Let there be forest

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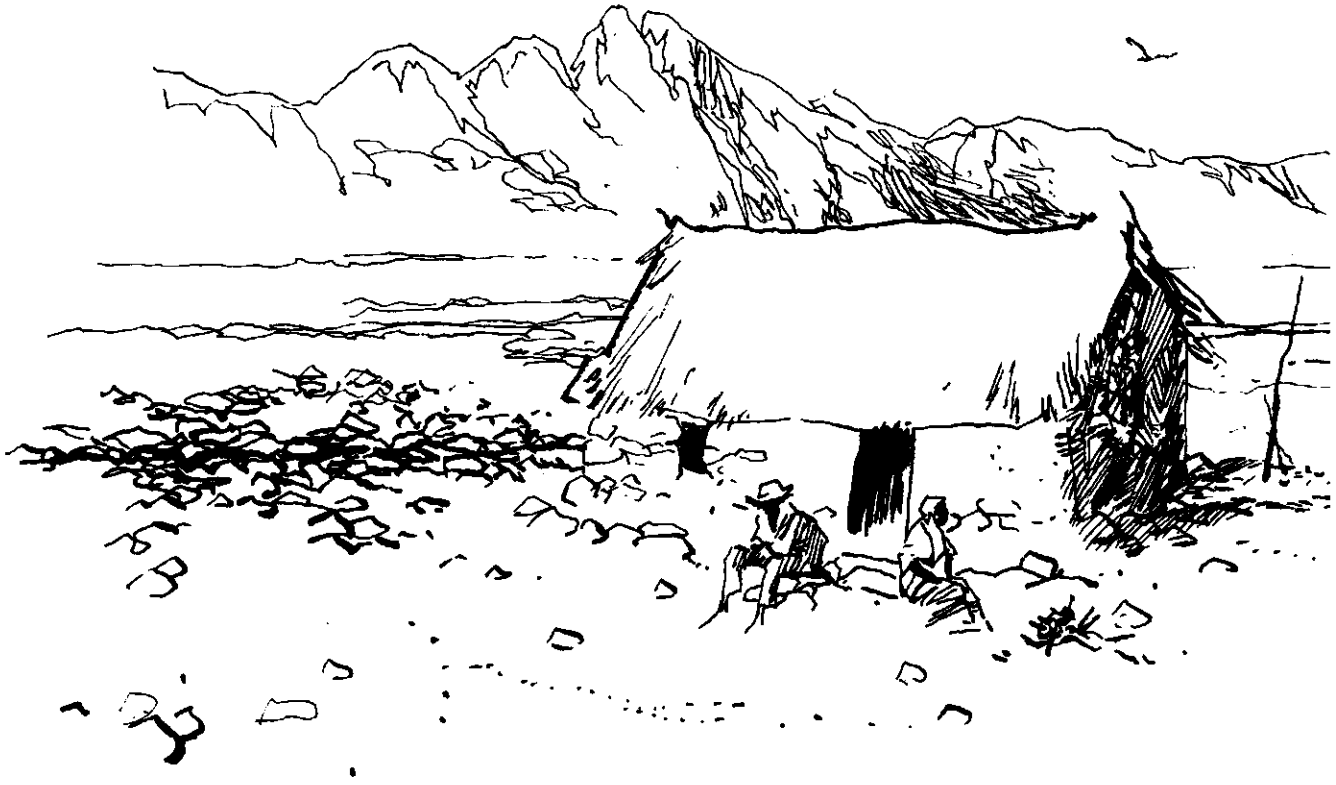
Foreword

For a long time, even in the Western world, forestry has often been neglected in planning for rural development. Forestry has remained in the shadow of agriculture, food being considered far more important than wood. It is only during the past few years that we have truly begun to see and appreciate the fundamental role forests and trees play in the production capacity of the world. It seems as if only now we are learning that uncontrolled deforestation leads to deterioration of the land, and that this in turn leads to decreasing agricultural production, scarcity of food and energy, and unemployment. The resulting crisis has become so acute that we now realize that we can only effectively arrest or counter-balance deforestation if massive action is undertaken to 'regreen' the earth, an action in which dedicated experts from all over the world must cooperate with government officials, voluntary organizations and millions of local farmers. To make this possible, various international organizations launched the Tropical Forestry Action Programme in 1985. This programme provides the framework for international cooperation aimed at considerably increasing forestry development activities. It calls not only for a doubling of the present aid flow, but also for the raising of awareness about the need for increased rates of afforestation to restore the productive capacity of the land and to protect remaining forests from destruction.
This book, which summarizes the outcome of an important international symposium on afforestation organized by the Wageningen Agricultural University in the Netherlands, aims to make it clear that forestry is a sine qua non for rural development.

the Netherlands Minister of Agriculture and Fisheries,
G.J.M. Braks



Chapter 1 Let there be forest: now and forever

The world forests are shrinking

The forests of the world are shrinking. In several industrialized nations they are slowly being cleared for agriculture and urbanization. In many tropical nations, the same processes are taking place with frightening rapidity. At the same time, many forests are being degraded through overuse.

The consequences of this shrinkage, if it is not reversed, are dreadful to contemplate. Shortages of basic forest products, particularly fuel wood, are already worrisome in many places, and ecological damage caused by a lack of sufficient forests is occurring now. These problems will intensify if the shrinkage of forests is not halted.

The solution for these problems is obvious. We must have more and better forests. How can that be done? By using the forests that now exist in a manner that conserves them for future generations. By replacing forests where they recently grew (reforestation). By establishing forests where they have long been missing (afforestation). This work, hereafter called forestation, is needed on all suitable land that is not needed for non-forest purposes. Furthermore, these efforts must be on a huge scale. The alternatives are ecological disaster and shortages of forest products that many people need for survival.

The point of no return

In 1969, U Thant, Secretary-General of the United Nations, argued for a worldwide partnership to manage the population explosion and improve the environment. He warned that without such a partnership the problems might reach such dimensions that they could not be managed.

More than 10 years have passed, and the effective actions he called for have not been taken. The problems associated with shrinking forests are approaching the point of no return – the point at which a solution is no longer possible.

Compared with other resources, the forest is a curious one. On the one hand, it is a source of many important raw materials – timber and fiber, resin, oils, medicines, fruits, and rattan to name a few. On the other hand, the same forest provides important forms of environmental protection – soil stabilization, soil improvement, and cleansing of water and air are some examples. The conflict between these two primary functions is obvious. Exploiting the forest can and often does reach such proportions that it can no longer perform its environmental functions.

Millions of people depend on the forest for their daily lives. They must burn wood for warmth and cooking and use timber to build their dwellings. But they also must eat, and this last need must take precedence over the others. The needs of these people for food, fuel, and fiber have grown in proportion to increases in population. Due to the lack of development in most tropical countries, improvements in systems for

Main reasons for deforestation and forest degradation

- Replacement by agricultural land-use, often unstable
- Destruction by fire
- Overgrazing by livestock
- Inadequate and ill-controlled forest exploitation
- Overcutting for fuel wood
- Atmospheric pollution in industrial countries

production of food, fuel, and fiber have not kept pace with increases in population. The result has been a steady increase in forest exploitation. Looking into the future, it seems that these individuals have little choice but to continue this exploitation, even to the last tree.
In the early 1980s, some 112 million people were suffering from a serious lack of fuel wood. Without effective new systems for planting trees and managing forests, this number can only grow, and grow very rapidly.

More than 125 million hectares of new forest

It has been estimated that some 48 million hectares of additional forest are needed simply to supply present fuel wood deficits. The area of additional forest needed to supply fuel wood needs projected for the year 2000 is estimated at 105 million hectares. Needs for new forest to supply industrial wood demands in the year 2000 are a more modest 20 to 40 million hectares.
Fortunately, land is available for the planting of these new forests. In tropical countries there is vast potential estimated at around 2000 million hectares for establishment of forest plantations.
The majority of this land is arid, and establishment of a tree cover on such land can be extremely difficult. In many such places, the forests that can be established may not be highly productive. The point is, however, that an adequate amount of land is available.
An important characteristic of forests is that they take several to many years to develop. The forests that are being harvested

Estimated areas needed to be reforested

Area needed to cover deficits in wood production	
Present fuel wood deficits	48 million hectares
Fuel wood deficit in the year 2000	105 million hectares
Industrial wood deficit in year 2000	20-40 million hectares
Potential for forestation in tropical countries	
Desertified arid and semi-arid lands	1556 million hectares
Deforested watersheds	87 million hectares
Logged forests	156 million hectares
Forest fallows	181 million hectares

now were established in the past. Where today's forests are insufficient to meet people's needs, the fault is to be found in the past, when the forestation and forest protection efforts were insufficient. Similarly, if future generations are forest poor, they will have our generation to blame.
A rough indicator of the adequacy of forestation efforts is the change in forest area. If we are losing forest area, there is likely to be trouble ahead. In fact, such losses are taking place, particularly in tropical countries. The world is presently losing about 7.3 million hectares of moist tropical forest each year. It is also losing 3.8 million hectares of semi-arid forest each year. Meanwhile, only about 1.1 million hectares a year are being reforested in tropical areas.

In Africa 29 hectares are deforested for every 1 hectare planted

If the goal is to keep forest area constant, one would like to see forest establishment approximately equal to deforestation. In fact, however, the ratios of plantation establishment to deforestation are nowhere near 1:1 in many parts of the world. In Africa, the ratio is a shocking 1:29. That is, for every 29 hectares of deforestation, only 1 hectare of forest plantation is established. In tropical America, the ratio is 1:10.5, and in tropical Asia it is 1:4.5.
In much of the industrialized, temperate world, the ratio approaches 1:1. One reason for this balance, however, is the heavy dependence many industrialized countries place on forest products imports from tropical countries. In other such

nations that do supply their needs from their own forests, use of forest products is increasing rapidly. Without major improvements in forest management and reforestation in these countries, they too will become importers of forest products before the year 2000.

Overall changes in forest acreage do not reveal some other trends that are quite disturbing. One is an apparent increase in damage to existing forests. In industrial countries, there are reports of severe damage from air pollution. In addition, many areas of forest are damaged each year by overgrazing, by poor logging methods, and by excessive harvesting. Unprotected forests are often damaged by fire, insects, and diseases. Furthermore, it must be recognized that forest land varies

widely in its productivity. It cannot be assumed that one forest hectare is about the same as another. It is normal to clear the most productive forest land for agriculture, and it is normal to reestablish forests on the least productive agricultural land. In exchanges of equal areas of land between agriculture and forestry, therefore, forestry is normally the loser.
To counter these disturbing trends in the world's forests, care of forests that still exist must be improved. In addition, however, there is a need for forestation on an unprecedented scale. Such forestation efforts must include establishment of tree plantations on recently deforested land and on land that has never supported trees or has not done so for a long time.

Annual planting must increase five-fold

At present, less than 5 percent of the world's forests – some 99 million hectares – are in forest plantations. A 1975 compilation indicated the following distribution of these plantations and the following annual planting rates:

Type and location of country	Total planted area (million hectares)	Yearly planted area (million hectares)
Developed		
North America	11.0	0.9
Western Europe	12.7	0.4
Oceania	1.7	0.1
Others	10.5	0.2
Total	35.9	1.6
Centrally planned		
Europe and USSR	23.6	1.6
Asia	28.0	4.5
Total	51.6	6.1
Developing		
Africa	1.4	0.1
Asia	6.4	1.2
Latin America	3.7	0.2
Total	11.5	1.5
All nations	99.0	9.2

Plantation forestry in Nigeria

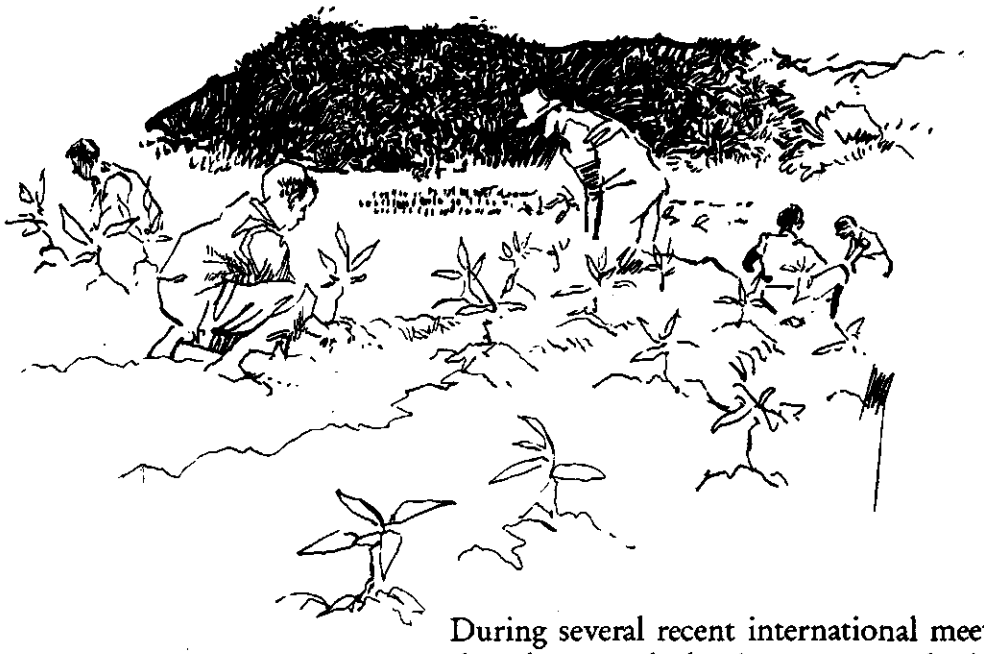
In the West African country of Nigeria, most of the remaining timber-producing forests are situated in the south. Closed forests that can produce valuable timber are found only there. In the rest of the country, savanna forests predominate, which are less productive and have often been degraded by fire or agricultural exploitation.

Recent studies have indicated that there is a growing deficit in wood production in Nigeria. The difference between the supply of round wood from the existing forests, which can be sustained, and the forecast demand is expected to increase from 1.4 million cubic metres in 1975 to 5.4 million cubic metres in 1985 and even 15.6 million cubic metres in 1995. These deficits are due to the rapid increase in demand as a result of economic development and population increase. But the production of the limited area of natural moist forest reserves cannot be increased much beyond the present capacity of 1.5 m^3 per hectare per year. Man-made plantations of fast-growing tree species could give much higher yields of 10-30 m^3 per hectare per year.

To improve the future situation of wood supply and to prevent the forecast deficits, the Nigerian Government is now actively stimulating the establishment of large-scale plantations. Up to 1977, there were only around 130000 ha of forest plantations in the country. But during the period 1981-1985, it was planned to establish an area of 90000 ha annually. These plantations will consist of several fast-growing species, such as teak (Tectona grandis) grown for timber, yemane (Gmelina arborea) which is used as a source for pulpwood, Eucalyptus species and the local species Acacia nilotica.

In addition to this program for large-scale industrial plantation development, additional programs have been planned for the establishment of plantations for non-industrial purposes. A program on the production of non-wood products is aimed at the establishment of plantations to provide gum arabic (a base for confectionaries) from the tree Acacia senegal, shea butter (from the tree Butyrospermum paradoxum), tannin, fodder or fruits. The environmental forestry program includes the planting of shelterbelts and windbreaks to arrest desertification and the establishment of plantations for erosion control and watershed protection.

This national forestation development plan demonstrates how government plans to stimulate plantation forestry should span the entire range of activities from the establishment of production forests for efficient satisfaction of national timber demands to the planting of protective plantations for environmental control and local plantations for non-industrial uses.



During several recent international meetings it has been urged that the annual planting rate must be increased at least five-fold. Such a goal implies a bold, worldwide program that mobilizes extensive human and technical resources. The target will be reached if human institutions are capable of responding to obvious human needs. To do so will require the active involvement of local people, foresters, governmental agencies, and volunteer organizations alike. There is plenty of work for people and organizations of all types.

Idealistic pronouncements are easy to make and difficult to implement. Implementation is going to be complex, and it will require innovative approaches. This publication describes various activities that can be undertaken.

