# 16. Tropical Forestry as if People Mattered

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**Abstract.** Despite great advances in our understanding of tropical forest ecology and management in recent years, the area of well-managed tropical forests and the rate of reforestation are insignificant compared to that undergoing rapid deforestation around the world. This failure of tropical forestry is frightening because forest management is the only hope for the conservation of the tropical forests, the most biologically complex yet least understood ecosystems on Earth. Many important species and biotypes of economically important tropical trees, and the ecosystems and communities in which they are found, have already been lost or are threatened. Traditional forest management is usually sophisticated and sustainable; it includes many practices, from the management of fallows in shifting agriculture to the protection, selection, and enrichment of seminatural forests. Natural forests of most tropical areas increasingly appear to be the product of human intervention. The major forces driving deforestation are government subsidies and incentives that promote unsustainable practices that are culturally and environmentally destructive. New approaches for tropical forestry must be developed, beginning with detailed analyses of past and present tropical forest management and of the interaction between tropical forests and local cultures. A better understanding of ecosystem dynamics also needs to be developed.

## The Vanishing Forests

The rapid disappearance of the tropical forests is unprecedented. Millions of hectares of extraordinarily complex forests are falling beneath the saw, the bulldozer, and fire (World Resources Institute 1987; Chapter 2, this volume). Despite recent advances in our understanding of tropical forest ecology and forest management, reforestation efforts are insignificant, and the area of forests under good



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management is growing very slowly. This failure of tropical forestry management is frightening because improving forest management is the only hope for saving the tropical forests, the most biologically diverse and least understood ecosystems on the Earth.

Many important species and biotypes and the communities in which they are found have been lost or are threatened. These losses are more than a simple biological tragedy because these forests play an important role in regional and planetary metabolism. They also contain many species of economic importance and thousands of as yet unstudied species with potentially important economic value. They are the major source of genes for future uses in genetic engineering.

The roots of this crisis can be found in the educational system of the developed world, which has developed a narrow vision of forestry. This narrow vision has emphasized intensive industrial production of monocultures of trees, has failed to include information on agroforestry application for trees combined with agriculture, has neglected cultural factors, and has ignored traditional management practices developed and refined over the centuries (Bainbridge 1987b).

Although agroforestry is receiving long overdue attention as a resource-efficient, environmentally positive method of resource management (Boonkird et al. 1984, Vergara and Briones 1987, Winterbottom and Hazelwood 1987), and the world's major donors have agreed to direct more funding to agroforestry (J. Brewbaker, Nitrogen Fixing Tree Association, personal communication 1989), it will take many years and a corps of skilled agroforesters to develop widespread appreciation for agroforestry. Sadly, the increasing interest and promotion of agroforestry have not been accompanied by well-funded interdisciplinary research to better understand how traditional agroforestry systems work, how to implement agroforestry development programs, or how to train agroforesters to address these complex problems.

As a result, in the short history of agroforestry, many of the mistakes of traditional international development assistance have been repeated. These include using a single species, the "magic bullet" approach; focusing on the maximum production of single products, typically for cash sale, rather than on meeting human needs; working with the wrong or a too limited group of people; and not giving adequate consideration to the local environment.

The reasons for these failures include ignorance, arrogance, and inadequate consideration of social and economic factors. These are often intimately interwoven. Institutional reform is needed to improve forest management and development (Bainbridge 1987b). In this chapter we present guidelines for designing and implementing an agroforestry development program, review the needs of a demonstration site, and suggest several steps for improving the scientific and cultural foundation of tropical forest management.

## Lessons in Tropical Forest Management from the Maya

Our approach to tropical forest management has been shaped by our work with the Maya people of Mesoamerica. Although the culturally and ecologically sophisti-

