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TROPICAL FORESTRY RESEARCH

Developing a U.S. Strategy

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PREFACE

Tropical trees and forests play a central role in the lives o hundreds of millions of people. They are a major component of th global biosphere. Yet they are being rapidly degraded an destroyed, often for short-term gains and with little thought to th future. The purpose of this report is to suggest how the Unit States could help ensure that constructive research is undertaken t better understand the relationships among people and tropical tree and forests. This review should be viewed as one further step i the process of expanding the scope and practice of tropical forestr research and policy within an evolving area of scientific developmental, and public interest.

The impetus for this study came from the findings of the recen Co[illegible]e on Forestry Research of the National Research Counci ([illegible]. Their July 1990 report, *Forestry Research: A Mandate fo Change*, called for an expanded vision of the role of forestry i society. Their conclusions, which provided both the timel justification and the foundation for this review, can be summarize as follows:

> *Forestry research must change radically if it is to help meet national and global needs. It must become broader in its clients, participants, and problems, and at the same time it must both become more rigorous and be carried out in greater depth. The number of scientists and amount of resources devoted to forestry research have declined significantly [in the United States] and are continuing to decline, even as needs increase. To meet the challenge of change, new approaches and new resources ... are required. The educational and fiscal systems that support forestry research must be restructured and revitalized; integrated research facilities must be created where public and private resources can be effectively concentrated on basic questions and extension activities. These changes will be expensive, difficult, and, for many, painful. ... The consequences of not making them, however, would be more painful: a national and global society increasingly unable to preserve and manage forest resources for its own benefit and for the benefit of future generations.*
>
> *We emphasize that both the wise use and the misuse of forests are consequences of human activity. Without a large additional increment of knowledge derived from increased forestry research to provide policy alternatives, the misuse exemplified by deforestation, destroyed productive potential, and lost biological diversity will prevail. Knowledge gained from an improved system of forestry research will enable society to choose wise use and thus to secure the environmental, economic, and spiritual benefits of forests.* (NRC, 1990a, p. 7)

Given the rapidly expanding scope of forestry highlighted by the NRC Committee on Forestry Research, an NRC Review Panel on International Forestry Research was formed at the request of the Forestry Research Subcommittee (John Gordon, Chair) of the Research Advisory Committee (RAC, Bryant Rossiter, Chair) of the U.S. Agency for International Development (AID). The RAC itself is a long-standing, independent committee that provides scientific and technical advice to AID, an agency of the Department of State. All NRC advisory panels to the RAC are supported by AID agreement DAN-5052-C-00-9071-00, administered by the Office of Research and University Relations, AID Bureau for Science and Technology.

The following report represents a collaborative effort of seven forestry researchers selected by the Board on Science and Technology for International Development (BOSTID) of the NRC. RAC and AID officials asked the international forestry panel to advise "on appropriate AID research roles and activities within the larger national and international framework" (the Statement of Task in Appendix A). International development and forestry research converge in the tropical forests of the world.*

The panel met in Washington in December 1990 for discussions with RAC, AID and NRC staff, and other appropriate individuals. Based on discussions and deliberations at that meeting, the panel drafted this report before meeting again in Seattle in January. The draft was then revised by the panel and reviewed by the National Academy of Sciences' Report Review Committee. This report is intended to present the views of the NRC Review Panel to RAC. It is not a comprehensive and detailed technical analysis of research and policy, but a summary and an appraisal.

* In this report, tropical refers to the broad geographical region that is generally frost-free. The forests of the tropics, which are almost exclusively in developing countries, are those vast areas in which trees are a predominant component of the vegetation.

Forestry attempts to harmonize production with resource conservation. Especially in the tropics, its practice is not limited to areas that are forested, nor to foresters. The panel recognizes the substantial amount of basic research being done on the biology, chemistry, and physics of tropical forests and their relationship to the land, sea, and atmosphere. Our focus here, however, is on research into the use, misuse, protection, and management of tropical forests and trees by people. It is in this broad sense that we use the term "tropical forestry research."

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Research on forests and their components and their interactions with people currently spreads far outside forestry institutions and companies. No scholarly effort to fully inventory research on forests has been made in the United States, nor is there any widely recognized forum that facilitates communication among all the parts of forestry and forest research. This lack of leadership contributes to an overall fragmentation of effort and absence of clear definition of what constitutes forestry and forestry research.

Forestry Research: A Mandate for Change
National Research Council, 1990

EXECUTIVE SUMMARY

This report reviews tropical forestry research and suggests an enhanced role for the United States in the immediate future. The first chapter highlights current concerns over tropical forests: their condition, their value, and the role of research and science. Chapter 2 summarizes the status of research in tropical countries and the international community, and contains a discussion of the expanding scope of forestry research. Chapter 3 assesses current U.S. participation and provides a framework for future involvement. The final chapter contains the panel's suggestions of what we can do now to meet research challenges and opportunities. Explanatory notes and further references are provided at the end of each chapter.

Developing nations increasingly devote more of their scarce resources to the myriad and diverse dilemmas posed by forest exploitation and conservation. The international community is banding together to help resolve many of the complex social, economic, and environmental problems faced by developing countries. In general, both are developing collaborative approaches to the quandaries and opportunities presented by research on tropical forests. However, the panel points out that a major weakness of this global effort remains a diffuse and limited U.S. scientific contribution. Still missing are coherent and long-term commitments to tropical forestry research, education, and extension that coordinate both funding and practice into a strategy.

The panel reaffirms the conclusions of earlier studies, and urges the continued expansion of U.S. tropical forestry research activities, at both the federal level (particularly within the Agency for International Development and the U.S. Department of Agriculture) and throughout the nongovernmental sector. It proposes a peer-reviewed grants program (with suggested financial administration through the Department of Agriculture) that would build both individual and institutional capacity while addressing the most pressing issues. An ad hoc, independent Tropical Forestry Research Council would provide strategic coordination of U.S. efforts. In these times of increasing cooperation, such an expanded, collaborative partnership could contribute to both prosperity and the global environment. The United States could become a full participant in tropical forestry research and development, as well as being the major sponsor it is today.

CHAPTER 1
TROPICAL FORESTS

The fate of the world's tropical forests has become a major element of the global agenda. Declining resources and increasing environmental degradation are now focusing worldwide attention on the direct contributions that forests and trees make to our well-being.[1]

Trees in the tropics-underpinning a vast diversity of plant and animal life-are an immense source of food, fuel, fodder, fiber, timber, and medicines for gatherers, hunters, farmers, and townfolk. Tropical forests themselves are home to millions.[2] They provide economic as well as environmental and cultural benefits to more than four billion people in the tropics.[3] Indeed, tropical forests are of use to everyone. Their products and the markets they create are important to international commerce.[4] Many new products, uses, and markets remain untapped.[5] Tropical forests play important roles in local, regional, and perhaps global climates.[6] Forests stabilize environments and are essential components of the global ecology (NRC, 1991a). The burning of tropical trees also increases the atmospheric gases—especially carbon dioxide—that could engender climatic change and the uncertainty that would entail.[7] In addition, it is estimated that the humid tropical forests ("rain forest") alone, which occupy only about 7 percent of the earth's land area (roughly 1.0 billion hectares or 2.5 billion acres), contain well over 50 percent-perhaps significantly more-of all living species.[8]

Estimates of the extent of natural forests in the tropics, and of the rate at which these forests are disappearing, vary considerably.[9] Too frequently, even when forest is cleared for other purposes such as agriculture, poor land-use practices following conversion often lead to landscapes both devoid of productive use and ecologically disrupted. There is a growing consensus among scientists, governments, and the public that the degradation and disappearance of tropical forests have increasingly serious global repercussions.

In view of rapidly increasing pressures on tropical forest land, today's social, economic, and environmental development activities must not further jeopardize the options of present and future

generations.[10] Some tropical forests need protection, others may be managed on a sustainable basis for multiple products and values; many will be cleared for timber, agriculture, settlements, and roads. Natural and planted trees growing outside the "forest" will become increasingly important in directly providing essential needs and in conserving soil, water, and biological resources. Forestry today must therefore more fully encompass the harnessing of trees for human betterment while protecting them–and the natural habitat they engender–for the future. This will depend on forestry research, and the communication of research through education and extension.

Science cannot confront problems without political, economic, and popular support. Nonetheless, the scientific community must take the lead in uncovering methods of using tropical trees and forests for human needs without endangering the resource base. And only by providing viable alternatives to forest misuse can concerns such as climate and diversity be successfully addressed. Given the basic dependence of billions of people on tropical forests, the panel's fundamental conviction is therefore that the well-defined goal of tropical forestry research should be the improvement of people's lives in a sustainable way. It is in this spirit that this report is written and the recommendations made.

Notes to Chapter 1

1. The notes and references of this report provide a starting point for further inquires. A current review of tropical forestry research issues and needs, international activities, and U.S. policy options, together with extensive bibliographic references, appears in Chapter 7 (The Forestry Sector) of *Changing by Degrees* (Office of Technology Assessment [OTA], 1991a). A thorough and still-relevant assessment and analysis of science and policy from the U.S. perspective is OTA, 1984; many of its recommendations are embodied in Appendix B. See Miller and Tangley (1991) for a general discussion of tropical forest issues, and Lugo and Lowe (1991) for case studies of the history of tropical-forestry research in the Caribbean and suggestions for research worldwide. A general overview of the status of world forestry and forests is found in Westoby, 1989; tropical forests are placed within a broader context of environmental concerns in Silver and DeFries, 1990. These are only a few of a plethora of excellent reviews published within the past few years.

2. A minimum of 140 million "forest farmers" were living under closed canopy, moist tropical forest in the mid-1970s (Myers, 1980); in 1978 the World Bank estimated 200 million living within or on the margins of forests (World

Bank, 1978). Given the broader definition used in this report (see note, page iv), the number may be many times higher.

3. The United Nations estimates developing-country population will rise to seven billion by 2025 (United Nations, 1989). Virtually all tropical forest is inhabited. Where indigenous cultures have been displaced, absorbed, or are now extinct, they have been supplanted by colonists.

In 1987, developing countries used about 95 percent of their forest production, exporting the remainder. This represented about 90 percent of forest-product value, or very roughly $60-85 billion. Figures are for marketed products only (logs, timber, pulp, paper, panels, particle and paperboard, and fuelwood). These figures do not include locally consumed products (notably logs, timber, and fuelwood) that are not part of national production statistics, nor do they include food, fodder, or other nonmarket, non-"forest" products, nor the value of watershed, wildelife, or habitat protection, nor the value of commodities that originated in the tropical forests, such as bananas, chocolate, citrus, coffee, cola, oil palm, pineapple, rattan, rubber, or tea, nor the increasing monetary value of recreation and tourism. Removing fuelwood (which is generally unprocessed and constituted only 0.1 percent of export volume and value) lowers internal consumption volume to 85 percent. All calculated figures are from Annex Tables 1 and 4 of Food and Agriculture Organization (FAO), 1989, using "export unit values" ($ per m^3, from Annex Table 5) for internal valuation.

Approximately one-fourth of U.S. industry is based on the value of wood production alone (NRC, 1990a). Given the much broader industrial base of the United States (in transportation or energy, for instance), it seems likely that the contribution of forest products to the market and nonmarket economies of less-developed countries is significantly higher.

4. Export market values were at least $7-10 billion (see preceding note), and perhaps as much as $40 billion (FAO, 1985).

5. For further information, see Ashton and Panayotou, 1991 and FAO, 1991a.

6. For technical references on the relationships between forests and climate, see IPPC, 1990, which notes, "[a] major modification of the forest cover could have a significant climatic impact." (p. 303); see also Salati, 1989, and NRC, 1990a. For general information, see OTA, 1991a and NRC, 1991c.

7. Tropical deforestation is currently estimated to contribute around 10 percent of our annual "CO_2-equivalent" emissions of CO_2, CH_4, CFC-11, CFC-12, and N_2O (calculated from Table 2.1, NRC 1991c). Other estimates range considerably higher and somewhat lower (see, for example, OTA, 1991a, p. 205). For information on global-change research strategies, see NRC, 1990b. However, unlike burning "fossil fuels" such as petroleum and coal, forest flames release carbon only recently taken from the atmosphere. For information on forests as carbon sinks, see NRC, 1991c; see also Kyrklund, 1990 and (for tropical forest estimates) Lugo and Brown, in press.