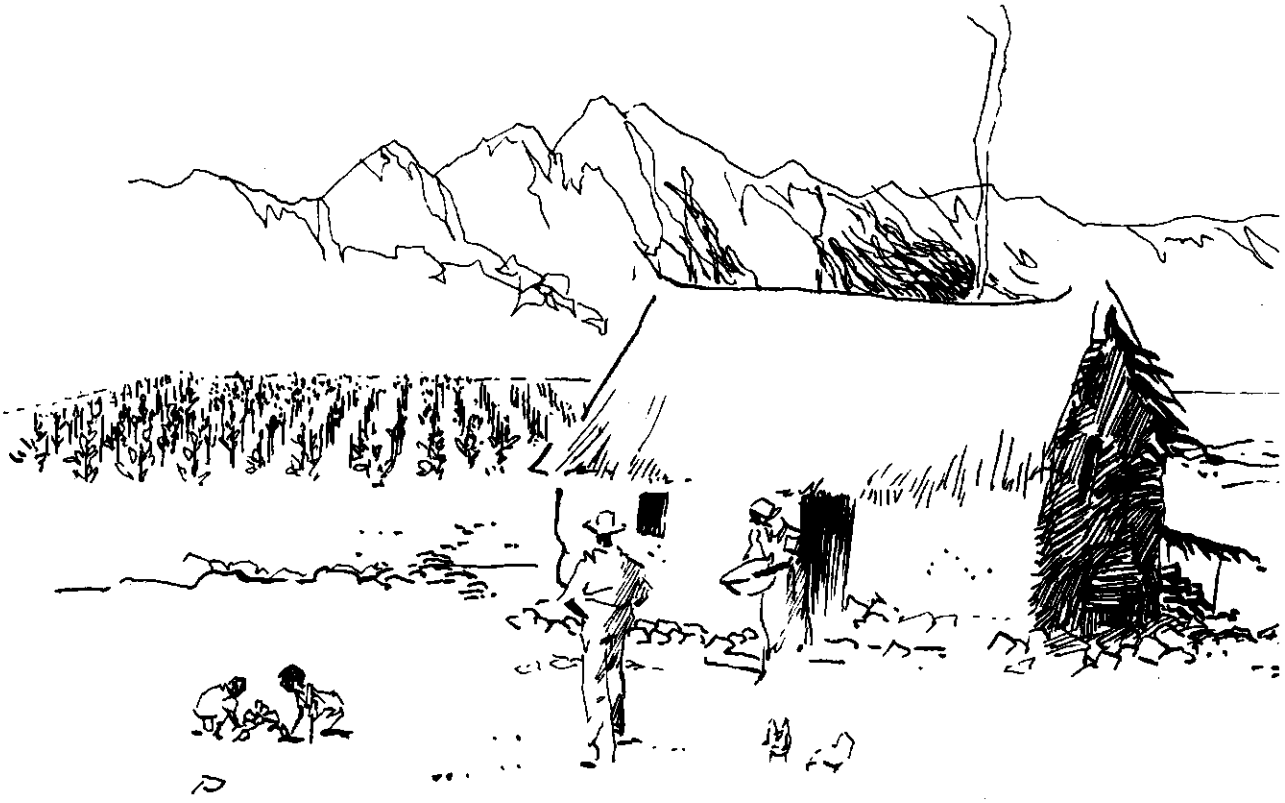
Present areas and changes in natural forests and plantations in tropical countries (1 000 ha)

	Area of natural forest	Annual rate of deforestation	Total area of plantations	Annual rate of plantation establishment
Tropical America	895652	5611	4620	535
Tropical Africa	703079	3676	1780	126
Tropical Asia	336458	2016	5111	438

Some of the actions that will be needed may be thought to be obvious, but failures in past programs indicate the need for adjustments in traditional reforestation practices. The potential of some other approaches has only recently been recognized by land use planners and other government officials. The opportunities for wider application of these new approaches are obvious.

The purpose of this book is to indicate that there are many options for increasing the rate of tree establishment inside and outside of what we now think of as forests. The conclusion that the degradation of the world's forests can be reversed is more than an affirmation of faith in man's future. It is a professional judgement. The effects of deforestation are so devastating to human and natural environments that we cannot fail in this task.

Let there be forest – now and forever



Chapter 2

Tree planting as a solution to local problems

More than 7.5 million hectares new tropical plantations needed each year

A global analysis of forest resource needs indicates that current forestation rates in tropical countries should be increased five-fold. Stated in another way, there is a demonstrated need to successfully establish some 7.5 million hectares of forest plantation each year to meet human demands for the products of forests. The size of the task is appreciated by knowing that in 1975 there were only 11.5 million hectares of such plantations existing in the tropics. Clearly, the planting of 7.5 million hectares in a single year would be quite an achievement, but more than that is needed. The goal must be reached every year, and when droughts and other agents intervene, the losses must be made good in succeeding years. In several countries in temperate regions too, it is necessary to increase the rate of forestation.

How can such a goal be reached? One step at a time – or in this case one tree at a time – by individuals who are pursuing their own interests. Forestation in its various forms must be viewed as the solution to a host of local problems rather than as the single solution to a global problem. Only in this way can it take on the many forms that will be required to generate local commitment of land, labor, and capital.

Even if he could establish 7 million hectares of plantation a year, no one man could solve the world's forestation problems. Some people would refuse to let this man apply his skills on their land. Others might accept his gift but fail to protect it. Still others would take the trees for firewood or Christmas trees long before they had reached their full potential.

Managers of national and international forestry agencies have learned these lessons to their regret. They have learned that successful forestation requires the support of the people who control the land. A tree planting program succeeds only when

those who control the land see forestation as an asset – a satisfactory solution to a local problem.
As solutions to local problems, forests have a great deal to offer. Their benefits may be placed into several classes: wood products (including fuel), environmental improvements, food for humans and useful animals, and other products.

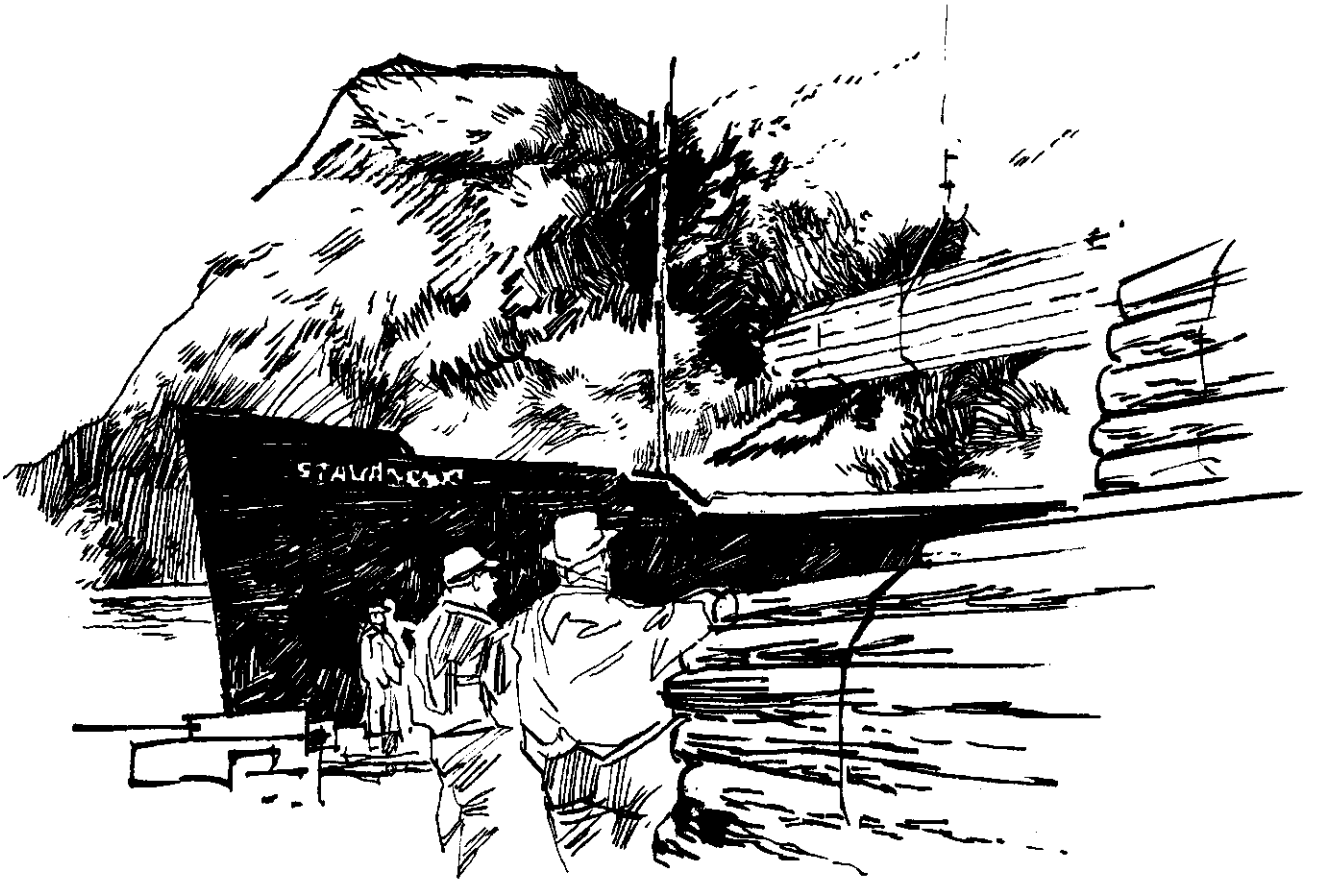
Plantations to avoid overexploitation of natural forests

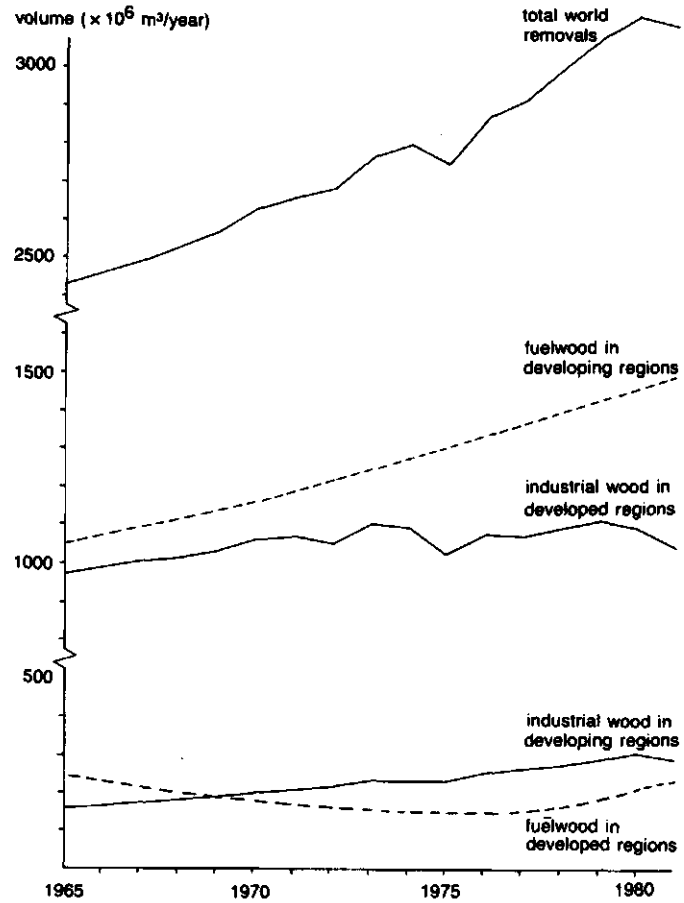
It should be recognized at the outset that plantations are not exact substitutes for natural forests in supplying these benefits. Forest plantations typically contain a single tree species or at most a limited number of species. Natural forests contain a few to very many tree species. In natural tropical rainforests, more than a hundred tree species may be found in a surprisingly small area. Because of the lack of species diversity, plantations of single species cannot offer the wide variety of organisms and products found in natural forests. Neither can they provide the same quality of environmental protection or the same quality of experience to the human visitor.
In recent years, forest scientists have been exploring the mysteries of natural forest ecosystems. They are beginning to understand the complex interactions among the various species in a forest. This knowledge is helping them to create more complex, and therefore more stable, ecosystems in plantations. These new mixed species plantings can be expected to produce many of the benefits once associated only with natural stands.
Even single-species plantations offer certain advantages to their owners. They offer the opportunity to concentrate the bounty of the land into the production of a single product of more or less uniform quality. This characteristic is particularly attractive to forest products manufacturers, but its advantages are by no means confined to industrial corporations. Much of the world needs firewood, and plantations can produce it very efficiently. If it is the only product that is desired, plantations can produce firewood far more efficiently than natural forests. Furthermore, productive plantations can take pressures off natural stands. If enough plantations are established, it may be possible to avoid over-exploitation of natural forests so that they can be managed in ways that will preserve them and

their diversity.
Thus, the achievement of forestation goals does not imply a decrease in the area of natural forests. Many people are dedicated to the maintenance of diversity in forest ecosystems. It is hoped that they will see forestation efforts as a contribution, and that they will help rather than hinder these efforts.

Trees for fuel and industry

Worldwide, fuel is the most important use of wood, and this use is increasing. In developing countries, burning of wood for fuel is increasing approximately in proportion to population growth where supplies are available. In industrialized nations





Historic growth in wood consumption. Note how fuel wood is most important in developing countries and in developed regions the use of industrial wood.

like the United States, consumption of wood for home heating all declined steadily through the 1960s because fossil fuels were readily available and convenient to use. Increases in the price of fossil fuels have caused a return to wood for home heating. This use was not expected a few years ago, and no one knows how much wood fuel developed countries may use in the distant future.

Demands in tropical countries are worrisome enough. The Food and Agricultural Organization of the United Nations estimates that there will be a deficit of fuel wood stands of 105 million hectares by the year 2000. It further estimates a

smaller, but important, deficit of 20 to 40 million hectares in industrial wood stands by that time.

Consider the implications of these numbers! They suggest that if effective action is not taken by the year 2000 people will have to clear 125 to 145 million hectares of forest each year to supply their basic needs for fuel and industrial wood. And what happens when the forest runs out? Then there is no wood for basic needs.

That is not precisely what would happen, of course. Long before the world was cleared of all its forests, consumption patterns would change. Effects on individuals would depend upon their location and their economic and social status.

We can get some idea of the effects by examining things that are already happening in some countries that now have severe fuel wood shortages. There is a decline in the standard of living. In the countries where these shortages are occurring, some of the people are already living at the subsistence level. Their nutrition suffers. Local people who cannot get wood to burn, often use animal dung and crop residues that were once used to improve the soil. In the long run, these practices reduce production of food, which is already in short supply. Others find that their diet is less nutritious when it is not properly cooked. People with greater economic status find that they must pay more for fuel, which means that they have less to spend for other things.

World consumption of forest products (1980)

	Fuel wood	Industrial wood
Total consumption (10^6 m^3)		
World	1718.0	1705.8
Developed regions	233.2	1361.8
Developing regions	1484.8	344.0
Consumption per person (dm^3)		
World	370	329
Developed regions	141	1098
Developing regions	452	79

Insufficient supplies of industrial wood also have serious implications. Worldwide, wood is the most common material for home construction, and shortages imply a decline in quality of housing. Furthermore, paper is basic to modern communication and wood fiber products contribute much to the standard of living of the developed world.
Thus, if fuel wood is necessary for the survival of many people in the rural development stage, industrial wood is necessary for the development of modern economies. These are tangible benefits of the wood from forests.

Trees for environmental improvement

Trees do much more than provide wood products to a landowner. Because of their size and longevity groups of trees strongly influence their environment. Tree roots penetrate deep into the soil, using water and nutrients that are not available to other plants. When a tree drops its leaves or dies, the nutrients are deposited on the soil surface, increasing its fertility. Leguminous tree species also fix atmospheric nitrogen with their root bacteria, further increasing soil fertility.
For centuries, human agriculture in the tropics has relied upon the improvements in soil fertility accomplished by trees. Farmers have cleared small fields in the forest and grown crops on them for a few years, taking advantage of the fertile soil. When the nutrients were exhausted, as indicated by declining crop yields, the farmers moved on and cleared another field.

The old one returned naturally to forest, and its soil nutrients were replenished by the tree cover.

As populations have increased in such areas, the need for farmland has increased and the length of the forested portion of the cycle has been reduced. In some places, continuous crop production has been attempted, but without heavy fertilizer application these attempts have been unsuccessful.

Trees reduce water erosion of the soil in two ways. First, their roots anchor the soil and loosen it so that water can pass downward. Second, forest litter forms a protective layer over the soil, reducing the impact of raindrops, absorbing water, and impeding flow across the soil.

Effects of trees on water supplies are not all positive. Trees reduce flows from the land during storms, decreasing flooding. On the other hand, it should be recognized that a tree cover uses more water for transpiration than other types of vegetation.

Because a tree cover reduces movement of soil, the water flowing from a forested area is cleaner than that flowing from areas covered by other types of vegetation. Trees also break windspeed and prevent wind erosion. They play a major role in the fight against desertification. Trees are also credited with removing some pollutants from the air. They are efficient at removing carbon dioxide from the air and returning oxygen to it.

Trees are often used to rehabilitate degraded land in desertified, severely disturbed, or badly eroded areas. Any landowner can appreciate these values, if he can afford to take advantage of them. It is too often assumed that poor farmers know and care little about environmental protection. It is probably more accurate to assume that they want to protect their land if they can afford to do so. Their land and their children are often their only major long-term assets, which they understand very well.

Trees for food, fodder and other uses

A reason often given for not planting trees is that the land in question is required for production of food. In fact, however, trees are highly efficient producers of food in many situations.

Bananas, apples, cherries, coffee, citrus, cacao, mangoes, and nuts of many species are but a few examples of important, commercially produced human foods that grow on trees. In many situations, trees can be the most efficient food producers on a particular piece of land.

The fruit and leaves of trees and the plants that grow on the floor of the forest are also food sources for animals that man eats. In Java, villagers have profited by growing a leguminous shrub, Calliandra calothyrsus, and harvesting the leaves to feed to livestock. Later, the trees are harvested for fuel wood. Forested range is quite common around the world, because the combination of trees and grassland is somehow more attractive to the landowner than range or forest alone. Oils, gums, and medicinal preparations are forest products of considerable importance in some areas. In Korea, plantations are sources of mushrooms and resins as well as wood. In the Sudan, landowners grow Acacia senegal with the primary purpose of obtaining gum arabic.

