Environmentally Sound Small-Scale Forestry Projects

by: Peter F. Folliott and John L. Thames

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ENVIRONMENTALLY SOUND SMALL-SCALE FORESTRY PROJECTS

GUIDELINES FOR PLANNING

a CODEL * VITA publication

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Guidelines for Planning

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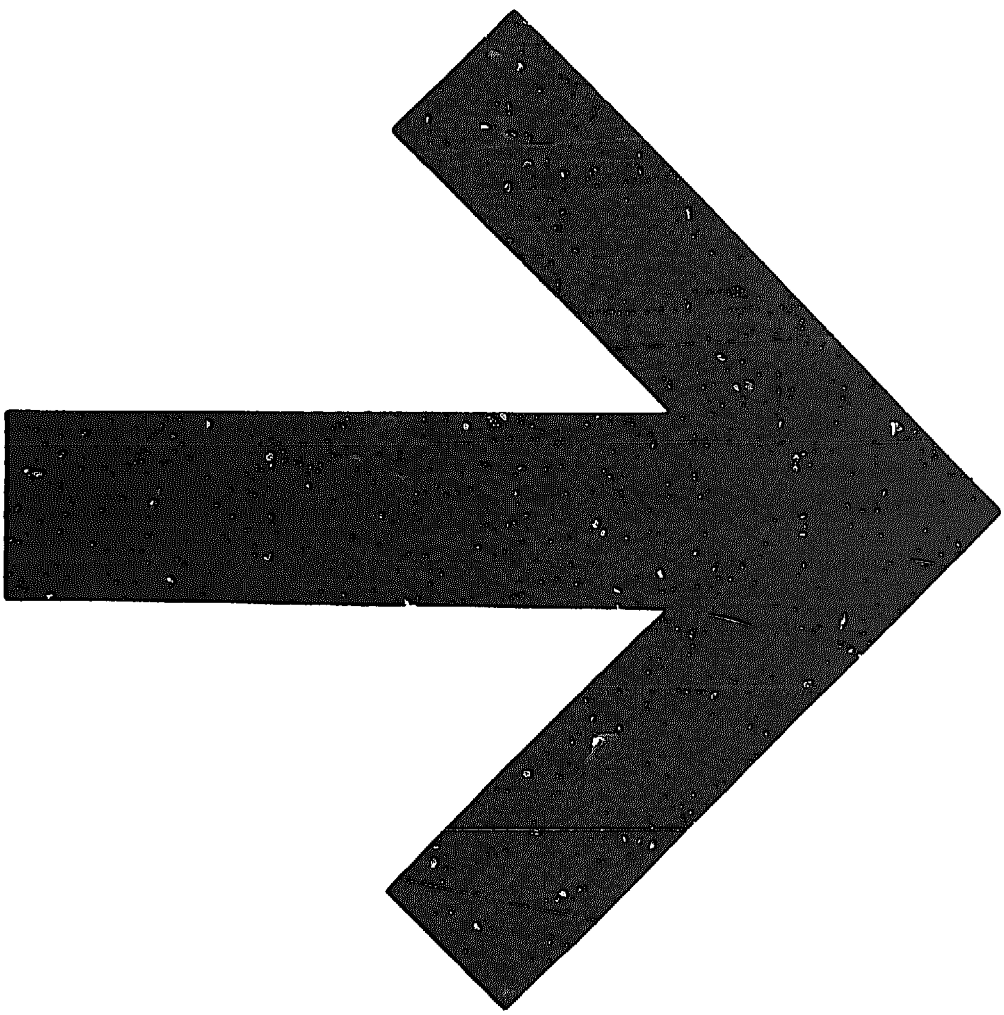

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PREFACE

This manual is the third volume of the Guidelines for Planning Series. The first volume, Environmentally Sound Small-Scale Agricultural Projects, was published in 1979; it is now available in French and Spanish. The second volume, Environmentally Sound Small-Scale Water Projects, was published in 1981. The booklets can be ordered from VITA.

This manual has been written for community development workers in Third World countries who are not technicians in the area of forestry, but who want some general guidelines for planning environmentally sound small-scale forestry projects.

The CODEL Environment and Development Committee has guided the development of the Guidelines for Planning Series and this volume. CODEL acknowledges the contribution of the members of the Committee who commented on drafts of the booklet:

Father John Joe Braun, Missionaries of Africa, Committee Chairperson
Ms. Elizabeth Enloe, Church World Service
Mr. George Gerardi, Attorney at Law
Mr. George Mahaffey, The Peace Corps
Rev. John L. Ostdiek, Franciscan Missionary Union of Chicago
Dr. Ragnar Overby, The World Bank
Ms. Agnes Pall, International Division, YMCA
Mr. C. Anthony Pryor, Center for Integrative Development
Mr. A. Keith Smiley, Mohonk Consultations on the Earth's Ecosystem
Dr. Gus Tillman, Cary Arboretum

In addition, a number of reviewers read a draft of the text carefully. These include:

J. E. M. Arnold, U.N. Food and Agricultural Organization
Michael Diamond, International Division, YMCA

Hans Gregersen, University of Minnesota
Sam Kunkle, USDA Forest Service
Richard Saunier, Organization of American States
Mervin Stevens, UN Food and Agriculture Organization and other members of the forestry staff of FAO
Fred Weber, Forestry Specialist

The book was also reviewed by VITA volunteers and AID personnel.