8. Wilson (1988) and McNeely et al. (1990) provide full discussions of the status and importance of bio[logical]-diversity. Briefly, our food, nearly half our medicines, and many of our materials come from other organisms, whose potential value has only begun to be explored. We rely on fewer than a dozen species for

the bulk of our food, have screened a few percent of species for medicinal activities, and rely on less than a handful of plants for, especially, our wood and paper. Each of these species is vulnerable to calamity from pest and plague, as are we.

Biodiversity also refers to the genetic variation within species, which is being "eroded" at an alarming rate. Threatened are not only trees and wildlife, but the ancestors and wild relatives of many of our most common foods. The greater the genetic diversity the greater our security; yet, once lost, genetic resources cannot be recreated (ibid). See also American Association for the Advancement of Science (AAAS), 1991 and (for trees) NRC, 1991a.

9. Much depends on definition. Tropical wet and dry forests, nearly all in developing countries, cover between 2 and billion hectares (about 5-7 billion acres) (OTA, 1991a and FAO, 1991b), about half of which is open woodland and savanna (McNeely et al., 1990). A recent estimate of annual tropical-forest loss is at least 17 million hectares, or 42 million acres (FAO, 1990; see also Dembner, 1991). At least a further 10 million hectares (25 million acres) are "grossly disrupted" (McNeely et al., 1990). In spite of some regrowth, a few tropical countries have lost over 90 percent of their natural forest; overall, only about 60 percent-perhaps less than half-of tropical closed forest remains. Deciduous forest, prime human habitat, has almost disappeared in much of the tropics (Wilson, 1988). A comprehensive forest inventory is anticipated from FAO in 1992; see Dembner, 1991; FAO, 1991b; and Lanly et al., 1991.

10. For a full discussion, see the "Bruntland Report" (World Commission on Environment and Development [WCED], 1987).

CHAPTER 2
THE STATUS OF TROPICAL FORESTRY RESEARCH

Thousands of organizations are involved in understanding the relationships between people and trees.[1] Many-both forestry and nonforestry-attempt to enhance and extend the reach and impact of tropical forestry research. In recent years an imposing number of technical analyses and policy documents have dealt with the human, environmental, and economic implications related to forestry in the tropics; the inadequacy of current knowledge is well-documented. The directions and emphasis of tropical forestry itself continue to evolve, which is reflected in the research undertaken by many of these organizations.[2]

Forestry Research in Tropical Countries

National research organizations in tropical countries range from a few well-staffed, well-equipped forestry institutes to small research units attached to agricultural services where one or two staff members can work only on a narrow range of forestry investigations. In some countries, a basic infrastructure exists, but trained scientists are few or missing. In others, scientists have been educated (usually abroad), but basic institutional support, including facilities and equipment, is lacking. Most developing countries, in spite of burdens such as poor health care, inadequate nutrition, and foreign debt, have increased their forestry research budgets over the past decade.[3] However, overall and with few exceptions, tropical countries continue to have insufficient forestry research systems hampered by inadequate infrastructure, equipment, training, personnel, and policy.[4]

These deficiencies often preclude even the simplest and most narrowly focused research efforts. Little if any tropical forestry research addresses, in a comprehensive or pragmatic fashion, the crosscutting environmental, social, and policy issues associated with prevention and reversal of tropical deforestation and degradation, or with the sustained provision of forest products for human needs. The complexity of natural and human systems and issues in the tropics can cause both strategic and integrated research to be even more complex and costly than comparable studies in temperate

countries. This expense is compounded by the general dearth of demographic, resource, and infrastructure data in developing countries.

When useful research does take place, the problem often becomes one of communication. Researchers are often institutionally, socially, or physically isolated from those who control or manipulate trees, forests, people, and policy. These structural features and subsequent lack of information flow hinder forest users and decision makers from influencing research agendas and from implementing research advances.

Governments increasingly confront these hurdles. They are aware that investment in agricultural and forestry research frequently yields substantial economic returns.[5] Equally important, improving the quantity and quality of in-country research capacity greatly increases a nation's ability to access, accept, and adapt research done elsewhere. Support for research related to the role of tropical forests and trees in land use continues to grow (see notes 2 and 3, and Chapter 3, note 2). Although this trend is apt to continue, significantly increased funding levels from sources within many developing countries seems unlikely because of myriad competing priorities such as basic nutrition and health, which, in turn, are a lesser part of develop-country budgets.[6]

Evolution of International Research

There is a growing awareness that forestry research over most of the tropical world needs strengthening and redirecting to more fully reflect the need for informed and relevant institutions, research, and decisions. Organizations and individuals representing virtually every country have become involved–especially over the past decade–in an ongoing effort to understand the status of tropical forests, their use, and their preservation. Scientific communication and cooperation have increased enormously, and much has been learned from past failures as well as success.[7]

A consensus in the international community has evolved that:

- It is in the interests of developed countries to increase substantially their investment in support of research on forest and tree related problems in developing countries.
- Increased emphasis should be given to broader land-use issues, such as the relation of people and trees in agroforestry, fuelwood production, environmental quality, and watershed management.

- Many of the most urgent problems associated with tropical forest use and misuse arise from outside the forestry sector and, hence, need to be addressed there, with the input of forestry and other scientists and policy analysts. An increasing amount of such research is now carried out in organizations far removed from traditional forestry (examples include analyses of national policy and economic decisions; the effects of technological changes in other sectors such as agriculture, transportation, infrastructure, and energy; or the impacts of changes on agricultural objectives, land tenure, or indigenous peoples).

International acknowledgment of the need to increase support for forestry research by the industrialized countries came at the 1981 World Congress of the International Union of Forestry Research Organizations (IUFRO).[8] Based on recommendations made by the World Bank and the Food and Agriculture Organization (FAO) of the United Nations, IUFRO established the Special Programme for Developing Countries (SPDC). The SPDC is charged with working with national forestry institutions to help them identify and secure both financial and technical support for research programs, thus underpinning the rural forestry oriented development ("social forestry") that became the major thrust of forestry development strategy in the 1980s.

By the mid-1980s, initiation of the Tropical Forestry Action Plan (TFAP) confirmed the increased awareness of the broader role of trees in land use, the importance of focusing on human-related forestry issues, the need to foster links with other sectors, and the importance of greater emphasis on research and training (FAO, 1985). TFAP was the first time that the environmental and social sciences had been fully involved in a unified strategy of funding and activities among donor agencies and developing countries.[9]

Major evolutionary changes in TFAP were made at the Bellagio I and Bellagio II forestry meetings, held at the Rockefeller Foundation Conference Center in Bellagio, Italy. These broad international assessments of the status of tropical forestry were organized by The Rockefeller Foundation, the United Nations Development Programme, and the World Bank. Bellagio I, in 1987, recommended that TFAP give stronger emphasis to research. In 1988, after vigorous interaction with national and regional forestry research institutions and organizations, scientists from both developing and developed countries (the International Task Force on Forestry Research) prepared recommendations for "Bellagio II." This meeting was devoted exclusively to forestry research.

The representatives of the 22 donor countries and multilateral agencies that attended Bellagio II, held in late 1988, accepted the recommendations of the Task Force (see below). Further, this group endorsed the concept that all aspects of forestry research need to be integrated, including agroforestry, social forestry at the village and farm level, the use of forest land for commercial purposes, and issues of forest land management that may impinge on the preservation of wilderness areas.[10]

Bellagio II also recommended that forestry research be incorporated into an expanded Consultative Group on International Agricultural Research (CGIAR) system.[11] In 1989, forestry was formally written into the mandate of the CGIAR. In November 1990, the CGIAR invited the International Council for Research in Agroforestry (ICRAF) into the system, and decided to establish a second international research center that would address the broader arena of forestry. In May, 1991, ICRAF joined the CGIAR system.[12]

Today, there is solid international recognition of extensive, well-developed multilateral and bilateral activities in research related to tropical forests and trees in land use.[13] A great deal of recent thought and effort have gone into identifying and defining key research needs related to tropical forests and trees in land use. The two major recent international assessments of tropical forestry research priorities–the one carried out by the Bellagio II Task Force on Tropical Forestry Research, and the one undertaken over a two-year period by the Technical Advisory Committee of the CGIAR–both emphasized essentially the same five areas of activity:

- Agroforestry and watershed management systems (both biophysical and socioeconomic), particularly related to more effective and efficient use of trees in land use;
- Natural forest ecology, conservation, and management for goods and environmental services;
- Tree selection and improvement, including fast-growing, multipurpose species;
- Utilization and marketing of wood and nonwood products from natural and plantation forests and trees, and from native and introduced germplasm; and
- Development and analysis of policy, monitoring, inventory, resource, and information systems for improved management, conservation, and utilization.

The panel generally affirms the above research goals and priorities of the international community, while at the same time recognizing that they are neither fixed nor inclusive. Much is expected to happen within the next few years, with the inclusion of forestry within the CGIAR, the implementation of a TFAP successor, possible agreement on a world forest convention at the U.N. Conference on Environment and Development in Rio de Janeiro in 1992, and the continued increase in public and government awareness, interest, and pressure. The development and form of international political and institutional infrastructures exceeds the charge of this panel. Rather, emphasis is given here to what the United States itself can do now, understanding that we are only one of many participants throughout the world. Most-public and private-have been implementing ever more explicit and coherent policies for understanding and addressing the needs of tropical forestry research.

Expanding the Scope and Practice of Research

There is a clear need to expand the forestry research mandate. Research frontiers are often determined by factors outside forestry: poverty, population, and land tenure; agriculture and settlement at local, regional, and national levels; and political, economic, and environmental agendas far removed from the needs and goals of those people dependent on forests. These crosscurrents merit increased awareness: nonforest events are often the root cause of forest depletion.

Forestry, particularly in the tropics, will require further research in well established traditions. Such efforts can have great practical value and have been the source of broad and revolutionary advances in understanding, concept, and practice. Too often, however, the patterns of intertwined systems and processes are neglected. Without progress across a broad front of issues, the practice of sound tropical forestry will not in itself restore degraded landscapes, prevent further deterioration, or enhance the provision of forest products.[14] This will require full consideration of the interplay among the physical, biological, cultural, economic, institutional, and political forces that affect tropical forests and peoples.[15]

There must be broader participation in research and greater coordination of goals through a synthesis and communication of science and practice. Rarely is the conduct of research and the communication of knowledge through multiple channels simultaneous and sustained. Research on tropical forest issues increasingly must

assimilate insights and wisdom from other arenas such as political powers, economic sectors, development organizations, and human communities. It must also enhance the understanding of others by extending well-considered scientific knowledge and perspectives. This will require expanded education and extension systems as well as greater use of the scientific, environmental, developmental, and popular presses. Consolidating diverse knowledge and focusing it on tropical forestry research topics can help all interested people-most especially researchers themselves-assess various options in terms ranging from the personal and local to global priorities.[16] The results can help better predict the social and environmental implications of alternative strategies and tactics.

However, efforts to curb loss of livelihood, diversity, and stability are not likely to succeed without considering the motivations and goals of those who inhabit and use the forests of the tropics. The daily dependence of people on forests and trees-coupled with the realization that management for one purpose can have adverse consequences for another-presents a profound challenge to those concerned with the sustained meeting of a variety of needs.[17] The design of relevant research efforts requires that the often-conflicting roles and interests of those directly affected be recognized, clarified, and-if possible-explained.[18] Their active involvement-and reliance on their opinions and judgment-needs increasingly to be considered within the scientific and policy communities.[19] Integration of local and scientific knowledge makes research more effective and efficient: uncovering connections among biological and cultural systems is one of the most promising areas of research. A major goal is to find timely solutions to the problems facing people. In so doing, research can directly enhance both social and environmental health.