Taken together, these forest products in addition to wood hold great promise for stimulating forestation. First, they offer opportunities to grow wood and food on the same land. Second, they reduce the delay between the time trees are planted and the time some tangible product is obtained from them.
The importance of rapid returns from forestation cannot be overemphasized. Forestation is difficult and expensive, and the long delay between that effort and the realization of important benefits is a major reason for not planting trees. To many, it appears that efforts other than forestation will yield benefits sooner.

Benefits from various types of forest plantations

The key to successful forestation efforts is in producing a combination of benefits that is more attractive than any other land use.
The promise of profit from the sale of commercial crops of wood is often sufficient to encourage a landowner to plant trees. This goal was the primary reason for the establishment of the majority of forest plantations that exist today. Commercial fuel wood plantations also offer considerable promise. They are not common today, but increases in prices for fuel wood could improve their financial prospects. Such commercial wood plantations are often established by private enterprises.
For local farmers, such commercial benefits are often less important than the benefits from integration of tree growing with agriculture. For instance in Latin America, the pejibaya palm (Bactris gasipaes) is frequently planted. The immediate goal is edible fruit and oil. When the trees mature, their wood is harvested for lumber. Farmers there also plant Cordia trees to shade coffee, cacao, or plantains. When the Cordia mature, they provide excellent lumber. Such combinations of benefits are likely to be crucial in persuading relatively poor landowners that tree planting is in their interest.
Pure forest plantations are often not the most beneficial use of land. Often, as in China, only small pieces of land are available for trees. Trees form living fences at the edges of fields. They are found along roads and on field borders. They pro-

vide shade around houses. Such plantings, multiplied by thousands, can be important sources of forest products for a nation.

In other situations, tree planting is advantageous but is not feasible for the small farmer. In such cases, communal and village wood lots may be practical. They offer the efficiencies of a larger scale in establishment, maintenance, and protection. Furthermore, their greater size may make distribution of commercial products more practical. In South Korea, more than 20000 village forest cooperatives have been established with government support. The village wood lots or forest cooperatives are not without problems, of course. Agreement must be reached on the appropriate distribution of products. There may be fears that only a few selected people will take away the fruits of local labor. Furthermore, if forests are established on communal lands, consideration must be given to the land use that is lost. Often the land in question may now be in common grazing, and a substitute may have to be found.

Often, there is no substitute for government establishment and management of forest plantings. This will usually be the case where the profits from forestation are very distant or doubtful. Government support also is usually needed where the primary benefit of forestation is land rehabilitation or flood prevention.

Thus, no single approach to forestation is advocated here. National forests are valuable. So are the large commercial plantations established by wealthy landowners and forest industry. Village plantings and the individual trees people plant around their homes and fields have a place. Many trees will have to be planted one at a time for many reasons if mankind's needs for forests are to be satisfied.

Forest development on Java, Indonesia

The very high population density on the Indonesian island of Java causes a heavy population pressure on forest land. About 30 million people live in villages surrounding the still remaining forests, which have essential productive and protective roles. About three quarters of the people are small farmers and farm labourers; about half of their family labor is underemployed. Understandably, these people crave for land and forest products such as fuel wood or fodder for their livestock. Forest management was not adjusted to cope with these demands and as a result around 250000 hectares of forests have been depleted. Essential protection forests have been damaged.

The Government's forestry policy aims at increasing the production of essential forest products and at contributing to rural community development and the generation of employment. A large variety of projects have been initiated, which combine reforestation of depleted forest areas with community-oriented activities such as the cultivation of fodder, food crops and medicinal plants or the stimulation of bee-keeping near forests and the introduction of fish-breeding in newly-constructed small reservoirs.

An example of such a combined approach is the program for intensification of agricultural intercropping in young plantations. Since the 19th Century, local farmers have been allowed to cultivate selected crops in newly established teak plantations. Such intercropping could last for two years and the farmers had then to tend the plantation for another three years. This system allows farmers to obtain food crops from forest lands. But also the Forest Service profits from the system, because it does not need to pay the full costs of terrain preparation and of tending the plantation. Since 1972, the Forest Service has been trying to intensify this system and to make it more profitable for the farmers. These intensification efforts are based on the use of high-yielding crop varieties, chemical fertilizers, pest control and better adapted management practices. With these means, the agricultural yields may increase considerably, e.g. dryland rice production may increase from about 700 kg/ha to 2000-3000 kg/ha. Such intensification has proved to be financially attractive to the farmers. To stimulate the adoption of the new techniques, the Forest Service is now providing technical assistance to the farmers. The farmers can obtain credit and subsidies from the Forest Service to buy seed and fertilizer. The farmers need only repay 70% of this credit, because tree growth is also stimulated by the more intensive management practices.

The application of these intensified intercropping techniques is spreading rapidly. The program demonstrates a possible way to combine the intensification of forestry and agriculture at the same time. It also serves as an example of a possible approach to integrate reforestation with other activities aimed at improving the livelihood of local farmers.

Chapter 3 *Tree planting as a national endeavour*

Populations growing faster than trees

Forestation programs must operate on both a small and a large scale. At the local level, trees must be planted by landowners, land managers, and laborers who are pursuing their own interest as they see them. These activities, however, require planning and coordination at a higher level for major forest tracts, nations, and groups of nations.

Planning and coordination are dictated by the nature of forests and the uses men make of them. Because there is a long delay between forest establishment and forest harvest, free-market signals often cannot be relied upon to stimulate production for future needs. In areas where fuel wood supplies are running low, for example, there is ample evidence that fuel wood prices did not rise soon enough or fast enough to encourage landowners and land managers to plant fuel wood plantations. Tradition and the distribution of wealth, of course, had a great deal to do with this failure. The impacts of rural change have snuck up on all of us, but most of all on those living in countries of the tropics with rapidly expanding populations. Traditionally, people in these countries have had ample supplies of wood for their needs. In fact, they have viewed forests more as a barrier to agriculture than as a source of valuable products. They have always gone to the forest for what it gave them, and never before have they been disappointed. Wood has been available to them essentially for the cost of the labor expended in gathering it. Who can blame these people for resisting the notion that forest products have a price? Their entire history has taught them that forest products are obtained through labor alone.

In these countries, the distribution of wealth has also been an important factor controlling wood prices. Many of the people who most need wood for fuel or construction have no money to pay for it. Their limited supplies of cash must be spent on the commercial goods needed for survival. They cannot afford

to spend money on a product that they have always obtained free.
Since free-market signals cannot be relied upon, economists and foresters have developed sophisticated techniques for ensuring that vital demands for forest goods and services are met. Economists are adept at examining historic changes and projecting future demands. Professional foresters know how to predict the amounts of various products that can be removed from a large area of forest *on a continuing basis.*

How to achieve a sustained yield

The notion of continual removal of no more than a forest is capable of producing is vital to long-term forest planning. The forester's term for this concept is 'sustained yield'. Forest production is a biological process, and, although they may not be precisely known, there are obviously limits to the speed of this process. To achieve a sustained yield, foresters compute 'allowable cuts' – the quantities of wood that can be taken from a forest area year after year without depleting its ability to produce wood.
Like much of forest planning, these concepts are designed for application over very large areas. An individual landowner

may or may not decide, when he plants trees, that they will be harvested in equal annual amounts in perpetuity. This approach makes sense if he is producing industrial wood and has a large amount of land or if he is producing fuel wood for his own consumption. More often, however, the individual landowner has only a few 'stands' – groups of trees of similar age and condition. A stand is harvested when it seems convenient to do so, and many years may pass before another stand is harvested.

The individual landowner fits into the scheme of sustained yield by reestablishing a stand of trees when the existing stand is cut. He is usually unaware of the concept of allowable cut

Main objectives for various types of forest plantations

	Main objective for planting
National forests	Combination of multiple benefits for both local people and regional interests – sustained production of forest products for rural and urban people – sustained environmental protection – in more developed countries also tourism and recreation.
Large-scale private forest enterprises	Optimum economic returns – maximum production of wood and other commercial tree products – production of wood and other tree products for processing in own factories.
Community forest	Combination of multiple benefits especially for local people – sustained production of forest products especially for indigenous use, sometimes also for commercial use – economic use of (marginal) communal lands or cooperative management of small private landholdings.
Farmer's forest	Often subsistence production of tree products for home consumption or as agricultural resource by integration of tree growing with agriculture. Intermittent production of commercial tree crops as a means to obtain increased income or a financial reserve.

because it does not apply to his situation. As a result, a region or nation's forests can be harvested at a rate that exceeds the allowable cut without landowners realizing that anything is amiss.

The situation is somewhat similar with respect to wood supplies and demands. Economic projections of demand and foresters' projections of supply leave little doubt that the world's forests are in trouble, or that fuel wood is the product in shortest supply. About 90 percent of fuel wood consumption takes place in developing regions of the world, where some 74 percent of the earth's population resides. Landowners there may have noticed that there is occasionally a profitable market for fuel wood where none existed before. If anything, such a market is an interesting opportunity for a landowner rather than a problem.

The problem is recognized by the people who need wood and cannot buy it and by the planner, who has a regional or national perspective. Planners know that the hopes for development of the people in developing countries may be dashed by inadequate wood supplies. With economic development, demands of such people for fuel wood could decline, but the savings would be more than offset by increased demands for industrial wood products like lumber, paper, and furniture. These products are probably an inseparable part of development.

A nation's forests may be viewed as an interest-bearing savings account. In this picture, the allowable cut is the interest. It may be taken and spent, because it continues to accumulate. When amounts in addition to interest are taken, the principal in the account is reduced and prospects for future income are dimmed. Throughout the world, men are spending their forest principal.

The productive role of plantations

We must seek ways to increase the amount of principal in the world's forest account, and the plantation is the most promising way of doing so. Sowing trees, or planting of tree seedlings or cuttings is the fastest and most reliable way of establishing a forest where none now exists. The only obvious alternative

Tropical countries with major areas of reforestation

	Estimated area of plantations (1000 ha)
Brazil	3850
India	3800
Indonesia	1400
Philippines	318
Madagascar	270
Thailand	247
Mexico	195
Sudan	180
Nigeria	170
Angola	160
Kenya	156
Bangladesh	153

is to allow areas to be reforested by natural means. Natural reforestation can be rapid in some places, but in others it is very slow indeed.

Fortunately, forest plantations offer additional advantages. Plantings of the right species in the right places are capable of producing useful wood far faster than natural forests. Use of fast-growing, high-yielding species often permits 15- to 20-fold increases in yields of target products. These products tend to be of uniform quality, and they are concentrated in a small area. These advantages translate into increased profits for the landowner, who is able to sell all or most of the wood from a harvested stand to a single buyer.

At present, most forest plantations are concentrated in industrialized countries. Here, governments and private corporations have seen enormous advantages to plantations as suppliers of industrial wood. Comparable plantings for the production of

fuel wood and other locally needed tree products are relatively rare, but offer good promise for development.

Only 10 percent of the world's forest plantations are in tropical regions, where shortages of wood are most critical. Only a few tropical countries such as Brazil, India, and Indonesia have developed such plantations on more than a very modest scale. The purpose of more than 60 percent of these plantings is to grow industrial timber products, and most of the remainder have been established for environmental protection.

Whatever their purpose, the yields of wood volume from plantings in tropical countries have been very impressive. The best wood yields in the United States are obtained from loblolly pine (Pinus taeda) on fertile sites in the Southeast. Here, average annual yield seldom exceeds 20 cubic metres per hectare per year in rotations (ages at which stands are harvested and replaced) of 20 to 40 years. In Europe, Norway spruce (Picea abies) is often grown in 50- to 80-year rotations with an expectation of obtaining a yield of 5 cubic metres of wood per hectare per year.

In southern Brazil, loblolly pine is grown in 12-year rotations with expected yields of 20 cubic metres per hectare per year. In central Brazil, Eucalyptus species are grown on 7-year rotations, and yields average 25 cubic metres per hectare per year. In Gambia and Senegal, Eucalyptus yields are a more modest 17 cubic metres per hectare per year, but rotations are also 7 years. Caribbean pine (Pinus caribaea) plantings are yielding 14 cubic metres a year in 15-year rotations in Borneo and 18 cubic metres in 7-year rotations in Amazonia.

The relatively short timber rotations in tropical countries are possible because growing seasons are long. In temperate climates, trees do not grow during cold seasons. In tropical countries, it is never too cold for trees to grow. Growth there is controlled by rainfall. In dry seasons the trees grow slowly if at all, and in wet seasons they grow rapidly. Areas with abundant rainfall have usually been chosen for establishment of tropical forest plantations.

The short rotations are extremely attractive to investors. A 7-year rotation makes it possible to obtain returns 7 years after the planting investment. Other things being equal, shorter rotations translate into greater profits.

Man-made forests of Brazil

Brazil provides important demonstrations of how much forest plantations can mean to the economy of a developing tropical nation. Unlike many nations, Brazil has an unusually large land area on which trees grow rapidly and much of this land is not needed for food production. Like many developing nations, however, Brazil is poorly supplied with fossil fuels and suffers from trade deficits.

Rather than spend international exchange credits on energy, Brazil has embarked on a program to achieve energy selfsufficiency with wood fuel as its heart. Much of this wood fuel is being grown in plantations, which covered some 4.5 million hectares in 1982. The annual rate of plantation establishment is about 400000 hectares. The yields indicated above are averages. In fact, in individual plantings, they range up to 60 cubic metres per hectare per year.

A combination of excellent conditions for tree growth and financial incentives for investors has stimulated the extensive planting efforts. The man-made forests of Brazil support a large and growing industry for pulp and paper, part of which is exported. Another part of the wood from the plantations is converted into charcoal to supply a major share of the energy needs of a growing steel industry. A large program is under way to produce wood alcohol as a substitute for petroleum. Yields from Brazil's natural forests are insufficient to support these ambitious programs. In natural forests of great age, annual growth is roughly balanced by natural mortality. Trees of many sizes and many species are present, making harvest and utilization inefficient.

Risks of tropical forest plantations

High-yielding plantations do not come free, and they can be a mixed blessing. Sites must be carefully prepared for planting. Seedlings of appropriate size and vigor must be grown in nurseries. Nursery and outplanting techniques must be learned, often by trial and error. The basic technology for tree planting arose in temperate regions. Often, neither the techniques nor the target species are directly applicable in tropical countries. Forest plantings in tropical areas often carry high risks for several reasons. First, they are necessarily experimental to some degree. Second, they normally contain a single species. Ecologists note that natural forests in the tropics contain very large numbers of species, and they theorize that this diversity offers protection against damaging organisms. Each species of insect or disease organism usually preys on only one or a few species. The concentration of a single species over a large area provides ideal conditions for the rapid buildup of populations of damaging organisms. In the tropics, the organisms may have many generations in a single year. In temperate climates it has usually been possible to protect plantings of single tree species from insects and diseases. For the reasons given, the same may not be true in the tropics. There are several examples of plantation failures in the tropics, particularly some time after exotic species were imported and planted in large numbers.

Some major species used in tropical forestation

Predominantly industrial plantations	
Tropical pines	Pinus caribaea, P. elliotii, P. kesiya, P. merkusii, P. oocarpa, P. patula
Other coniferous species	Cupressus lusitanica (Mexican cypress)
Eucalypt species (gum trees)	Eucalyptus alba, E. camaldulensis, E. citriodora, E. deglupta, E. globulus, E. grandis, E. saligna, E. tereticornis
Other hardwoods	Acacia mearnsii (black wattle)
	Casuarina spp. (she-oak)
	Dalbergia sissoo (shisham)
	Gmelina arborea (yemane)
	Swietenia spp. (mahogany)
	Tectona grandis (teak)
	Terminalia spp.
Predominantly multi-purpose and village plantations	
	Acacia spp. (e.g. Acacia senegal – gum arabic)
	Albizzia falcataria
	Alnus spp. (alder species)
	Azadirachta indica (neem)
	Cassia siamea
	Calliandra calothyrsus
	Erythrina spp. (poro)
	Gliricidia sepium (mother-of-cacao)
	Grevillea robusta (silky oak)
	Inga spp.
	Leucaena leucocephala (ipil-ipil)
	Populus spp. (poplar)
	Prosopis spp. (algarroba)
	Sesbania spp.

Intensively utilized plantings of single species do not afford the same degree of environmental protection as natural forests. Fragile soils may be seriously impaired over several rotations of plantation timber production. Furthermore, there is evidence that supplies of some soil nutrients may be depleted over many rotations. The biomass that is harvested contains soil nutrients, which are replenished through natural processes. If the rate of removal exceeds the natural rate of replenishment, a reduction in soil fertility and in forest productivity must eventually result.

These dangers must be placed in perspective, however. Forest

planting is advocated primarily for areas that do not contain trees at present. In general, a tree cover provides greater environmental protection than the vegetation currently occupying these sites. The establishment of a well managed tree cover on degraded sites will certainly improve environmental conditions. Additional environmental protection can be provided later when needs become apparent. Furthermore, the perfection of techniques for establishing multiple-species plantations will do much to alleviate several problems associated with single-species plantations. The other risks associated with tree planting will be reduced as more experience is gained in individual countries. Industrialized countries can do much and are doing much to assist in developing the necessary technology instead of just exporting the technology employed in temperate regions.

