest and tree-based SSEs? How does government bureaucracy affect these SSEs? Specifically, what are the effects of foreign exchange policies that favor capital imports or imports of products competing with those produced by forest and tree-based SSEs?

Familiar Policy and Socioeconomic Research Themes Cutting Across All Four Issues

Cutting across all four of the above issues are some basic and familiar areas of expertise that socioeconomic and policy researchers need to develop further in order to deal more

effectively with the issues. Expertise is particularly needed in the following areas:

- *Development of baseline social and economic data.* In all four issues, knowledge of basic socioeconomic conditions is sorely lacking. A significant amount of resources needs to be devoted to generating improved baseline data for use in research.
- *Economic analysis of sustainable land use and management.* Cutting across all four issue areas is the need for basic production economics information on alternative land-use and management regimes. In many cases, methodological issues need to be addressed, since the economics of incorporating trees into farming systems tends to be quite different from the traditional economics of tree plantations. Included here are the important areas of agroforestry economics and multiple-use management of tropical forests, drylands, and upland watersheds.
- *Valuation of nonmarket and nontimber market outputs.* Related closely to the previous item is the need for better understanding of values associated with the tropical forest, with dryland forest outputs and potentials, with upland watershed forest values (in terms of animal fodder, for example), and with the myriad uses for trees in farming systems.
- *Assessment of externalities and intersectoral policy linkages.* Although a serious void exists in the area of physical/biological information on such relationships as upstream land-use effects on downstream areas, there also are some issues relating to policy and economics concerning income distribution policies and the externalities associated with policies in other sectors, for instance, the effects of agricultural price support policies on tree growing and deforestation activities.
- *Analysis of economic, social, and policy issues related to incentives and local participation.* This area has received a good deal of attention by researchers over the past few years, but much more work is needed to understand the motivations of people and their responses to various types of incentive programs and outside interventions. This relates specifically to the need for more sociological and anthropological research in the area of local participation and motivation. One of the key areas of interest is the effects of land and tree tenure policies on tree growing and deforestation. Incentive and tenure issues cut across all four issue areas.
- *Assessment of employment diversification opportunities and policies.* In all four issue areas, one obvious and important step is toward better understanding of how to create new employment opportunities that do not lead to pressures on existing resources. Forest-based, small-scale enterprises provide one such opportunity area. In fact, this is one of the major sources of off-farm employment in most countries, in carpentry, forest food production, fuelwood and charcoal, and so forth.
- *Evaluation of policy instruments and tools for implementing policies.* As discussed earlier, many countries have sound policies on forests and containing deforestation; they just lack the appropriate instruments and tools to implement the policies and to make them effective. Although more research is needed to find improved policies and strategies to deal with the emerging forestry issues, just as much effort needs to be devoted to understanding why the present policies are not being implemented more effectively.

Moving Ahead

A good deal of research has been done in many of the areas listed above. However, many more policy and socioeconomic researchers could be kept busy for years addressing the aspects not yet dealt with. Further, much of the past research has been isolated, preliminary and exploratory in nature. Such work needs to be duplicated and verified. A body of research needs to be built up before reliable policy

prescriptions can be developed. One isolated study is not enough in most cases.

A good example of the evolution of policy analysis based on the accumulation of research results is that of fuelwood. Perspectives on what has been called the "fuelwood crisis" have changed over time as researchers have uncovered new relationships and facts about fuelwood availability and use, and about the broader roles of trees in farming systems. Dewees (1989) and Leach and Mearns (1988) have discussed these changes in perceptions of the problem. Similar synthesis research is needed to deal with many of the other aspects of forestry development, particularly in the areas of forestry incentives, deforestation, and upstream-downstream relationships associated with watershed management.

In moving ahead with policy and socioeconomic research, several factors are important to keep in mind:

- Policy and socioeconomic researchers depend directly on the results of physical/biological and technology research for the basic production functions associated with forestry activity. Thus, close collaboration and interaction with scientists working in different areas is essential.
- As forestry becomes more closely integrated with agriculture through joint activities in agroforestry, it becomes essential that agricultural and forestry researchers interact more effectively. In fact, agroforestry research currently is undertaken in both forestry and agricultural research organizations.
- Much of what happens in forestry—and many of the research issues mentioned above—are affected directly and indirectly by actions and policies in other sectors. It is important that intersectoral policy linkages be explored by forestry researchers working with researchers in other sectors. This point applies to each of the four issue areas discussed.

The future in forestry will require resourceful and imaginative research and major policy decisions to avoid disasters and to take advantage of opportunities to move forestry ahead as a major contributor to sustainable development. Forestry researchers will be expected to take on a more central and integrative role in finding solutions to broad development problems, since increasingly it is being recognized that forestry is not an isolated field, out of the mainstream of development, but a central one for dealing with such important development objectives as food security, employment creation, energy security, and environmental stability and protection.

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CHAPTER 5

Sustainable Land Use Involving Trees in the Himalayan Region: Perspectives and Policy Implications

N. S. JODHA

Sustainable land use may be defined as a pattern or system of use that ensures a flow of products and services from the land to meet current and future demand, without damaging its long-term production potential. By referring to the satisfaction of human demands, this description links sustainable resource use and sustainable human welfare (Gregersen and Lundgren 1990). By referring to the flow of products and services, it incorporates sustainability of both resources and welfare, as well as potentialities of the resource base. Under some circumstances, when human needs are radically transformed or delinked from local resources and supplied through external subsidization, aid, or imports, it is conceivable that human welfare could be sustained without sustaining resource use. However, under normal circumstances, especially where production and consumption activities are interlinked and closely associated with the local natural resource base, as in mountain habitats, people's welfare cannot be sustained without sustaining the health and productivity of land resources. Hence, in the process of meeting current or increased (welfare) demands, the resource base should not lose its long-term potential through overuse.

The scope for sustainable land use to meet these conditions is determined by the ability of land (or land resources) to withstand higher use intensity, to absorb increasingly complex and higher levels of inputs, to tolerate a higher degree of disturbance and manipulation, and to rapidly regenerate in the event of damage and destruction. Whether the system is conducive to strengthening these capabilities through external interventions and linkages is also a critical factor. Finally, as stated earlier, the conditions should be fulfilled without damaging the long-term potential of land resources (Jodha 1990a). In the event of nonfulfillment of these conditions, where resource zones are fragile, human survival can be ensured by adapting the level and structure of human demands to the limitations and capabilities of land resources, rather than the other way around.

This paper describes some specific features of mountain areas, particularly their biophysical resources, and considers circumstances that are conducive to or detrimental to the sustainable use of land resources. It identifies the degree of convergence between the sustainability-related needs of mountain characteristics (herein called mountain specificities) and the attributes of forests or trees that make them important components of land-use systems, and it indicates the possibilities for enhancing sustainable land use and sustainable human welfare in mountain areas. (The terms "trees" and "forest" are used interchangeably here.) It also discusses the circumstances that may either promote more intensive land use for higher productivity, or, on the other hand, overemphasize land-extensive (as against land-intensive) features of tree-based production systems. A land-extensive system implies that

both more land and time are required for each unit of production or each generation of a plant or tree. A land-intensive system represents the opposite situation. Finally, some options are considered that can help to integrate trees into an approach to land use focused on intensification in mountain areas. The policy implications of these changes are discussed briefly. The paper draws on conceptual work, reviews of existing knowledge, and field studies conducted by the International Center for Integrated Mountain Development (ICIMOD) in selected hill areas of China, India, Nepal, and Pakistan (Jodha, Banskota, and Partap 1990).

Dominant Characteristics of Mountain Habitats

The severity of environmental degradation and poverty in mountain areas throughout the developing countries is well known and well documented (Ives and Messerli 1989; Eckholm 1975; Rieger 1981). They share the common scenarios of rising population pressure, rapid resource degradation, increasing poverty, and unsustainability of present patterns of resource use (Jodha 1990). Unsustainability persists despite increased concern and development interventions in recent decades.

The ICIMOD-sponsored studies on strategies for sustainable mountain agriculture identified and analyzed several negative trends relating to resource base, productivity, and resource management systems in selected areas of the Hindu Kush and Himalayas (Table 5.1) (Jodha 1990a, 1990b). A number of these changes, described as indicators of unsustainability, have direct or indirect links to the changing role of woody perennials in the production and resource use systems in mountain areas. ICIMOD's reviews of public policies and programs and site-specific field studies revealed that these negative trends are associated with a lack of perspective and understanding regarding the characteristics of mountain areas in public and private interventions in those areas (Jodha, Banskota, and Partap 1990). Consequently, the imperatives of specific mountain conditions, which alone can determine the relevance and effectiveness of interventions in mountain areas, are seldom incorporated into development policies and programs for those areas.