Ms. Molly Kux, AID Office of Forestry, Environment and Natural Resources, has been uniquely helpful in identifying the authors and moving the project forward. Ms. Kux and Mr. Albert Printz, AID Environmental Coordinator, continue to support and encourage the Environment and Development Program and, especially, the Guidelines for Planning Series.

The AID Office of Private and Voluntary Cooperation has supported the development of the CODEL Environment and Development Program. CODEL gratefully acknowledges their contribution to the publication of this volume.

A special note of gratitude is owed to Carol Roever who has worked with the Environment and Development Program since its inception, and who contributed her accumulated expertise to the production of this booklet.

CODEL is pleased to publish this book by two noted authorities in the field of Watershed Resourses Management. Short biographies of the authors can be found at the end of the book.

We welcome comments from readers of the book. A questionnaire is enclosed for your convenience. Please share your reactions with us.

Boyd Lowry, Executive Director

Helen L. Vukasin, Environment and Development Program

AUTHORS' NOTE

The need to plan environmentally sound small-scale forestry projects, especially in Third World countries, is increasing as greater demands are placed on forest-based resources. This manual has been written to assist development workers and others in planning these projects. It is impossible to consider all of the possible multiple wood products from trees and multiple uses of a forest ecosystem in a given locale. The authors hope that the guidelines presented in this manual will furnish a point of departure for environmentally sound planning of small-scale forestry projects.

It is important to note that planning guidelines for small-scale forestry projects to be implemented in humid, temperate, or arid forest ecosystems have been grouped together, whenever possible. Certainly, specific guidelines may be more appropriate to one particular forest ecosystem than another. However, it was the authors' opinion that many guidelines are general in nature, and their applications may be independent of forest ecosystems.

To a large extent, this booklet is intended to complement others in the Guidelines for Planning Series co-published by CODEL and VITA: Environmentally Sound Small-Scale Agricultural Projects and Environmentally Sound Small-Scale Water Projects.

For their contributions to and suggestions for the preparation of this manual, the authors owe a debt to many, including: Samuel H. Kunkle and John H. Dieterich, USDA Forest Service; Richard E. Saunier, Organization of American States; Hans M. Gregerson, University of Minnesota; J. E. M. Arnold and Mervin Stevens, UN Food and Agriculture Organization; Michael Diamond, National Council of the YMCA, Fred Weber, author of Reforestation in Arid Lands (VITA 1977), and Molly Kux, U.S. Agency for International Development.

Finally, the authors wish to express their gratitude to Helen L. Vukasin, CODEL, Environment and Development Program, for her support throughout the preparation of this manual.

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CHAPTER I: USERS AND USES

An area in Kenya desperately needed water in 1976. There were no permanent sources of water and only one well in the local community. To help this situation, a cooperative project involving the Kenya Forestry Department was initiated to build catchment dams and to plant trees in the Hurri Hills. The Hurri Hills are the lifeline of the Gabra people, who graze their cattle and camels in the hills. Therefore, the wishes and needs of the tribe were critical in planning the project. As a result, the project personnel worked with the community, after first carrying out research to determine appropriate dam sites and trees to be planted. Gabra elders participated in the supervision of the project, and local people were trained to maintain dams and to plant trees. Local labor was hired from as many households as possible.

Who should use this manual?

This manual can be useful to development workers and those interested in planning, implementation, or management of small-scale forestry projects who wish to:

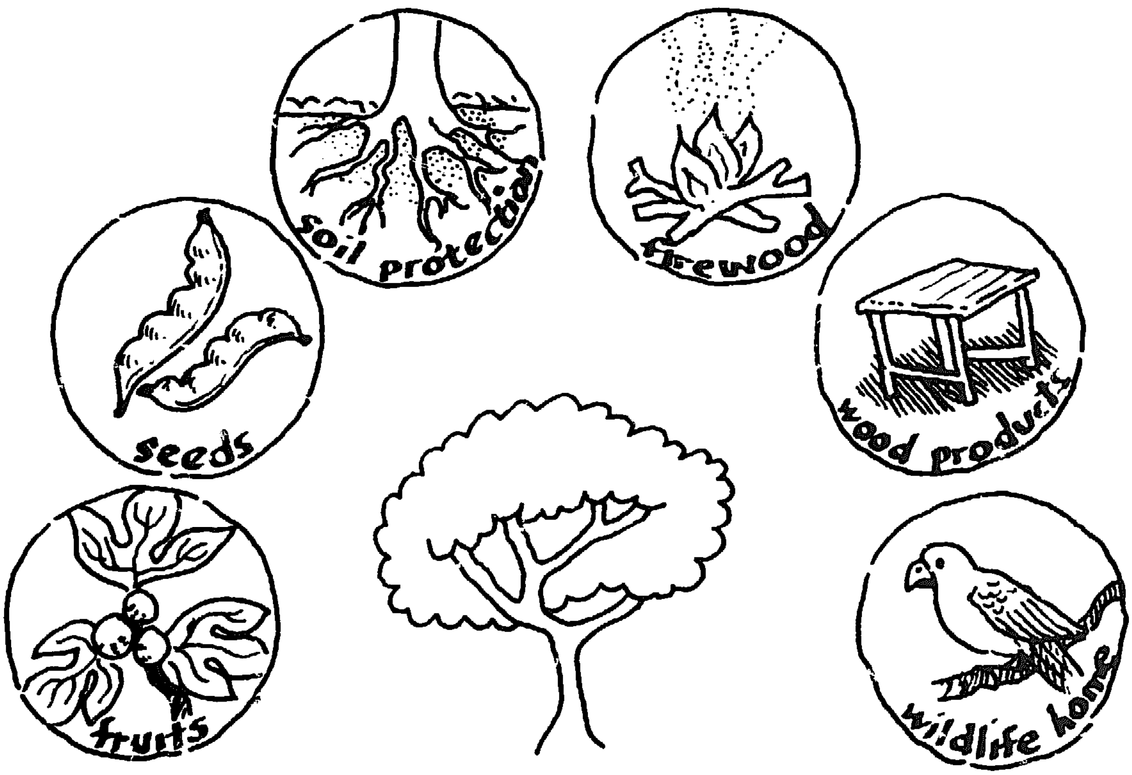
— Become aware of major factors that should be considered in planning small-scale forestry projects,