The importance of plantations for environmental protection

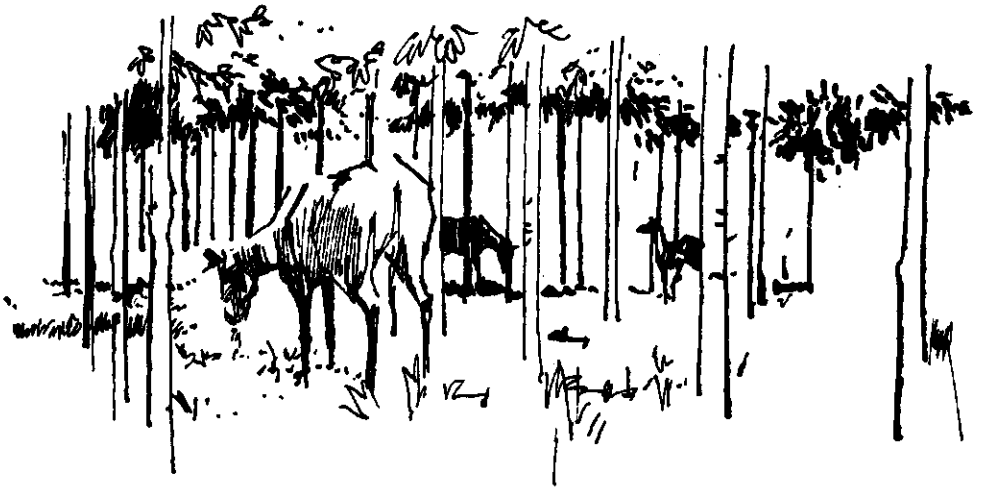
World-wide there are 87 million hectares of degraded tropical watersheds in dire need of reforestation. In addition, a staggering area of 1556 million hectares of arid and semi-arid lands are being endangered by desertification. Tree growing can also do much to alleviate this problem. The establishment of protective plantations is thus essential. With the singular role forests play, we are the custodians of the environment. Without protected watersheds and alleviation of desert encroachment, the production of food will be increasingly hazardous and the lot of the poor increasingly perilous.

Yet, the encouragement of protective forestation has been called the Cinderella of forestry. Combating environmental degradation is usually expensive, yielding few directly saleable products, although it brings about many other benefits and helps to improve productivity on adjacent or lower-lying lands. It requires an integrated land-use strategy in which forestry and agriculture are not kept separate, whereas the traditional approach in forestation has largely been to divorce the practices of forestry and agriculture, and to emphasize differences.

There are major differences between the techniques for establishment of industrial plantations and protective plantations.

Industrial forests will often be planted in areas of low population density and on land not under great pressure from firewood collectors or pastoralists. Many protective plantations will need to be established in heavily used or even overused land where there are high populations of people and animals. Mostly they will be on steep slopes of mountainous regions with highly erodible soils, or on arid flat areas at risk of sand and dust storms. The trees to be planted should be able to thrive under such harsh conditions and to provide a protective soil cover as quickly as possible. As site protection must be optimized instead of yields, it may be necessary to restrict exploitation.

Obviously, such endeavours can only succeed when there is a political will to plan and encourage such projects. The establishment of protective plantations must be carried out as a truly national effort. It should involve the local people at all levels of implementation. This should include provision of employment, participation in decision-making and in choosing areas to be treated, and being granted concessionary rights on the restored land, whenever possible.



To be effective, plantations must be well-managed

The wise establishment of tree plantations on underutilized lands can contribute in overcoming several pressing problems of rural poverty and land degradation. But such tree planting in itself will not be very effective, unless the plantations are well managed after their establishment. Notwithstanding the several differences between natural forests and plantations, they are similar in one major aspect. That is that they are both vulnerable to degradation unless they are managed in such a way that account is taken of the various needs of the local people. Many examples of forestation schemes are known, where hardly any trees remain after a few years, because of lack of adjustment of management of these plantations to the basic causes of deforestation.

A serious social question associated with establishment of tree plantations is, Who benefits and who loses from them? If trees are planted primarily to supply some distant mill or to protect lower-lying agricultural lands and cities from flooding, local residents may be less than enthusiastic, particularly if the plantings make the former uses of the lands impossible or if the plantation does not provide the products local people have been accustomed to gathering from these sites. Under such conditions, it may be impossible to prevent the plantations from being damaged quickly by local people. The reason for such failure is not because local people do not understand the values of forests, but because planners do not understand basic needs as perceived by local people.

To base plantation establishment on the assumption that its social effects will always be positive is to invite failure. But much can be done to prevent negative social impacts. The scale of planting can be altered, as can plantation management. In planning programmes for tree growing, full attention should be given to the various possibilities offered by the establishment of either national forests, plantations managed by large-scale forest enterprises, community forests or farmer's wood lots. Also species may be chosen with an eye towards the needs of local communities and farmers. Such adjustments will do much to stimulate tree planting and tree maintenance.

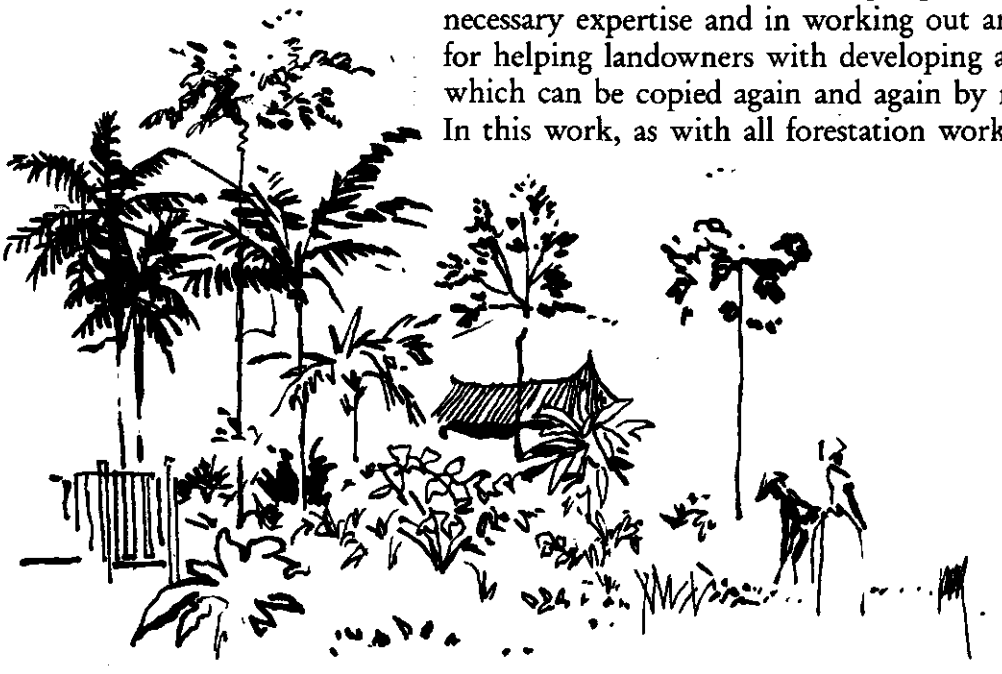
Combining tree growing and agriculture in agroforestry

The adjustments in tree-planting designs made to accommodate local needs can be very large. In one kind of approach, the adjustments are so sweeping that a special term, 'agroforestry' has been used to describe it. This term is applied to some very old practices and some very new ones. It is meant to denote the growing of trees and agricultural crops on the same piece of land at the same time.

The approach is especially promising where forestry faces fierce competition for land. The objective of agroforestry is to bring some trees onto farms by mixing them with agricultural crops or placing them in livestock pastures.

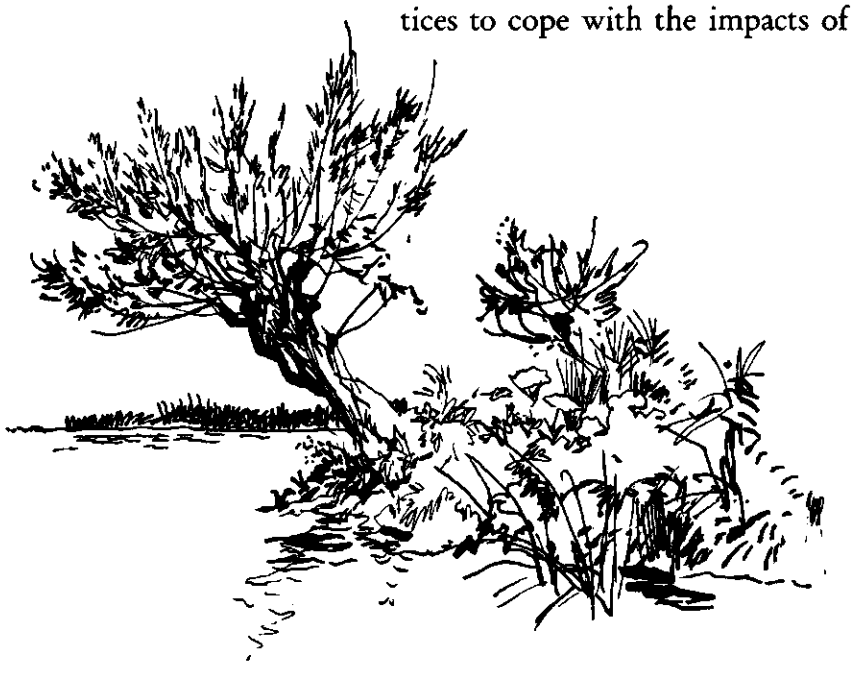
The concept is simple and quite old, but its promise for tropical nations has only been recognized in the last decade by land-use planners. The major wood products from these projects tend to be simple ones like posts and fuel wood. The trees may also contribute to the farm by stabilizing the soil, providing shade, and producing fodder and fruit. Often these benefits are valued more highly by the landowner than the wood that is produced.

At present, much effort is being expended in gathering the necessary expertise and in working out an effective approach for helping landowners with developing agroforestry practices, which can be copied again and again by neighboring farmers. In this work, as with all forestation work, there is no substi-



tute for a thorough knowledge of local needs and desires. Would a new fruit be a good supplement to the local diet of roots and grain? If the fruits were available, would the people eat them? People are often very reluctant to accept changes in their basic diets. How long will it take the farmer to produce a desired crop? Is the farmer likely to cut the trees for some other purpose before the envisioned product can be harvested? These are very practical questions that must be answered during the design of an agroforestry project.

Fortunately, traditional agroforestry practices in many tropical countries are a rich source of information for technical experts. Through careful observations on existing farms, experts can learn much about the kinds of trees that can be combined with specific agricultural crops in specific situations. Practices that are traditional in one place often are unknown in another, so one valuable function of the expert is in transferring the wisdom that has been accumulated in one place to many other places with similar problems. Here again, it should not be assumed that traditional farmers who have little formal education have no knowledge about the management of their environment. The task of the professional land-use planner should be to assist farmers in adjusting traditional local practices to cope with the impacts of rural change.



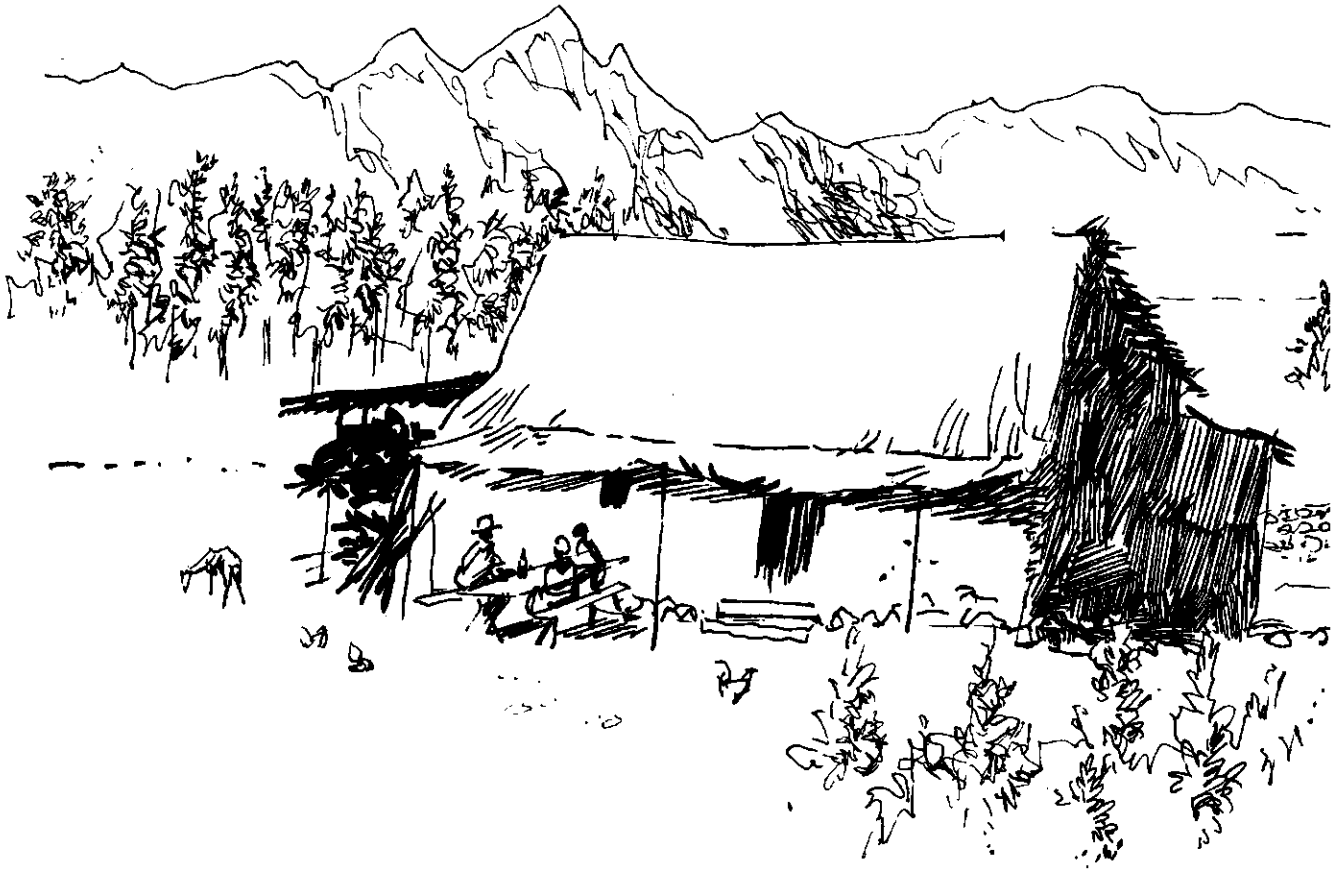
Community forestry development in Nepal

The living conditions of the rural population in the hills of Nepal have severely deteriorated as a result of uncontrolled deforestation. Fuel wood and fodder have become scarce, and erosion has increased. So the Nepalese Government has started an extensive program for reforestation and protection of the remaining forest. This program is based on the principle that local people should take responsibility themselves. This was made possible by enacting legislation, which allowed national forest lands to be handed over to the local communities.

To assist the local communities with reforestation and forest protection, as well as with the production of forest-related resources, the Government established a community forestry development project in 1980. The aim of this project was to establish 420 local nurseries and 12000 ha of new forest plantations, to distribute 1000000 seedlings for private planting, and to bring 40000 ha of existing forest under improved management. The project also stimulates the distribution of 15000 improved stoves, which use fuel wood more efficiently than traditional stoves.

There are considerable differences between Nepalese villages in the need for various tree species and the conditions of the planting sites. So the program has delegated authority to implement the project direct to the local district and village level. The activities of local field workers are supported by an extensive training and extension program. They are also assisted by the provision of new types of nursery and plantation technologies, which have been developed by the Forest Service. All these support activities have been developed according to needs expressed by field workers. The project also continuously monitors and evaluates the program, using feedback from field workers and meetings with village and community leaders. So local constraints to tree planting and management are soon noticed, and activities are adjusted accordingly.

In project villages, this approach resulted in a considerable improvement in attitude towards the forests in three years. As a result of the successful project's activities, community forestry is now largely accepted by both the Government and local people as an important step towards preventing further deterioration of the Himalayan environment.

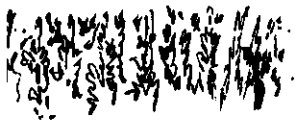


Chapter 4 *Topics in planning forestation projects*

Treat with care!

Experience throughout the world demonstrates that local populations remember failures for a long time. If a new project fails in its first application, no matter what the reason, it may be a long time before someone in the community is willing to try anything similar again. That is why new projects must be planned with the greatest care.

A host of practical considerations go into the planning of a successful forestation project. Because the project must meet local needs, local effort and acceptance are required. Planning is a time for hard-headed, practical thinking about land, labor, capital, ecosystems, technology, and organization. In this Chapter, these topics are discussed individually. Then some examples of successful planning are provided. In such efforts, reality and practicality must dominate. Perhaps the best application of idealism is in assuring that the planning is done thoroughly and well.



Land: the main resource

Every forest must be somewhere. The planner must know exactly where the forest in question will be. Who owns the land? It makes a large difference whether trees are to be planted on public land, communal land, or private land. In making this determination, a legal investigation may not be sufficient. One must also be certain that the legal forms of land ownership correspond with the thinking of local people.