The important conditions that characterize mountain habitats, which separate them from the mainstream situation of the plains, are inaccessibility, fragility, marginality, diversity, the possibility of developing a "niche," and the ability of humans to adapt to mountain areas. These features, their biophysical and socioeconomic dimensions, their interrelationships, their variability from one mountain location to another, and their operational implications for different purposes are elaborated elsewhere (Jodha 1990b). Here only the implications of mountain characteristics for sustainable use of land resources are considered. Table 5.2 describes specific mountain conditions; their implications for sustained productivity of land resources through more intensive land use, higher input applications, and better management; and guidelines for implementing options and activities for sustainable systems of resource use.

Inaccessibility, a product of altitude and terrain, is a major constraint in most of the mountain areas (Hewitt 1988). It obstructs mobility, leads to higher costs of transport and other inputs for interventions, imposes a degree of isolation in production and exchange systems, and makes external links less dependable.

By implication, these circumstances restrict the scope for higher productivity of resources through enhanced use, higher input use, upgrading of resources, and harnessing of opportunities, because such changes crucially depend on mobility and linkages to the outside world. Sustainability of human welfare or survival under such conditions is closely associated with local resource-centered diversification of activities, with focus on regeneration, protection, and recycling of resources and products. As will be elaborated later, forests can play a crucial role in theses activities. Their disregard

Table 5.1—Negative changes as indicators of emerging environmental risks in mountain areas

Visibility of Change	Changes[a] Related to		
	Resource Base	Production Flows	Resource Use/Management Practices
Directly visible changes	**Increased landslides and other forms of land degradation,** abandoned terraces, reduced per capita availability and fragmentation of land, **changed botanical composition** of forest/pasture. Reduced water flows for irrigation, domestic use, and grinding mills.	**Prolonged negative trend in yields of crops and livestock;** increased input need per unit of production; **increased time and distance involved in food, fodder, and fuel gathering;** reduced capacity and period of grinding/saw mills operated on water flow; **lower per capita availability of agricultural and forest products.**	**Reduced extent of fallowing,** crop rotation, intercropping, **diversified resource management practices; extension of plowing to submarginal lands; replacement of social sanctions on resource use by legal measures; unbalanced and highly intensive input use, subsidization.**
Changes concealed by responses to changes	Substitution of cattle by sheep or goats; deep-rooted crops by shallow-rooted ones; **shift to nonlocal inputs.** **Substitution of** water flow by fossil fuel for grinding mills; **manure by chemical fertilizers.**[b]	Increased seasonal migration; introduction of externally supported **public distribution systems (food, inputs)**[b]**; intensive cash cropping on limited areas**[b]**.**	**Shifts in cropping patterns** and composition of livestock; **reduced diversity, increased specialization in monocropping;** promotion of policies/programs with successful record outside, without evaluation[b]
Development initiatives—potentially negative changes[c]	**New systems without linkages to other diversified activities and regenerative processes, generating excessive dependence on outside resources** (fertilizer/pesticide-based technologies, subsidies), ignoring traditional adaptation experiences (new irrigation structures); **programs focused mainly on resource extraction.**	Agricultural measures **directed to short-term, quick results, primarily production-centered (as against resource-centered) approaches** to development; service-centered activities (for example, tourism) with negative side effects.	**Indifference of program and policies to mountain specificities; focus on short-term gains;** high centralization; excessive, crucial dependence on external advice **ignoring traditional wisdom; generating permanent dependence on subsidies.**

Source: Table adapted from N.S. Jodha, "Mountain Agriculture: The Search for Sustainability," *Journal of Farming Systems Research Extension* 1 (1,1990).

Note: The changes indicated in bold letters in the table are related to disregard of trees in the land-use systems.

[a] Most of the changes are interrelated and they could fit into more than one block.

[b] Since a number of changes could be for reasons other than environmental instability/risk, a fuller understanding of the underlying circumstances of a change is necessary.

[c] Changes under this category differ from the ones under the above two categories in the sense that they have not yet taken place, and their potential emergence can be understood by examining the involved resource use practices in relation to specific mountain characteristics.

Table 5.2—Mountain characteristics and their implications for sustainable resource use and sustainable welfare

Mountain Characteristics and Conditions Generated by Them	Implications for Sustainable Production[a]	Options for Sustainable Welfare or Survival
Inaccessibility Isolation, high cost of mobility and operational logistics, low dependability of external support, limited access to supplies	Infrastructural logistics and costs are detrimental to resource use intensity, high input use, resource upgrades, harnessing of potential	Focus on local resource-centered, diversified activities, resource regeneration, protection, and recycling
Fragility Vulnerable to degradation with small disturbance; limited, low-productivity payoff options	Low resource use intensity; low physical and economic capacity for input absorption; limited scope, high cost of resource upgrading	Land-extensive, low-intensity activities with organic linkages, combining production and conservation needs.
Marginality Limited, low payoff options; resource scarcities and uncertainties	Limited capacities and resources to upgrade and maintain resources and to benefit from high-cost, high-production opportunities	Low-cost activities requiring few external inputs; dependence on local resource regeneration and natural processes
Diversity Potential for naturally suited, temporally and spatially interlinked, diversified products and activities	Diversified, organically interlinked, local resource-based activities as a basis for sustainable productivity	Sustainable production systems using spatial or temporal heterogeneity, linkages
Potential comparative advantage ("niche") Potential to develop unique products and activities	Basis of diversified, local resource-centered products or activities with comparative advantage	Proper advantage taken of unique opportunities for sustainable gains
Human adaptability Traditional resource management practices	Basis for evolving technological and institutional approaches for sustainable land use	Use of rationale of traditional practices for intensive, but sustainable, land use

Note: Sustainable production is the uninterrupted or enhanced flow of products or services without resource degradation.

is partly responsible for the emerging indicators of unsustainability.

Fragility, a product of steep slopes, thin soils, and other associated biophysical conditions, makes mountain areas vulnerable to degradation as the result of even a small disturbance (DESFIL 1988). Limited resource use and production options are available under such circumstances, and payoffs to investment are low. Fragility not only prevents higher intensity of land use, but limits the physical and economic input-absorption capacities of the land. Scope for resource manipulation or upgrading is also limited due to physical restrictions, and investment and maintenance costs are high.

Fragility is thus the most constraining factor in sustainable land use (implying higher productivity through more intensive land use) in mountain areas. Options for sustainable resource use in the context of fragility need to focus on land-extensive systems; on a combination of productivity and protection measures; on upgrading of resources using nature's own processes (such as use of plants that build or bind soils); and on intensification as permitted by adaptations of resource characteristics (such as terracing steep slopes before using them for cropping).

Marginality, like other mountain characteristics, has both biophysical and socioeconomic dimensions. It is a product of both natural and man-made factors (Blaikie and Brookfield 1987). In terms of the scope for sustaining resource use, marginality shares most of the implications of fragility. Limited options with low payoff and high costs to upgrade resources make the marginality of resources and of people a major constraint. Accordingly, greater dependence on nature's processes, including regeneration; diversification and interlinkage of production activities; and limited dependence on external, high-cost inputs are the only possibilities for survival and growth in such a context. In this light, trees have a significant role to play in sustainable resource use and welfare in mountain areas.

Diversity, or internal heterogeneity, resulting from spatial, temporal, physical, and biological differences over short distances, is an important feature of mountain areas (Troll 1988; Jochim 1981). Diversity offers a potential for sustainable land use involving both diversification of products and higher resource-use intensity to achieve higher productivity without damaging the production potential of the resource base. However, a key requirement is to understand and take advantage of the diversity of land resources and to avoid narrow specializations. The central role of trees and perennial vegetation in such an approach hardly needs elaboration. In fact, the reduced diversity of mountain agriculture—as one of the most important indicators of emerging unsustainability—is partly due to the marginalized place of trees in land-use systems.

Exploiting ecological niches refers to local situations in mountainous regions where resources and environmental conditions create some potential for products and activities that give the mountain areas comparative advantage over lowlands (Brush 1988). The implications for sustainability are similar to those for diversity, because the possibility of finding a niche is partly a manifestation of the diversity of mountain resources. From the point of view of sustainable land use, a number of opportunities for resource- and product-centered activities exist that could enhance both productivity and welfare. Taking advantage of such niches should be a key focus in planning in mountain areas. Many of the niches that have been found in mountains are linked to trees or tree-based activities.