— Become acquainted with the potential of forestry projects to contribute to the quality of life of rural peoples and to local economies,

— Learn how to protect the life support system of the community through environmental relationships between forestry, agriculture and other land use.

What is a small-scale forestry project?

The type of forestry planning discussed in this manual is for projects developed at a local farm level and primarily for the benefit of the local people. These projects could include only one or two farmsteads with land holdings of a few hectares, or they could involve an entire rural community in a cooperative effort extending over several hundred hectares.



Without production in rural areas, people cannot be sustained. Unless the land produces abundantly, on a sound ecological basis, a country is in difficulty. Nevertheless, people who work the land are the most vulnerable members of society. They are the first to feel the effects of hard times. Environmentally sound forestry projects can help moderate the ups and downs of local economies by providing sustained products over long time periods. This should be a goal of planning small-scale forestry projects.

What purpose does this manual provide?

Complete planning involves the often more difficult task of understanding and working within social and economic constraints which, invariably, prevail at national, regional, and local levels in all countries. This is beyond the scope of this manual. However, it is hoped that this manual will enable development workers to understand technical and environmental issues which are the ultimate basis for planning and implementing sound projects.

Specifically, the manual has two main goals:

-- To promote technically planned and environmentally sound small-scale forestry projects.

-- To assist in the transfer of technology by using the manual as a tool for education and extension.

The purpose of this manual is to present an introduction to the planning of small-scale forestry projects, particularly as they may be integrated with agricultural and other land uses. The scope of the manual is limited to technical and environmental aspects of small-scale forestry projects.

CHAPTER II: A PLANNING PROCESS

Projects are not necessarily transferable from one region to another, even if the projects are designed to eliminate the same problems. For example, the Lorena stove, a stove which reduces the amount of smoke output, has been beneficial in Guatemala. Lorena stoves were also introduced to villages in Africa to reduce smoke-related diseases and increase cooking efficiencies. However, in one area insect-carried diseases increased because insects, formerly kept away by the smoke from open hearths, proliferated. Consequently, the new stoves were abandoned pending a solution to this new problem.

Why plan?

Most areas capable of growing trees have limits in size and ability to produce or sustain goods and services. However, they contribute to the well-being of people only if they are properly managed and protected. To attain specific goals, a proper balance is needed between social and economic benefits derived from products and uses, and the social and economic costs required for operation and administration. To achieve this balance, planning is needed.

How should planning be approached?

Planning begins with a dialogue whereby local people assess their needs, define their goals and objectives, and agree on methods for reaching the objectives. The results of this dialogue is a consensus which has emerged from discussions among community members and is endorsed by the community and development worker. This shared responsibility and understanding of an approach to an objective or problem is especially critical for small-scale forestry projects for two reasons:

— Because economic and social issues are so closely intertwined.

— Because long periods of nurturing and protection are often needed for forestry projects to yield noticeable and desired results.

Good planning has not occurred if a development worker arrives in a location and unilaterally decides that the village can benefit from a woodlot project in an area used by villagers to graze their animals. This early dialogue between villagers and development workers (who share their knowledge and goals and agree upon a particular approach to solve a mutually agreed upon problem) makes it more likely that a mutually endorsed objective can be achieved. Trees are planted by people and cared for by people to ultimately benefit the people. The emphasis is on people, not vegetation. Forests and small-scale-forestry projects will flourish only if the people care. Whether or not they care depends, in large part, upon their participation in the planning process.

Planning to meet the needs of local people — food, as well as fuel.

Planning can be time-consuming. However, without this communication between development workers and villagers, a project is likely to be delayed in its implementation or neglected after it has been implemented because project designs may be inappropriate for local conditions and needs. A commitment to share the decision-making process with the community does not guarantee that a plan will succeed, but it is a prerequisite for the community support needed to maintain a project.

Methods for "animating" or facilitating village discussions are discussed in various sources. For example, the Lik-Lik Buk is especially helpful. Other references are listed in the bibliography at the end of this manual.

What is the planning process?

Ideally, the planning process follows a sequence of several phases. Although the overall process might be described in different ways, the major steps are:

- Identifying problems and objectives by the local community.