Poorly stocked forest land presents obvious opportunities for plantation establishment. Such land, however, often is also a grazing or hunting common, regardless of who owns it. A plantation may disturb these activities, and if it does the local population may not permit the planting to succeed.

Since land is not necessarily worked by its owner, the land tenure system must be examined. Is the land being rented or

tilled under a share-cropping system? People who have an insecure or short-term right to utilize land normally are not inclined to make long-term investments in it. Tree planting is such a long-term investment; it will often fail if current tenants are dispossessed by it, or if they will be expected to assist but will not reap the benefits of their work.

Do land tenure rights coincide with tree tenure rights? In many traditional societies, land belongs to the tribe or extended family. But the trees cultivated on the land may belong to the planter. Differences in tenure rights to land and trees may result in conflicting expectations of landowners and tree planters. Careful negotiations may be needed to resolve such conflicts, and they should be conducted before planting begins.

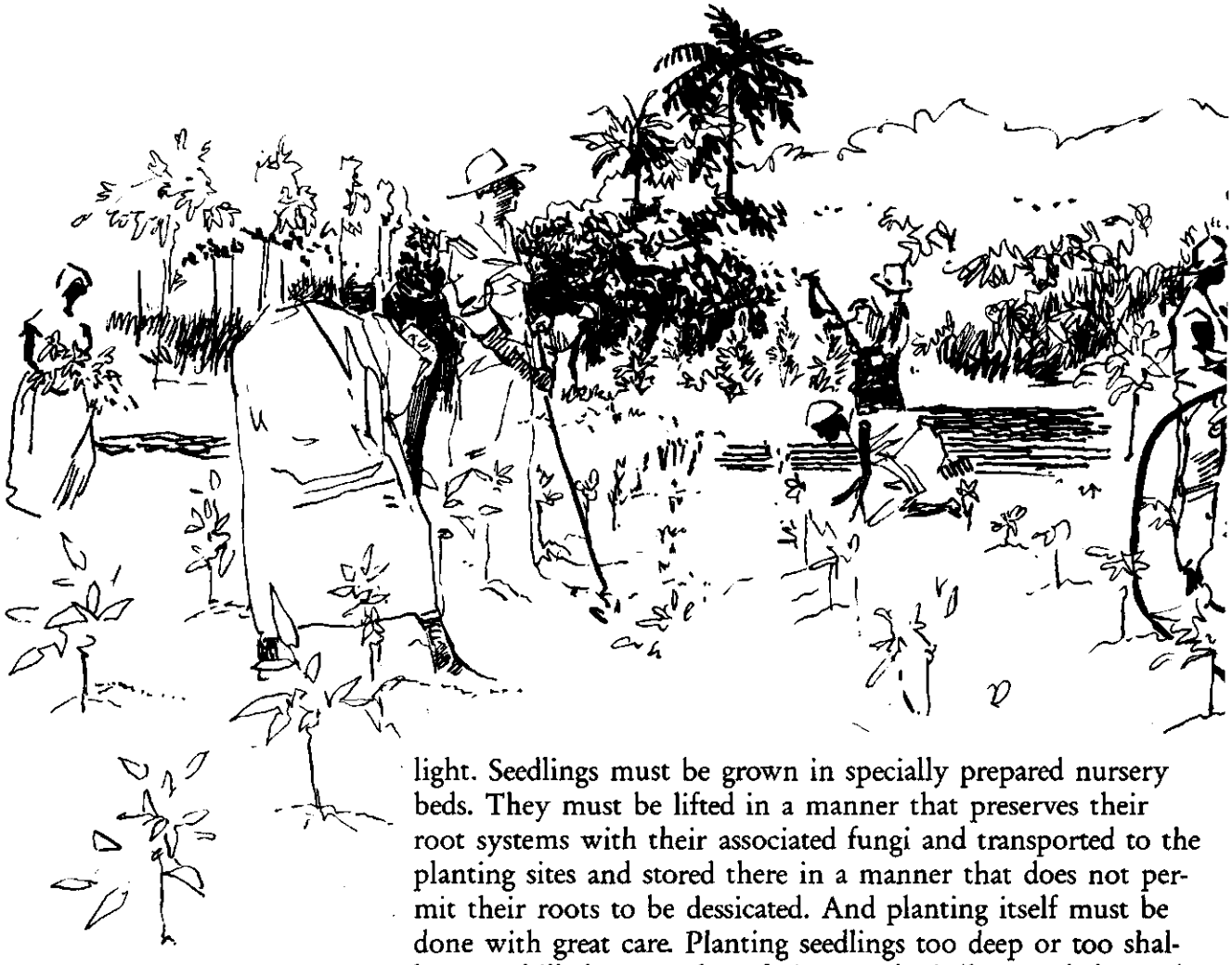
Careful attention must be given to the present use of the land. If a forest is planted there, who will gain and who will lose? Distant planners have a tendency to construct forests of the mind. If those dreams are to become reality, they must fill the

everyday needs of real people. If a forest takes away local grazing land or local sources of food, what will be offered in return? Projects that hurt large numbers of people seldom succeed, and they probably should not succeed.

The planner must also be aware of the physical condition of the land. In forestry, there is no substitute for an intimate knowledge of the land, and this knowledge cannot be gained by sitting in an office. Most often, it is gained by walking, observing, and recording observations. As a minimum, these observations must include soil texture, soil fertility, topography, moisture supply in various seasons of the year, and a detailed account of the kind and condition of the existing vegetation. Without this knowledge, the prospects of consistent success in forestation are very slim.

The importance of skilled labor

A major forestation project requires labor in large quantities. Land often must be cleared of vegetation that will compete with the planted seedlings for moisture, nutrients, and sun-



light. Seedlings must be grown in specially prepared nursery beds. They must be lifted in a manner that preserves their root systems with their associated fungi and transported to the planting sites and stored there in a manner that does not permit their roots to be dessicated. And planting itself must be done with great care. Planting seedlings too deep or too shallow can kill them or slow their growth. Soil around the seedling's root system must be packed firmly to prevent dessication. After the trees are planted, weeds around them often must be controlled for a few years to ensure seedling survival and speed early growth.

All this work must be done in specific seasons by workers who have been properly trained. It is often assumed that plenty of labor will be available in countries with large populations of rural poor. Often, however, labor is only available at certain times. At other times, most people are fully occupied with the tending of the crops they rely upon to survive. When possible, forestry operations must be scheduled around these vital activities.

It should be recognized, however, that production and planting of tree seedlings also have demanding schedules. In temperate regions, they should be lifted from nursery beds during the dormant winter season. When the seedlings are dormant, they are better able to withstand rough handling. They are planted after growth stops but before the ground freezes in the fall, and after the ground thaws but before growth begins in the spring. In tropical areas with rainy and dry seasons, the best time for planting on forest sites is at the start of the rainy season. That is also an excellent time to plant agricultural crops. Furthermore, in order to produce seedlings that are ready for planting at that time, it is usually necessary to irrigate in the nursery.

The importance of proper training and local supervision for forestation operations cannot be overemphasized. In much of the world, the planting of more than a few trees at a time is an unfamiliar activity. Workers must be shown precisely what is expected of them, and they must be told why these things are expected. They must know, for example, that drying of the fine roots of pine seedlings causes their death, regardless of the amount of care that is taken in growing and planting them.

How to make capital investment in forestation profitable

As it is practised in temperate regions, forestation requires large investments of capital and a long wait for returns. Capital is required to obtain land, to arrange for proper access to the land, to prepare it for planting, and to get tree seedlings planted. Additional outlays must be made to protect the tree crop as it matures through typical timber rotations of 20 to more than 100 years.

In tropical countries many similar costs must be made. As capital is often chronically short in these countries, investors demand that any investments in tree growing show a high and rapid return. Fortunately, various tropical regions offer good promise for profitable investment in forestation. One of the advantages of tree growing in these areas is the rapid growth and high yields possible on many well watered tropical soils. This offers much promise for shortening the periods for for-

estry investments and obtaining high returns. Furthermore, in tropical regions with large areas devoted to forest plantations, land costs are normally lower than in the temperate countries. And costs for local labor are considerably lower. Major investments from outside the tropical regions have therefore been made for the production of industrial wood in the tropics. The costs of acquiring land and of developing the necessary infrastructure, such as roads and residences for workers needed for the establishment of the plantations and for the removal of harvested trees, have often been a determining factor in the profitability of such ventures.

Such industrial plantations may be established in areas where facilities for processing the wood do not yet exist. Under these circumstances, additional investments must be made for manufacturing facilities. The plantation project must then produce minimum amounts of wood to justify the construction

of these processing facilities. Some values that may be regarded as minimum for establishing a new industrial plantation are as follows:

Processing facility	Green timber (m^3/year)	Plantation area (ha)	Investment (million US$)	Manpower
Sawmill	15000	1000	1	30
Sawmill and plywood	100000	7000	10	200
Pulpmill	500000	25000	250	2000
Woodchip export	100000	5000	4	60

These amounts must be regarded as minima to compete on world markets. If markets are primarily within the developing country, they may be slightly less.

Such combined investments for processing facilities and plantations often take at least 20 years to return significant profits. Outside investors want to minimize the risks of losing these investments before then as a result of political or social changes. This can best be done by making certain that the plantations have a positive social and ecological effect in the target region.

The profitability of industrial plantations much depends on the capability of providing high wood yields of over 15 to 20 cubic metres per hectare per year. Such yields are not often achieved on a nation's poorer lands, the ones left after agricultural needs are met. Such lands are normally the ones available for forestry. Much of them urgently need reforestation to prevent further degradation, but outside investors cannot be expected to show much interest in establishing such protective plantations.

Outside investors may also have little interest in growing low-priced products for local consumption such as fuel wood. For such projects, local capital will predominate. Much of it may take the form of labor invested by farmers with the promise of local environmental benefits and future consumption.

Regardless of the situation, such investments in tree planting can seldom be made without an assurance that the investor, either private farmer or commercial enterprise, will reap benefits from these trees.

Financial benefits of tree planting may sometimes be insufficient to repay the costs of establishment. This does not mean that such plantations may not have important benefits of an indirect non-financial nature such as environmental control. For such benefits, there is an obvious need for public investment in tree planting in several forms. A government may fund their own program for the establishment of national forest plantations. Such a form of public investment in forestation is very common. But the government may also stimulate private investors by providing them with financial incentives. Both approaches may be stimulated by aid funding from more developed countries, with low interest rates and long repayment periods.

Stimulating forestation with financial incentives

Often, free-market signals at the local level will not be sufficient to stimulate the amount of forestation that is needed. In such instances, effective action will have to be taken at a higher level, and one of the most effective actions that governments can take is to reduce the capital expenditure required for forestation. Typically, such government programs provide financial incentives through direct subsidies, through low-cost

Different forms of incentives to stimulate forestation

Direct subsidies	Free or subsidized seedlings Donation of land and small plantations Free technical assistance Capital donations in form of finances, equipment or food Cooperation in building infrastructure
Credit concessions Tax benefits	Exemption or reduction of all tax Exemption or reduction of property tax Exemption or reduction of income tax on invested capital or profits Exemption or reduction of inheritance or donation tax over forested lands Exemption or reduction of duties on imported forestry equipment

credit, and through financial concessions. The forms of incentives vary from place to place, but their purposes are similar – to convince local people that tree planting is a desirable activity.

A financial incentive program has been highly successful in encouraging establishment of industrial wood plantations in Brazil. Between 1910 and 1962, some 8 million hectares of forest were cleared in São Paulo State alone. To reverse this trend, a law was passed in 1966 to encourage forest planting. The law allows up to 25 percent of income taxes to be used for approved afforestation projects in specified regions or districts. Incentives cover the total cost of the project, excluding land purchase, from establishment through 3 years of stand maintenance. That period is normally sufficient to get a healthy plantation established. Largely as a result of this legislation, the area of forest plantations in Brazil increased from 500 000 hectares in 1964 to about 4.5 million hectares in 1982.

Tax savings, of course, are of little interest to subsistence farmers, who seldom pay taxes. Fiscal incentives of that type, therefore, are not very appropriate in most agroforestry and village woodlot projects. For them, direct subsidies are more suitable. The subsidies may be in the form of capital donations or free materials. In many cases, forestation has been stimulated by distributing seedlings free of charge or at a nominal cost.

Combining the knowledge of planners and farmers

The scientific knowledge about the culture of most tropical tree species is far from adequate. Unfortunately, there is little choice but to plunge ahead using the knowledge that is available. Under these circumstances, however, project planners must be fast learners and flexible thinkers. They must profit from their experiences, and they must keep themselves informed about the successes and failures of others who are facing similar problems and conditions.

Planners and other fellow professionals are important sources of knowledge, but local people are equally important. Local communities contain a wealth of traditional knowledge and accumulated wisdom. This knowledge is not static. It keeps de-

veloping as the community adapts to the changing rural situation. Indeed, the most important function of a planner may be in adding in small ways to that accumulation of knowledge, which is based on perceptions of local farmers about their surroundings and their ability to alter them in useful ways.

In many cases, farmers are aware of the processes of environmental degradation and the ability of trees to prevent those processes. And farmers would not be farmers if they did not know how to plant trees.

Frequently, however, outside forces make it impossible or unprofitable for farmers to apply their forestry knowledge. Especially in village woodlot and agroforestry programs, planned activities should be based on the principle that local traditional knowledge is as valuable as outside professional knowledge. The goal of these projects should be to assist farmers in the further development of their traditional knowledge to make it applicable under modern conditions.

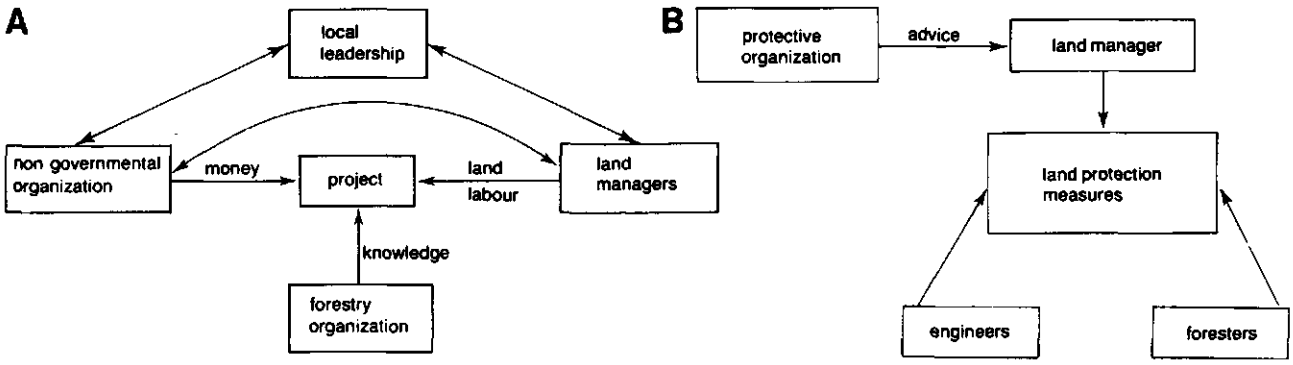
Agroforestry project in Haiti

In Haiti, there is an urgent need for reforestation to control widespread erosion and to produce sufficient fuel for the local population. Foresters and development planners have recognized that the scale of reforestation can only be achieved with active participation of local farmers. In the past there has been an inadequate conception about how to reach this goal. Mostly, the image of reforestation included the following.

- The reason that peasants do not plant trees is that they do not understand the importance of trees; the first step is to educate peasants about the need for trees.
- The needs of the peasants are short-term; therefore they cannot afford to incorporate trees into their farms.
- An outside agency should pay local people to plant trees, as such a payment will attract local interest.
- The trees to be planted should never be cut, in order to provide optimal environmental protection; therefore the tree stands should be managed by the outside agency.
- Trees should be planted for the long-term benefit of the region; therefore people should be taught to plant trees for their grandchildren rather than for themselves.

In the late 1970s, a group of private organizations proposed an Agroforestry Outreach Project with the object of stimulating tree planting by farmers. As a precept, this project assumed that Haitian farmers do not have to be told that trees are important. Rather they need assurance that the planter will directly benefit from the trees they plant. Consequently, the project did not focus on communal planting for conservation with restriction on harvesting, but rather on the encouragement of the planting of fast-growing fuel wood trees as a financially profitable cash crop. Family-level activities were stimulated after it was found that most rural families have access to land, although much of it is almost useless for agriculture.

The project provides both technical assistance on the selection of sites to be planted and on the management techniques for the plantation. It also provides seedlings for cost price. The project does not pay any wages for the planting of the trees, but a small financial incentive is sometimes given for each tree surviving after 6 and 12 months. This is done to encourage the maintenance of trees up to a harvestable age and to prevent trees from being planted only to obtain a wage. Such farm forestry can only make a significant economic impact for the planter, if trees are planted in reasonably large numbers. So, the minimum number of trees to be planted is 250. But to avoid an undue proportion of seedlings from going to large farmers, the maximum number of trees issued to any farmer is 1500. This approach has had rapid impact. Two years after its inception, 4000 farmers were participating in the program. They had planted some 1750000 trees. The project demonstrates how tree growing may be attractive to farmers under suitable conditions of availability of underutilized private lands and a good prospect for marketing wood products. The opportunity to increase his income is often a principal motive force for tree growing by local farmers.