Adaptation mechanisms include the traditional approaches and methods of people for adapting to the limitations and potentialities of mountain conditions (Guillet 1983). Various features of traditional farming systems reflect them. They involve either amending the circumstances to suit human needs (terracing of steep slopes for cropping, for example) or focusing on activities (such as mixed farming or intercropping) that make efficient use of diverse resources. Besides technological measures, adaptations include institutional arrangements such as the provision of common property resources and social sanctions to regulate use of fragile resources. Where demand pressures on mountain resources are low, adaptation measures help to sustain both land resources and food systems. Most of these measures assign a central role to trees in diversified, interlinked activities (as illustrated by linkages between farming and forestry); they encourage local resource regeneration and recycling for sustainable resource use. A number of traditional practices have become ineffective and less feasible under today's changed circumstances. However, their rationale may

prove useful for designing future approaches to sustainable land use in mountains (Jodha 1990a, 1991).

Potential Role of Trees in Sustainable Land Use in Mountains

As the preceding discussion indicates, the prospects for sustainable land use and human welfare in mountain areas are mixed. While mountain characteristics such as inaccessibility, fragility, and marginality restrict the scope for an intensification-focused approach to sustainability, diversity and niches provide considerable opportunities to intensify use and to conserve resources. However, since all the characteristics specific to mountains are interlinked so that disturbances in one resource usually has implications for others, they have both positive and negative externalities (Jodha 1990b). For example, the unique character of mountain areas may favor intensification of land use by making it possible to find a niche, but the resulting intensification may have an adverse effect on fragile resources.

Under such circumstances, one has to look for options that facilitate the exploitation of opportunities, with minimal negative side effects. Trees or tree-based production systems in highlands offer a range of such options. Trees have a potential role in promotion of both intensification- and extensification-focused approaches to sustainable resource use in mountains. In Table 5.3, the sustainability-enhancing imperatives of mountain characteristics (indicated in Table 5.2) are listed. They are related to specific attributes of trees or forests that suggest a degree of convergence between sustainable land use and welfare in mountain regions. The relevant attributes of trees are put under two broadly interrelated categories. First, trees and forests contribute to the processes and functions leading to the stability and productivity of mountain resources. The role of forests in biodiversity, natural regeneration, biomass productivity, nutrient and moisture circulation, and the building and binding of soils fall under this category. The second group of attributes relates to trees as creators of production circumstances that can form the basis for specific land-use systems and production practices in mountains. Land-extensive production systems involving trees as a key component; tree-induced regeneration and organic linkages of production factors leading to reduced dependence on external inputs in the context of a closed system; multiple production options based on stable and secure flows of diverse biomass due to trees and associated vegetation; and the potential for unique products or opportunities with comparative advantages in mountain areas are the key manifestations of the forest-generated production circumstances mentioned above. In summary, the characteristics of mountain areas that make them vulnerable to degradation can be alleviated by expanding the role of tree-based systems.

Incompatibility of Tree-Based Systems and Resource-Use Intensification

As Table 5.3 indicates, there is a wide range of possibilities for ensuring sustainable land use and welfare in mountain areas by taking advantage of the opportunities associated with land-use systems involving trees. Traditionally, mountain communities have used various adaptation mechanisms—often described as folk agronomy or folk engineering—to harness these opportunities. In analyzing the scientific rationale behind traditional practices, Jodha (1990a, 1991) reported that, under the pressure of recent demographic, institutional, and technological changes, most of the land-extensive traditional practices have become infeasible or ineffective. Some of these changes are also responsible for trends indicating nonuse or reduced use of trees in current production systems in mountains. Put differently, there are real or perceived incompatibilities between attributes of tree-based production systems and the factors influencing current land use in mountains (see Table 5.4). Land use has intensified as a result of factors such as increased pressure on land due to growth of

Table 5.3—Complementarity between sustainability imperatives of mountain characteristics and the attributes of forests (trees) as components of land use systems in mountains

Mountain Characteristics and their Relevant Imperatives[a]	Attributes of Forests that Match the Sustainability Imperatives of Mountain Characteristics						
	Forest as a Contributor to			Forest as a Creator of			
	Biodiversity, Regeneration, Diverse Biomass	Nutrient, Moisture Recycling	Soil Building/ Binding; Environmental Stability	Land-Extensive Production System; Annual-Perennial Linkage	Local Resource Regeneration; Low External Input Use	Diverse Biomass Stability, Security	Unique Products, Opportunities
Inaccessibility Focus on local resource-centered activities, regeneration, recycling	X	X			X	X	
Fragility/marginality Land-extensive, low-cost activities with greater dependence on local resource generation suited to marginal situations, production with conservation	X	X	X	X	X	X	
Diversity Spatially and temporally interlinked diversified activities conducive to sustainable resource use	X	X		X	X		
"Niche" Unique production opportunities with comparative advantage	X				X		X

Source: N.S. Jodha, "Mountain Perspective and Sustainability: A Framework for Development Strategies," in *Sustainable Development of Mountain Agriculture*, ed. N.S. Jodha et al. (New Delhi: Oxford, and IBH Publishing, 1990).

[a] Besides the imperatives mentioned here, experience has shown that human adaptability in mountains is also conducive to harnessing the specific attributes of trees.

Table 5.4—Factors obstructing use of trees in intensive land-use systems in mountain areas

Specific Attributes of Tree-Based Production Systems	Causes of Land-Use Intensification			Causes of Overemphasis on Land-Extensive Dimensions of Trees	
	Increased Pressure on Land from Population Growth	Use of Input-Intensive Technologies	Market-Induced Narrow Specialization	Focus on Selected Products and Functions of Trees	Narrow Public Policies Based on Commercial Extraction
Land- and time-extensive production process	X	X			
Local resource-centered regeneration, diversified farming system (farming and forestry linkages)	X	X	X	X	X
Annual-perennial complementarities; contribution to farmers' biomass-oriented strategies		X	X	X	X
Indirect, less visible, long-term contributions through biodiversity, biophysical processes and flows, and soil building and binding			X	X	X
Current degraded status, reduced productivity, slow regeneration, high time and investment cost of upgrading forest/tree resources	X			X	X

population and market demand (Jodha, Banskota, and Partap 1990); use of input-intensive technologies that have acted as a disincentive to efforts to exploit local resources; and narrow, commercially oriented specializations that have reduced the diversity of mountain agriculture. Intensive land use does not match with tree-based production systems, which are generally land- and time-extensive in character. Tree-based production systems depend heavily on biophysical processes and interlinkages of various land-based activities (farming-forestry linkages), for which there is a limited place in intensive production systems based on modern technology (Yadav 1990).

Without denying the space and time-extensive nature of tree-based systems, the perceived incompatibility with intensive production systems is partly a consequence of overestimation of the amount of land and time required for tree-based systems. Accordingly, under the policies directed to the management and use of tree-based systems, and the technologies and investment programs required for them, only the space- and time-extensive dimensions of trees are emphasized. The focus is on selected species (rather than a whole range of trees) and selected products (on timber, for example, rather than on a variety of nontimber products). Trees are singled out from the overall agroecological or production system, and their many short-term contributions are ignored. Because of these skewed perspectives on the contributions of forests or trees, the importance of several aspects of tree-based production systems, such as annual-perennial complementarities, off-site effects of trees, effective use of nature's regenerative processes, and interlinkages of different land-based activities are minimized or ignored (World Bank 1978; Lasschuit and Van Eerd 1983; Gupta and Guleria 1983; Mahat 1987). Proper consideration of these attributes shows that tree systems can also be space- and time-intensive and that gestation periods in production cycles involving trees may be shorter than is generally believed. In the next section, some policy measures and options are discussed to integrate tree use as an effective component of intensification-focused strategies for sustainable land use in mountain areas.

Incorporating Trees into High-Intensity Land-Use Systems

The approaches to tree-based production systems that are conducive to intense but sustainable land use are related to the very factors that act against the tree-based resource use systems. Hence, it is necessary to focus on the biophysical possibilities for making tree-based production systems more space- and time intensive, and therefore to increase their compatibility with approaches to sustainability that focus on intensification. The emphasis on the extensive dimensions of trees must be changes. However, all of these changes must relate to farm-level realities, which alone can determine their relevance to land-use intensification strategies.