As our scientific understanding of the planet's natural and cultural complexity and interrelatedness increases, the forestry term "multiple use" takes on fuller meaning. Experience has demonstrated the pitfalls of assigning "ideal" patterns according to narrow, predetermined, or fixed criteria, and of implementing "packaged" approaches. Rather, research options must reflect detailed and refined knowledge about use and management that cannot be addressed from a distant or abstract scientific or policy level. Without continual integration, reevaluation, and evolution of the principles and activities of research, "sustainable" forestry could become another set of prescriptive mechanisms that reflect sweeping and impersonal agendas rather than particular cultural and biological realities.[20]

It is not enough merely to increase financial support for research. The expansion of the forestry research mandate challenges the scientific and policy communities to develop flexible perspectives and methods that are adequate to the task and appropriate to the context of developing countries, established cultures, and tropical environments. There is fundamental benefit to broadening and strengthening research effectiveness in terms of solving complex human, forest, and tree-related issues. By taking advantage of these opportunities, research-no matter the context-can increase and improve our contribution to the goal of long-term stability and sustainability.[21]

Notes to Chapter 2

1. In 1986, more than 5,000 nongovernmental forestry and conservation organizations existed worldwide (Wilson, 1988). Numbers and effectiveness continue to grow.

2. These events can be traced through the literature cited at the end of this report. As an example, during 1967-1976, only about 5 percent of World Bank support for forestry went into watershed management and social forestry activities; the other 95 percent went to commercial plantation and forest-industry activities. This one-twentieth has increased to around two-thirds to three-quarters of total World Bank support for forestry today. Overall, including both bilaterial and multilateral donors, between 55 and 60 percent of the total official development assistance for forestry now goes into social forestry, watershed management, and other environmentally related areas (FAO, 1987a); see also World Bank, 1978, which provides an early institutional discussion of the changing nature of forestry in the tropics.

3. Overall, tropical countries have more than tripled funding of forestry research in the past twenty years (Mergen et al., 1988). Although available data were incomplete, the Bellagio II Task Force (see page 7) settled on a range of $250-300 million for their 1988-89 estimate (ITFTFR, 1989). This figure may now be approaching $350 million (information from H. Gregersen). These totals obscure the particularly low rate of research investment in the very countries where the results of research are so critically needed. By comparison, domestically the United States also invests about $350 million annually, of which $190 million is federal; calling current levels totally inadequate, the *Forestry Research* report recommended more than doubling them within five years (NRC, 1990a).

4. For each forest dollar earned in 1980, the United States and Canada reinvested approximately 14 times as much into research as did low and middle income developing countries (Mergen et al., 1988). This ratio does not include the value of fuelwood, forest foods, tree fodder, poles, and other products, nor the protection and environmental services associated with forests and trees.

Again on a per-dollar basis, only about 5-10 percent as much is invested in forestry research as in agricultural research in both developed and developing countries (ibid). The Committee on Forestry Research (NRC, 1990a) recommended the level be rapidly increased to approximately 20 percent (see preceding note).

5. See Gregersen, Lundgren, and Bengston, 1990. The overall rate of return for research is estimated at 25-30 percent (Mansfield, 1991); for basic and applied research in agriculture (including forestry), returns often exceed 100 percent (USDA, 1991).

6. For more information on the status and organization of forestry research in developing countries, see Gregersen, 1988, and Gregersen, Lundgren, and Bengston, 1990.

7. For notable examples of innovative tropical forestry research being successfully implemented, see, for example, Gradwohl and Greenberg, 1988.

8. Founded in 1892, IUFRO is one of the oldest international organizations. Membership, which meets every five years, includes universities and research institutions in 100 nations. See NRC, 1991a, for further information and references.

9. TFAP is currently undergoing a major re-evaluation. Whatever the outcome, it seems likely that such broadly based participation will be strengthened.

10. ITFTFR, 1989, on which much of this section is based; information on the current status and insdequacies of knowledge of tropical forest management can also be found in Gómez-Pompa et al., 1991; Ashton and Panayotou, 1991; and NRC, 1991a.

11. The Consultative Group on International Agricultural Research (CGIAR)-cosponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the World Bank-is an informal association of international organizations, nations, and private institutions. The CGIAR was formed in 1971 to provide long-term support for research of importance to developing countries. It operates without a formal charter, relying instead on consensus.

Each of the 13 CGIAR-affiliated research centers is independent, with its own board of trustees, mandate, structure, and goals. Individual centers originally focused on specific commodities such as rice; others now have regional or ecological mandates or perform specialized functions in food policy research, genetic resources conservation, and the strengthening of national agricultural research in developing countries. 1989 core funding was $272 million, of which $42 million was contributed by the United States through AID (information from AID, as reported in NRC, 1991b). This will increase significantly over the next few years, as planning is underway to add a total of six new centers to the system.

12. Founded in Nairobi as an agroforestry documentation and training center in 1978, ICRAF has highlighted the international importance of increased research in the area of trees in rural farming and livestock systems. ICRAF research

currently focuses on agroforestry systems, issues and methodology. See also NRC, 1991a.

13. For information on multilateral and bilateral institutions working in forest research, see, for example, OTA, 1984; OTA, 1992; and NRC, 1991a. Current information and research abstracts on a wide array of forestry-related topics are compiled by the SPDC of IUFRO, and printed and distributed through the World Bank in the series "Information Service for Developing Countries."

14. General issues are discussed in OTA, 1991a and NRC, 1991a; see also USITFTF, 1980 and ITFTFR, 1989.

15. *The kind of forestry research we have been conducting will need to continue, but research priorities must be much broader. The breadth of forestry and the study of forest resources requires information and expertise that must include principles of basic biology, ecology, agriculture, forest management, engineering, sociology, and economics.* NRC, 1990a, p. 15.

16. In addition to purely technical consequences, researchers are well-advised to assess the policy and social ramifications of their research, and of their research priorities; see NAS, 1989, and NAS et al., 1989. Guidelines for performing such research can be found in NRC, 1991d. Some current research priorities in forestry science may be found in ITFTFR, 1989; NRC, 1990a; NRC, 1991a; OTA, 1991a; and in Appendix B.

17. For further information see, for example, Anderson, 1990 (Latin America); Rocheleau et al., 1988 (Africa); and Poffenberger, 1989 (Asia).

18. For further information, see Institute for Low External Input Agriculture (ILEIA), 1989; Davis-Case, 1989; and Scherr, 1991.

19. For a summary, see Warren, et al., 1989. The U.S. government–through land-grant colleges and cooperative extension–has recognized the importance of local participation in domestic research for more than a hundred years.

20. For further information on sustainable use of the land's renewable resources, see, for example, WCED, 1987; NRC, 1989a; and NRC, n.d. For a discussion of the connotations of "sustainable agriculture," see Dahlberg, 1991. A strategic plan for sustainable development by the United States has been presented in Environmental and Energy Study Institute (EESI), 1991; a global forest convention is possible at the U.N. Conference on Environment and Development in 1992.

21. This discussion represents the experience and interactions of the panel; it is also based in part on NAS, 1989 and NRC, 1990a.

CHAPTER 3
THE ROLE OF THE UNITED STATES IN TROPICAL FORESTRY RESEARCH

The United States has political, environmental, humanitarian, economic, educational, and scientific interests in tropical forests and in the people who derive their sustenance and livelihood from them. An underlying principle of U.S. foreign policy is that helping other countries achieve sustainable development also works to the advantage of the United States (see Appendix B). The U.S. public is increasingly aware of the global and local impacts that the deterioration and destruction of tropical forests have on humanity and the environment. The realization that the biosphere has limited capacity to support human activities necessitates that increased scientific resources be directed to solving problems and creating opportunities in tropical forestry.[1] Obviously, neither the United States nor forestry research can solve all the dilemmas faced by developing countries in their efforts to improve the well-being of their citizenry, nor can the United States-even in its role as a donor nation-dictate research agendas to others. Nevertheless, research in tropical forestry supported by or undertaken by the United States can-if translated into practice-make an important contribution to the efficient use and effective conservation of the world's tropical forests.

The financial contribution of the United States to tropical forestry research has never been greater. On two important fronts-building the capacity for relevant research in developing countries and providing support to international forestry research efforts-our dollars represent about one-fifth of total international funding.[2] Yet paradoxically, on the home front, the U.S. investment and contribution to research remains meager and poorly organized relative to the global importance of tropical forests and to the overall quality of our institutions and expertise.[3]

U.S. Tropical Forestry Research

Many of the principles and approaches of temperate forestry in the United States, as well as many of the issues, are relevant to research in the tropics (NRC, 1990a). The United States thus has

considerable institutional and technical capability to support and participate in research related to tropical forests and people, and would seem qualified to play a much more direct and expanded role under tropical conditions. U.S. expertise is in large part the result of more than a century of collaboration and support between federal and state governments and the research and academic communities. Although not always obvious in practice, the rationale for this mutual effort has been to increase and apply the knowledge gained through scientific research to maximize benefits for producers and consumers, while conserving and improving the natural resource base itself.[4]

Federal Agencies: Recent efforts to expand funding for U.S. research capacity and extension related to tropical forestry are encouraging at the federal agency level. In particular, the Agency for International Development (AID) and the Department of Agriculture (USDA) are notable for their past and current involvement in tropical forestry research. Among other agencies, the National Science Foundation (NSF) and the Smithsonian Institution play major roles in funding research on the basic biology and ecology of tropical forests.[5]

AID-a funding agency of the Department of State-is the principal agency through which funds for international development are channeled, and plays a significant and positive role in U.S. support for forest and tree related research in tropical countries.[6] AID has a tradition of sponsoring collaborative and innovative research on a wide array of topics. In such endeavors, AID maintains a coordinating role based on in-house competence, but relies on contractors and cooperators-U.S. investigators and developing country scientists-for research performance. As the major source for dispensing U.S. funding, it has both experience and liaison with a wide array of tropical forestry research organizations and activities throughout most of the world. Over the years, AID has supported numerous programs and projects that have advanced the science of tropical forestry research.[7]

AID strategy has been to develop forestry projects that support related areas such as agricultural sustainability, biodiversity, global change, natural resource conservation, environment, and agroforestry. AID has only a small portfolio of pure forestry research.[8] The AID budget for tropical forestry research continues to increase, with investment through collaboration with the USDA, universities, industry, nongovernmental organizations, the international community, and developing nations. Overall, however,

support has been sporadic, diffuse, short-term, and far too limited to meet the urgent demand for results from research.

The USDA-a funding and implementing agency-has substantial in-house research capability that is closely linked with extension and operational forestry through the U.S. Forest Service.[9] However, research on tropical forests-even U.S. tropical forests-has been a relatively minor part of the overall research programs.[10] The U.S. Congress has begun to increase the budget of the U.S. Forest Service to improve its capabilities in tropical forestry research, particularly through its tropical field facilities.[11]

Universities: The U.S. academic community represents a substantial source of additional research, education, and extension experience that could be brought more fully to bear on the problems confronting the people and forests of the tropics.[12] Indeed, over the past decade, U.S. universities have shown increased interest in tropical forests, have begun to expand research and education programs, and have improved staff capabilities in foreign languages.

American universities are increasingly able to respond to the need for interdisciplinary problem solving in tropical forestry and land use. A greater number now view international and tropical issues as fundamental to their mandate, and many have established international programs, particularly emphasizing agriculture. Indeed, nonforestry faculties have played a major role in developing U.S. tropical forestry expertise in such areas as agronomy, ecology, botany, conservation biology, wildlife management, fisheries, watershed management, resource economics, anthropology, or sociology. It is in such departments that students of social forestry, agroforestry, forest product development, and natural forest management are often found. However, these efforts often remain isolated from the full context of tropical forestry research, in the field, in the literature, and in the international milieu.

U.S. forestry research itself, since its beginnings last century as an offshoot of European roots, has advanced until it is now a leading international force in terms of capacity and sophistication. This national asset-knowledge of forestry and of the methods by which forestry knowledge is acquired-should be made more accessible to tropical conditions. At present, only about half the more than 60 forestry schools in the United States have offerings related to tropical research or development issues (these are often taught by instructors with little or no tropical experience). Formal university efforts are notably limited, unorganized, and ad hoc; degree

programs in tropical forestry are scarce or absent. Further, there are limited career opportunities available in U.S. academic institutions for individuals whose primary interest is on-site tropical forestry research.[13] Lasting competence is rarely established through grant and contract programs that do not produce long-term institutional commitments.