For forestation projects to be successful various groups of people have to work closely together. In different kinds of programs different forms of cooperation will be necessary. For instance, village forestry projects (A) may take place on private lands with the involvement of both local farmers and village leaders, forestry organizations and non-governmental organizations. But for large-scale afforestation projects for protective purposes (B) it may be more effective if public lands are managed by a special protective organization with involvement of foresters and engineers.

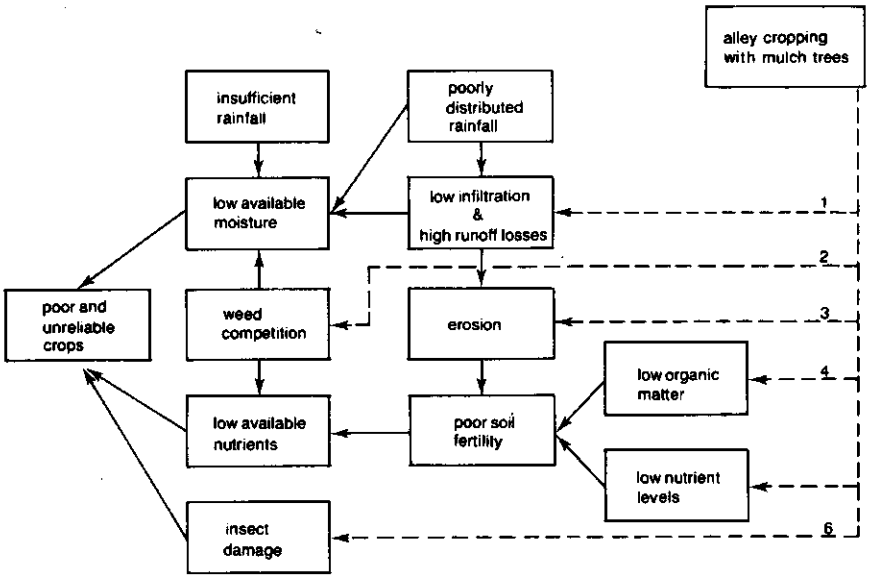
Organization with local and state participation

Suspicion of outsiders is a basic human trait. Since forestry expertise must often be imported into tropical countries, suspicion of forestry can be a major problem there. Local participation at every opportunity, therefore, is a key to successful forestation in the tropics. Only with it can distant expertise be translated into local success.

Local participation can take many forms. As already mentioned, local knowledge must be taken seriously. Traditional knowledge and professional expertise must be combined in approximately equal parts. Both the planning and the execution of a project should be based on such joint enterprise. The energies and land resources as well as the knowledge of local people should be sought.

What is the proper function of government in this process? Governments should probably be as flexible as possible, providing as much or as little help as is necessary to stimulate the desired amount of forestation. Arranging for education and providing expertise are government functions. Others are provision of financial incentives and low cost materials, and drawing up of regional forestation plans and of legal regulations.

Imagination and flexibility by government officials can be very helpful. In Nepal, a program started to succeed when the government indicated its readiness to turn over state lands for local use. In Korea, a plantation program was successful when it was incorporated into a long tradition of village cooperatives. The newly formed forest cooperatives were stimulated by passage of strong and clear laws and regulations, and by the provision of subsidies and adequate technical assistance. Private organizations are often helpful in forestation. Where there is opportunity for profit from the production of industrial wood, private corporations are often more effective than governments in getting projects off the ground. In other areas, there may be a lack of communication or even distrust between local farmers and government forestry personnel. Nongovernment organizations can often help in these situations by acting as a friendly third party. In Kenya and India, many church groups, women's organizations, and youth groups are helping to stimulate forestation activities.



In semi-arid zones agricultural yields are often declining by the combined effects of various factors that interact. By planting rows of trees in these fields, and pruning them regularly to provide mulch, the agricultural yields may be increased. These alleys of trees will assist in

1 improving the infiltration of water and reducing the amount of water running of superficially;

2 shading out weeds, resulting in less need for labor in weed control;

3 reducing the hazard for splash and run-off erosion;

4 improving the soil characteristics by increasing its content of organic matter;

5 improving the nutrient content of the soil by fixing atmospheric nitrogen and by the nutrient pump action of deep roots;

6 reducing insect damage through the use of insect-repellent mulch species, e.g. Azadirachta indica or Derris indica

Agroforestry plan for Kenya farms

A good example of how to combine the various elements needed for successful tree growing in planning a forestation project is the planning technique called diagnosis and design for the development of agroforestry projects. A summary of the results of such diagnosis and design for a representative farm in the Machakos District of Kenya gives some idea of what is involved in the process.

The climate of the area is semi-arid to subhumid with distinct

dry and wet seasons. Soils are sandy loams to imperfectly drained sandy clays. Crops of maize, beans, pidgeon peas, and cowpeas as well as Zebo cattle, sheep, and goats are raised. The operation is classed as subsistence farming.

In the dry season, shortages of staple foods are normal and food must be purchased. At that time, milk and meat production are also low because of insufficient livestock food. Droughts that cause crop failures occur every 5 years. The family must purchase fuel wood for cooking and for brick manufacturing, and there is a lack of quality timber and poles for farm use. Household income is spent almost entirely for staple foods, fuel wood, and construction wood.

Problems limiting cropland production are:

1 Low soil fertility and declining yields.
2 Lack of manure.
3 Low available soil moisture in some seasons.
4 Oxen too weak for deep plowing in the dry season.
5 Soil erosion and water loss from slopes due to heavy runoff.
6 Waterlogging in low spots in wet season.
7 Labor bottleneck at plowing and weeding time.
8 Insect pests.

Problems on grazing land include:

1 Small grazing area.
2 Insufficient dry season forage production.
3 Insufficient fuel wood production.

Diagnosis suggested five ways in which trees could be used to improve this farming operation:

1 By planting multipurpose fodder trees in grazing areas and as hedgerows in cropland the supply of cattle feed in the dry season would be increased, erosion would be reduced, and plowing during the dry season would be improved.
2 By planting cut-and-carry fodder trees and pan feeding the fodder to livestock, manure production would be increased.
3 Alley cropping and mulch farming amid planted leguminous and other trees would control soil erosion, increase water infiltration, conserve soil moisture, improve soil fertility and structure, reduce the need for tillage, and lessen the labor required for weeding.
4 Hedgerows and living fences of high-yielding fuel wood

species and fruit-producing thorn bushes would supply ample fuel, human food during drought years, and supplemental livestock food in average years, while protecting themselves with their thorns.
5 Fruit trees in grazing land would supply food to the family, and grass-legume pasture would grow beneath them.

Because their roots go deep into the soil, trees survive the dry seasons and the periodic droughts in this part of Kenya. Clearly, local farmers can improve their lot considerably by taking what trees have to offer.
Adoption of some or all of these agroforestry techniques depends upon effective extension activity to fully explain the possibilities to the farmer and to adapt them according to his preferences. Since the family has little cash, it may need some financial help to pursue its choice of agroforestry measures.

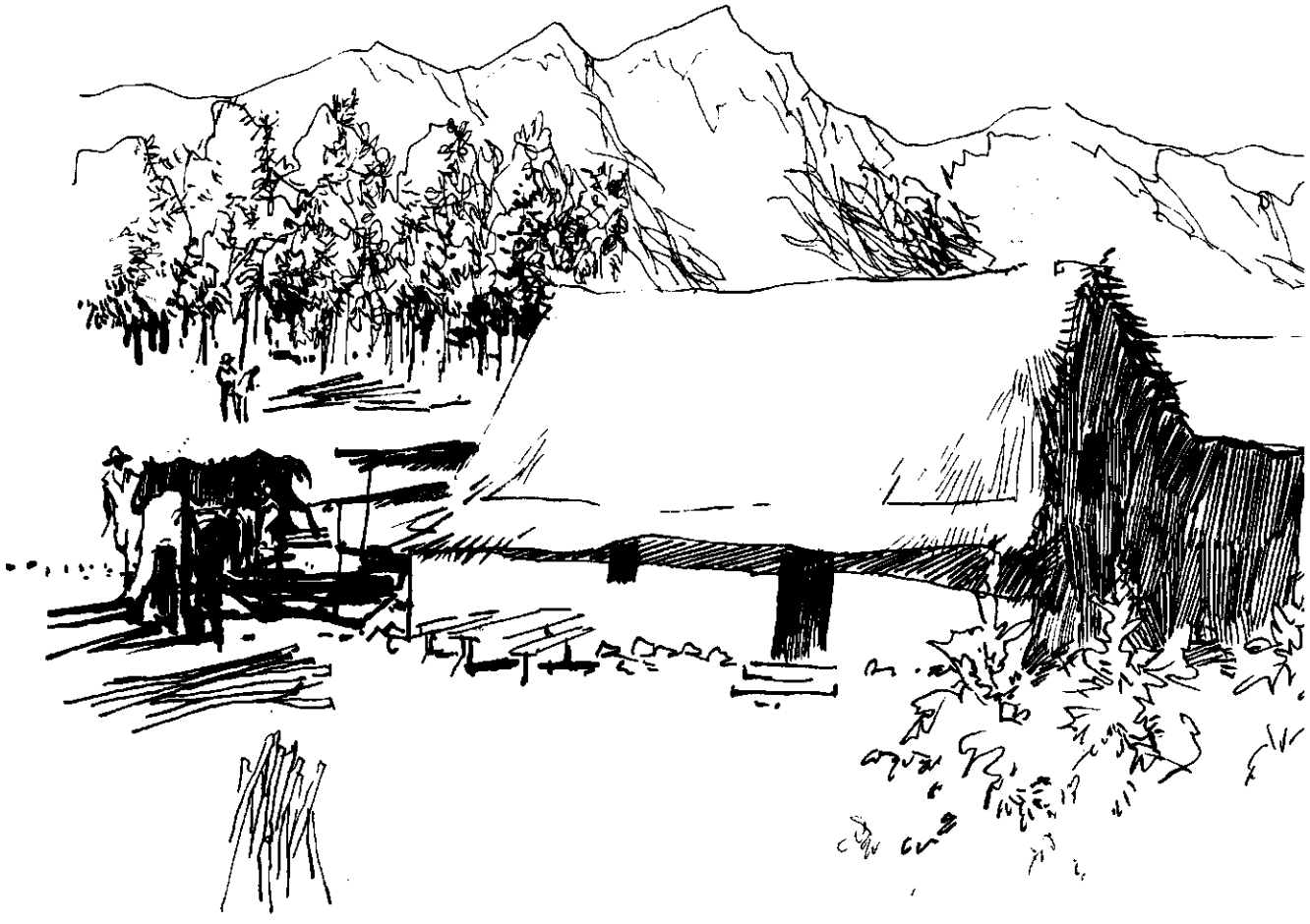
Farmer plantations with shade trees in Costa Rica

Many tree-planting programs have been based on the assumption that farmers were unaware of the benefits of trees and forests. However farmers in tropical countries have often planted trees themselves. There are many areas where farmers have incorporated trees in their traditional farming systems. One widespread example is the management of shade trees above agricultural crops or fodder grasses. These trees often fulfil a multitude of functions. They provide shade and improve the microclimate, and can restore organic matter and mineral elements to impoverished soils. Leguminous trees, which fix nitrogen from the air, are important in this respect. These trees may also provide fodder or wood to the farmers.

An example of the significance of such multiple-use shade trees can be found in Costa Rica. Many farmers plant here between 150 to 300 Erythrina poeppigiana trees in coffee plantations. These trees are pollarded 2 to 4 times each year, in order to maintain a shade canopy above the coffee plants. Cutting is normally at specific times, in order to promote flowering and berry maturation. The cut branches are left between the rows of coffee, where they enhance fertility. The mulch protects the soil against erosion and gradually releases minerals during decomposition. The pruned material may provide up to 10000 kg of organic material per hectare. It yields up to 200 kg of nitrogen per hectare as well as large amounts of other nutrients. As a result, coffee yields are often higher in shaded fields than in unshaded fields, and production may be sustained over a longer time span. The leaves of Erythrina may also be cut as fodder for the farmer's livestock.

In the Turrialba region of Costa Rica, farmers have developed an even more intricate system. They maintain naturally regenerated seedlings of the laurel tree (Cordia alliodora) in the coffee plantations. This very fast growing species forms excellent timber, for which there is a ready market. It is financially attractive for farmers to maintain between 75 to 200 laurel trees per hectare as an upper canopy above the coffee and Erythrina. On one farm, the inclusion of laurel trees in the farmer's coffee plantation increased the farmer's income by about a quarter.

People trained in temperate forestry may find such tree stands unimpressive. They are used to large plantations for commercial timber. However such indigenous examples indicate that tree planting is rarely a novel activity for smallholders in the tropics. These traditional practices are often well adjusted to the local environment and the specific needs of the farmers. They indicate a way to increase both agricultural and local tree production. If such approach to tree planting by smallholders is widely stimulated, it would help to meet regional demand for forest products and to sustain agriculture.



Chapter 5 *Learning from failure . . .*

. . . in order to minimize risks

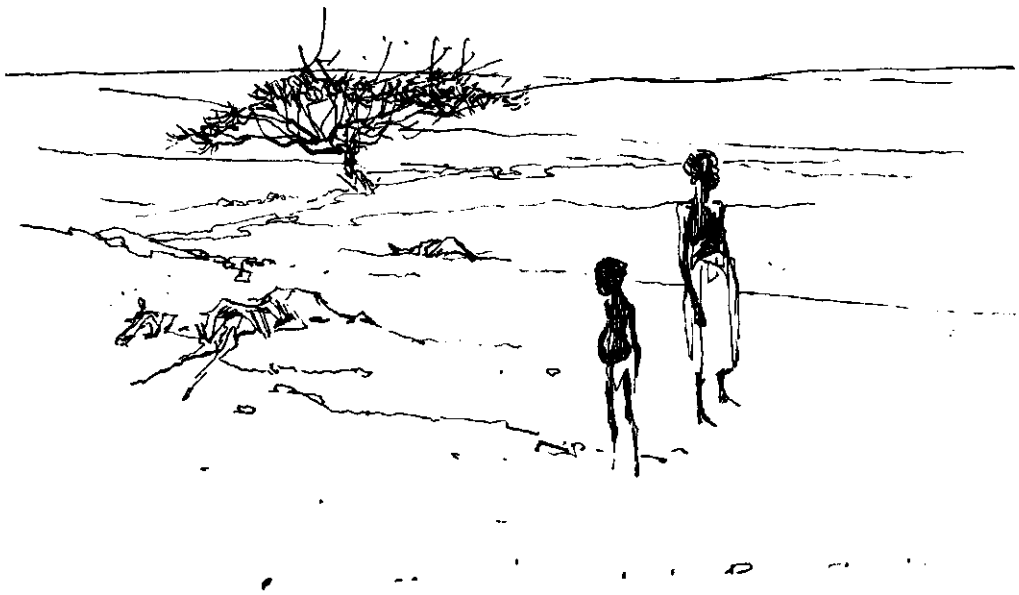
Most human endeavors carry some risk of failure, and those associated with large-scale forestation projects can be quite high. Certainly these risks must be considered and minimized, but they cannot be used as an excuse for inaction. Countries with large forestation needs have little choice but to accept some risks and social impacts and plunge ahead with promising development options. They must recognize, that they will have failures, and that the cost of these failures will go well beyond the loss of invested capital. They may lead people to question the value and practicality of forestation itself. It is important, therefore, to consider past failures and learn from them in order to minimize the risks.

Lessons from the Sahel

Nowhere are the risks of failure in forestation projects better demonstrated than in the Sahel – the huge strip of semiarid land stretching across Africa from Mauritania on the Atlantic to Sudan. To the north is true desert of the Sahara and to the south is savanna. Average annual rainfall in the eight countries in this portion of Africa ranges from near zero in the Sahara to well over 1500 mm in the mountains along the West African coast. In areas classified as Sahelian and Sudanian, rainfall averages less than 200 mm per year.

Rainfall and human activity are the primary determinants of the vegetation that is present. Rainfall is highly unreliable, and drought and consequent desertification are serious and well-publicized problems in the region.

Forests and forest products are extremely important in Sahel countries. Fuel wood and charcoal fill about 90 percent of the fuel needs, poles and lumber are the primary construction materials, and forests supply significant proportions of human and animal diets. In Burkina Faso, the retail value of fuel



wood sold in 1980 was almost double the value of the country's leading export, cotton. In Mauritania, it has been estimated that the value of wood consumed on an annual basis is equivalent to the value of all agricultural produce, including fish. By comparison, wood ranks second to oil as an import in the European Economic Community. Thus, in many different economies, wood occupies an important position.

An important feature of Sahel forests is their supply of multiple products as does the baobab tree. Its leaves and fruit are meticulously harvested for human food, the bark is used for rope, various parts of the tree are used for medicinal purposes, and the tree is used for water storage. Many other trees also provide a variety of products, but the range of uses of Sahelian tree species have not yet been fully catalogued.

The amount of forest in this region is insufficient to supply existing wood uses, and trees are seen as the most promising way of halting desertification. As a result, national governments and international organizations have seen forestation as one of the region's most important development needs for many years. Experts disagree on the amount of forestation that is required, but there is little doubt that an increase by a factor of 10 would be insufficient.