Biophysical Aspects

If the scientific basis for adapting tree-growing to the realities of mountain farming are properly understood, it is possible to evolve options that can help reconcile land-use intensification strategies and the space- and time-extensive nature of production processes involving trees (Table 5.5).

Taking a lead from the scientific advances in the fields of plant genetics and biotechnology, and making fuller use of the existing diversity in mountains, identification and introduction of quick-maturing woody perennials should be emphasized to reduce the inputs of land and time required for each generation of trees or each unit of the production cycle. Focusing on species with a high potential for producing several products can also enhance the intensity of land use in tree-based production systems. The integration of perennials and annuals in agroforestry can also help achieve the same goal (Denholm and Jodha 1990).

The introduction of trees with greater soil building or binding capacities, when incorpor-

Table 5.5—Approaches to adapt space- and time-extensive tree-based production systems to intensive land-use systems in mountains

Intensification of tree-based systems: biophysical aspects

- Identification and introduction of quick maturing, short-life-cycle trees specifically to reduce level of "land x time" input per unit of production cycle or per generation of trees
- Integration of trees and crops (for example, through agroforestry systems for varied locations) to harness complementarity of the two and to increase land-use intensity
- Identification and introduction of tree species with high potential for multiple products or intermediate-stage products, compared with terminal output (such as seasonally harvestable fodder, fuel, fiber, and food items, compared with timber as the terminal product)
- Introduction of trees with high soil binding or building capabilities, wider adaptability

Focus on "space- and time-intensive" dimensions of trees; changing conventional approaches and practices

- Focus on totality of products over lifetime (fodder, fuel, food, and so forth) rather than on a terminal product (timber)
- Assessment of invisible gains from trees (soil building, effects on the micro climate, off-site effects, and other externalities)
- Assessment of gains through tree-based secondary activities (such as processing and marketing) that generate income and employment, and their temporal spread to realistically project space- and time-intensity of tree-based systems and to properly assess cost effectiveness and the gestation period of investment in trees.

Handling waiting periods, incentives, and problems at the farm level

- Extend gains from scientific work on short-maturing, multiple-product trees that can be combined with crops and provide support for their adoption.
- Focus on strengthening linkage and complementarity between trees and other farm activities, such as cropping, livestock, horticulture, cottage industry, and off-farm jobs.
- Improve ready marketability and payoff to tree products and product-based activities through essential infrastructure and support systems to make them comparable to annual crops as dependable sources of income; recognize trees as assets similar to land collateral in credit transactions.
- Provide support systems (subsidies, side jobs) wherever undue waiting is involved.
- Focus on user groups and equity of access to gains from trees and forests on common lands in watersheds.

rated into agroforestry systems, can further reduce the land-extensive character of trees. The integration of trees with crops and the introduction or popularization of species with shorter felling cycles, multiple seasonal products, and improved ability to combine with annuals need special focus.

Perspectives on the Space and Time Dimensions of Trees

Because the conventional approach to assessing the productivity of trees is also responsible for the overemphasis on their land- and time-extensive attributes, the approach deemphasizes fruits, nuts, and other products that are supplied by trees over their entire life cycle. Such products are numerous, perennial, and, within a short period, have a total worth that far exceeds the final commercial value of the timber obtained at the end of the tree's life cycle (Myers 1990). Hence, a simple change in the perspective on productivity and the contributions of trees can make them an important component of a land-intensive system. Depending on the type and species and the nature of

the farming system using them, the products and services of trees and bushes may become available in only two-to-three years. Such a waiting period does not compare unfavorably with that of annual cropping systems with periodic fallowing of the land.

The productivity of land under trees over time can be better appreciated if consideration is also accorded to secondary activities based on tree products, which can generate employment and income on as regular a basis as annual crops do. Such activities range from those relating to agricultural input generation to agro-based cottage industries, already popular in mountain areas.

If other largely invisible but important gains from trees, such as soil building, moisture management, off-site benefits (reduced erosion, for example), and overall environmental stability, are measured and recorded, the space- and time-intensive dimension of trees can be better assessed (World Bank 1978).

Hence, changing perspectives can not only help establish tree-based production as a key component of highly productive land-use systems, but can also minimize several obstacles that artificially reduce the cost effectiveness of investment in trees and forests.

Meeting Farm-Level Realities

Through various biophysical interventions and changing perspectives on the space and time dimensions of forests, it is possible to reconcile tree-based production systems with intensive land-use systems for mountain areas. However, the exploitation of the potential faces several difficulties at the farm or watershed level, where realities call for concrete responses to the existing problems of tree-based production systems.

At the farm level, perspectives on products and contributions of trees are quite different from those at the macro policymaking and planning level. Farmers do focus on the multiple products and diverse contributions of trees. This is evident from the flow of products and the interlinkages established between tree, crop, and livestock-based activities under traditional farming systems. Various forms of indigenous agroforestry are also practiced. Secondary activities based on tree products are part of cottage industries and provide income-generating employment in mountains. However, in spite of all these factors, farmers are increasingly unable to accord high priority to trees on their land; forests are on the decline, and there is not much evidence to suggest that they are being substantially regenerated or protected by the people.

The reasons for this can be understood with reference to Table 5.4, which describes factors that make tree-based production systems incompatible with resource-use intensification induced by demographic, institutional, and technological changes in mountain regions. Hence, despite recognition of the multiple contributions of trees, forestry has not proven to be a sufficiently land-intensive activity to satisfy current requirements.

This underscores the importance of introducing short-maturing, multiple-product tree species that can be combined with annuals. Modern science and technology can help generate such options. However, their adoption and effective use at farm or watershed levels will be greatly facilitated by linking them with other farm activities, especially those treated as "lead activities" by the farmer because they fill cash income or subsistence needs. Accordingly, products of trees that facilitate dairy activity (by providing fodder for stall feeding) or service cash crops, perhaps by providing packing cases for horticultural products for market, or generate high-value, low-weight products, especially during the slack season, may gain quick acceptance from farmers. Besides a focus on these "linkages", other preconditions for acceptance of new tree-based options relate to their usability on the narrow land base of the farmer and to complementarity with other farm crops. Species suited to agroforestry or alley-cropping, which do not compete excessively with those crops and improve soil fertility through nitrogen fixation, are a case in point.

Furthermore, the potential for intensifying resource use of new tree-based production

systems, through the flow of multiple products or generation of employment and income opportunities, may not materialize unless the products have ready usability or marketability. This calls for a simultaneous focus on ancillary activities (such as processing and marketing) and on support systems and infrastructure. In other words, forests or trees will have to be integrated into a managed system of resource use (that is, a farming system) rather than being treated as nature's free gifts for extraction only.

Finally, despite development of short-maturity and multiproduct features, trees will continue to have relatively long gestation periods. The inevitable waiting period involved in the process may discourage many farmers from using production systems involving trees. Properly structured incentive schemes—for example, with graded patterns of subsidies over time—may be necessary.

An important provision to encourage the adoption of trees as a component of land-use systems in the mountains, despite the longer waiting period, treats trees at a par with land as a collateral in credit transactions (Chambers, Saxena, and Shah 1989). In addition to private land, this could also cover common-property lands (in the watershed), where the level of public grants or loans could be linked to the extent of community forests.

Another key issue regarding trees as part of intensive land-use systems in upland watersheds relates to trees on common lands. Effective strategies for management of common resources may require some additional elements besides those for trees on private farmland.

A focus on biophysical variables such as short-maturing species, rapid regeneration, and multiple products will have to be supplemented by some institutional measures to induce groups to promote, protect, and use trees and their products. In mountain areas, the tradition of community management of forests has weakened as the result of the increased role of market forces, increased population pressure, and formal public interventions, which have reduced the collective concern for and management of common lands. Revival of communal arrangements is possible, as indicated by a number of successful initiatives where control and management of forest resources have been returned to the people (Gilmour, King, and Hobley 1989; Fisher 1990). However, the key elements of success are equity in access and gains from common property resources and necessary investments and technical support from public agencies. Furthermore, neglect of common property forest resources is partly due to their degradation and low productivity and partly to the high investment and transaction costs of rehabilitation. This calls for initial investment and rigid regulation of their use. For the former, the communities will have to depend on public resources; for the latter, they will have to arrange their own group actions.