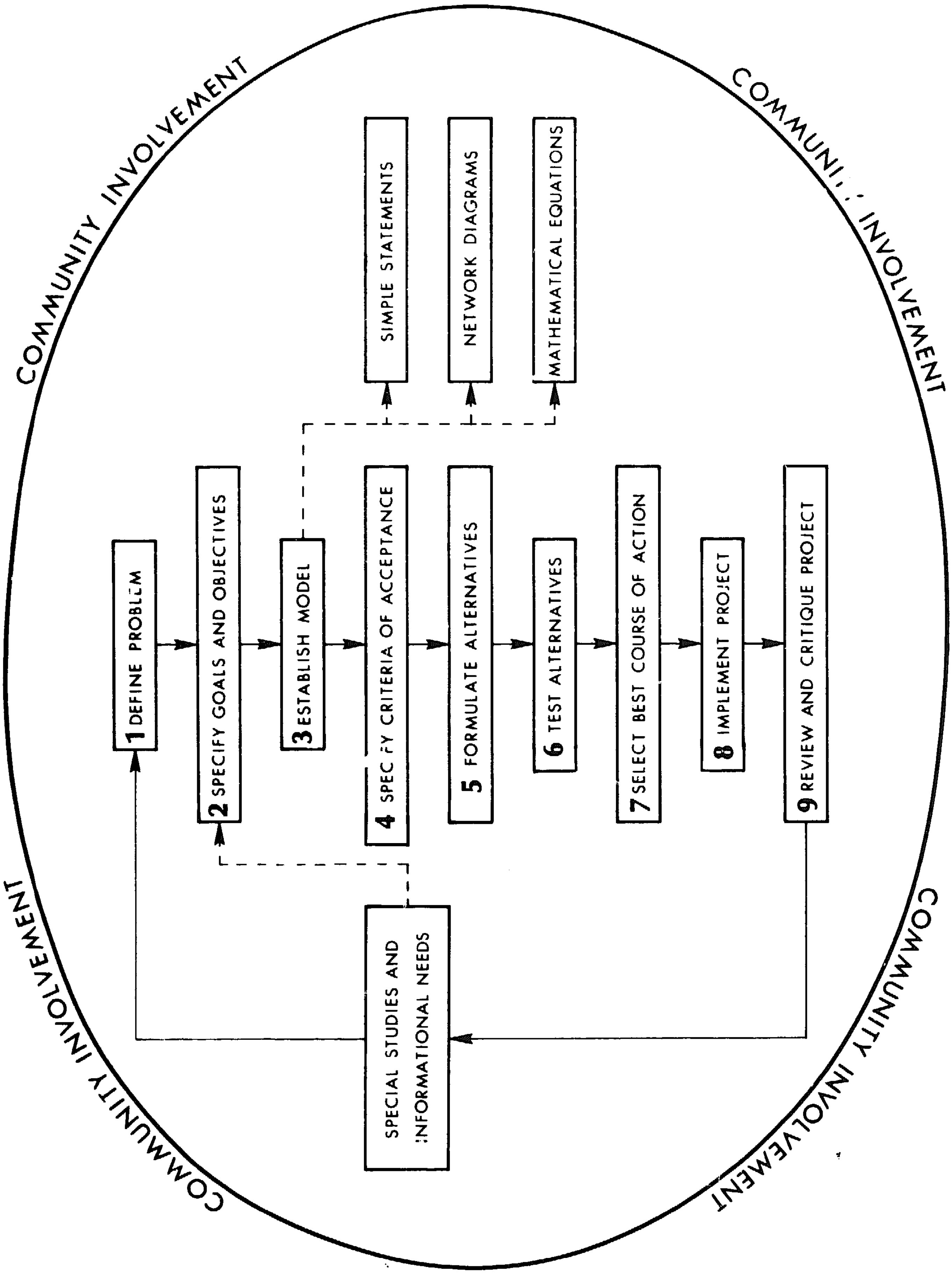
- Establishing/identifying criteria of acceptance with those who will carry on the project.

- Evaluating various alternatives and trade-offs involved in selection of a project.

Various quantitative techniques may be used to aid in completing the basic phases of a planning process. Some of these quantitative techniques can be quite detailed and require the use of computer programs and simulation techniques. Customarily, a development worker will not have ready access to computer programs and simulation techniques.

In the latter instances, it is helpful to have a checklist of steps to be considered as planning proceeds. The following diagram illustrates the various stages in a planning process.

Diagram: A Planning Process



Explanation of the checklist:

1. Define the problem, both in terms of sociological and economic factors.

   Villagers and development workers must understand and agree on the problem to be addressed by the potential project. Special studies and information collecting may be needed once the problem is defined. For instance, if a problem is defined as lack of fuelwood within a reasonable walking distance of a village, information on the village population and history of cooking activities may be needed, as well as information on the history of vegetation in the area. Obviously, much of this information can come from the villagers knowledge of the area and history. This information may be supplemented by information from local universities or development organizations working in the area. Sometimes, this is called the "needs assessment" or "needs identification" stage. Whatever the label, a sound planning process must include gathering this information at an early stage.

2. Specify goals and objectives of the project.

   Community involvement in specifying objectives and setting priorities among them is critical. If the community is not involved at this stage in the planning process, there is little chance that the project will be maintained and sustained over a long period of time.

3. Establish a model of the system in which the project will be implemented.

   After the problem has been defined and the project objectives clarified, it becomes imperative to consider how those objectives can be met within the established ecological and cultural setting. Therefore, a model should be established of the physical and cultural setting in which the project will be implemented; this is a representation of how that part of the real world operates. It can be done in various forms -- simple statements, network diagrams, or sets of detailed mathematical equations. The important thing to remember is that a "model" should be as complete and accurate as possible. The "model" includes two types of information: cultural and social descriptions, as well as information about the physical or ecological setting. This information can serve as baseline data which will be useful when the project is evaluated.