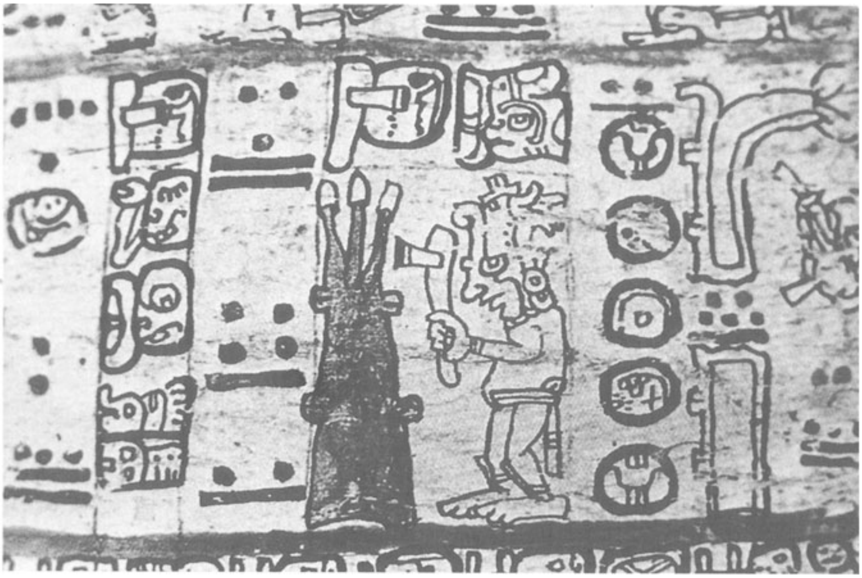

Figure 16.1. Maya maize god pruning a tree. From the *Codex Madrid,* p. 89C.

cated, complex forest management practiced by the Maya is matched in many other regions, these skilled agroforesters have provided much of our knowledge.

One of the first steps in ecological analysis is a description of the structure and diversity of the forest. This work is not yet complete in the Maya area, but the complexity of the forest is already clear, both in number of species and in temporal and spatial arrangement. One of the most striking features that has emerged from studies of lowland tropical Mexico has been the importance of human intervention and management in the development of the forests (Gómez-Pompa and Kaus 1990). We began noticing the abundance and dominance of useful trees in many of the areas studied (Flores Guido and Ucán Ek 1983, Gómez-Pompa 1987). For example, *Brosimum alicastrum,* the ramon tree, is a widespread species with multiple uses—food, fodder, and fuel—that may once have been a vital food resource (Puleston 1982). We also became aware of the regeneration process and of farmers' detailed knowledge of plants and soils and their management of trees and forests.

We know that the regions we are studying were much more densely populated in ancient times, and it has become apparent that agroforestry probably provided much of the support for these populations. A glyph of the *Codex Madrid* shows the Maya maize god pruning, not cutting, a tree (Fig. 16.1). It also became clear that the forests we see today are largely the result of human selection and management (Balee 1987, Gómez-Pompa and Kaus 1990). We have inherited the complex forests from the agroforesters of the past, but we have not inherited their knowledge and skill. The preliminary evidence suggests that the Maya may have been as active as the Kayapos of Amazonia, who selected the trees used in creating the tree islands (*apete*) of the savanna from an area larger than Western Europe (Posey 1984, personal communication 1989).

Forest management by the Maya included a number of methods and techniques, many still in use today (Gómez-Pompa 1987). These techniques are not all practiced in any one place, but all are likely to have been components of the forest management "package" of the past. They account for the presence and preponderance of useful "natural" forests in the region and the importance of these forests in Maya subsistence, even today. Maya agroforestry consisted of a series of activities of protection, cultivation, selection, and introduction of trees in their traditional agricultural fields (*milpas*), fallows, plantations, natural forests, forest gardens, living fences, sinkholes (*cenotes*), and urban centers.

One of the striking features of Maya towns is the abundance of useful trees in the forest gardens. These forest gardens, with 60 to 80 species in a family plot and a total of 100 to 200 in a village, have a great diversity of tree species (Herrera Castro 1988). Their composition, structure, and function need to be studied in a more comprehensive manner, but existing analytical tools have proved to be poorly adapted for these complex problems. Initial composition and structure surveys revealed such a large variation that a more detailed comparative study was delayed (Rico Gray et al. 1988).