An additional issue of community forestry is the locational factor. Forests and pasture lands are often situated in relatively poorer, submarginal parts of a watershed. The ownership patterns of watershed lands (except where common lands are involved) often reveal that poorer lands are held by poorer people. Allocating such submarginal lands to forest or pasture would deprive the poor of any land for food crops. In such circumstances, some compromises can be worked out through promotion of agroforestry systems and some provision of compensation for unavoidable waiting periods.

Policy Issues

A number of policy issues relating to the role of tree-based production systems for sustainable land use in mountains have emerged from discussion in this paper. To recapitulate them more systematically, the policy issues can be placed in four broad groups:

1. Policies that incorporate mountain perspective into the policies and programs involving tree-based production and resource-use systems in mountain areas.
2. Policies that promote land- and time-inten-

sive options for tree-based production and resource-use systems in mountain areas.

3. Policies to change the conventional approaches and perspectives on tree-based land-use and production systems from those that overemphasize land- and time-extensive characteristics of systems involving trees.
4. Policies that offer incentives for promoting tree-based systems at farm and watershed levels.

Table 5.6 summarizes the major issues covered, their operational implications, and the key agencies that should be responsible for carrying them out.

Incorporate Mountain Perspectives

The first policy issue implies explicit consideration of the mountain characteristics discussed earlier (inaccessibility, fragility, and so forth) and their requirements before attempting any intervention in mountain areas (Jodha 1990b). In the context of land-use or production systems involving trees, this means, first, treating forests and trees as key to sustaining mountain habitats, rather than as mere natural resources to be extracted for commercial use. The next step is to recognize that trees and tree-based systems are appropriate in light of the potentialities and limitations imposed by mountain characteristics. The third step is to focus on those trees whose attributes make them better suited to mountain conditions in the changing face of more intensive resource use.

Concrete steps to achieve these changes include emphasizing tree-based systems directed to local resource regeneration and recycling, limiting external dependence and diversification, and building and stabilizing soil and water resources (Table 5.6).

Promote Land- and Time-Intensive Systems

The policy issues under this category focus attention on various biophysical and management variables that can reduce the extent of the inputs of space multiplied by time in production processes involving trees. To implement these policies, research and development (R&D) activities and support systems for development and identification of early-maturing species better suited to agroforestry systems will be essential to make tree-based systems compatible with a resource-intensification approach to sustainable land use (Table 5.6).

Alter the Conventional Approach to Tree-Based Systems

Related to all of these aspects is the need to change the traditional approach to tree-based systems from an overemphasis on land- and time-extensive tree-based systems to tree-based systems that require less land and shorter time periods to realize benefits.

Initiate Approaches and Incentives at the Farm Level

In order to revive traditional approaches to trees and to encourage tree-based production systems for sustainable land use in mountains, policies and programs should be directed to the following: (1) promote rapid spread of gains from R&D, promoting tree-based options for more intense use of resources; (2) provide support systems for the new systems; (3) link tree-based systems to diversified farm activities; (4) implement graded subsidy schemes and treat trees as collateral (on a par with land) in credit transactions; and (5) focus on user groups and equity of access and gains from community forestry development in watersheds.

Table 5.6—Policy issues of sustainable land use involving trees in mountain areas

Broad Policy Issues	Responsibility for Implementation	Steps for Implementation
1. Incorporate mountain perspective into policies and programs for tree-based land-use systems and sectoral programs	Sectoral policymakers, R&D planners, land-use planners, project authorities	Focus on local resource regeneration; high-value, low-weight products (to address inaccessibility); soil building and binding attributes (to address fragility); low-input requirements and diverse biomass (to address marginality); diversification, interlinkages, and comparative advantage; people's biomass strategies, user group perspectives (to harness adaptation experiences)
2. Incorporate land-intensive elements into tree-based land-use systems	R&D planners, sectoral policymakers, project authorities	Focus on agroforestry and species with short-life cycles, multiple products, and soil-regenerating abilities; provide R&D and resource support for trees as an integral part of intensive land-use systems
3. Change perspectives on roles, functions, and products of trees to recognize their land-intensive character, treating trees as a part of resource-intensive management, rather than as part of the natural ecosystem (in watershed context)	Sectoral policymakers, public agencies, investment planners	Focus on totality of products, indirect gains, intrinsic worth of tree products, and secondary income effects; change norms and yardsticks to access cost-effectiveness and investment needs of tree-based systems; understand and use rationale of traditional mixed-farming systems involving trees
4. Promote adoption of tree-based systems at farm and watershed levels through incentive programs	Project planners, field agencies, user groups, farmers	Focus on rapid percolation of R&D gains relating to desirable species and attributes of trees, their linkages to diversification and "lead-activities" at farm and watershed levels, provide infrastructural support to enhance gains from tree products; treat trees as collateral for credit; provide graded subsidies; focus on user groups and equity of access and gains from forest in watershed context

Note: R&D is research and development.

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CHAPTER 6

Intersectoral Policy Linkages Affecting the Forestry Sector

MARC R. DE MONTALEMBERT

A salient recent change in the perception of forestry problems and opportunities has been the awareness of the growing interdependence between activities and policy measures in other sectors and the conservation and management of forest resources. A significant example of this recognition is that the Tropical Forestry Action Plan (TFAP), launched in 1985, specifically called attention to the need for complementary action and policy reforms in other sectors related to the conservation and sustainable use of forest resources. Furthermore, the International Task Force on Forestry Research in 1988 identified intersectoral policy issues as a special topic among its recommended priority areas for research (Rockefeller Foundation et al. 1988).

However, recent reviews of the TFAP implementation (*Independent Review* 1990) and of the World Bank experience in forestry development (World Bank 1991) have pointed to a lack of significant progress. The recognition that forestry problems have major roots outside the sector and that the contribution of the sector to development should be seen in a broader context has yet to be translated into concrete efforts and results. Both reports underlined that adequate development performance depends critically on understanding the nature of intersectoral linkages and on designing intervention strategies accordingly.

This paper is an attempt to assess the current degree of understanding of policy linkages between forestry and other sectors of the economy. Since the focus is on policies outside the forestry sector, forestry policies are deliberately left aside. It must be stressed from the outset that an intensive literature search carried out in preparation for this paper led to disappointing results, particularly concerning both conceptualization research and empirical evidence. Little seems to have gone beyond limited observation to substantive, systematic, and comparative analysis.

In order to lay the basis for discussion, the first section reviews briefly the main concepts and issues, which should orient the analysis of intersectoral policy linkages. The second section makes a synthetic presentation of a few examples related to some major agroecological situations. The third section draws on these examples to propose a preliminary analytical framework, building upon existing knowledge. Finally, the paper stresses the paucity of existing knowledge and the urgency of a major collaborative research effort.

Basic Concepts and Issues

Awareness of the importance of intersectoral policy linkages arose initially from the perception of the incapacity of traditional forestry strategies to address alone the accelerating pace of deforestation and forest degradation. In the rich industrialized North, concern for deforestation was accentuated by dieback of temperate forests due to acid rain originating in industrial emissions and by the possible impact of deforestation on global environmental stability. In the South, the concern was prompted by the realization that short-term

benefits may result in irreversible environmental degradation and jeopardize the prospects for sustainable development. In all cases there has been general recognition that the roots of deforestation lay mostly outside the forestry sector. However, a meaningful analysis requires the clarification of a few basic concepts and issues.

First of all, as pointed out by Hamilton (1990), deforestation tends to be a "slippery" word, meaning different things even to the same writer in the same paragraph. Deforestation is distinct from degradation: it is a change in land use away from forest cover in response to a variety of socioeconomic forces. Deforestation does not invariably have negative consequences; it may lead in some cases to very effective and sustainable agricultural systems, such as paddy terraces in Asia. Loss of forests may also be compensated by an adequate density of trees being grown in the fields and fulfilling the productive and protective functions required to sustain the livelihoods of local people. Deforestation must be judged on the quality of the change process and its effects in the broader context—where, why, by whom, and for what purpose—in order to set the stage for an analysis of the forces at work.

Furthermore, in a broader development perspective, the central issue is the productive use of land and water resources to meet the needs of both rural people and national economies in an equitable and sustainable manner. Forestry is an option whose validity must be demonstrated through the sustainable management and harvesting of forest products and services, treating the forest as an economic renewable resource. Where land is a common resource base, this entails the resolution of competing and sometimes conflicting interests between different economic sectors and social groups, including generations yet to come. This is what policy should consistently be about.