4. Specify criteria of acceptance.

These are guidelines against which project alternatives can be evaluated. No single set of criteria will be sufficient for judging the applicability of a proposed project. ECONOMIC objectives, as outlined in the chapter on institutional limitations, are often used as acceptance criteria. In addition, SOCIAL and CULTURAL criteria of acceptance are of the utmost importance in reviewing alternative projects; e.g., will grazing patterns be disrupted in such a way and extent as to encourage hostility among groups in the community? Will people be available to control poaching?

In addition, there are some general ECOLOGICAL guidelines which can be applied to the various types of forestry projects discussed in this manual. These guidelines would require that projects:

- Provide sustained benefits over long periods of time while meeting current needs of the community.
- Conserve forest ecosystem and protect the diverse, indigenous plant and animal populations.
- Be developed to provide multiple benefits.
- Maintain or improve soil productivity.
- Use water efficiently and maintain or enhance water quality.
- Use tree species appropriate to the local climate.

- Only use new species which have been tested to insure suitability to local site.

- Encourage the use of rapid growing, high quality trees.

- Protect the forest from destructive agents.

- Cut trees at appropriate biological and cultural times, if wood products are to be harvested.

- Harvest in a manner which does not disrupt other uses of forest (soil protection, water production, forage, animal habitat) and which maintains site productivity, if wood products are to be harvested.

Criteria or guidelines which reflect the principles of APPROPRIATE TECHNOLOGY or appropriate development have to be considered as well. These require that a project should:

- Make optimal use of locally available material and human resources.

- Have community support and involvement.

- Be based on community-identified and/or community-realized needs.

- Increase potential for community self-reliance in both short and long-term.

- Be compatible with available funding.

- Make use of and adapt traditional technologies.

- Have reasonable time frame for the community to take responsibility for the project.

- Have potential for being maintained and monitored by the community.

(These appropriate technology guidelines are taken from an earlier volume of the Guidelines for Planning Series, Environmentally Sound Small-Scale Water Projects.)

5. Formulate alternatives, including both project alternatives and alternate implementation methods.

   Because there is seldom a "right way" to approach a problem, project alternatives and alternate implementation methods need to be considered in a creative, yet, careful way. The appropriateness of dogmas from manuals and traditions should be examined in terms of the baseline data collected in the first step of planning and the constraints of the model developed in step 3. Each developmental situation is unique; each project should reflect the uniqueness of the setting.

   Remember, to do nothing (meaning, not to implement any small-scale forestry project) is a valid alternative which must be considered.

6. Test alternatives against specific criteria of acceptance.

   At this stage of the planning process, trade-offs are evaluated as the course of action is selected. Village participation continues to be essential. Does the project meet the CULTURAL, ECOLOGICAL, and ECONOMIC criteria? Is it compatible with the model?

7. Select best course of action, both in terms of a specific project and the methods for implementation.

8. Implement the project.

9. Review and critique progress of the project with the villagers, making adjustments as needed.

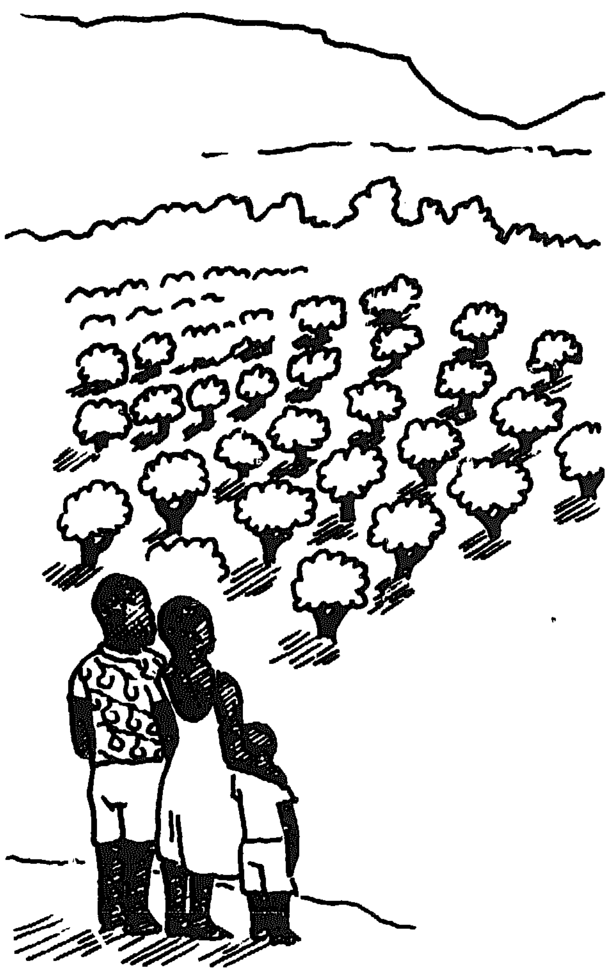
   The data collected when the "model" was formulated will again be useful here as the effects of the project are monitored.

Is this process definitive?

No -- this is not "the" definitive planning process. The above discussion makes the process sound very neat and orderly. Development workers with even limited experience know that it is anything but that. The steps suggested here must be adapted to suit individual situations. Other checklists may be more appropriate or may be used to supplement the steps discussed here. For instance, the Mini-Guidelines developed by Fred Weber (see appendix at the end of this manual) may be used to evaluate project alternatives and evaluate trade-offs. Regardless of the quantitative techniques employed or checklists used, the key to good planning is to achieve flexibility within predetermined guidelines of acceptance.