The trees of the forest gardens (also called dooryard, kitchen, or orchard gardens, or in Spanish, *solares* or *huertos familiares*) provide shade, firewood, food, drink, medicine, and fodder. Although many of the most common trees are the same species that are found in the "natural" vegetation (such as *Brosimum, Manilkara, Calocarpum, Cordia, Sabal*), new plants have also been introduced, including papaya, guava, banana, lemon, orange, and other citrus trees. In the light gaps, or in the shade of the trees, a variety of other indigenous and exotic species of herbs, shrubs, vines, and epiphytes is grown (nanche, chile, roses, chayote, pineapple, orchids, coffee, corn, beans, onions, and tomatoes, among others). Wild species that become established and are now weeded out are also found in these gardens.

These forest gardens probably originated with the ancient Maya and played a very important role in the domestication or semidomestication of many plant and animal species. In these gardens, the Maya probably germinated the seeds of forest trees that would subsequently be transplanted to more distant agroforestry plots. This procedure has been observed in the current use of the *caanché* (Vargas 1983), an elevated wood trough (now more commonly old galvanized buckets or cans) filled with a mixture of organic materials and soil. The *caanché* is primarily used to grow vegetables but is also used to germinate tree seeds before transplanting. The elevated bed prevents damage by household animals, pigs, horses, chickens, and turkeys. These seedbeds may have played a very important role in the domestication of tropical plant species.

A series of small patches of tall forest (20 m tall) have been found within the dominant low deciduous forest (8 to 10 m tall) of the semiarid area of northern Yucatan. Although some authors (Lundell 1938) have identified these patches as the original climax vegetation and the rest as secondary forests, recent studies have shown that they are composed of useful trees (e.g., *Brosimum, Manilkara, Sabal*) mixed with many other species of herbs, shrubs, climbing plants, and epiphytes. Some of these patches are surrounded by old stone walls that the Mayas call *pet kot,* meaning a circular wall of stones (Gómez-Pompa et al. 1987). They say these patches were made by the old Maya to concentrate and protect useful plants. These small patches of forest are very similar in structure and floristic composition to the "natural" forests of the Maya area and may represent the missing link between the managed forest gardens and the "natural" tropical forests. Similar forest gardens have been found in *cenotes, sascaberas,* and *rejolladas* (patches of deeper soils in the karst). Within the moist, protected ecosystem of the *cenotes* and *rejolladas,* the trees may reach 30 m and may represent more closely the appearance of a mature forest in this area.

The old Maya probably also planted trees at the edges of or scattered through their agricultural fields as the farmers do today. Many of these trees were nitrogen-fixing species, and the preponderance of nitrogen-fixing trees in the Yucatan forests of today may reflect human selection and protection (Flores Guido 1987). These nitrogen fixers provide most of the nitrogen required to maintain soil fertility under intensive, high-yield cultivation.

In the process of shifting (*milpa*) cultivation, several agroforestry techniques were used. The first was the selection of useful tree species on the site chosen for cultivation. The best individuals were protected and remain standing. The species to be saved was determined by the interest, knowledge, and needs of the farmer, factors that explain the high biological diversity in fallows and in old secondary forests. When the field was abandoned to build fertility, the protected trees might have played an important role in the succession and structure of the new forest. The presence of rare species in a Maya forest may simply reflect the preference of an ancient Maya farmer. Selection probably included consideration of many factors in addition to food and wood values, including medicinal value, fodder use, bee forage, and ornamental value. Religion may also have played a role in the selection and protection of tree species, as is the case of several species of *Ceiba.*

In the slash phase of Maya *milpa* cultivation, some farmers also made a careful selection. Useful species, mainly fast-growing, secondary species, were identified and slashed to a height of approximately 50 cm (pruning/coppicing), leaving the stumps to take advantage of the fallow that occurred when the area was abandoned 2 to 3 years later. Selection criteria included the tree's contribution to the recovery of fallow soil fertility (as in the case of legume species that were protected for this purpose). Coppicing is a key factor in the successional process because, although only 10% of plants may be coppice starts, they may account for more than 50% of biomass during the recovery phase (Illsley 1984, Rico Gray et al. 1988). Individuals arising from well-rooted stumps able to survive burning were at a competitive advantage because of their access to water and nutrients in deep cracks and soil pockets. After the initial cut, part of the root system died, contributing additional nutrients to the *milpa* crops.