Sustainable development policies should encourage the management and conservation of the natural resource base so as to ensure the attainment and continued satisfaction of human needs for present and future generations. When applied to forestry, sustainable development means conserving land, water, animal, and plant genetic resources and being environmentally sound, technically appropriate, economically viable, and socially beneficial. The context in which forestry must operate is characterized by population growth, inequality in land distribution, and limited opportunities for employment outside of agriculture. These, together with inefficient government policies, are increasingly forcing the rural poor to migrate onto fragile, marginal lands. Those are also the lands on which forestry has more to offer in addressing the twin problems of environmental fragility and rural poverty. Recently, there has also been an increased perception of and international interest in the global dimension of forestry problems associated with preserving the environmental role of forests (a role from which many benefit, but few are willing to recognize fully the implications in terms of alternative development options).

The problem is thus one of intricate relationships between forestry, food security, rural development, and environmental stability, at local, national, and global levels. It is not deforestation or even the sustainability of forestry that is at stake, but the sustainability of rural development. Intersectoral relationships and policy linkages must be seen as two-way interactions, enabling forestry to play its role in sustainable development. The focus must equally be on enhancing the positive contribution of forestry to socioeconomic development and on avoiding the wasteful degradation of an important, renewable natural resource.

Policy influences are largely determined by institutional arrangements, by the socioeconomic context, and by the behavior of the concerned agents. Although rural people depend—or are forced to depend—on the natural resource base, they know of policy developments only when their effects reach them. Particularly in relation to rural forestry matters, rural people are too far away from decisionmakers; they have little if any chance to make their concerns and priorities known. Policy decisions are thus seldom taken in cognizance of their likely effects and behavioral responses. This adds to the complexity of

analyzing policy interactions in relation to forestry.

A Few Examples

Three examples of marked policy interactions have been selected on the basis of how well they represent major forestry situations: they include pastoral economies in drylands in North and West Africa, new settlements in humid tropical forests of the Amazon Basin, and rehabilitation of marginal lands in Southeast Asia. Availability of analytical documentation and evidence of a complex set of policy interactions were criteria used in selecting the three cases. These examples focus on the most important policy interactions. In two cases, policies have been deleterious to forestry, with the resource being converted inefficiently to other land use or being destroyed. However, the third case exemplifies positive interactions.

Pastoral Economies in Drylands of Africa

Pastoral economies were once a predominant form of livelihood in the drylands of North and West Africa, and some 20 million people are estimated to be still practicing pastoral systems with a predominance of some form of transhumance (seasonal movement of livestock). A report of the Food and Agriculture Organization of the United Nations (FAO 1989a) provides an interesting analysis of 30 years of pastoral development efforts in the Mediterranean region. Another recent FAO report (FAO 1990b) focuses on the traditional knowledge and the decisionmaking process of herders in natural resources management in dry Africa. An initial important remark is that both reports, like many others, stress the degree of adaptation and effectiveness of local technical knowledge and the management systems of most pastoral societies. They underline the substantial capabilities of local people to use the limited potential of available natural resources wisely and flexibly under difficult and varying ecological conditions.

Four major types of policy interventions were initiated during the colonial period and they were largely extended after national independence. The first and most important political intervention was aimed at limiting the free movement of herds and herders and at bringing them under administrative control. In most cases, the policy was to encourage settlement through the provision of basic trade and social services, health services, and education at fixed points, generally in newly created villages. In most cases, the transition from a nomadic pastoral economy to a sedentary one entails serious ecological and economic risks due to the concentration of large numbers of livestock, unless the feeding problem has been solved.

The second intervention focused on the expansion of rainfed agriculture, particularly for grain production. North Africa has a large but not exclusive record of expansion of mechanized farming on wooded grazing lands which were quickly eroded and degraded. Subsidized inputs, including heavy machinery, were supplied to some cooperatives. The pastoral groups were excluded from lands that they had traditionally managed. For example, it has been estimated that, in Morocco by the mid-1950s, 7 million hectares of mostly former pastureland had been ruined by a misleading agricultural expansion policy (FAO 1989a). Similar examples exist in the Sudan and other Sahelian countries.

The third intervention resulted from livestock pricing policies that actually encouraged overstocking through subsidized inputs, such as increases in equipped wells, veterinary services, and provision of slaughter facilities. In addition, tax incentives were granted in some cases to hold livestock, while in other cases infrastructural deficiencies reduced the incentive to sell livestock during the dry season. Most of these well-intentioned interventions were based on insufficient understanding of pastoral system, and they often resulted in overstocking and overgrazing.

The fourth major policy intervention consisted of the systematic attempt to demarcate forestlands and collective lands. Furthermore, usage rights of herders were regulated under

conditions that were frequently unclear to the herders because they hardly related to traditional local management systems. In addition, policing practices generated lasting situations of misunderstanding and tension, which still prevail.

The uncoordinated nature of these policy interventions accentuated their negative consequences. It generated more difficult living conditions for pastoral groups whose capabilities were almost systematically neglected. It ignored the need for convergent approaches to sustainable development. Range and forestland areas have declined substantially as a result of expansion of subsistence and cash-crop farming. At the same time, increased human and animal populations have been constrained to make their living from a reduced land resource, left over because it was unsuitable for agriculture or already degraded, whereas access to remaining forestland was negated. Overexploitation of remaining collective lands has become unavoidable, as has encroachment and overgrazing of forestlands not kept under close control by usually weak forest services. Recent FAO studies, as well as the World Bank's Livestock Strategy paper (1987), have called for a much more prudent approach, with a closer articulation of interventions and clearer recognition of the validity of local management systems.

New Settlements in Humid Tropical Forests

The pace of reduction of humid tropical forests has been a growing concern, especially since both the FAO Forest Resource Assessment of 1990 and more localized studies have indicated that the pace accelerated during the 1980s. The situation in the Amazon Basin has raised the greatest concern, with a total of 41 million hectares having been deforested by 1990 in the Amazonia Legal region of Brazil alone, according to the Brazilian National Space Research Institute (1991). The major policy interventions that led to the accelerated destruction of the Brazilian Amazon forest is the best documented case of intersectoral policy linkages (see, in particular, Mahar 1988; Browder 1988; Binswanger 1989). Similar situations have been observed in other parts of Latin America, where the effects of high demographic growth, inequitable land distribution, and rural poverty have been compounded by government policies. The main policy interventions have been related to infrastructure development, to rural credit and land titling for agriculture and livestock expansion, and to cash crop development.

Major road-building programs radically changed the accessibility of the Brazilian Amazon in the 1960s, with the addition of 1,900 kilometers of the Brasilia-Belem highway and 1,500 kilometers of the Cuiaba-Porto Velho highway. In the 1970s, the National Integration Program provided resources for a further expansion of the road network by 15,000 kilometers. Hundreds of thousands of square kilometers were thus opened up, but rates of penetration varied. The population in the Belem-Brasilia highway zone was multiplied by 20 during the 1970s. Similar rates of population increase were noted in the 1980s along the Cuiaba-Porto Velho highway, as the result of a combination of pull and push factors, analyzed by Mahar (1988). By contrast, there was no significant population increase along the Transamazon highway, where only 3 percent of the land is suitable for agriculture and where the economic factors were quite unfavorable. Major hydroelectric projects, mining programs, or oil exploration activities were also instrumental in providing channels to new areas of spontaneous migration.

Effects of infrastructure development are accentuated when accompanied or followed by incentives, subsidies, or fiscal measures that encourage the uncontrolled expansion of agriculture and livestock activities. In Brazil, Operation Amazonia for industrial and agricultural development included a fiscal incentives system, supported by a regional development bank and a regional development agency. A tax credit system was established, and it initially allowed agriculture, livestock, industry, or service projects to benefit from a 50 percent income tax reduction. The consequences have been particularly notable in the livestock sec-

tor, which accounted for almost two-thirds of all approved projects and a geographical concentration in two states where it contributed most to deforestation. Overall, however, Mahar estimates that ranching's contribution to deforestation did not exceed 10 percent. Recent analyses have underlined the lack of sustainability of the resulting livestock development; the system encouraged the rancher to create new pastures rather than to maintain existing ones. Only the wealthier investors benefited from the US$700 million in subsidies distributed by Superintendencia do Desenvolvimento da Amazonia (SUDAM) during the 1970s and 1980s (Browder 1988). Small farmers who do not pay income tax did not benefit.