However, the principles behind the process are important in any developmental situation. Cultural and ecological factors usually coexist in a developmental setting. It is always important to maintain a continuing dialogue between development workers and community members, whereby resources and outlooks are shared. These principles are relevant to the development worker who is present when the planning is just beginning or who arrives in the midst of implementing a project. The specific steps may be changed, but the principles of the process endure.

Are education and training necessary?

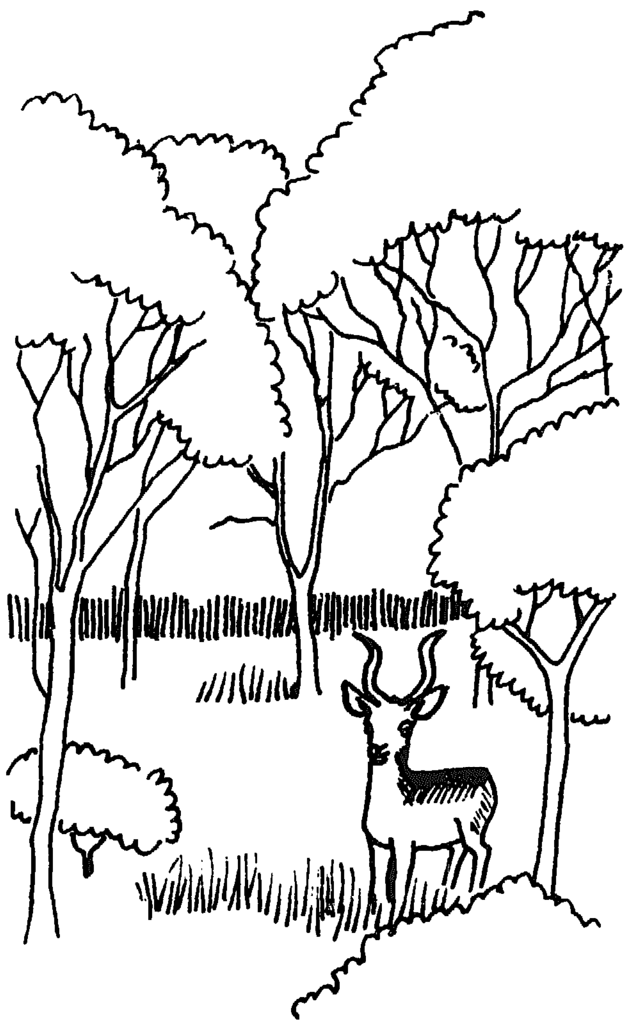


Yes, both are important. The goal of development is self-reliant communities. However, the education and training, which make this goal attainable, are not one-directional. Like the dialogue in the planning process, education and training have to be two-directional: a sharing process between the resources of a development worker and the resources and knowledge of the local community. Because forestry projects may not show immediate results like agricultural projects which can produce new crops after one growing season, it is critical that dialogue and interaction between all parties involved be continuous and conducted in a genuine spirit of sharing.

CHAPTER III: FORESTRY AND THE ENVIRONMENT

As in other tropical countries around the world, the rain and dry forests of Bolivia are being depleted at an alarming rate. Clearing forests for agricultural and range use by small farmers and others contribute to the forest depletions. Before anything can be done to reverse the situation, involved agencies must understand the ecology and limitations of the forests, as well as the situation of the small farmers with neither financial means nor know-how to utilize high technology.

What is meant by ecology and the environment?



The study of plants, animals and humans (as individuals, populations and communities), in relation to their biological and physical surroundings is called ecology. Environment, on the other hand, refers collectively to the biological and physical surroundings of plants, animals and humans.

Also, as dealt with in this manual, the environment includes cultural, social, economic and legal aspects that must be considered when planning sound small-scale forestry projects.

What is forestry?

Forestry is the practice of managing forests and associated natural resources for desired goals, with ecology providing a basic foundation. Forestry is also defined as a profession involving the science, business, and art of managing, creating and conserving forests and associated natural resources for the continuing use of their values by people.

It is important to note that while growing trees is an essential part of forestry, other vegetation (including grasses and grass-like plants, forbs, and shrubs) and natural resources (soil, water, wildlife, recreation, and minerals) must be considered in planning environmentally sound small-scale forestry projects. A desire to produce wood products (such as saw timber, fuelwood, or fruits) should not lead to a disregard for the other values of natural resources.