Despite growing interest and capability in tropical forestry issues, the research efforts of U.S. academia remains piecemeal and excessively dependent on the personal interest and initiative of individual scientists. What efforts are in place are not well linked with U.S. government initiatives, nor to activities and needs in tropical countries. There is little organized, programmatic effort, and funding is scarce. There are still far too few scientists with tropical skills, and universities have been unable or unwilling to assemble the critical mass of experienced scientists necessary to address tropical forest problems from a team approach.[14] For universities to make their potential contributions to tropical forestry research, bolstered research and teaching efforts are needed. To help ensure effectiveness, these programs must be increasingly structured to avoid academic and institutional isolation by maintaining liaison with other areas of policy, science, and development–and with those affected by their research.

More undergraduate and graduate students must be encouraged to undertake advanced studies in tropical forestry. There must be greater involvement of foresters in other sciences and greater exposure to the complexities of forestry problems in the tropics and in development, while there must be greater inclusion of nonforesters in tropical forestry education. And more researchers in related fields must gain working knowledge of the scientific underpinnings of forestry research.

In short, the cadre of appropriately educated U.S. researchers is insufficient to meet the need. This deficiency is reflected in the public, private, and scientific concern over the inability of science and policy to slow the deterioration of tropical forest resources. For direct involvement in tropical forestry research issues, there must be qualified personnel.

Industry: Many segments of the U.S. private sector have the capacity and experience to contribute to tropical forestry research, should the situation warrant and the opportunity arise. The extensive industrial forestry experience of U.S. companies in this country and abroad can be particularly useful in research programs that focus on

national economic needs and private sector development, specifically the need for starting, maintaining, or augmenting wood-based industries. Special capabilities include forestry infrastructure development; strategic and tactical planning; project and business management skills; scheduling, logistics, and implementation; nursery and seed orchard development; applied research and development for forestry and products from wood; market analyses and development; and efficient mill and forest environmental programs and research.

U.S. forest products companies have enhanced their capabilities to scientifically manage for multiple objectives. Many are developing practical approaches that combine production efficiency with environmental protection. It is therefore encouraging that U.S. industry is devoting increased attention to the potential of forestry in the tropics. However, harnessing technical, managerial, and research experience-and sharing it with others-remains a challenge.[15]

Nongovernmental Organizations: Many nongovernmental organizations (NGOs) have integrated research activities into development programs and have sharpened their definition and practice of research participation. A growing number of NGOs now have substantial research programs in collaboration with developing-country nongovernmental organizations, universities, and government agencies.[16] There is now ample precedent within the international and grassroots NGO community for research (some of it long term) in technology innovation and development.

Nongovernmental organizations have the potential to strengthen the U.S. contribution through their direct experience and expertise in tropical forestry research. Many also have extensive access to tropical locations through established institutional and person-to-person arrangements; their collaboration in developing research, sites, logistical assistance, public education efforts, and community participation is essential to much long-term research. In some instances, NGOs constitute the only viable mechanism for promoting workable linkages between scientists and local people.

Improved communications of field results from practical, on-site NGO research can have a significant overall impact on the advance of understanding. NGOs possess a great and too-often neglected potential for joining hands with a host of scientific institutions to foster tropical forestry research. Any future U.S. strategy would be incomplete without the substantive participation of nongovernmental organizations.[17]

Framework for U.S. Involvement

The design, conduct, and communication of effective research must flow in multiple directions (see **Scope**, page 11). Throughout the world, many institutions and organizations are now involved in tropical forestry research activities, and much talent and capability exist beyond the borders of the United States. The U.S. community can learn a great deal from the research and knowledge of other scientists, development workers, and rural populations themselves.[18] Indeed, much advanced and innovative research and development work has been done outside the United States, and increased U.S. participation can further forestry research within our own country.

Today, both public perceptions and U.S. policy envision an active U.S. role in international development and environmental protection (see Appendix B). Changes and advances in international, national and local programs will happen faster and more effectively if the assets of the United States and other nations are coordinated. Each country has certain strengths based on the time, resources, and effort it has focused on the development of scientific understanding and problem-solving. The panel believes the United States has particular competence in the following areas of forestry technical knowledge and institutional capacity:

TECHNICAL

- Ecology
- Biology
- Genetics and germplasm evaluation
- Biotechnology
- Resource inventory and mapping, remote sensing, and geographic information systems
- Environmental monitoring and protection
- Natural resource, watershed, range, wildlife, pest, and fire management
- Commercial and industrial forestry and wood utilization
- Land-use planning and management
- Policy sciences
- Economics
- Social sciences

INSTITUTIONAL

- Management
  - formal research management, both public and private
  - project planning and management
  - cooperative models
- Graduate and continuing education, training, and extension
- Interdisciplinary and integrated research
- Library, document, and information services

In addition, the United States has substantial expertise in many related sciences.

Given today's numerous developing country organizations and research centers that have relevant research expertise related to tropical forestry and agroforestry, collaboration between them and the United States-utilizing the advantages of both-has become a crucial component of research. Such "twinning" has a special advantage to the United States, in that many researchers in developing countries were educated here. This educational link presents a bridge of opportunity for the United States to offer encouragement through further access to its scientific community and facilities, while receiving the benefits of active transnational collaboration.

Available resources, even under the most optimistic circumstances, are far too limited to permit duplication and competition with others who are trying to achieve similar goals. There is a need to build partnerships, working groups, and networks across topical lines (forestry, agriculture, social science, ecology, for example) as well as among various types of institutions (such as policy, research, extension, development, and user groups).[19] The approach to research must be broad and examine expanding capacity, skills, and content in a systems sense: integrating particular priorities and needs into the larger social and political web in which research takes place.

The mutual interests of tropical-forest countries and of the United States would be best served by a cooperative and collaborative U.S. strategy, performed in concert with other interested nations and international research organizations, as well as with nongovernmental organizations, businesses, and other qualified groups and individuals. It is within such a multidimensional matrix-this framework for U.S. involvement-that the skills and advantages of the United States can be most effectively expressed and implemented.

Notes to Chapter 3

1. See USITFTF, 1980; WCED, 1987; NRC, 1990a; EESI, 1991, and OTA, 1991a, as well as USDA Forest Service, 1989 and Appendix B.

2. FAO, 1987b. Globally, Official Donor Assistance (ODA) for forestry is rapidly increasing. For example, overall funding for forestry in the tropics nearly doubled between 1984 and 1988, from less than $600 million to more than $1 billion (FAO figures, from Laarman and Contreras, 1991). Of this, the United States provides approximately 10 percent (see note 6).

Current ODA figures for research and training are unavailable, but have generally not increased in proportion to overall forestry funding. However, in 1986-87 (the most recent available breakdown of expenditures) research funding reached about $100 million ($44 million for research and $54 million for training). This includes the United Nations, multilateral banks, and bilateral agreements between donor and recipient nations.

Of this $100 million for research, the United States funded approximately 20 percent, or $20 million: total bilateral support equalled $16.1 million ($7.4 million for research; $9.5 million for training) (FAO, 1987b). The remainder supported multilateral activities such as the World Bank and the United Nations (together less than 15 percent of ODA). The figures do not include domestic expenditures by the United States (see next note) or other developed countries, a few of which have notable tropical research capacity.

All development funding by the 18 "developed" countries amounts to $46.68 billion. Overall, the United States ($7.66 billion) ranks second to Japan ($8.95 billion); in percentage of gross national product the United States ranks last (OECD, 1990).

A very rough estimate of total global funding on tropical forestry research issues would be approximately $550-700 million. This speculation consists of $350 million from the tropical countries themselves (1991; see Chapter 2, note 3), $100 million ODA (1986; see above), generously $40 million for U.S. domestic spending (1990; see next note), and no more than half that amount for each of 5-10 other developed countries for in-country funding ($100-$200 million).

3. Documentation of the total U.S. domestic investment in tropical forestry research issues is critically lacking. However, federal funding seems to be about $10-20 million (including basic sciences). This is probably greater than non-federal funding by academia, industry, and nongovernmental organizations combined. See preceding note, and notes 5, 6, 11, 12, 15, and 16.

4. This "land ethic" was succinctly described by Aldo Leopold:
A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise (p. 224). Leopold, 1949.

Forestry Research: A Mandate for Change (NRC, 1990a) notes:
In the last decade of this century, we see a renewed emphasis on a land ethic, but this time with a global perspective. .... It holds that human beings and nature are interrelated, that humans are not superior to the

natural world, but depend on the biosphere for their existence. The biosphere's resources are finite, and human activities must not destroy the biosphere's intricate workings (p. 14). See also WCED, 1987 and Appendix B.

5. Within the broad category "tropical biology," NSF funded 35 grants totaling slightly more than $3 million in FY 1990. Information from NSF Biotic Systems and Resources Division.

The Smithsonian Institution is a major U.S. sponsor of research in the tropics. Predominantly basic science, much of it has broader applicability. Although no separate accounting of "tropical research" is kept, discussions with the Office of External Affairs, the Office of Research, the National Museum of Natural History/Museum of Man (NMNH), the Smithsonian Tropical Research Institute (STRI), the National Zoological Park (NZP), and the Environmental Research Center (ERC) yielded a general, institution-wide estimate (both federal and nonfederal) of slightly more than $12 million in FY 1990. In particular, of total funding for NMNH, approximately one-fourth-roughly $7 million-was devoted to natural science and ethnographic research in the tropics. At STRI, about one-half (or $4.25 million) of a budgeted $8.5 million for staff, equipment, and project consultants (but not including other bureau activities, library and protective services, or construction) was directed to research related to terrestrial science. The National Zoological Park supported less than $1 million for tropical research, and ERC funded, by the broadest definition, no more than $100,000 on forest, animal, agricultural, and general ecology in the tropics (information from STRI, NMNH, NZP, and ERC).

A small but notable federal interagency program is the U.S. Man and the Biosphere Program (U.S. MAB), which coordinates with the MAB programs of 114 other nations bilaterally and multilaterally through the United Nations Educational, Scientific and Cultural Organization (Unesco). One of five MAB program areas is the directorate on Tropical Ecosystems, whose mission is "to foster harmonious relationships between humans and the biosphere through an international program of policy-relevant research that integrates social, physical, and biological sciences to address actual problems" (MAB Mission Statement, 1989). Although not prebudgeted among the program areas, annual funding for individual research projects and core directorate interdisciplinary programs in tropical research has consistently ranged between $3-500,000. Information from MAB Secretariat.

Many other federal agencies also touch upon concerns related to tropical forestry research.

The National Park Service (NPS) of the Department of Interior maintains an Office of International Affairs that coordinates NPS international activities and serves as the primary contact for other government, international, and private organizations on related matters. It is responsible for bureau programs that exchange information with and provide assistance to other nations, international organizations, and U.S. territories in conjunction with natural and cultural park heritage and resource conservation programs. It coordinates training of foreign park and resource management personnel. The Office administers international park seminars and initiatives related to cooperating with other nations. Currently, the Office manages 14 bilateral agreements with foreign nations and provides staff assistance to the Assistant Secretary, who serves as delegate to the World Heritage

Committee. In addition, the NPS—as steward of the U.S. National Park System—is responsible for U.S. protection forests. It has a long tradition of basic and applied research on natural forest ecology, and its role is likely to increase significantly in the near future.

The Fish and Wildlife Service of the Department of Interior maintains an international affairs office and has an international action plan. A major component is the implementation of the Western Hemisphere Convention, for which long-term funding supports wildlife management eduction programs and regional biodocumentation centers in Brazil, Costa Rica, and Venezuela. It also is involved in environmental education programs, training workshops, and enforcement of the Endangered Species Act. It has worked closely with AID in North Africa, Asia, and the Middle East, and is currently involved in a program in India to train wildlife managers, promote long-term research on endangered species and migratory birds, and to develop education materials. Eastern Europe, particularly the USSR and Poland, are now receiving increasing attention.

The Environmental Protection Agency (EPA), an independent government agency, maintains an active international office that addresses international issues and cooperation on a wide range of environmental matters, including forestry, natural resources, and energy issues. Its policy division is also active in forestry. A major EPA concern is global climate change, especially through the Intergovernmental Panel on Climate Change, a United Nations working-group that sponsors studies, conferences, and workshops on the role of trees, forests, agriculture, and energy-use in climate change (see IPCC, 1990).