Other land tenure and tax policies have a significant impact on the dynamics of land use of more direct relevance to small farmers, particularly to poor migrants. Most notable is the policy according to which deforestation is the proof of land improvement, which gives an individual claiming a parcel a recognized right of possession. In the Brazilian Amazon, Ecuador, and Guatemala, half of the land claimed must be deforested before tenure can be officially recognized (Mahar 1988; Southgate 1990). Such policies are a great disadvantage to forest dwellers, particularly those making their living from extractive activities; they are also a source of violence and conflicts between indigenous groups and new settlers. Furthermore, in Brazil, rebates on the rural land tax were granted according to the degree of utilization of the land—that is, the proportion of the land deforested, irrespective of whether the land was good or poor.

Agriculture pricing and marketing policies, as compared with pricing policies for forest products, can have a significant influence on land-use changes and on the amount of forestland being cleared for agriculture. The extent to which forest has been converted to growing of sugarcane, cocoa, coffee, rubber, and oil palm, as compared with subsistence farming and with maintaining and managing forest for productive purposes, is not well documented. But cash-crop pricing policies are known to be a major factor in the reduction of tropical forest area in Southeast Asia, in West Africa, and in Central America. Agricultural pricing policies introduce market distortions that affect the value attached to forest resources and related activities. They make proper valuation of the resource, as well as investment decisions, more difficult.

Estimating the effects of nonforestry policies on tropical forests and on transfer to other land uses is complex. In 1989, the Brazilian government decided to suspend the subsidies that promoted the clearing of the Amazon forest. Even if this is only one among various favorable factors, the deforestation rate for 1989-90 showed a significant decrease from 2.1 to 1.4 million hectares per year, according to the Brazilian National Space Research Institute (1991). However, the suspension of subsidies is not sufficient; it should be part of a consistent reform of those policies that attract new settlers through, for example, land titling systems, access roads, and public services. Ultimately, intersectoral policy linkages should be mobilized through convergent approaches to more effective development models. Such models should realize the comparative advantage of economic activities based on existing forest resources to provide a sustainable livelihood to indigenous groups and to new migrants.

Rehabilitation of Marginal Lands

Marginal lands cover extended areas in the developing world. They are characterized by their low productivity and by a higher ecological vulnerability. They are of special concern to forestry for several reasons. First, in many cases, they are degraded former forestlands, which still provide significant subsistence or marketable products from their tree and bush cover. Second, these lands are being occupied by growing numbers of rural poor forced to migrate under population pressures and increased landlessness. Third, sustainable development on these lands depends on solving the twin problems of environmental restoration and poverty alleviation to which forestry can make a major contribution. An example from

northeastern Thailand (FAO 1989a) provides an interesting case of intersectoral policy linkages to be seen from the perspective of complementing forestry actions toward sustainable rural development.

By 1980, only 10 percent of the forest cover of the Khao Phu Luang Forest was left, after decades of successive waves of legal and illegal loggers had opened access to the forest. Encroachment and clearing for crop production was not undertaken only by poor, landless farmers, practicing shifting cultivation and subsistence farming, however. Agricultural pricing policies and the growth of agricultural export markets raised considerably the profitability of cash crops, particularly maize and cassava. Forestlands were thus also cleared for cash cropping by commercial farmers and urban entrepreneurs using hired labor. The process was therefore a typical one of deforestation for agriculture in an ecologically fragile, relatively dry, hilly environment, subject to quick degradation. The result was a degraded area of marginal productivity occupied by immigrant, illegal settlers with no land tenure rights, living mostly on subsistence farming in scattered homesteads, with poor or no administrative and social services. This scenario could be found in many areas of Southeast Asia.

A strategy was developed and applied to promote integrated sustainable rural development under the leadership of the Thai Royal Forestry Department, but with a number of policy ingredients from other sectors. The objective was to provide a viable alternative to shifting cultivation through an integrated land use approach, which combined food and cash crops, livestock, and aquaculture with forestry activities. The effort was organized under a resettlement scheme providing better access roads, water points, and administrative, education, and health services, as well as rural credit and marketing facilities. Such a complex undertaking called for unprecedented collaboration between the various departments active in rural development, acting under convergent policy lines. The common focus was to assist in improving the livelihood of illegal farmers and to enable them to enjoy services normally provided by the government in established villages and to exercise their rights as normal citizens.

The landholding, tenurial status, and land-use issues were the most critical. Detailed land use was organized on the basis of soil suitability and of watershed protection needs. Scattered farmers were encouraged to regroup into constituted villages, around which the land was distributed, with a fixed-size plot allocated to each family. Farmers were given a usufructuary certificate recognizing their rights to their new land. However, the process of land allotment and of recognizing usufructuary rights was constrained by the resistance of some farmers to move to new land, which they considered less appropriate than the one they occupied, or by their lack of confidence in the titling certificates. Village community consolidation was also slow, despite the infrastructure, services, and amenities provided in the new villages. This was mostly due to resistance to relocate from scattered homesteads and to difficulties in selecting leaders.

Another key issue in the development strategy has been the focus on income generation, with a wide variety of activities being promoted both on- and off-farm. As a result, average income per household has been raised substantially, with increased diversification and reduced risk exposure. A critical factor has been the availability of credits and loans from a local bank, which enabled farmers to invest in improving productivity. However, the correlation between the conditions and amounts of loans and credits, the size of the holding, total inputs and outputs, value, and income needed to be kept continuously under review to ensure equitable access to income opportunities.

A critical factor in the success of the program's strategy has been the ability to marshal interdisciplinary cooperation and to develop effective working relationships among a number of rural development agencies responsible for land reform, forestry, agriculture, livestock, fisheries, infrastructure, health, local administration, credit, extension, training, and research. The main lesson from this example is the effectiveness of the convergent approaches,

which were built upon complementarities between various sectoral and subsectoral policies and which brought together action and support on the various facets of sustainable rural development. Tree-growing and forestry-related activities continued to be a main feature of the new economy, but they benefited from the positive context created by the transformation of the area from a disorganized and backward frontier land into a normal rural socio-economic environment, with agroforestry as the dominating farming system.

The three examples cover a wide diversity of situations. Recognizing and understanding local circumstances and behavioral specificities are critical to any serious analytical work. However, an important observation is related to the fact that in all three cases major interactions between policies were apparent: a policy development in one area was likely to have repercussions in other areas and, in particular, to affect forestry. A second observation is that unsustainable use of natural resources is exacerbated by government policies that are either ill-conceived or carried out for other reasons and do not recognize the intersectoral linkages or externalities. On the other hand, when the linkages were not only recognized, but in fact an integrated approach was built on them, progress toward sustainable development was evident.

Toward an Analytical Framework on Intersectoral Policy Related to Forestry

The previous section provided evidence of substantial policy interactions affecting the use or misuse of forest resources. It clearly showed the existence of negative effects of one sector on another, with an ultimate impact on the sustainability of development. But, as already stressed, a review of the literature provided no indication of systematic analytical efforts aimed at identifying relevant linkages; understanding their effects, positive or negative; analyzing the weaknesses of policy formulation processes involved; or proposing options for appropriate action, in particular for addressing the externalities involved.

On the basis of analysis of experiences, such as those described in the previous section, and empirical evidence, Table 6.1 is constructed to show, for the purpose of further analytical work, the major policy areas involved, some specific types of components or instruments influencing these policies, the linkages by which forestry is influenced, and the possible effects related to forestry. It can be used either to identify the influences and consequences of major policy areas or to trace the causes of forestry problems or opportunities. Its focus is institutional, permitting each policy area to be identified with a government department. An alternative would have been to focus on major policy instruments, such as fiscal policies, pricing policies, land distribution policies, and their applications through various sectors. However, this would have made the recognition of institutional responsibilities more difficult.

In identifying forestry-related effects, it must be remembered that such effects must be looked at from the perspective of a positive or negative contribution to sustainable development, and not limited to a resource conservation point of view. Furthermore, in most cases, the same intersectoral policy linkage can have a positive or a negative influence, depending on the way it operates and the reaction of the groups that are influenced. Forestry-related effects should most appropriately be identified and classified under the four major contributions of forestry to sustainable development: generation of revenues and economic growth; food security and off-farm employment; expansion or reduction of the forest area; and protection of the natural resource base, biodiversity, and environmental conservation.