Although the *milpa* was planted mainly with a mixture of annual crops, principally corn, beans, and squash, some Maya farmers also intercropped perennials with the corn to create a perennial garden with a variety of trees. The first step in the establishment of the plantation was the planting of shade trees (mainly legumes) in the *milpas*. At a later date, cacao and coffee may have been planted below the mature shade trees as they have been found in the Lacandon region of Chiapas. It seems that the use of legume trees as shade trees for cacao was a pre-Hispanic practice now also used for coffee (Cardós 1959, Jiménez and Gómez-Pompa 1981). This interplanting provides many benefits and is still used today. Shaded coffee plants produce less crop per year, but shade extends their useful life over many years. This practice reduces the annual amortization cost and provides protection from the volatile international coffee market.

Another technique related to shifting cultivation was the conservation of a strip of forest along the trails and surrounding the *milpas*. This belt of vegetation is known by the Mayan name of *tolche* and probably played an important role in regeneration on the fallowed lands (G. Remmers and H. de Koyer, personal communication). These tree belts provided valued shade on the hot trails to distant fields. As Lovejoy's studies in the Amazon have shown (Lovejoy et al. 1984), these forest nets also increase the effective size of the forest and help maintain diversity. The role of these trees as wildlife corridors was probably important, and they may have played a critical role in maintaining deer, birds, and other game that provided a welcome food source to the skilled Maya hunters.

The first colonizers of the Maya area found a rich and diverse mosaic of ecosystems in which they lived and from which they derived their subsistence. They managed and used their environment for an unknown length of time, starting a selection process that has continued to the present. We believe their ecological conservation strategy was built into the management of these complex systems and that this explains why there is no evidence of mass extinctions of species in this area, despite the low "inherent" soil fertility, the high human population density, and the intensive use. The proof of this belief can be found in the richness of endemic species in the flora of the Maya area (Sosa et al. 1985), from the humid areas of the Lacandon rain forest to the drier, deciduous, tropical forest of northern Yucatan. It is important to mention the special richness of the secondary successional flora with its great many leguminous species, which may be a gift that the old Maya gave to us (Gómez-Pompa 1971).

The regeneration of the ecosystems of the Maya area after successive abandonments (the last one after the Spanish Conquest) was possible only because of the existence of seed banks in managed and protected "natural" ecosystems in the area (Gómez-Pompa et al. 1987) and because of land uses that did not cause irreparable harm to the soils.

The techniques that the Mayas used to manage their forests are not unique, and most have been found scattered in many other traditional cultures of the New and the Old World (Chuan-chun 1983, Fernándes et al. 1984, Poulsen 1985, Michon et al. 1986). This finding is not surprising because we know that efficient subsistence techniques and useful species spread very rapidly, though it is not improbable that they were discovered independently. The human presence in the tropical environment has been felt for a long time, and if we look carefully, it can be observed almost anywhere (Hynes and Chase 1982). It is likely that the structure and composition of many forests and "primary" vegetation types of the tropics were influenced or determined by the deliberate actions and selections of traditional cultures.

## Improving Tropical Forest Management

If the advantages and the potential of these complex, traditional types of forest management are so great, then why have these techniques not been more widely utilized? Several factors account for the disparity between the promise and the reality. To paraphrase Mark Twain, everyone is willing to talk about agroforestry, but nobody is willing to do something about it. Immediate reform is needed to improve forest management, to slow tropical deforestation, and to promote reforestation.

Ignorance is clearly the most serious problem. Although some agroforestry work had been done in the past (under other names), it took the International Development Research Center (IDRC) report by Bene et al. (1977) to legitimize agroforestry. The major agroforestry journals did not begin publication until the 1980s: the *International Tree Crops Journal* in 1980 and *Agroforestry Systems* in 1982. International research was given a boost by the establishment of the International Council for Research on Agroforestry (ICRAF) in 1977, but a comprehensive work program for the Council was not developed until 1982 (B. Lundgren and J.B. Raintree, personal communication).

Despite some improvement in recent years, the resources committed to agroforestry remain minuscule compared to expenditures for much simpler programs for single commodities such as rice, maize, and wheat. Many of the thousands of tree species that need to be evaluated would benefit from efforts akin to those devoted to even the minor crops. The evaluation of agroforestry systems would benefit from resources comparable to the current expenditures for rice, maize, and wheat.