The National Aeronautics and Space Administration (NASA), an independent government agency, has developed satellite imagery and remote sensing technology that today is in great demand around the world. In addition, NASA continues funding of long-term monitoring and assessment of natural resources and environmental change. An important effort underway today links NASA capabilities with the FAO tropical forest assessment project.

6. Unlike most federal agencies, the authorizing legislation for AID is resubmitted each fiscal year. Therefore, budgetary and program categories from year to year are difficult to compare, and reliable data on multiyear trends are inadequate. Nevertheless, overall AID funding for FY 1991 amounted to about $12 billion, about half of which was for development assistance and economic support (AID, 1991). Of this, the AID Office of Forestry, Environment, and Natural Resources (FENR; soon to become the Office of Environment and Natural Resources) estimated funding for tropical forestry research (broadly defined) to be about $8 million in FY 1989—about 10 percent of all AID funding for current forestry-related activities (see Chapter 2, note 4). Of this, approximately half was funded through FENR, $3.6 million through Regional Bureaus and Missions, and roughly $400,000 through competitive grants under the Program in Science and Technology Cooperation of the Office of the Science Advisor (AID, 1990). This $8 million-notably increased from about $5.4 million in FY 1988 (AID, 1990)-is roughly 0.1 percent of total AID economic assistance (OTA, 1991a). Overall, there has been an approximate ten-fold increase in forestry activities since the late 1970s, with a doubling of the proportion devoted to forestry research itself.

In view of the difficulty in making distinctions between forestry and related research, as well as between applied research and some forms of technology demonstration, $8 million is only a rough approximation. AID officials believe

the actual figure-in the context of this report-would be somewhat lower. Above information from J. Vanderryn, I. Morrison, and D. Deely, FENR, AID.

Although not directly comparable, agricultural research represented approximately 20 percent of overall AID agricultural expenditures (the approximately $600 million contained in AID Development Assistance and the Development Fund for Africa) in 1989, the last year in which "research" was a separate account item. Together, research, education, and extension ("Technical Development") were more than a third of total agricultural funding, although this level may have declined somewhat (based on November/December, 1989, data from Activity Code/Special Interest System, Office of Policy and Program Coordination, AID).

7. Within the category "tropical forestry research," the focus and emphasis of AID funding continues to change. Early on, AID focused on production research. By the 1980s, fuelwood research formed the major component of research funding; today it receives little or no new support. "Biodiversity/forestry" research has grown from 5-10 percent of tropical forestry research funding in 1989 to perhaps 20-25 percent in 1991 (information from D. Deely, FENR, AID). Such shifting of priorities is in part due to the evolving nature of research, in part due to the designation of funds outside the agency for particular types of research ("ear-marking"), and in part due to the dual mission of AID itself: attempting to support on-going development efforts while serving as a catalyst for new areas of attention.

A recent overview of AID tropical forest programs and projects is in AID, n.d. The role of AID in tropical forestry and research is given in Appendix B. Current AID priorities, which align closely with those identified by the global forestry research community (see page 10), are described as:

- Halting deforestation;
- Biological diversity (through the conservation of tropical ecosystems, including tropical forests);
- Genetic improvement of multipurpose trees for small farm use and agroforestry systems;
- Development of agroforestry technologies;
- Increasing the availability of fuelwood;
- Development and implementation of forest policy;
- Forestry's role in maintaining sustainable agricultural production;
- Forestry's role in natural resource management and conservation; and
- Natural forest management and conservation, including its role in halting deforestation and in conserving biological diversity (taken from AID, 1990).

8. Information from J. Vanderryn, FENR, AID.

9. The U.S. Forest Service (USFS)-with more than 750 scientists in numerous laboratories, experiment stations, and field facilities-researches a wide array of subjects, such as forest lands, utilization, and related natural resources. The Office of International Forestry coordinates scientific exchange, technical assistance, training, and support with international organizations and other countries; its Forestry Support Program (funded by AID) provides ad hoc technical assistance to AID, the Peace Corps, and nongovernmental organizations. Although much U.S. Forest Service research is relevant to tropical countries (NRC, 1990a), three facilities in particular emphasize tropical forestry research.

The Institute of Tropical Forestry in Rio Piedras, Puerto Rico (founded in 1939) conducts research in tropical forest ecology, sustainable management, wildlife protection, biological diversity, climate change, watershed management, and tropical tree plantations (the 11,000 hectare Caribbean National Forest/Luquillo Experimental Forest is the only tropical forest in the U.S. National Forest system). Staff share information throughout the tropics and participate in technical assistance, training, and cooperative research. It is well-suited to expand, as planned, into a full-fledged International Tropical Forestry Institute.

The Institute of Pacific Islands Forestry in Honolulu, Hawaii (founded in 1959) conducts research on agroforestry, plantations, fuelwood, bioenergy, and endangered species. It could play a much greater research and technology transfer role, not only in Hawaii and the current and former U.S. territories of the Western Pacific, but also through cooperative research programs with other countries.

The Forest Products Laboratory in Madison, Wisconsin (founded in 1910) conducts basic and applied research on almost all aspects of wood products, and responds to scientific inquiries from both temperate and tropical nations. Future research should greatly expand investigations into both wood and nonwood products from tropical forests.

10. This is not surprising: less than 1 percent of tropical forests are now within the United States, mostly on state or private lands. These domestic ecosystems merit exemplary attention.

11. Tropical forestry has been identified as a "Priority Research Program" by the U.S. Forest Service. As a result, tropical forestry research appropriations grew from $2.2 million in FY 1989 to $3.6 million in FY 1990, with a proposed $6.3 million in FY 1992. The budget also calls for nearly quadrupling (from $2.5 million to $9 million) technical assistance and training for tropical countries. This is largely in response to the President's announced intention at the 1990 Economic Summit Conference to expand the Institute of Tropical Forestry in Puerto Rico into a "full-fledged International Institute of Tropical Forestry." Information from D. Harcharik. The basis for current policy is given in USDA Forest Service, 1989.

12. "University" is used to broadly represent the U.S. academic community. Data are not available for the monetary resources devoted by U.S. universities to tropical forestry research. Much is subsumed in other forestry or natural resource budgets, or in other university departments. Tropical forestry research is rarely a separate funding item (see Appendix C).

13. Preceding information from H. Gregersen, D. Harcharik, D. Rocheleau, and D. Thorud.

14. Universities have attempted to coalese scarce and scattered expertise by forming consortia. This approach has helped, but generally greater weight has been given tropical agricultural development than forestry research. Notable exceptions are the Organization for Tropical Studies (OTS) and the Central American and Mexico Coniferous Resources Cooperative (CAMCORE). OTS is a consortium of more than 50 institutions that now facilitates research on basic and applied tropical biology. At its inception in 1963, however, it was designed

to be a forestry organization as well. Forestry courses were taught the first seven years, and introduced many of the current U.S. tropical foresters to academic research. CAMCORE-managed by North Carolina State University-is a cooperative of forest industries and governments involved in protecting and utilizing forest genetic resources in Central America and Mexico.

15. From practically no involvement in the 1970s, today perhaps a dozen or more U.S. companies have entered into long-term collaborative agreements with governments, companies, and individuals in developing countries. Little research is involved. Currently, most projects involve the production of pulpwood on abandoned agricultural lands. In other cases, production is on small, farmer-owned plots (information from N. Johnson).

Primary obstacles to greater U.S. private sector tropical forestry research and development are less technical than infrastructural: the need for stable investment and clear policy environments (Gregersen, Lundgren, and Lindell, 1990), and often a reluctance to share proprietary research results.

U.S. industrial forestry research capacity is limited, however. It is estimated to have declined by 50 percent in the past few years, to between $50 and 100 million (little of this research is "tropical," although much of it may be adaptable to such conditions). Fewer than a dozen companies currently have research programs. For further information and documentation, see NRC, 1990a.

16. There are many types of NGOs involved in tropical forestry research. These include development and conservation organizations, foundations, botanical gardens and clubs, policy groups, professional societies, and humanitarian groups. For general information, see OTA, 1991a; see also Chapter 7 (The Role of U.S.-Based Private Voluntary Organizations and Nongovernmental Organizations in Forestry Development in the Third World) in SAF, 1986, and Davis-Case, 1989.

Separate data for NGO tropical forestry research funding are not available, but does not exceed a very few million dollars at best (see note 3).

17. Such involvement is increasingly mandated in the program and policy decisions of development agencies such as AID (see Appendix B) and the World Bank.

18. U.S. production and technical forestry research has focused predominantly on wood off-take, generally from uninhabited forest and plantations (NRC, 1990a). As noted in Chapter 2, this is in contrast to much recent non-U.S. research.

19. Networks have become more common in recent years, but the tendency has often been to specialize and narrow membership to include only the scientific community, or a slice of it. Although sometimes appropriate, the scientific research establishment is too small and too specialized to generate forestry technologies and policies for the multiplicity of diverse conditions in the tropical developing world. By forming a conduit for collaboration and communication, open research networks would, overall, facilitate better communication and strategies for finding solutions.

CHAPTER 4
DEVELOPING A U.S. STRATEGY

The continuing decline of tropical forests and rending of traditional cultures-in the face of population growth, increasing per-capita consumption of forest products, and the expansion of tropical agriculture, ranching, and logging-mandates a sense of urgency.[1] Wise decisions require good science, yet we do not have the luxury of a leisurely approach to tropical forestry research.[2]

The panel notes that the national agendas of tropical countries are not within its purview and that the international community has developed its own consensual methods and mechanisms over many years. The panel restricts its recommendations to what it perceives as a weak link in a global effort: how the United States itself could begin to develop an effective program of tropical forestry research, extension, and education that would fit within the existing international context while being of benefit to all. In so doing, this strategy lays the foundations for developing even more vigorous research efforts in the near future.

At present, the overall U.S. tropical forestry research effort is both diffuse and limited. To rectify these inadequacies requires both coordination and an increase in action.[3] The panel believes that there should be expansion in both U.S. involvement and investment in the research, education, and extension related to tropical forest depletion and to the role of trees and forests in providing human security.[4] This national effort should 1) continue to broaden and strengthen research, education, and extension programs and capacities of developing countries while 2) expanding the research and educational capacities and activities of the governmental and private sectors in the United States.

The panel believes that the most effective means for enhancing U.S. forestry research capabilities is through augmenting current structures and relationships, and weaving them more closely together. Infrastructures are in place, but require far more effective participation by institutions and individuals now only marginally involved in the tropical forestry research community.

Currently, the lead federal agencies involved in tropical forestry research endeavors are the Agency for International Development (AID) and the U.S. Forest Service of the Department of Agriculture

(USDA). Numerous other agencies conduct activities that affect the peoples and forests of the tropics. Universities, forest industry, and nongovernmental organizations also have much to contribute and should be encouraged to assume a significant role in the complex research tasks that lie ahead. All need to become stronger partners in U.S. efforts. This will require cultivating a research, education, and extension system-the federal government, academia, the forest industry, and nongovernmental organizations-that would be stable, mutually supporting, and capable of implementing a U.S. tropical forestry research agenda aimed at sustaining tropical forests while meeting human needs.

Recommendations

This goal lead the panel to support the following recommendations:

- **The United States should more rapidly expand federal funding for research, education, and extension related to tropical forestry.**[5]
- **The Agency for International Development should continue to focus on the worldwide meshing of U.S. efforts to strengthen research capabilities of developing countries in collaboration with U.S. researchers.**
- **The Department of Agriculture should focus on strengthening domestic tropical forestry research capabilities, and coupling them with international efforts.**
- **The panel suggests a competitive grants program to strengthen and integrate the overall U.S. ability to conduct research on tropical forestry issues. The grants, broadly based and widely accessible, would be targeted at institutions, individuals, and issues. The panel suggests financial administration through a Department of Agriculture scientific contract office.**
- **The panel suggests a broadly based independent council to help advise, guide, and coordinate federal initiatives, as well as the efforts of other organizations that wish to participate.**[6]

Agency for International Development

The experience, counsel, and partnership of AID can be invaluable in bringing the capacities of U.S. government, academic, and private institutions to bear on tropical forestry research issues. In the proposed collaborative approach, AID programs would retain their primary focus of strengthening the forestry research capacity and activity of tropical countries through funding of in-country and

collaborative programs, and through provision of technical assistance and institutional strengthening both here and abroad. Funding through AID would continue to be dispersed through normal country mission channels and through the Bureau of Science and Technology (soon to become the Bureau of Research and Development) and the Office of the Science Advisor in support of the following types of activities:

- provide funding, guidance, and policy support for developing initiatives in appropriate international, bilateral, and national organizations;
- support tropical forestry research in developing countries, both through increasing in-country capacity and through direct support for research through AID projects coordinated with national ministries, universities, nongovernmental organizations, and working groups;
- Support professional and graduate level education of tropical scientists;
- Support information exchange and research activities among clusters of U.S. and tropical-country institutions and personnel;
- Initiate and support policy dialogue and research to build support in developing countries for effective and sustainable forestry research and extension;
- Coordinate and integrate agency forestry research activities with other program, project, policy, and technical areas within AID, among U.S. agencies and organizations, and nationally and internationally;
- Fund all of these activities within the longer-term framework of forestry (minimum 10 years) so as to encourage stability of programs as they evolve.