Efforts at forestation began more than 50 years ago, and they have been very common over the last 10 years as concern over desertification has grown. At best, the results of these efforts have been disappointing. Local people have not been enthusiastic, and sometimes have been downright hostile.

When the first programs started, Sahelian governments and donor organizations placed great hope, considerable emphasis, and substantial finance in establishment of large-scale rain-fed plantations of exotic species that were selected to meet growing demands for fuel wood and other wood products. Results were poor for several technical reasons:

1 Exotic species did not perform as well as expected. In areas of low rainfall, Eucalyptus species, which were favored in these projects, yielded no more wood than the native species that were removed to plant them.

2 Sale of wood products was counted upon to finance continuation of the projects. Since production was disappointing, continuation of the projects is costing far more than expected and extension to new lands is becoming impossible.

3 The multiple benefits of the native vegetation that was cleared to make room for the exotics were underestimated.

4 Because of the clearing of native vegetation and the poor growth of the plantations to limited size, the plantings have been insufficient to meet projected needs for fuel wood.

But equally responsible for the poor results were several social constraints. There is a history of antagonism between local populations and national forest services. The planning techniques used aggravated the situation. There has been a tendency to plan from above, ignoring local needs and desires. Efforts have been made to stimulate communal planting, but they have been plagued by a lack of attention to such essential elements as distribution of products. The preferences of government for large block plantings and exotic species have not been shared by local populations. In addition, insufficient attention has been given to tree species that produce human food, animal forage, medicinal preparations, and other traditional products.

In addition to rainfed plantations, some irrigated plantings were established as pilot projects in the hope that they would produce very large amounts of wood on relatively small areas. As with rainfed plantings, costs have soared, and wood

The failure of large-scale plantations in the Sahel

Trees and forests play a wide range of important roles in the Sahel. For instance, 90% of all energy consumed in the region consists of fuel wood and charcoal. And the trees are also essential to control soil erosion and to halt desertification. During recent years, much attention has been given to forestry development in the Sahel, especially after recent droughts. This forestry development has been based on two interrelated concerns: a concern about desertification and a concern about meeting the energy needs of the Sahelian people.

Originally, much attention was given to the establishment of large-scale plantations of newly introduced tree species. It was hoped that these exotic trees would grow faster than the natural vegetation. These efforts, however, have often not been so successful as anticipated. Especially in areas with an average rainfall rate less than 1000 mm/year, the growth of these new species has often been disappointing. The expected fast growth had often been obtained in small experimental plots with excellent tree care. However under the normal field conditions, native species proved to be better adjusted to the large variations in annual rainfall and to different soil conditions. As a result, yields of the plantations have often been only marginally higher than those of well managed natural vegetations. Furthermore, the costs for clearing the original vegetation by bulldozer has been increasing steadily. High transport costs and a lack of a well-developed market for fuel wood have even prevented marketing of the fuel wood obtained during land clearing for a plantation.

As a result of these many factors, other approaches to forestation are now getting increased attention. These are based on a better understanding that most forest products are used for subsistence by the scattered people. Tree planting must therefore be integrated with the other land-use practices of these people. So much attention is now being given to small-scale tree planting by local communities, integration of tree growing in irrigated agriculture and local participation in the management of the natural vegetation.

production has been well below expectations. While this approach cannot be ruled out for the future, substantial research and careful analysis will be needed before it can be pursued on a practical scale.

But not all forest establishment and management projects in the Sahel have shown such dismal results. There are several examples of successful plantation projects. Management of natural forest has been attempted, and seems promising in many parts of the Sahel. Of course, it cannot be relied upon to establish trees where they do not currently grow, but it is one bright spot in a generally dim picture.

Another promising approach to the forestry problems of the Sahel is improvement in utilization. Native wood and charcoal stoves are not efficient utilizers of energy, and various models with greater efficiency have been introduced. Some of the 'improved' models have not, however, been adequately tested and did not meet expectations. Questions remain about the long-

term performance of many models, and there is a feeling that too many models were introduced at the same time and that the move from prototype development to dissemination was too quick.
Charcoal has long been a commercial product in the Sahel, but local processes for its manufacture are not energy-efficient. At present, more efficient processes are being taught to local manufacturers. The success of this extension effort remains to be seen.
The forestation and wood-utilization projects of the Sahel were begun with the best of intentions, and they were designed to address very serious problems. Nevertheless, many failed. There are many such failures throughout the world, in developed as well as underdeveloped nations. By examining such failures, valuable lessons can be learned and corrective actions taken.
It may be useful to classify the causes of forestation failures as social constraints, biological barriers, capital constraints, poor work, and lack of recognition of forestation needs.

Social constraints: can you satisfy everybody?

Men are the unquestioned rulers of the earth, which they feel free to alter to their convenience. What some men build, other men can tear down, often with considerable enthusiasm. Is it surprising, then, that men whose interests have been ignored are the primary causes for failure of some forestation programs?
Much of the past effort at forestation throughout the world has been directed at the production of wood for forest industries. The rural poor in developing countries benefit little from such plantings, and they cannot be expected to be enthusiastic about something that does them no good. This lack of enthusiasm can turn to hostility if the plantings hurt their interests, as has often been the case.
Can such people be blamed? Imagine for a moment that you are a landless farmer in a tropical country. Assume that you and your ancestors have always looked upon the forest as a wild place full of useful objects. You have always gone to the forest for fuel, fruit, game, and other necessary things. In recent years, the forest has been disappearing under pressures

from you and your neighbors, who are becoming increasingly numerous.

Enter a forester who does not speak your lanquage. He makes it known that the forest you have always relied upon is to be rebuilt. But he plants trees you have never seen before and he tells you that the forest is no longer yours to use as you choose. Disgression may prevent serious argument, but when this fellow leaves, what whould you do to this new forest that is not yours?

Land management must serve the needs of local populations. If it does not, local people will alter the management system, and the alterations are not likely to please the land manager. The desire of national planners to produce saleable items in the forests of developing nations is understandable. The needs of local populations must be satisfied at the same time, however. In fact, in most instances they must be satisfied first.

Fuel wood is normally the most important local product of forests in developing countries, and fuel wood supplies are dangerously short in many of these countries. This need must be recognized and accommodated in forestation plans. If it is not, failure is predictable. At the same time, it must be remembered that poor farmers expect multiple benefits from trees. They are rarely motivated to grow trees for a single purpose unless that purpose yields large amounts of cash quickly. Tree crops seldom do that. Therefore, even in fuel wood plantings, multipurpose trees should be favored.

How to cope with biological risks?

The science of forestry is most advanced in temperate climates. Research results and recorded experiences provide a wealth of information on causes of failure there. The information base for tropical and subtropical climates is nowhere near as extensive.

Most of the species grown in temperate climates do not thrive in the tropics, and there are inherent dangers in moving a plant from one tropical area to another. The most obvious dangers come from insects and diseases, which can spread with astonishing speed in moist, tropical areas. Even native species in single-species plantings have been destroyed by forest pests.

Single-species plantings are mostly even-aged and have a uniform structure. This makes them especially vulnerable to pest attacks as well as high winds.

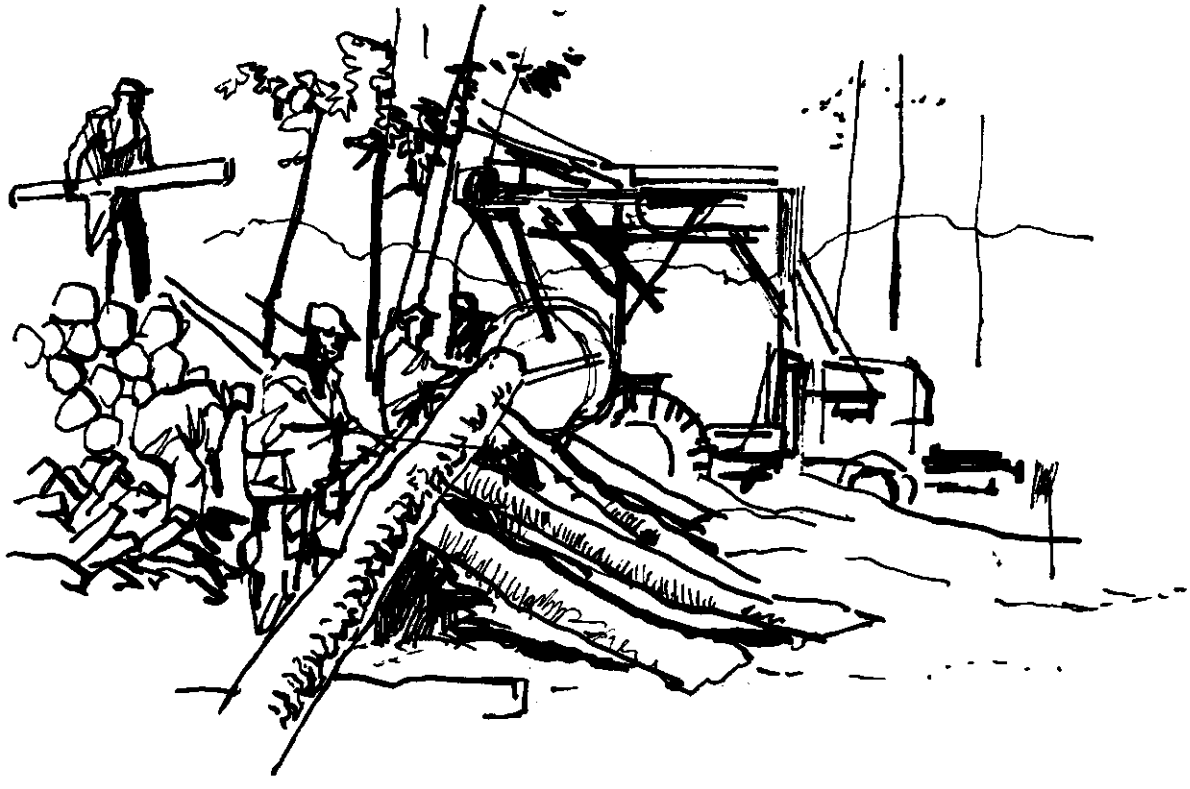
Many ecologists believe that a high degree of diversity is required for the survival of entire forests. Natural forests in tropical areas normally contain large numbers of tree species and trees of many ages. These features decrease the risk of total destruction by natural disaster and by pests or diseases, and there is growing interest in improving the management of these natural forests. Some useful management techniques have been developed, but there are still huge unknowns. In the long run, such natural forest management may be best. But while additional knowledge is being gathered, the biologically more risky plantations offer some promise of reducing human pressures upon natural forests.

Furthermore, there is little choice but to establish plantations where forests are needed and no longer exist. Plantations will often provide obvious ecological benefits, especially on severely eroded or otherwise abused land. And the risks are partially offset by application of good management techniques and by the huge increase in yield of target products that is possible in plantations.

The risks associated with man-made forests can be further reduced by increasing their diversity. Natural forest ecosystems have defenses against destruction, and forest scientists are beginning to understand these defenses. Such knowledge will permit them to establish multi-species plantings with a high probability of success. Even if knowledge on multiple-species planting is not available for a particular area, several species can certainly be planted in alternating blocks. Or the experience of local farmers can be used to find satisfactory combinations of species. Home gardens on the Island of Java are one example of man-made plant communities that display much of the diversity of the natural forests. Many other examples can be found especially in the more humid tropics of such indigenous agroforestry practices with efficient combinations of several tree species and crops. Experience from various field workers in different parts of the tropics show that such examples can provide rewarding information on possible management techniques for mixed plantations.

Investing the proper amounts of capital, labor and education

A lack of investment capital can hurt forestation efforts in two ways. First, it often prevents the use of the best available technology. When money is short, there may be no choice but to accept increased risks. The second and perhaps greater effect, however, is that capital shortages are preventing necessary forestation projects from being attempted.
Often, however, a lack of capital is blamed where the primary cause for inactivity is a fixation on establishment of large plantations for the production of industrial wood. In most developing countries, the need for fuel wood far exceeds the need for industrial wood, and small fuel wood plantations can often be established with little outside capital. The largest need, other than technical expertise, is for unpaid local labor. In effect, this labor forms capital. People are not likely to



form capital with their sweat to supply a distant mill they have never seen, but they may work very hard to obtain tree products for their own consumption. Education is the key to success in this area. First, the planner must be educated about the needs of the local population. After these needs are known and appreciated, the planner can educate the local population on appropriate forestry techniques. The first step, however, must precede the second.

'Poor work': the human factor

International surveys of planting activity and its success indicate that many failures are caused by a variety of things that generally fall into the category of 'poor work'. This category is meant to include all failures to apply the technology that was known by the people who planned and supervised the projects. Often, the underlying causes are poor planning and supervision.

Tree seedlings are delicate organisms with a limited tolerance for adversity. This makes that the range of conditions under which seedlings of a given species will survive after planting is relatively narrow. The right species must be chosen for each planting site, and it must be planted at the appropriate time. Often, nursery production is poorly coordinated with out-planting needs. Trees of the wrong species are supplied, or trees of the right species are supplied at the wrong time. Predictably, results are very poor.

Many seedlings die because they are poorly planted, and responsibility for poor planting must be placed on individual foremen. The forester in charge of a planting program should visit the planting sites frequently to check on the quality of work. Experience has shown that good foremen need occasional encouragement, and that poor foremen can be quickly identified in this way.

Particularly in the tropics where competing vegetation grows rapidly, new plantations must be weeded. Neglect of weeding is probably the most important single factor contributing to failure of tropical plantations. Often, this failure is attributable to a lack of sufficient funds – an indication of poor planning.

The two most important hazards to young plantations are fire and grazing. The need for firebreaks and for exclusion of cattle from seedlings is well known. Yet many a plantation is destroyed by these agents.

These last examples of the lack of proper supervision of young plantations are unfortunately all too common. In planning forestation projects, attention is too often only given to financing the establishment of a certain area of new plantations without committing funds for maintenance in subsequent years. More attention should be given to the maintenance of existing plantations than to gross areas planted.

Foresters and farmers must listen to one another

Although many indigenous peoples are aware of the importance of forests to their environment and livelihood, and many have managed trees for multiple benefits, the implications of the unprecedented rate of deforestation may not be well understood by them. Many tropical regions are being settled by migrants from other ecological zones. Often, these people's need for land and their ill-adjusted husbandry practices have changed the local traditions of tree management. In other regions where fuel wood and other forest products have traditionally been available for the taking, changes in land and tree ownership and tenure rights have taken place. In some places, fuel wood consumption by the growing population has gradually surpassed the production potential of the woody vegetation.

Through such processes of rural change, wood shortages have snuck up on people. Nothing in their experience warned them of the danger. Many have no way of knowing that their local shortages are multiplied a thousand-fold throughout the world. Consequently, the implications of deforestation are not well understood by the local people who are in the best position to do something about it. That is one reason why forestation efforts fall so far short of recognizable needs.

Under these circumstances, it is obvious that public education or extension programs must accompany forestation programs. These extension campaigns should not be based on the assumption that farmers do not know the value of trees or the

ways in which they can be grown, however. Rather, they should concentrate on helping farmers to understand how specific forms of tree growing can assist them in meeting the challenges of everyday life in a rapidly changing world. To be effective, the extension work must consist of a true dialogue between rural people and professional foresters. In this dialogue, the farmer should be able to express his tree-related needs, his traditional knowledge, and his perceptions about his own living conditions. The professional forester should use the farmer's experiences in the search for ways to supply the farmer's needs. Solutions should be compatible with traditional wisdom as well as the present-day rural environment.

Chapter 6 Towards a global forestation strategy

Implications of deforestation

In previous Chapters of this book we have examined what is happening to the world's forest and what people are attempting to do about it. In this Chapter, we summarize the situation and attempt to draw some useful conclusions.

The world's forests are disappearing – slowly in some places and rapidly in others. The reasons for deforestation differ with location. In some places, trees are being cleared to make room for some other land use that appears to be more profitable. In others, trees are being harvested for valuable uses and insufficient thought is being invested in reforestation.

Whatever the causes, the implications of deforestation are extremely dangerous. Decreases in forest area must inevitably lead to decreases in supplies of forest products for the future. Long-term economic projections are risky, but there seems to be little doubt that human demands for forest products will increase in the years ahead. If the development plans of the tropical countries are even moderately successful, demands for industrial wood products like paper and construction lumber can be expected to increase many-fold. Use of these products appears to be closely related to a family's overall standard of living.

Demands for these products in industrialized nations are expected to increase at slower rates, but the increases are equally significant because per-capita consumption of forest products is already quite high in these nations. Furthermore, the needs in many industrialized nations are already being supplied through importation. In these nations, foresters have computed the capacities of domestic forests for sustained yields of wood products. Harvests are kept within sustainable capacities, but the feat is accomplished by importing forest products. In effect, deforestation is exported. Canada is a major exporter of forest products, but so are some tropical nations whose forests cannot long sustain the exports.