The lack of funding and support for agroforestry also makes information on agroforestry very hard to get. Most of it falls within what librarians refer to as nonconventional literature, i.e., literature that is poorly distributed and indexed (Posnett and Baulkwill 1982, Posnett and Reilly 1986). A recent survey of the literature on *Acacia albida* (Bainbridge 1987a) found that only 10% of the references were readily available in the United States and that more than 50% were in the nonconventional literature. The often excellent materials from international groups such as ICRAF, the Nitrogen-Fixing Tree Association (NFTA), and the International Tree Crops Institute (ITCI) can be very hard to obtain, and the equally important publications of national research groups in other countries are often completely unavailable. The need for an international repository and lending library for agroforestry is clear, and development of an agroforestry collection at the University of California, Berkeley (Menzies et al. 1988) deserves special recognition.

The educational systems of the developed countries, particularly of the United States, which once played a dominant role in training foresters and agricultural specialists and continue to exert a strong influence on what is taught and studied, are ultimately responsible for many of these problems. In both forestry and agricultural science, the fundamental importance of ecological and cultural interactions and the effects of management decisions on people have been ignored. Instead, emphasis has been and continues to be placed on improving production of annual cash crops or single-purpose tree crops using large-scale monoculture on intensively managed lands with extensive resource inputs and little or no concern for cultural and environmental impacts. This emphasis has reflected the priorities of the national and state governments and should not be seen as an indictment of the people within these systems. The impact of this bias in the educational systems is direct and far reaching, with a generation time of faculty on the order of 30 years.

This single-minded approach has led to the use of monocultures of nonnative, single-purpose (primarily timber or fiber) tree species under the banner of social forestry or agroforestry. This approach ignores local plant materials that could provide comparable yields, already have a balanced predator/prey/symbiont community in place, and meet the requirements of the local community for a variety of products and labor (Kardell et al. 1986, Bainbridge and Felger 1989). Furthermore, this approach has led to failures and unacceptable risks in many forestry programs, for example, the *Leucaena* jumping louse, *Heteropsylla cubana* (McCauley 1986, Ford 1987).

Experience has also shown that expert recommendations in forestry are often of little value or interest to local people because they reflect the goals of the experts rather than of the local people. The experts' driving concern for single-purpose production when local people need a wide range of products has been a persistent failure in development. It is absolutely essential to talk with the local people and find out what they are doing and using and what they need (Jequier 1976, Raintree 1987, Gómez-Pompa and Jiménez Osornio 1989). The role of women is particularly important, and the full community must be involved (Fortmann and Rocheleau 1985; D.E. Rocheleau personal communication).

This failure to recognize and analyze local and even national needs from an interdisciplinary perspective has contributed to the development of distorted markets that have been the driving force behind much of the recent tropical deforestation. The shifting cultivator is often blamed for problems that are really caused by large-scale plantations and governmental development (Gómez-Pompa and Kaus 1990). Government subsidies and incentives promote conversion and lead to practices that are unsustainable and that can be catastrophic for the local culture and environment (Repetto 1987). The identification and internalization of what are now external costs, for example, environmental degradation and loss of genetic diversity, will be key elements in agroforestry development. It may be essential to restructure international debts to reduce the pressure on areas that are being exploited to service foreign debts.

The knowledge and wisdom of farmers are often ignored by experts who underestimate the value of the farmers' experience. This has been a persistent problem in agriculture and in forestry research and extension. Agroforestry systems, which fall under neither forestry nor agriculture, have been considered primitive and neglected while intensive, high-input systems with a modern and progressive image have been favored. In many cases, these high-input systems have introduced nonnative tree species that perform poorly while local people continue to use long-established (but unstudied) agroforestry systems with native trees (Michie 1986). Much of what we have learned about tropical forest management has come from our study of traditional systems of forest management.

A farmer's ability to teach has usually been downplayed by experts who view the farmer as ignorant. Yet farmer-to-farmer extension work is a major factor in the success of any transfer of *chinampa* agriculture to new areas (Gómez-Pompa and Jiménez Osornio 1989). A program to transfer Australian ley farming methods to the Mideast, although not as complex as that required for an agroforestry system, was partially successful only when Australian farmers rather than government agricultural experts were involved (Springborg 1986).