To accomplish these goals, it is necessary to have sufficient in-house staff appropriately qualified in tropical forestry research issues, design, development, and evaluation.

AID would differentiate itself from many donor agencies if it would make documentation, communication, and transfer among users and researchers a key component in its research portfolio. Many of the following activities could be developed in collaboration with USDA and other programs:

- Organize documentation of existing tropical forestry research and information;
- Design and perform participatory data collection on tree and forest use, and provide documentation, analysis, and dissemination of the experiences and knowledge gained from these efforts;
- Prepare publications-in English and other languages-based on literature and experiences, and tailored to local audiences;

- Strengthen the interactive extension function of AID; and
- Train staff of in-country organizations, especially in adaptive and community-based research and in extension practices.

AID began funding tropical forestry research more than fifteen years ago. Although greatly increased in the past decade, funding levels-approximately $8 million annually-remain inadequate. The panel recommends that-in the short term-AID research funding continue to increase as rapidly as possible to a level of about $15-20 million annually. At present, this would represent an increase to approximately 20 percent of overall forestry program expenditures.[7]

Department of Agriculture

The USDA has more than a century of experience in conducting and supporting research focused on U.S. issues. It has developed mechanisms for collaborative research at the federal level, and for cooperative involvement with U.S. academic, industrial, and nongovernmental institutions. The panel recommends this administrative and scientific acumen be applied to tropical forestry research.

The USDA, through the Forest Service, is the lead federal forestry research agency. Accordingly, the panel supports the significant strengthening of existing Forest Service research programs in tropical forestry that is already underway.[8] This is necessary in particular to continue expansion of research at the Institute of Tropical Forestry and the Institute of Pacific Islands Forestry, as well as the Forest Products Laboratory and other facilities. Funds should also be sufficient to allow-without sacrifice by other scientists and units-the U.S. Forest Service to more fully develop cooperative international research with tropical countries. Forest Service tropical forestry research should be more closely linked with other Forest Service activities (especially those administered by the Office of International Forestry), other U.S. government agency activities (especially AID), and a future U.S. tropical forestry research community.

Competitive Grants Program

The panel proposes a targeted competitive grants program that-given short-term ability to absorb funding-is modest in size.[9] Built on existing strengths, it would focus on individuals, institutions, and issues. Within a short time, it would significantly enhance the capacity of the United States to support research on

tropical forestry issues. The goal is to encourage multidisciplinary and international collaboration through an independent, peer-reviewed process. The panel suggests financial oversight and administration be housed within a competitive research grants office, such as those of the USDA.[10] All agencies and organizations would be encouraged to collaborate and participate. Yearly costs for a program such as outlined below would be around $11 million.[11]

Priorities and terms of reference for competition-which should adhere to the spirit of this report-would be established through a broadly based consultative process that would rely on advice from experienced professionals in federal agencies, the academic community, nongovernmental organizations, and the private sector. This could perhaps be done by a Tropical Forestry Research Council, as outlined in the next section.

The suggested grants program is composed of the following three components.

- **Individual grants to increase the number of qualified researchers.**

  The United States should support an ongoing program that would sponsor Ph.D. fellowships (preferably three-year) and postdoctoral awards (preferably two-year) on a competitive basis for work in tropical forestry research by U.S. participants.

  Applicants for these awards would submit proposals that identify their qualifications, the qualifications of any institution or institutions with which they propose to affiliate, the nature of the research they plan to pursue in tropical forestry, and career objectives. A requirement is that research be done in tropical countries. Exceptions to this policy (such as data analysis and interpretation) would have to be well documented and clearly show the relevance to advancing tropical forestry. Applicants would be free to propose their preferred affiliation(s), either U.S., foreign, or both.

  The awards could be used for stipend, travel, equipment, and seed money for research projects. Winners would be free to use their awards to gain additional funding on a matching basis.

  A program to support (at a minimum) 10 new Ph.D. or postdoctoral students per year would cost approximately $1 million annually.

- **Institutional grants to increase research capacity at U.S. institutions and organizations.**

The United States should support a competitive grants program to develop U.S. research capacity and actual research programs to address priority issues related to forests, trees, and the people of tropical countries. This program should be open to any institution for research on these subjects. These one-time grants would be for a maximum of five years.

Competitive features of this program would include assessment of institutional capability and experience in tropical forestry, some level of matching support, and other measures of long-term commitment to tropical forestry research, education, extension, and training.

Collaboration and integration with developing-country institutions should be favored through joint proposals from two or more institutions involving a multidisciplinary research and extension approach. All proposals should indicate potentials for education and training of researchers and for enhancing research programs and interrelationships that can become sustainable beyond the five-year competitive grant period.

This five-year program should attempt to support the initiation of ongoing programs at five to seven institutions, and would cost approximately $5 million annually.

- **Issue grants to address the highest research priorities.**

The United States should support a competitive grants program targeted on the most crucial tropical forestry research needs. The competition should be accessible to all. No minimum or maximum funding levels would be established. The grants would be funded in their entirety at the outset. Indirect costs could be allowed. A requirement is that the research be done in tropical forestry. Exceptions to this guideline would have to be well justified.

The proposed projects should be structured to encourage the broad participation of collaborators, in particular, counterparts in tropical countries, and interdisciplinary approaches. Explicit contributions to international scientific and policy efforts and networks, and the twinning of U.S. researchers and institutions with clusters of counterparts in developing countries, would be encouraged. The proposals

should include anticipated means by which the research results would be disseminated and implemented.

The panel recommends that the annual funding level for this program be about $5 million. This would be sufficient for about 10 major initiatives a year, or for a greater number of small or collaborative projects.

Linking Research and Development

Effective research on the interrelationships among humans, trees, and forests in the tropics cannot take place in isolation from development efforts. Conversely, tropical forestry policy and practice-no matter the goals-should be closely allied to ongoing research. It is necessary for research and development to reap insights from one another. However, particularly within the United States, this overlapping has been incidental and the result of intermittent or individual initiative. Given the expanding nature and magnitude of tropical forestry research, the panel believes this a propitious time-even if additional funding should not soon become available-to take a further step in the coordination of U.S. efforts.

The panel recommends that a Tropical Forestry Research Council (TFRC) provide policy advice and guidance to participating programs for building U.S. and developing-country capacity in tropical forestry research.[12] The TFRC would assist participating agencies and organizations involved in research relevant to tropical forestry. It could provide a forum for the deliberation of research strategies. It might also encourage or initiate needed studies, particularly on the U.S. tropical forestry research system itself, and on it priorities.

Membership in the TFRC would be drawn from universities, industry, nongovernmental organizations, the professional community, and-to the extent appropriate-government agencies. Members would serve as individuals and not as representatives. Membership of the council should be broadly representative rather than restricted to researchers. Participation of individuals experienced in the realities of tropical forest management and peoples would be especially welcome, and the views of those outside forestry should be solidly represented. It would be desirable to encourage greater participation by both the basic sciences (such as biology, botany, or zoology) and cross-cutting initiatives (such as biodiversity and climate change). The relative merits of 1) including representatives of tropical countries on the Council versus 2) establishing a complementary advisory group from tropical countries should be explored.[13] The Tropical Forestry Research Council

should maintain close liaison (and perhaps ex officio membership) with the National Forestry Research Council, currently under establishment.[14]

Unless the TFRC were an independent body, it should be convened under the auspices of an organization or organizations that can facilitate discussion and action. Structuring of authority and responsibilities-including any role in international and bilateral efforts-should be determined insofar as possible by participants in the Council. Financial support for the Council's activities should come from participating organizations, most notably federal agencies, and from interested sponsors. Initiation of the TFRC could be combined with the design stage for the research competition, which calls for the counsel of the U.S. community in establishing priorities and terms of reference (see above).[15]

Parallel with the TFRC, coordination and linkages among government program, project, policy, and technical staff should be enhanced and perhaps formalized.[16] Active collaboration among research managers would provide on a day-to-day basis a ready conduit for communication and would help ensure interaction, coordination, and relevance of research, while avoiding duplication of effort. Effective expenditures and successful programs are a strong incentive to funders and implementers alike to achieve the goal of coherent use of tropical forestry research funding and knowledge.

Expected Results

Implementation of the panel's recommendations would provide the impetus for the United States to begin the daunting task of effectively addressing the problems and opportunities of research in tropical forestry. The proposed actions-focused on the needs of tropical forests and the people dependent upon them-allow for a substantial "multiplier" effect through the existing research and educational capacity and infrastructure of U.S. organizations. It is hoped the stimulus created by these proposed programs would soon lead to greater efforts, and help create long-term U.S. commitments to tropical forestry research, education, and extension.

Specific benefits of the proposed focus and enhanced support of tropical forestry research, education, and extension include:

- Greater institutional capabilities in forestry research and extension in tropical countries; strengthened financial support for addressing and targeting tropical forestry research issues; increased understanding of the role that forestry research and extension can

make on behalf of both people and environmental health, and broader recognition of these contributions.

- Strengthened and more sophisticated U.S. technical and educational capability in tropical forestry research, education, and extension; greater involvement of its scientists in tropical forestry issues; career incentives for tropical research; better international access to U.S. research organizations; enhanced educational opportunities in the United States for students with interests in tropical forestry research, extension, and education; a better understanding of tropical forestry issues on the part of the public; and more opportunities and encouragement for the United States to contribute to cooperative international projects in tropical forestry research and communication.
- Enhanced international networks of researchers; long-term collaboration among research and extension institutions (both public and private) in tropical countries and counterparts in the United States; a source of professional and student expertise on a long-term basis; and research results for addressing the most pressing tropical forestry research priorities, and researchers trained to help solve those problems.

It is clearly in the best interests of the United States to be a qualified participant in tropical forestry research. The research and development communities and the American public want to see this happen. If given the opportunity, there is a great deal more our scientific establishment can offer as well as gain. The Review Panel on International Forestry Research believes that relevant, long-term tropical forestry research can develop and flourish more efficiently and effectively through an open and evolving network of encouragement such as recommended here. It remains for the United States to act.

Notes to Chapter 4

1. These examples, from among many, are drawn from U.N., 1983; NRC, 1990a; and OTA, 1991a.

2. Two examples: At current rates, tropical forests could be gone in 100-150 years or less (Wilson, 1988). Fuelwood (currently used by more than half the world for cooking and providing up to 80 percent of energy in some developing countries) is becoming scarce in many places (FAO, 1989); by the year 2000, the FAO anticipates that nearly three billion people may suffer from fuelwood shortages (FAO, 1983).

3. Regardless of funding levels, U.S. research efforts should be integrated without delay into a coherent plan of action (see Appendixes B and C).

4. OTA (1991a) recommends: "Congress could increase funding for AID projects on agroforestry, sustainable agriculture, and nontimber forest products (*without reducing other programs*)." (OTA, 1991a, p. 231, emphasis added; see also following note). Given the inadequacies of current support, the panel feels that any initiatives currently merit separate funding, rather than being drawn from either domestic forestry programs or from other federally funded scientific research or development efforts. (See also OTA, 1991b and USDA, 1991.)