Projected demands for industrial products, however, are dwarfed by those for fuel wood in tropical countries. This problem was created by the rapidly growing human population and the lack of economic development. For the poor, who use a majority of this fuel wood, there may be no satis-

factory substitute in the near future. Yet in many countries harvests already exceed the capacities of the forests.
The environmental effects of deforestation are frightening to contemplate. The extent to which tropical rainforests influence the earth's climate is not known, but there is little doubt that there are important effects. It is known that forests prevent soil erosion and filter and purify water and air. It is known that soil erosion is increasing rapidly in many areas that have recently been deforested, and that flooding increases when forests are removed.
In the long term, no one benefits from deforestation as it is now occurring, and forests must be viewed in the long term. Up to a point, a forest is a renewable resource if people care to manage it as such. Some useful products can be removed from a forest forever. People all over the world know that. Throughout human history, people have been taking things from forests and giving little in return. It is time for people throughout the world to realize that there are limits to these harvests and that these limits have been exceeded.

Solutions to deforestation

There are two obvious solutions to the problem of deforestation – decrease the consumption of forest products or increase the ability of forests to supply the things people need. For people in developed nations who consume large quantities of industrial forest products, decreases in consumption and substitutions may be possible in the long run if they take place slowly. For many people in tropical countries who need wood fuel for warmth and cooking, decreases in consumption are unthinkable. They may have no choice but to use their forests to the last tree.
Fortunately, there is another answer: forestation in combination with improved management of existing forests. Trees can be planted on open land that is not needed for other purposes. Fast-growing species can produce many times more wood for simple products like fuel than natural forests are producing. These plantations are not a perfect substitute for natural forests, and there are risks associated with their establishment. But these risks are dwarfed by those associated with the

deforestation we are now experiencing.
Opportunities for tree planting are not limited to forest situations. On farms, the trees planted around buildings, along streams, and at the edges of fields can contribute significantly to supplies of forest products.
Worldwide, the needs for tree planting of all sorts is massive. Planting efforts must be multiplied many-fold. The difference between what is being done and what needs to be done is so large that a statement of some numerical goal seems almost pointless. Worldwide planting of 10 million hectares per year certainly would not be excessive, and might be sufficient. In tropical countries that goal would require more than 5 times the present effort.

Education for enlightened self-interest and public involvement

How can such a massive goal be attained? One tree at a time by people who are pursuing their own interests. How can people be convinced that it is in their interest to plant trees? Primarily through education. In the long term, the deforestation that is now occurring hurts everyone. People who understand the situation can only conclude that something ought to be done.

Village plantation program, Republic of South Korea

In Korea, severe deforestation has taken place in the past. The resulting shortages of fuel wood forced rural people to collect leaves, grass, forest litter and crop residues for use as fuel. This removal of organic matter meant large loss of humus and increased erosion.

To counter these trends, the Korean Government started a program to protect forests and to create new village plantations in 1973. The target of the 10-year program was to plant a million hectares of trees. Of these, about a third were to be fruit and nut species, another third were to be fast-growing trees, especially for fuel, and the remainder slower growing timber trees.

This tree-planting program became a part of the Saemaul Undong Movement. The objective of this nation-wide program was to modernize rural existence through self-help for rural development. To implement this program, emphasis was placed on cooperative action between Government and citizens. In villages, local Village Forestry Associations were organized. These locally elected bodies are organized like cooperatives and are voluntarily managed by villagers. They are responsible for the development of local forest areas. In total, 21000 village groups have been established. They are members of a county forest association, which in turn belong to the National Federation of Forestry Association Units. This network allows a great deal of independence for the local organization, but also allows close working relations with the governmental forest service. So the Forest Service can effectively advise and help VTAs. Thus, villages are provided with subsidized seedlings, fertilizer and other materials. The costs of tree planting are shared, with the villagers providing about 45% of all costs, mainly in kind.

In addition to these institutional arrangements, legislative changes were an important element of the plantation program. As a result of a major land-reform, almost three quarters of the country's forests came into private hands. The majority are in relatively small plots. Further laws and regulations were then drawn up, which emphasized the landowner's own responsibility for forest protection.

This combined approach was singularly successful in stimulating tree growing. By 1977, five years ahead of schedule, the overall planting target of the program had been reached. In 1978, the total income from these village forestry cooperatives was already US$90 million. The main reasons for this success were the active community commitment and involvement coupled with the strong government's policy and practical encouragement and support for the establishment of new plantations.

The first job, then, is education. The message of sustained yield – of the limits of any forest to produce goods – must be carried to people who have not needed such a message in the past. These educational efforts must be directed at politicians, decisionmakers, and land-use planners as well as at the people who will have to do the actual job. The assistance of opinion leaders of all sorts is needed badly. In part, this publication is meant to ask for that assistance.

The second major job is to see to it that forestation is in the interest of the people who will have to get the job done. Incentives of various kinds can be offered, including cash and technical assistance for tree planting itself. It should be recognized, however, that the biggest incentive is a profit from the tree crop. People will plant trees if they think the work will improve their lives in some way. They are a lot less likely to plant trees if they believe that others will get all the profits. Governments can do much to assure an appropriate distribution of profits.

The third major job is to involve all levels of national and international institutions, government services, and nongovernmental and volunteer organizations in the stimulation and implementation of the first two jobs. The task of forestation is so large that it will only be possible if appropriate policy deci sions and field activities are undertaken by the entire forestry profession and the entire land-use planning establishment as well as the residents and leaders of rural communities.

There is a need to use many approaches and to establish forests of many types, depending on need. There are places for national forests, industrial forests, community forests, and the small plantings of agroforestry.

National forests for safeguarding essential environmental value

Forests administered by national and state governments have been highly successful in Europe and North America. In developing countries, they have been less successful for a variety of reasons. Some reasons for insufficient knowledge about appropriate locally adapted management systems are lack of sufficiently trained foresters for implementing fieldwork and high pressure on forests through heavy demand for forest land

and for products by local people. Nevertheless, such national forests have a place in the developing world. Especially under conditions where forests need to be maintained to safeguard essential regional functions of a watershed or to protect ecological forest resources for future generations.

Forestation efforts by national governments are perhaps best directed at reclamation of degraded land that is currently unoccupied. The environmental protection that trees offer is important in such areas, but the land is often so poor that individuals cannot be expected to reforest it for profit. Public funds should then be made available. And the new forests will need to be managed by a government organization in order to sustain their protective value.

Possibly because they have followed the pattern of their counterparts in developed countries, national forest services have often emphasized their policing tasks as a means to protect state forests from being disturbed by people living in its surroundings. But such single-minded enforcement of forest-protection laws has proved ineffective and unpopular. Forest services can gain much more credibility and respect at the local level, if they combine their essential tasks for forest protection and reforestation with activities creating new opportuni-

ties for local people. So they must be more flexible.
An interesting example of the combination of activities for state forest management and socio-economic development for local people can be found in Thailand. The program there succeeded in developing a cooperative and productive relationship between farmers and foresters. Originally, when the forests were treated as national property, the national forestry agency had little success with forest protection. Success began when the government started to encourage local community development in combination with reforestation of large areas in the forest reserves, which had been cut during the previous 30 years.
A major aspect of this program is the allocation of selected plots of forest land to squatter families, who already live in the reserved forests. These families are granted a certificate for 5 year's use, which can be converted into a permanent right of tenure after that period of proper use. Extension is encouraging people to establish fruit orchards or agroforestry plantations on these lands. The forest service has constructed several new villages for these people and is assisting with schools and health centres. It also provides advice on the establishment of cottage industries such as charcoal production, beekeeping and fish culture in new reservoirs. Further employment for the people is being provided in the government's nurseries, which provide seedlings of both fruit and timber species, or in the reforestation work.

Industrial forests: a case of profits and risks

Forest industries and other commercial forestry enterprises have much to offer in expanding forestation efforts. They have unrivaled expertise in the establishment and care of forest plantings. They also have a keen sense of the profit motive that must be tapped if forestation efforts are to be expanded rapidly. Finally, forest industries can obtain adequate financing for profitable projects.
The keys to profit in industrial plantings are large scale, rapid tree growth, and relatively short periods between successive harvests. The shorter the rotation, the briefer the period that capital investments have to be carried before profits appear.

Rapid tree growth, of course, is what makes short rotations possible. A large scale is required for industrial plantings to justify planning, management, establishment of transportation facilities, and construction of a mill to process the wood. Outstanding examples of successful industrial plantings are found throughout the southeastern United States. These plantations were established and are owned by United States Corporations, and there is little evident conflict over their management or the disposition of their products.

Other fine examples of successful industrial plantations are found in Brazil, New Zealand, and Chile. The program on man-made forests in Brazil has been described in Chapter 3. Plenty of land was always available at a low price, and that land was capable of supporting rapid growth. Profits were possible because the value of the products exceeded the costs for land acquisition, plantation establishment and care, harvesting, transportation, and risks.

Risks may be biological, economic, or political. The possibility of plantation failures is always there, and there is always a chance that economic conditions will change, making an investment appear foolish. Anyone investing in a long-term en-

terprise such as plantation forestry must consider the risk that some political change will remove the profits of the venture. If you think that costs are always lower in developing countries than in developed ones, think again. Labor costs for unskilled labor are low, but skilled labor is also needed, and it may not be available inside the country. Importing skilled workers is expensive. Furthermore, in a tropical country the costs of establishing an adequate road system may be too high or materials needed may have to be imported at high cost. Clearly, there are severe limits to what can be expected from industrial plantings established by private corporations. They cannot be expected to take unreasonable risks with venture capital, and they can only be expected to grow wood if they are certain of obtaining the harvest some time in the future.

Community and farmer's forests: involving local people

Who will supply the wood needs of all those people living in small communities in tropical nations if commercial enterprises do not? The answer is obvious: the people who live in those small communities.

As early as 1972, the Food and Agricultural Organization of the United Nations recognized a need to give more emphasis 'to human and social criteria in the evolution of forestry'. The FAO World Conference on Agrarian Reform and Rural Development recommended community control over natural resources including forests. It further recommended that forestry activities involving local people be promoted to protect the environment and to meet local needs for fuel, fodder, and other products.

There are many examples of success with community and farmer's forestry, which is a joint effort between government agencies and local people. The last may work either in cooperation or individually. In general, the government must provide at least part of the expertise as well as needed materials. Local people must do the work.

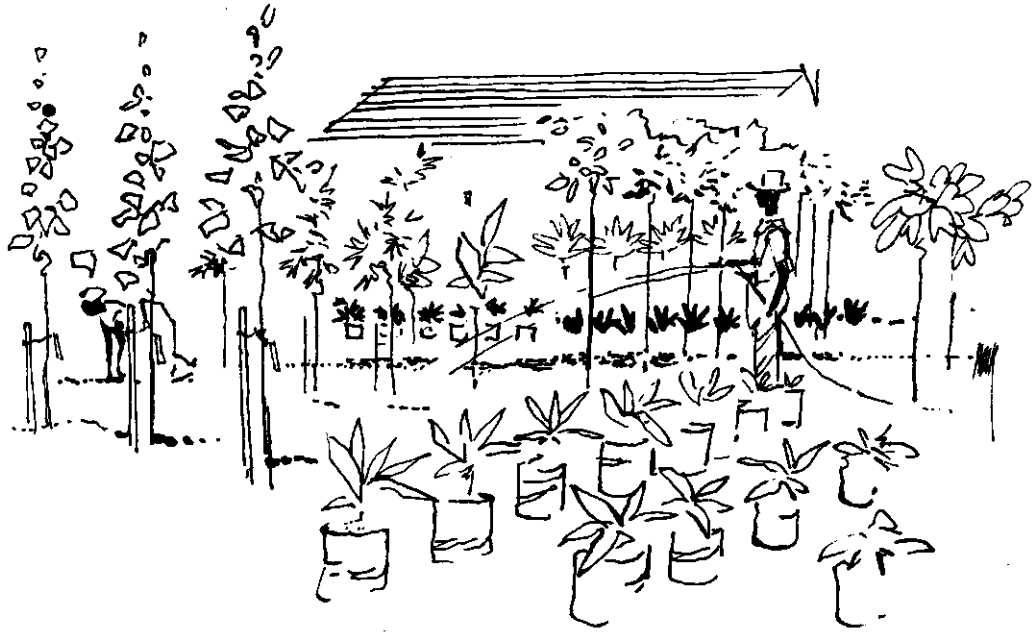
The targets for community and farmer's forestry are the lands owned by communities and by individuals. Often growing of trees can be stimulated in combination with agricultural crops on farmer's fields. An example of the potential for such

agroforestry projects has been described in Chapter 4.
Bare land that will support trees but not agricultural crops should be another target, especially for community forestry. The land often produces little of value at present, but has the potential to produce valuable tree crops. Getting the job done requires joint participation and joint management.
Bera, India, has a very successful community forestry program that has been functioning for 30 years. Two full-time forest wardens are paid in rice by the community for guarding a tract of forest. The village council decides who can harvest wood and how much can be harvested each year. A locally appointed forest manager carries out the council's decisions.
At first, the value of this system was not understood by the state's forestry department. The gap between the local community and the forestry department was bridged through the efforts of a voluntary development organization. This organiza-

tion helped members of the local community to form contacts with professional foresters in the state forestry agency. As a result, the forestry activities of this community were extended to include reforestation of bare land. These activities were integrated with other rural development activities such as improved agricultural practices, processing of forest products, and adult education.

A second example of the success of community forestry can be found in the Sahel country of Burkina Faso. To control desertification and to produce sufficient fuel wood for local needs, the Forest Service there has embarked on an extensive program of village forestry. In addition efforts are directed at enhancing management of natural forests and controlling their exploitation. In the same program, highly efficient wood stoves are being introduced into the community.

The long-term goal of the program is to encourage farmers to accept responsibility for and take charge of their own environment and the tree resources in their village territory. Activities are not limited to extension messages. They include technical assistance and material incentives for the establishment of village nurseries and plantations. The program encourages the establishment of both communal forest plantings and the plant-



ing of trees on and around private agricultural fields. Four years after the program started, some 860 villages were participating in it. The villages had planted more than 1200 hectares collectively and 1500 hectares individually.
So far, however, these examples remain just that. They are still too few. They are interesting, but they must be multiplied many-fold to significantly alter the supply of forest goods and services in the world.

Let there be forest: now and forever

People need trees and people need forests. They need these forests for the things forests do for the environment and for the products that can be made from them. These needs must increase if human opportunities are to increase, but the world's forests are presently being over-used. The challenge in the years ahead is to turn the various examples of successful forest management, agroforestry, and industrial and community forestation into prevalent patterns of land use. For these examples represent the most promising ways to assure that future generations will have the forests and forest products that they need.
No matter how desirable their intent, however, idealistic pronouncements are far easier to make than to implement. We have seen enough examples of innovative approaches to substantiate the claim that an increase in the rate of forestation is feasible. To implement the needed programs, new policies will have to be adopted at the national and international levels, and additional funds will have to be provided to implement them.
Both the new and existing programs must be finely tailored to local environmental conditions. Tree seedlings will not survive if they are not adapted to the conditions in which they are placed. Foresters are well trained to recognize the physical environment and match the species to that environment. Foresters and policy makers must recognize that there is also a human environment for forestation. So far, they often have failed to recognize the human environment and adapt their programs to it.
The Tropical Forestry Action Plan launched in 1985 by the

Food and Agricultural Organization of the United Nations tries to achieve exactly such goal. But this plan will remain one more paper plan, if it is not supported by all kinds of institutions from national governments and their forestry agencies to local organizations and private people.

Foresters are accustomed to viewing themselves as guardians of the forest. They also must come to see themselves as cooperators in rural development. The trees they are planting and the forests they are establishing are for the benefit of people – most often local people. The primary significance of forestation is its effect on the rural landscape, and forestation is just one of the changes occurring there. Government development

agencies and their representatives must learn to act together and to work closely with the local population, and forestation must be integrated into that process.

For the most part, local people are the soldiers in the forestation army. Without their help, the programs that are needed cannot succeed. Their help can be obtained by recognizing the forest benefits that are most important to them and emphasizing those benefits in programs.

An integrated strategy that uses forestation and other development efforts to help rural populations is most likely to enlist the support of rural populations. But an integrated strategy implies more than that. It also requires the coordination of the best efforts of all the people who are willing to help.

Professional organizations are in place, and private foundations and volunteer organizations have been formed for the conservation and sound use of forest resources. They need support of all kinds, and they can make good use of it.

We invite people at all levels to help in world forestation. Take a stand! Join us in a simple declaration:

Let there be forest – now and forever

List of some important organizations promoting tree growing and forest management

Food and Agricultural Organization FAO, Rome, Italy.
United Nations Environment Program UNEP, Nairobi, Kenya.
United Nations Educational, Scientific and Cultural Organization UNESCO, Paris, France.
United Nations Development Program UNDP, New York, USA, with special International Tree Project Clearinghouse ITPC/UNDP, New York, USA.
World Bank, Washington, USA.
World Food Program WFP, Rome, Italy.
Inter-American Development Bank, Washington DC, USA.
Asian Development Bank, Manilla, Philippines.
International Union of Forest Research Organizations IUFRO, Vienna, Austria.
International Council for Research in Agroforestry ICRAF, Nairobi, Kenya.
International Union for Conservation of Nature and Natural Resources IUCN, Geneva, Switzerland.
Earthscan – International Institute for Environment and Development IIED, London, United Kingdom.
Environmental Liaison Center, Nairobi, Kenya.
International Tree Crops Institute, Braintree, United Kingdom.
International Society of Tropical Foresters, Washington DC, USA.
Volunteers in Technical Assistance VITA, Arlington, USA.
CARE International, New York, USA.
Global Forest Fund GFF, Wageningen, Netherlands.

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