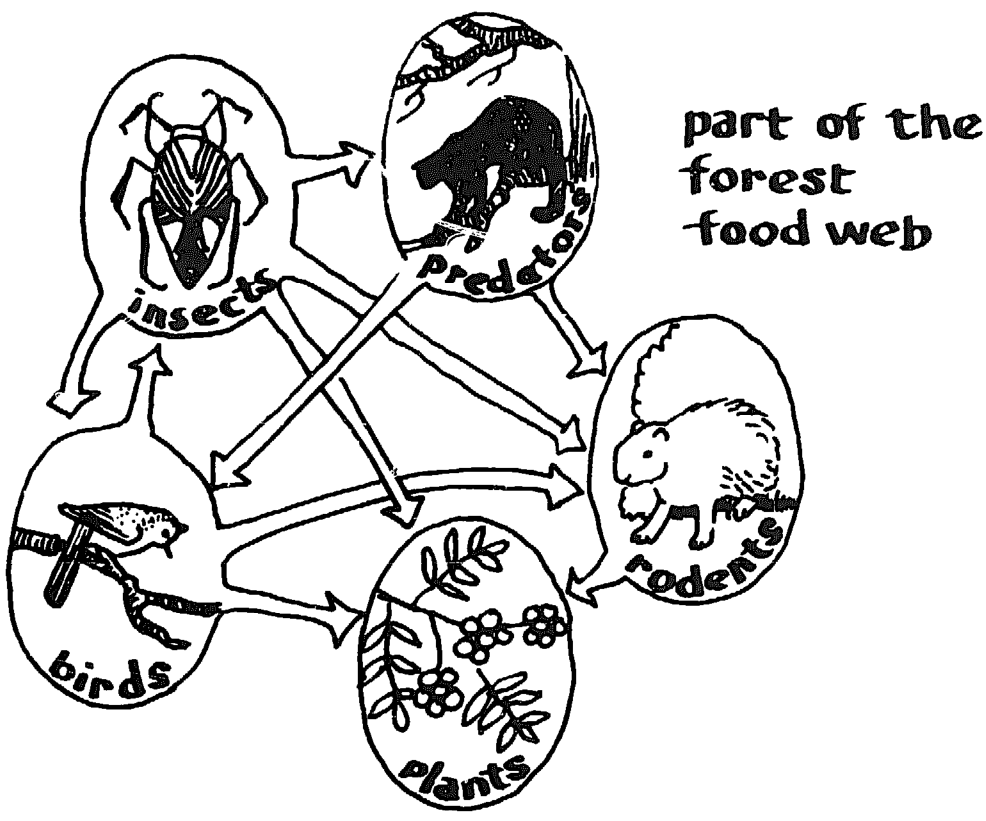
How are forestry and the environment related?

Forest activities, regardless of their purpose or scale, take place within a complex system of biological, physical, legal, social, and economic factors, that comprise the environment. Therefore, in planning a small-scale forestry project, all of the factors in this complex system need to be considered. A development worker will have to look beyond technical designs to understand the interrelationships among the environmental factors in determining project feasibility.

What are forest ecosystems?

When viewing a site for a proposed project a development worker is looking at a kind of ecosystem. An ecosystem is the basic unit in ecology. It is a complex system including plants, animals, and humans in their environment that can be mentally isolated for purposes of planning.

Within forest ecosystems, there are producers, consumers, predators (and scavengers), and decomposers. Forest plants are producers and are able to convert sunlight and nutrients into plant tissues. Many of these plant tissues are used as food by consumers (such as insects, birds, rodents, domestic animals, and man). When consumers eat other animals, they become predators. Decomposers (chiefly bacteria and fungi), break down dead organic materials, absorb some of the products of decomposition, and release substances for use by producers. Interactions among producers, consumers, predators, and decomposers, which define a "food web," must be analyzed when planning an environmentally sound project.



Producers, Consumers, Predators and Decomposers
Interact in a Forest Ecosystem

When a small-scale forestry project is implemented, relationships among living organisms and their environment are usually changed. If there have been no major changes in recent years, a forest ecosystem is probably in balance. In other words, it is self-perpetuating and in equilibrium with the environment. A decision to change the ecosystem (for example, by harvesting wood products) must be made with an awareness of the existing system, and an understanding of how the change will affect the balance within that system.

How do trees protect the productivity of ecosystems?

Soils are basic to the productivity of any ecosystem. Trees protect soils from wind by serving as wind-breaks, from water by intercepting rainfall (so that it can be more slowly absorbed into soils), and from the sun by providing shade. This protection, in turn, allows dead organic materials to decompose and oxidize, releasing nutrients for growth of forest plants. Dead organic materials on top of the soils also retain moisture, providing water for plant growth.

What can happen when the protection of trees is taken away and not replaced by other vegetation may be illustrated through a few examples:

— Winds can pick up and blow away dead organic materials and, thereby, dry out soils, resulting in a lessening of inherent site productivity.

— Nutrient-rich soils may be dislodged by intense rainfall and carried away by surface runoff, again lessening the productivity of a site.

— Trees maintain soil porosity (a measure of the space in a soil body not occupied by solids, important in determining the degree of soil aeration), absorb rainfall, and help retard runoff which, in turn, protects villages and agricultural crops from floods. With the removal of trees, protection against flooding can also disappear.

— Primary sources of saw timber, fuelwood, and other wood and non-wood products are no longer available for local needs, or for marketing.