5. This recommendation restates earlier governmental and independent analyses, most recently funding options presented to Congress by the Office of Technology Assessment:

"Congress also could increase direct funding and technical support through AID for U.S. and foreign NGOs that work on forestry-related issues.... Congress could increase support for international research organizations that address forestry-related issues.... The United States could support development of an applied research system that both focuses on issues not currently covered adequately (e.g., nontimber forest products, natural forest management) and coordinates existing efforts. Congress also could increase support for U.S. university and Peace Corps programs to train U.S. professionals in tropical forestry and direct AID to expand its support of research and training in forestry." (OTA, 1991a, p. 230-231)

6. *Forestry Research: A Mandate for Change* states:

With numerous advisory committees representing organizational research interests, leadership in forestry research has been fragmented. Government agencies and other organizations responsible for research activities can obtain policy advice from a wide variety of sources, such as internal advisory committees at the level of agency head or the level of division. Research organizations can also draw upon other groups for advice, groups such as the National Research council. Because of the broad range of research organizations and clientele of forestry research, none of the existing forestry advisory committees has adequately met the needs of the forestry research community in general. ***Therefore, a policy advisory mechanism must be established to provide leadership that transcends the interests of individual organizations.*** NRC, 1990a, p. 3 (emphasis added).

The Office of Technology Assessment (1991a) notes this problem is not restricted to the United States: "No central body ... coordinates tropical forestry research or offers help to donors and national governments." (p. 231); see also OTA, 1984 and EESI, 1991.

7. Research does not preclude development. Participatory research in particular often yields practical field results as well as data. Indeed, with forethought and follow-through, nearly any project can yield valuable new scientific information.

8. U.S. Forest Service funding for tropical forestry research remains inadequate. However, it is outside the charge of this advisory panel to make specific recommendations.

In this section, it should be noted that although members of NRC panels serve as individuals rather than as institutional representatives, Dr. Harcharik officially recused himself from both the formulation and unanimous panel endorsement of recommendations potentially affecting USDA.

9. We provide a greater level of detail for these proposals than in discussions of existing programs.

10. Such a precedent was firmly established within the Competitive Research Grants Office (CRGO) of USDA (USDA, 1991; see also NRC, 1989b).

11. Estimated totals are based on average costs of research and education provided in NRC, 1989b.

12. This recommendation is not new. In 1980, the President's U.S. Interagency Task Force on Tropical Forests recommended a formal, permanent review and evaluation panel to "provide central coordination of [U.S.] policy, strategies, and programs..., cochaired by the Departments of State and Agriculture (Forest Service)." The Task Force noted that "policy planning and program implementation must be strengthened, particularly through improved coordination at the Federal level. This same conclusion was reached at the 1978 U.S. Strategy Conference on Tropical Deforestation." (p. 49, see Appendix C). Similar approaches are recommended by the National Science Board (NSB), 1989; OTA, 1984; and OTA, 1991b.

Section 118 ("Tropical Forests") of the authorizing legislation for AID ("The Foreign Assistance Act of 1961, as amended," see Appendix B) states in subsection (b) ."..the recommendations of the United States Interagency Task Force on Tropical Forests [1980] shall be given high priority by the President- - (1) in formulating and carrying out programs and policies with respect to developing countries, including those relating to bilateral and multilateral assistance and those relating to private sector activities; and (2) in seeking opportunities to coordinate public and private development and investment activities which affect forests in developing countries." Similarly, USDA Forest Service policy states that it will "[c]ooperate with the Department of State and other government agencies in determining the official United States position with respect to world forestry issues dealt with by international organizations." USDA Forest Service, 1989.

The panel believes that, in calling for a Tropical Forestry Research Council, the recommendations and requirements immediately above can now be begun. It

is hoped that the less-formal and less-authoritative proposition in this report would be sufficient to initiate the goals called for by the President's Task Force and by Congress, and endorsed by this panel.

An analysis of the multiple levels of decision making in federal science funding (competition with nonscience initiatives, across scientific areas, within fields and agencies, and among programs) is presented in OTA, 1991b, which states "[p]riority-setting mechanisms that cut across research fields and agencies, and that make selection criteria more transparent, must be strengthened in both Congress and the executive branch" (p. 11).

13. See NRC, 1991a for a discussion of national-regional-global cooperation.

14. NRC, 1990a. See OTA, 1991b for a discussion of the hierarchy of decision making within the federal government.

15. Guidelines for determining national and interagency research priorities are discussed in NAS et al., 1989; NRC, 1989b; EESI, 1991; OTA, 1991b; and USDA, 1991. A current model for grant design in multidisciplinary natural-resource management studies is given in NRC, 1991d; see also NRC, 1989b and Greene, 1991.

16. Pressures have grown throughout the federal structure for increased interagency cooperation and coordination of efforts, which has been described as "unsystematic and sometimes haphazard" (NAS et al., 1989). Frequently, successful interagency collaboration has been informal contact among individuals managing ad hoc programs. On the other hand, programs of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), under direction of the President's Science Advisor, have grown to represent formal, joint interagency efforts to coordinate overall funding and research strategies (Office of Science and Technology Policy [OSTP], 1990; see also NAS et al., 1989).

Neither extreme-informal contact nor formal interagency structure-seems appropriate in the case of tropical forestry research (a rationale is provided in OTA, 1991b; see also NRC, 1989b). A possible management procedure could be derived from the biodiversity research collaboration between AID and the National Science Foundation (NSF; see NSB, 1989). This cooperation is both funded and managed jointly, with AID funding the international component and NSF funding much of the domestic-based research, as well as handling the day-to-day administration of the programs. Decisions concerning both the overall strategy of the program and the allocation of grants are arrived at jointly. OTA (1991b) provides a discussion of various options for funding-decisions and coordination.

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APPENDIX A

REVIEW PANEL ON INTERNATIONAL FORESTRY RESEARCH

STATEMENT OF TASK

The Agency for International Development (AID) has requested advisory assistance from the National Research Council's Board on Science and Technology for International Development (BOSTID) to review a variety of research programs supported by AID. The advisory assistance process includes advising AID on new areas of science and technology that might be useful to the AID program, on the scientific merit and methodological soundness of research proposals, and on ongoing science and technology projects. To perform this continuing series of external review and evaluation functions, BOSTID selects review panels relevant to the specific task that is requested.

The task of the Review Panel on International Forestry Research is to advise AID, through its Research Advisory Council (RAC), on appropriate AID research roles and activities within the larger national and international framework, given the rapidly expanding scope of forestry, RAC Research Criteria,* and overall AID objectives of natural-resource management and sustainability. Panel membership reflects expertise in the areas of human-forest interactions, ecosystem function and management, forest biology, forest materials, and trade.

The panel will meet in December to formulate recommendations on possible AID forestry research strategies. At this time, the panel will hold informational discussions with the RAC, staff from the AID Office on Forestry, Environment, and Natural Resources, and other appropriate individuals. Further panel deliberations--including a possible January meeting--will yield a short report for Academy review, and delivery to the RAC in April 1991. Funding for BOSTID's Review Panels Program is provided by the AID Bureau of Science and Technology Office of Research and University Relations.

*The Research Advisory Council Research Criteria are:

1. Large numbers of LDC people should be reached by results;
2. Useful results should be anticipated over defined times;
3. The U.S. should have a comparative advantage in the research pursued;
4. AID should have a coordinating role based on in-house competence, but should rely on contractors and cooperators for research performance.

November 1990

APPENDIX B

Tropical Forests and the Agency for International Development

Foreign Assistance Act of 1961
Sections 101 and 118 (as amended)

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled. That this Act may be cited as "The Foreign Assistance Act of 1961."

SEC. 101. GENERAL POLICY.--(a) The Congress finds that fundamental political, economic, and technological changes have resulted in the interdependence of nations. The Congress declares that the individual liberties, economic prosperity, and security of the people of the United States are best sustained and enhanced in a community of nations which respect individual civil and economic rights and freedoms and which work together to use wisely the world's limited resources in an open and equitable international economic system. Furthermore, the Congress reaffirms the traditional humanitarian ideals of the American people and renews it commitment to assist people in developing countries to eliminate hunger, poverty, illness, and ignorance.

Therefore, the Congress declares that a principal objective of the foreign policy of the United States is the encouragement and sustained support of the people of developing countries in their efforts to acquire the knowledge and resources essential to development and to build the economic, political, and social institutions which will improve the quality of their lives.

United States development cooperation policy should emphasize four principal goals:

(1) the alleviation of the worst physical manifestations of poverty among the world's poor majority;

(2) the promotion of conditions enabling developing countries to achieve self-sustaining economic growth with equitable distribution of benefits;

(3) the encouragement of development processes in which individual civil and economic rights are respected and enhanced; and

(4) the integration of the developing countries into an open and equitable international economic system.

The Congress declares that pursuit of these goals requires that development concerns be fully reflected in United States foreign policy and that United States development resources be effectively and efficiently utilized.

(b) Under the policy guidance of the Secretary of State, the agency primarily responsible for administering this part should have the responsibility for coordinating all United States development-related activities.

SEC. 118. TROPICAL FORESTS.--(a) IMPORTANCE OF FORESTS AND TREE COVER.--In enacting section 103(b)(3) of the Act the Congress recognized the importance of forests and tree cover to the developing countries. The Congress is particularly concerned about the continuing and accelerating alteration, destruction, and loss of tropical forests in developing countries, which pose a serious threat to development and the environment. Tropical forest destruction and loss--

(1) result in shortages of wood, especially wood for fuel; loss of biologically productive wetlands; siltation of lakes, reservoirs, and irrigation systems; floods; destruction of indigenous peoples; extinction of plant and animal species; reduced capacity for food production; and loss of genetic resources; and

(2) can result in desertification and destabilization of the earth's climate.

Properly managed tropical forests provide a sustained flow of resources essential to the economic growth of developing countries, as well as genetic resources of value to developed and deverloping countries alike.

(b) PRIORITIES.--The concerns expressed in subsection (a) and the recommendations of the United States Interagency Task Force on Tropical Forests shall be given high priority by the President--

(1) in formulating and carrying out programs and policies with respect to developing countries, inlcuding those relating to bilateral and multilateral assistance and those relating to private sector activities; and

(2) in seeking opportunities to coordinate public and private development and investment activities which affect forests in developing countries.

(c) ASSISTANCE TO DEVELOPING COUNTRIES.--In providing assistance to developing countries, the President shall do the following:

(1) Place a high priority on conservation and sustainable management of tropical forests.

(2) To the fullest extent feasible, engage in dialogues and exchanges of information with recipient countries--

(A) which stress the importance of conserving and sustainably managing forest resources for the long-term economic benefit of those countries, as well as the irreversible losses associated with forest destruction, and

(B) which identify and focus on policies of those countries which directly or indirectly contribute to deforestation.

(3) To the fullest extent feasible, support projects and activities--

(A) which offer employment and income alternatives to those who otherwise would cause destruction and loss of forests, and

(B) which help developing countries identify and implement alternatives to colonizing forested areas.

(4) To the fullest extent feasible, support training programs, educational efforts, and the establishment or strengthening of institutions which increase the capacity of developing countries to formulate forest policies, engage in relevant land-use planning, and otherwise improve the management of their forests.

(5) To the fullest extent feasible, help end destructive slash-and-burn agriculture by supporting stable and productive farming practices in areas already cleared or degraded and on lands which inevitably will be settled, with special emphasis on demonstrating the feasibility of agroforestry and other techniques which use technologies and methods suited to the local environment and traditional agricultural techniques and feature close consultation with and involvement of local people.

(6) To the fullest extent feasible, help conserve forests which have not yet been degraded, by helping to increase production on lands already cleared or degraded through support of reforestation, fuelwood, and other sustainable forestry projects and practices, making sure that local people are involved at all stages of project design and implementation.

(7) To the fullest extent feasible, support projects and other activities to conserve forested watersheds and rehabilitate those which have been deforested, making sure that local people are involved at all stages of project design and implementation.

(8) To the fullest extent feasible, support training, research, and other actions which lead to sustainable and more environmentally sound practices for timber harvesting, removal, and processing, including reforestation, soil conservation, and other activities to rehabilitate degraded forest lands.

(9) To the fullest extent feasible, support research to expand knowledge of tropical forests and identify alternatives which will prevent forest destruction, loss, or degradation, including research in agroforestry, sustainable management of natural forests, small-scale farms and gardens, small-scale animal husbandry, wider application of adopted traditional practices, and suitable crops and crop combinations.