The decision-making processes of farmers have also been neglected, although Gladwin (1979, 1983) has laid the groundwork for a more careful appraisal of why farmers and foresters plant and harvest crops. The success of an agroforestry development program will require an understanding of these processes. It has often been assumed that people will accept an innovation because "it is good for them." But to be a success, a program must not only meet real needs but also fit the social and cultural setting (Leeger 1989). Community forestry programs have often failed because they neglected the cultural setting. These programs have emphasized tree planting on community land but have ignored existing users of this land and subsequent impacts on production of goods other than wood products.

## Developing and Implementing Agroforestry Systems

As we look around the world today, there are few alternatives with as much potential as developing and building on traditional tropical forestry as it is practiced by local people and their ancestors. Despite the grandiose effort of the Tropical Forest Action Plan, little progress has been made in developing and implementing new forest management systems. Developing detailed data on traditional agroforestry systems, many of which are fast disappearing, is a vital step that will take many years (J.B. Raintree, personal communication). Because forestry research takes many years or decades, capturing as much information as possible from these traditional systems is critical.

This research should involve multidisciplinary teams in which the human dimension plays a central role. The development and testing of agroforestry design methods and implementation programs must be begun even before all the desired information on tree species and traditional agroforestry systems is available. Fortunately, as we have learned in ecological studies (Odum 1971), it is possible to make advances without a complete understanding of each component of the environment. However, agroforestry development and implementation will rarely be simple, and new tools may have to be developed to consider properly the complex ecological and social factors involved (J.B. Raintree, personal communication 1987). It may prove difficult to match the ecological and cultural adaptations achieved by traditional farmers after centuries of trial and error, despite the much wider selection of plant materials and our scientific understanding of plant interactions.

The first step in agroforestry development must be a careful and detailed evaluation of the cultural and ecological setting, problems and constraints, and opportunities. This includes studies of current uses of trees and other crops, existing and past community structure, soil surveys, water, wildlife and livestock, and environmental quality considerations. The Agroforestry Research Networks of Africa (AFRENA) survey (Scherr 1987) is a useful starting point, but this should be augmented with more detailed ethnobotanical and ecological surveys.

By working with the local people, this information could then be used to develop a set of management goals and objectives. These would include economic (cash crops), subsistence (e.g., food, fodder, medicine), and environmental objectives. Planning should include long-term objectives (10, 20, 50, 100 years) and project future demands based on expected population growth.

Native species and preferable local ecotypes should be used whenever possible. To reduce risk, development should generally emphasize mixed stands rather than monocultures. Working with, rather than against, ecological succession can reduce the cost and uncertainty of establishment in challenging environments (Ewel 1986, Khoshoo 1987, Virginia and Bainbridge 1987). In traditional societies, new, nitrogen-fixing trees are of special value in agroforestry systems (Virginia 1986, Flores Guido 1987), and they will play a major role in environmental rehabilitation and restoration. Unfortunately, traditional systems that rely on nitrogen-fixing trees to maintain fertility remain little studied and poorly understood.

Agroforestry design should also include a review of the structure and needs of various institutions, so projects can proceed with minimal interference and maximum support from regulatory and administrative programs. This review must investigate not only the structure and needs of the obvious actors, such as schools and forestry departments, but also those of the market system, the commercial sector, religious groups, and the economic community (e.g., banks, lenders). Research should also include an evaluation of tax policy and possible incentives to promote long-range planning.

Careful planning and a comprehensive understanding of the cultural and ecological settings and the specific demands of candidate species are the keys to success in tropical forest management. Many lessons for improving forest management, reforesting devastated areas, and developing sustainable systems can be learned from traditional societies. One of the critical areas requiring immediate attention is the need to develop a series of demonstration sites to test this approach and to train scientists, extension workers, and farmers. One of the few programs attempting to use many elements of this approach is Daniel Janzen's effort to reforest the Guanacaste National Park in Costa Rica (Murphy 1987, Janzen 1988). Many more are needed in a wide range of tropical environments with different cultures.