In analyzing forestry-related effects, efforts should focus on identifying more specifically the nature of the effect, as this generally provides indications of appropriate ways to correct a negative linkage or to strengthen a positive one. For example, at the interface between forestry and other sectors, the wasteful use of forest products will generally be related to insufficient economic value attached to such

Table 6.1—Intersectoral policy linkages related to forestry

Policy Area	Component/Instrument	Linkage	Forestry-Related Effect
Macroeconomic policies	Monetary and credit policies	Credit allocations and interest rates	Investment capacities in resource management and utilization
	Foreign investment regulations	...	Reduction or increase of investment in forestry/ forest industries
	Trade policies: exchange rates	Valuation of production	Incentive or constraint to production and export
	Import controls	Reduced imports of equipment and spare parts	Wasteful harvesting and processing
	Export promotion	Subsidies	Overutilization of selected species
	Fiscal policies	Tax levels and collection, reallocation of fiscal revenues to forestry	Rent levels and capacities for reinvestment
Structural adjustment	Public investment and privatization	Expansion of private-sector role	Social and environmental functions
	Pricing policies	Correcting market distortions	Valuation of forest products/services
	Institutional reforms	Reduction in public sector's role and expenditures	Sectoral management and development capacities
Land distribution and reservation	Fiscal policies	Taxes and subsidies	Reduction of forest area, standing stock, and biodiversity
	Legislation	Land titling and tenure	Security of rights, sustainability, or exploitation of resources
	Land demarcation/ privatization	Resource management, access to resources, usage rights	Forest resources management system. Forest reserves
Population	Colonization	Subsidies and infrastructure development; modifications of land uses	Appropriate land use development, including forestry or overexploitation and encroachment
	Sedentarization	Same as above	Sylvipastoral management

(continued)

Table 6.1—continued

Policy Area	Component/Instrument	Linkage	Forestry-Related Effect
Agriculture/ livestock	Pricing policies	Agriculture pricing versus wood pricing	Intensification of agriculture and/or expansion of agriculture on forestlands, changing consumer behavior, and impact on value of wild foods
	Subsidized inputs	Mechananization	Expansion of agriculture, forest clearing, marginal land cultivation
	Taxes and credit	Expansion of livestock numbers, overgrazing	Degradation of tree cover
Energy	Pricing and distribution	Gasoline prices and supplies/mechanization	Land clearing/agriculture expansion
	Alternative fuels	Household/rural industries fuel substitution	Fuelwood and charcoal demand
	Hydroelectricity	Dams	Watershed management
	Enery self-reliance	Encouraging local renewable energy resources	Developing fuelwood production/demand
	Roads, railways	Opening access to new areas	Increased opportunities for forest-based income or for encroachment

products, or to the dichotomy between actors and beneficiaries or both, and to the lack of clear ownership and use rights. The economic or social nature of the effect will lead to tracing the interaction either in pricing policies in agriculture compared with forestry or in the legal arrangements for tenure and use of land or trees, or both. Analyzing the financial, economic, social, and institutional nature of the identified effects is already a first step in understanding the nature of the linkage and in identifying the possible scope for corrective action.

Among all of the linkages, the macroeconomic policy environment has a critical importance for forestry's performance and for the sustainability of related activities whereas, except in a few cases, the forestry sector has no influence at the macroeconomic level (FAO and the Netherlands 1991a, 1991b). Of course, a solid base of forestry-sector analysis is indispensable for understanding the influences of factors originating beyond the sector's boundaries. For example, information on the total economic value of the forest and its components should be available if comparisons are to be made with the value of alternative uses of the land or if the results of modifications in the macroeconomic environment, such as tariffs, taxes, or credit, are to be identified. Yet there is a general failure of the market, or policies, or institutions to reflect or capture the true value of forests. A major obstacle is the lack of information. But also, the market is failing because it receives and relays distorted price information, which in turn results in policies having unexpected results because of market distortions. Another issue of a macroeconomic policy nature relates to interest rates and to the extent to which they are compatible with the intertemporal character of forest resources and of their utilization. High interest rates tend to favor short-term economic behavior and to work against investment in forestry.

The issues related to the macroeconomic environment are numerous and important, especially when structural adjustment programs (SAPs) are introducing substantial modifications into it. Issues include the effects of trade and market liberalization on the utilization of forest production, the reduction in public expenditures and its impact on forestry institutions, and more general effects on natural resources (FAO 1990a). Concern has also been expressed about SAP effects on rural poverty, but little is actually known of the linkages, and about the way that poverty affects rural migration and the clearing of marginal lands for subsistence farming.

Another element of critical importance relates to land use and tenure as the land resource base constitutes the common denominator of all sectoral policies dealing with natural resources and rural development. Furthermore, land use constitutes an integrative element in sustainability. To be appropriate and sustainable, land use requires convergent policies and articulated approaches and strategies among the various sectors depending on the same resource base. National governments, governmental and nongovernmental organizations, communities, households, and individuals are all agents with their own strategies and with their own reactions to socioeconomic effects and to incentives or disincentives. On the other hand, forestry and the sustainable management of forests have a temporal dimension that requires stability in land use if the results of investment are to be allowed to mature. Last, but not least, the important role of forestry in relation to biodiversity and conservation requires an integrated approach to land management that reconciles conflicting demands and ensures adequate protection through promotion of development alternatives in adjacent areas.

Among the many other policy areas that may have significant interactions with forestry, the table draws attention to population, agriculture and livestock, energy, and infrastructure. Each of these deserves further elaboration and a treatment of its own. Some examples of the types of linkages involved have already been provided. What must be underlined here is that each of these policy areas uses its own set of policy instruments in pursuance of its development objectives, which have a substantial influence on development of the forestry

sector. Therefore, a systematic effort is needed to better understand the nature of their influences and to identify the scope for harmonizing the content and instruments of these policies with those of forestry.

While the table may be useful for stimulating discussion, there is a clear need for substantial analytical work to develop a framework that helps in identifying the more important intersectoral policy linkages and in understanding the way they operate. To be useful, such a framework should be action-oriented. It should help identify specific linkages at work in given situations, the corrective actions required to arrest deleterious effects, and the possible actions needed to build more effectively on opportunities. Furthermore, the framework should help identify means for internalizing the policy externalities involved, or at least help make them explicit whenever appropriate.

The Need for a Significant Research Effort

The quick review presented here confirms the importance and complexity of policy interactions between forestry and other sectors, particularly within the broader framework of macroeconomic policies. The effectiveness of future efforts for the conservation and wise utilization of forest resources will increasingly depend on the ability to improve the policy environment of these activities. This includes the incorporation of forestry concerns into the broader policy context, as well as the harmonization of policies for forestry and other sectors, particularly on land-use questions. However, the information available on intersectoral policy linkages related to forestry is fragmentary and does not lend itself to systematic and comparative analysis.

A significant research effort is thus indispensable both for generating information and for developing an appropriate analytical framework. The following are possible orientations for such a policy research effort:

1. Systematic identification and understanding of the most important policy linkages should be developed both in relation to the ways they operate and the nature of their effects. This effort should consist of a number of case studies with well-articulated and consistent terms of reference.
2. A review of experiences available in other sectors concerning the analysis of policy linkages should be conducted with the aim of identifying possible socioeconomic tools and methodological approaches applicable to forestry.
3. Viable policy instruments should be identified through which policy interactions between sectors related to forestry can operate more effectively, together with an understanding of the relevant context.
4. In view of the special importance of the land-use dimension, collaborative efforts should be launched between institutions in forestry and related sectors. Work should focus on identifying specific areas or issues on which policies should be harmonized and on working the necessary adaptation of the formulation procedures in pursuance of convergent and sustainable land-use approaches. A related priority area for research is the development of consistent incentive systems for sustainable natural resource management and use.
5. Research and training activities should be undertaken aimed at analyzing and addressing more systematically intersectoral policy linkages related to sustainable land use and forestry in sectoral reviews and planning exercises. Such incorporation should work both ways, between forestry and other sectors and vice versa. Monitoring progress and results would provide important feedback for methodological research. TFAP reviews and agriculture sector reviews are an immediate priority field of application.

Most importantly, if the new research effort is to be effective, a collaborative undertaking of an interdisciplinary nature between policy research teams in forestry and other sectors is required. Only if such efforts are consistently pursued will the research results be likely to fit the specific approaches prevailing in the sectors concerned, and therefore be more easily adapt-

able to the needs of the users (and adopted by them). The gaps in understanding of how intersectoral linkages operate should be filled as soon as possible. A challenging and urgent task lies ahead, calling for the mobilization of efforts and resources. However, in a world of increasing interdependence, the results should provide significant inputs into realizing more effectively the contribution of forestry to sustainable development.

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