(10) To the fullest extent feasible, conserve biological diversity in forest areas by--

(A) supporting and cooperating with United States Government agencies, other donors (both bilateral and multilateral), and other appropriate governmental, intergovernmental, and nongovernmental organizations in efforts to identify, establish, and maintain a representative network of protected tropical forest ecosystems on a worldwide basis;

(B) whenever appropriate, making the establishment of protected areas a condition of support for activities involving forest clearance or degradation; and

(C) helping developing countries identify tropical forest ecosystems and species in need of protection and establish and maintain appropriate protected areas.

(11) To the fullest extent feasible, engage in efforts to increase the awareness of United States Government agencies and other donors, both bilateral and multilateral, of the immediate and long-term value of tropical forests.

(12) To the fullest extent feasible, utilize the resources and abilities of all relevant United States Government agencies.

(13) Require that any program or project under this chapter significantly affecting tropical forests (including projects involving the planting of exotic plant species)--

(A) be based upon careful analysis of the alternatives available to achieve the best sustainable use of the land, and

(B) take full account of the environmental impacts of the proposed activities on biological diversity, as provided for in the environmental procedures of the Agency for International Development.

(14) Deny assistance under this chapter for--

(A) the procurement or use of logging equipment, unless an environmental assessment indicates that all timber harvesting operations involved will be conducted in an environmentally sound manner which minimizes forest destruction and that the proposed activity will produce positive economic benefits and sustainable forest management systems; and

(B) actions which significantly degrade national parks or similar protected areas which contain tropical forests or introduce exotic plants or animals into such areas.

(15) Deny assistance under this chapter for the following activities unless an environmental assessment indicates that the proposed activity will contribute significantly and directly to improving the livelihood of the rural poor and will be conducted in an environmentally sound manner which supports sustainable development:

(A) Activities which would result in the conversion of forest lands to the rearing of livestock.

(B) The construction, upgrading, or maintenance of roads (including temporary haul roads for logging or other extractive industries) which pass through relatively undegraded forest lands.

(C) The colonization of forest lands.

(D) The construction of dams or other water control structures which flood relatively undegraded forest lands.

(d) PVOs and Other Nongovernmental Organizations.--Whenever feasible, the President shall accomplish the objectives of this section through projects managed by private and voluntary organizations or international, regional, or national nongovernmental organizations which are active in the region or country where the project is located.

(e) Country Analysis Requirements.--Each country development strategy statement or other country plan prepared by the Agency for International Development shall include an analysis of--

(1) the actions necessary in that country to achieve conservation and sustainable management of tropical forests, and

(2) the extent to which the actions proposed for support by the Agency meet the needs thus identified.

(f) Annual Report.--Each annual report required by section 634(a) of this Act shall include a report on the implementation of this section.

APPENDIX C

1980 Report to the President of the U.S. Interagency Task Force on Tropical Forests

Chapter 9, "A Strategy and Program for the United States" Part C: Program Coordination and Support (pp. 49-50)

Program Coordination: To mobilize and mount an effective new U.S. effort on tropical forests, policy planning and program implementation must be strengthened, particularly through improved coordination at the Federal level. This same conclusion was reached at the 1978 U.S. Strategy Conference on Tropical Deforestation, and led to the establishment of the U.S. Interagency Task Force on Tropical Forests. ....

To provide central coordination of the policy, strategies, and programs set forth in this report, the U.S. Interagency Task Force on Tropical Forests, cochaired by the Departments of State and Agriculture (Forest Service), recommends it assume the following responsibilities:

- Review the policies, plans, and programs of all U.S. Government Agencies in the tropical forest area.
- Recommend measures for improving the collective efficiency and impact of these policies, plans, and programs.
- Identify overall program gaps and weaknesses, and propose corrective measures.
- Assemble a consolidated, coherent U.S. Government tropical forest program on an annual or biannual basis to help Agencies structure and justify program and budget requests.
- Maintain close linkage and a continuing dialogue with representative non-Federal institutions to insure their participation in, and support for, the Government's activities.
- Recommend U.S. international initiatives, as well as U.S. positions on tropical forest issues and programs, that are to be discussed in international and regional fora.
- Insure that the studies and analyses called for in this report are carried out (if the overall policy and strategy are approved).

The Task Force further recommends it arrange for detailed periodic reviews and evaluations of individual components of the proposed U.S. program (especially the bilateral assistance, research, training, and information and data transfer components), to determine how each might be strengthened and possibly refocused or expanded to address evolving domestic and international needs. Such analyses should include participation by both Federal and non-Federal representatives.

Authorities and Mandates: The implementation of an effective, broad-based U.S. program will require the active participation of many Federal Agencies. In most cases, these Agencies have sufficient statutory authority to collaborate with other countries on tropical forest programs. Some Agencies, however, seem uncertain of the breadth and degree of their authorities to work overseas on such activities. And others, the U.S. Department of the Interior, for example, indicate that they are constrained from carrying out certain types of international activities that will be important for the implementation of the type of U.S. program envisioned by the Task Force. Therefore, the Task Force recommends that all Federal Agencies review and assess their mandates and authorities for contributing to the tropical forest strategy program proposed herein, and seek necessary modifications, working in cooperation with the U.S. Department of State.

Funding and Staffing: The Task Force was not able to calculate the total current U.S. investment in tropical forest programs, either public or private, because the programs are so wide ranging and because many institutions do not classify relevant activities under a "tropical forests" heading. If the proposed U.S. policy, strategy, and program framework is accepted by the U.S.

Government, the development of a comprehensive project inventory will be justified. Such an inventory is, therefore, recommended as a high priority "next step" by the Task Force, with initial emphasis to be placed on U.S. Government activities.

As to funding, neither the short-term program priorities nor the broader program framework presented in this report are of a nature that budgetary requirements can be assigned at this time. While much more can be done in this area within existing budgetary constraints, additional funding may well be required to mount a meaningful, expanded U.S. effort dedicated to tropical forests. But details will have to await responses by the Agencies to the general strategy and program recommendations set forth by the Task Force—evaluated in relation to activities already underway and planned in this area, and other competing program priorities. Such an evaluation should be carried out by each Federal Agency. The Task Force should then review the totality of the Agencies' program proposals, recommend to the Agencies where modifications or the addition of gap-filling activities should be considered, and consolidate the final Agency decisions into a coherent, integrated U.S. Government program. .... Such a unified tropical forest program for the Federal Government might then by used by the Agencies to guide the allocation of budgetary resources.

Federal Agencies should examine their staffing levels, since staffing shortages may be especially limiting—even more so than funding. Several Agencies have indicated that they already are reacting to new tropical forest concerns and interests by transferring existing staff to this area. Others, however, will have to go beyond reassigning staff and add new technical expertise.

APPENDIX D

Panel Biographies

David B. Thorud (Chair) has been Dean of Forest Resources at the University of Washington since 1981, after four years with the Forest Service of the U.S. Department of Agriculture (USDA). He was earlier Director of the School of Renewable Natural Resources and Professor and Head of the Department of Watershed Management at the University of Arizona. His Ph.D. from the University of Minnesota is in Forest Hydrology, with research centered around forest resources, watershed function and management, and hydrology. He was co-chair of the Ad Hoc Working Group of the 1980 U.S. Interagency Task Force on Tropical Forests, and a member of the 1990 NRC Committee on Forestry Research of the Commission on Life Sciences.

Nancy Glover is Vice President of the Nitrogen-Fixing Tree Association (NFTA). She has held positions with the Centro Agronómica Tropical de Investigación y Enseñanza (CATIE) in Costa Rica and the East-West Center in Hawaii. Her research studies include nutrient cycling in agroforestry systems, tree selection and genetic improvement, and biological nitrogen fixation. She received a B.S. in Soil Science at New Mexico State University and an M.S. in agronomy at the University of Hawaii, where she is currently Ph.D. candidate in Agronomy.

Nancy Glover was coordinator (and co-editor with N. Adams) for *Tree Improvement of Multipurpose Species* (1990), and is co-editor of *Leucaena Research Reports* and *Nitrogen Fixing Tree Research Reports*. She is consultant to the AID-funded Forestry/Fuelwood Research and Development (F/FRED) Project, which exchanges research plans, methods, and results on production and use of trees for rural needs.

Hans M. Gregersen is Professor of Forest Resource Economics at the University of Minnesota, with a joint appointment in Forest Resources and in Agricultural and Applied Economics. He has been actively involved in research planning and implementation for developing countries, most recently as Chair of the Standing Panel on Natural Resources, Forestry and Agroforestry of the Technical Advisory Committee of the Consultative Group on International Agricultural Research. He has served as a consultant with the World Bank, the Food and Agriculture Organization of the United Nations, the InterAmerican Bank, the Organization for Economic Cooperation and Development, and AID. He was a member of the 1980 NRC/BOSTID Panel on Firewood Crops, and the Bellagio II International Task Force on Forestry Research.

David A. Harcharik is Director of International Forestry for the Forest Service of the U.S. Department of Agriculture. Before joining the Forest Service in 1981, he was Forestry Officer in Afforestation and Tree Improvement for the Food and Agriculture Organization (FAO) of the United Nations, and has served as Visiting Professor in Forest Science with the Agrarian University in La Molina, Lima, and as Professor of Tropical Silviculture at the University of the Amazon in Iquitos. His Ph.D. from North Carolina State University is in Forestry. He has performed basic and applied research in silviculture and tree improvement and--more recently--in project design, planning, and scientific exchanges. His field of expertise is tropical forest ecology, silviculture, and management.

David Harcharik is on the Board of the American Forestry Association and he has served the Society of American Foresters on the World Forestry Committee and Chair of the International Forestry Working Group. He also performs international forestry assignments for the World Bank and the World Food Program.

Gary S. Hartshorn joined the World Wildlife Fund (WWF) in 1989 as Director of the AID-funded Biodiversity Support Program, a joint venture of WWF, The Nature Conservancy, and the World Resources Institute. In 1990 he was named WWF Vice President for Conservation Science. He lived in Costa Rica for 20 years, working throughout tropical America as a researcher and consultant on tropical forestry, ecology, and conservation. He was president of the Tropical Science Center and chaired the La Selva Advisory Committee for the Organization for Tropical Studies. His doctoral study was on tropical tree demography, leading to research on gap-phase forest dynamics, a basis for natural forest management. His Ph.D. is from the University of Washington. Gary Hartshorn has been President of the Association for Tropical Biology, and was a member of the recent NRC/BOSTID Panel on Biodiversity.

Norman E. Johnson has been with Weyerhaeuser Company for thirty-five years, serving as Vice President of the North Carolina Region from 1980-1984, Vice President for Research and Development from 1984-1990, and Senior Vice President - Technology since 1990. He joined Weyerhaeuser in 1956 as a forest entomologist. He began development of the southern forestry research program in 1969 and later became manager of tropical forestry research. In 1976, he was appointed Vice President of the Southeast Asia Region and President of the International Timber Company of Indonesia, a Weyerhaeuser subsidiary. He received his Ph.D. in Forest Entomology from the University of California.

Dr. Johnson was on the faculty of the Department of Entomology at Cornell University for two years, and he is currently Adjunct Professor in the North Carolina State University School of Forestry; he serves on the advisory councils of four universities, as well as foundation associate and director for the Pacific Science Center and a member of the Barrington Moore Memorial Committee of the Society of American Foresters. Norman Johnson was a member of the President's Agriculture and Foresty Mission to Honduras in 1982 and 1983, and to Zaire in 1985, and currently serves on various committees with the USDA and AID. He was a member of the NRC/BOSTID Committee on Research Grants.

Dianne E. Rocheleau recently became Assistant Professor in the Graduate School of Geography of Clark University after seven years in Africa. There she served as Program Officer in Social- and Agroforestry for the Ford Foundation and earlier was Senior Scientist at the International Council for Research in Agroforestry (ICRAF). Her research has focused on resource-partitioning in African agroforestry systems, based on the ethnoecology of resource use. Her Ph.D. from the University of Florida is in Geography and Systems Ecology.

Dianne Rocheleau serves on the Working Party on Forest Law and Related Legislation for the International Union of Forestry Research Organizations (IUFRO) and is an Associate Fellow of the International Institute for Environment and Development (IIED). She recently published (with F. Weber and A. Field-Juma) *Agroforestry in Dryland Africa*.