## Demonstration

A successful demonstration is worth thousands of papers and proposals, and one of the priorities when applying for new funding should be the establishment of demonstration sites. There is no shortage of potential sites, but there is a lack of trained personnel and administrators, and one function of these projects must be on-the-job training.

The desired characteristics of these demonstration sites are:

- There should be a need and desire at the country or state level to stimulate forest development and rehabilitation.
- The local government and local people should be willing to work in a democratic, consensus-building manner.
- The community must have tenure or be given tenure over the trees, by ownership of either the trees and/or the land. Other legal issues should also be examined carefully to protect the participants and the environment.
- There must be long-term commitment and political will.
- The promoter–developer should live in the community as the local people live. Preference should be given to projects prepared by local people and based on traditional resource management systems.
- The early projects should be in areas with cohesive communities with common cultural and ecological factors.
- Economic development should be given careful attention, with careful evaluation of short- and long-term costs and returns. Marketing and profiting from development will be essential for widespread adoption and maintenance. Diversity in product output and benefits should be emphasized.
- Working with the project should be a stable organization—a university, foundation, institute, or private voluntary organization.
- Funds may be largely from abroad or from extracommunity sources, but funding should be determined on a local cost-matching basis. When local funds are limited, this could be labor, land, or in-kind contributions.
- Children should be included in the project from the beginning. Schools should provide on-site training to create incentives for new approaches to teaching a wide range of subjects and to ensure that the managers of the future are aware of the opportunities and problems of sustainable development.

The project should be studied from within and without, by interdisciplinary male–female teams of local students and international collaborators, to provide detailed information on what works, what does not, and why. This study should include not only the cultural factors that are usually paramount but also the detailed and practical issues of tree propagation and establishment. Although a project on a research station may provide the nucleus of a demonstration, the emphasis should be placed on farm-based plots and development. These can be encouraged by minimizing risks through cost sharing or insurance.

## Conclusions

Improved tropical forestry management cannot be imposed from above or abroad but must be developed by working with local communities and people. Research, education, and development organizations should begin working with ecologically sophisticated and sustainable traditional forest management practices. This approach will require improving the training of researchers and development specialists. The educational systems in both the developed and developing world must be revised to introduce the following: ecological (Bainbridge 1985), cultural (Chowdry 1984), and systems analysis (Bawden et al. 1984); literacy requirements for all forestry, development, and agricultural students; interdisciplinary graduate programs in agroforestry (which should include a well-financed program to encourage women to enter agroforestry programs and to facilitate their field work); and an international program to develop, as rapidly as possible, a comprehensive census of the world's useful trees and existing and extinct agroforestry systems. New incentives must also be found for research that involves both basic and applied or management considerations and for facilitating farmer-to-farmer exchanges and farmer-managed research.

If this approach is followed, we are confident that the needs of the tropical forests and the people can be met. By providing security and an adequate standard of living, these practices can also reduce the pressure of population growth on tropical forests.

This approach to reforestation can, if carried out on the large scale required, provide conservation of the biological, ecological, and cultural diversity of the tropical forests; improved quality of life in the rural, often impoverished, areas of the tropics; increased output of forest products for a variety of uses, both locally and internationally; and a carbon sink to help balance the global carbon cycle and reduce $CO_2$ buildup in the atmosphere.

This approach is not a substitute for plantation forestry or natural forest management in unpopulated areas, but it is equally important. This people-centered approach to tropical forestry offers the best hope for improving tropical forest management, promoting reforestation, and improving people's living conditions.

If we do not follow this approach, we will continue to lose forests, encourage the continued "mining" of tropical forests and contribute to further poverty and hardship. It is folly to continue to ignore the skills and knowledge of the local people who have in many cases managed the forests in a sustainable manner for hundreds, if not thousands, of years. If we fail to adopt this biocultural approach, we will also continue to devote great effort, with little success, to protecting areas of the forest from people when, with a broader vision, we could protect the environment and meet the needs of the people. As Janzen (1988) notes, "Restriction of conservation to the few remaining relatively intact habitat patches automatically excludes more than 90% of tropical humanity from its direct benefits; restoration is most needed where the people live."

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