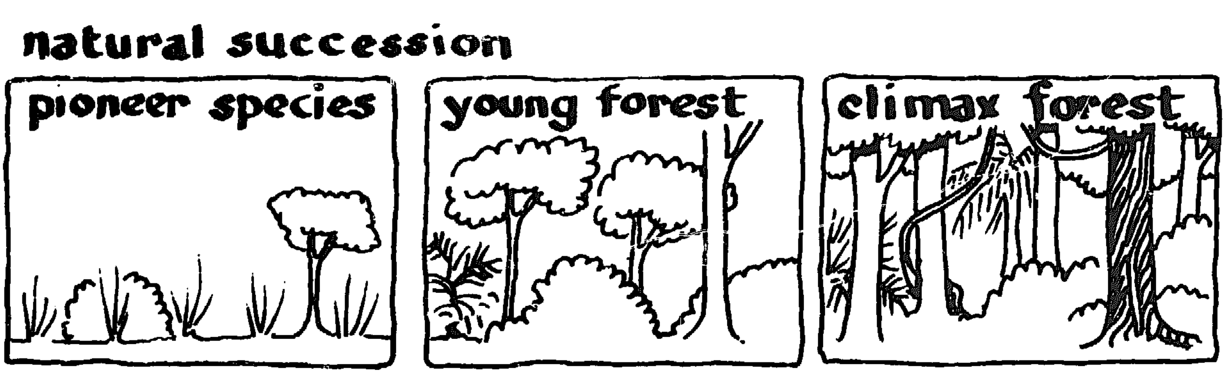
— Diversity of plants and animals is affected, with many species disappearing due to a loss of suitable habitat (including food and cover).

— Recreational values such as hunting and fishing are often detrimentally affected.

What is meant by forest succession?

The natural process of change in the composition of a forest ecosystem is called forest succession. These changes take place in response to changes in the environment and in response to climatic and site factors that are changed by the forest vegetation itself. Primary succession occurs on newly exposed sites (such as lava flows and sand dunes), whereas secondary succession occurs after the previous forest plants are destroyed or disturbed (by fire or agricultural operations, for example).

If undisturbed for a long time, forest ecosystems evolve from initially bare areas into a final, stabilized type of vegetation into a dominant type of vegetation through a series of successional steps. This dominant vegetation is called the climax forest type. Once established, no other tree species can naturally invade and replace the climax, unless the type is subjected to an external form of destruction or disturbance. Also, a change in one or more of the climatic or site factors that brought the forest climax into existence can result in the replacement of the type.



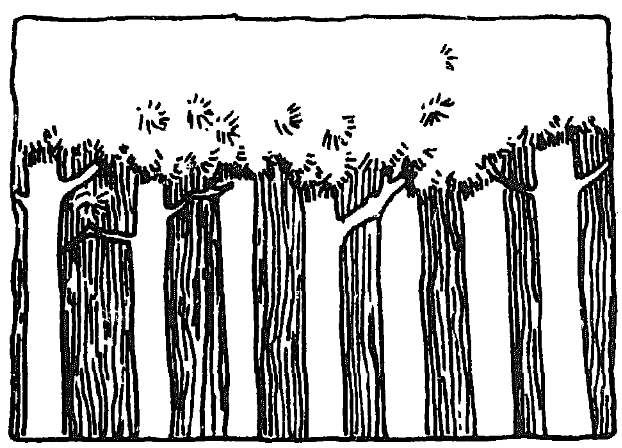
The development worker should understand these successional trends. Some projects can have major impacts on succession, such as causing erosion of top soils, or reducing the level of water tables. These impacts, in turn, can either be reversible or irreversible by natural processes. If reversible, it is possible to have regeneration of the forest; if irreversible the results may be deforestation or desertification.

Areas can be found around the world where man cleared forests hundreds of years ago, and the unprotected sites have remained barren and unproductive -- an example of the process of desertification.

Is there an ecological difference between natural and man-made forests?

Yes -- there are important ecological differences between natural and man-made forests (or plantations) which must be taken into consideration when planning a small-scale forestry project that is environmentally sound.


a natural forest


a manmade forest

Natural forests regenerate naturally, either by natural seeding or from vegetative reproduction of plants on the site. Often, but not always, natural forests are comprised of several native tree species, with the trees having different ages.

Once established, and if not disturbed or destroyed, natural forests will proceed along well defined successional trends. It may be necessary to hold back succession and to check the natural encroachment of the less valuable trees. This is why controlled burning to discourage forest succession is considered a good forestry practice in some situations.

Man-made forests are regenerated artificially, either by sowing or planting -- this is a man-made forest ecosystem. Depending upon the purpose, man-made forests often consist of a single tree species (either native or introduced), with the trees having one age.

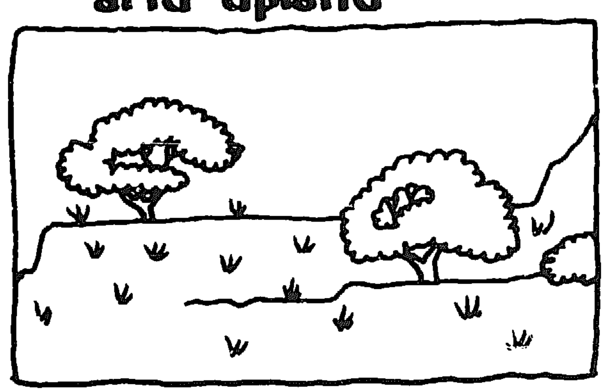
What are limiting factors?

To occur and thrive in a given situation, trees must have basic nutrients which are necessary for reproduction and growth. These basic requirements vary with tree species and with the situation. Basic nutrients available in amounts closely approaching the critical minimum need for reproduction and growth tend to be limiting factors.

Forest ecosystems are inherently able to support a number of plants, animals and humans. The limits of this support are determined by the availability of the essential materials for life; this limit is referred to as the biological potential of the site. Obviously, the biological potential of a fertile flood plain is higher than that of an arid upland of the same area because greater amounts of water, more nutrients, and better soils are available.

fertile floodplain

arid upland



Often, the biological potential can be improved by increasing the availability of limiting factors. For example, forest production can often be increased by adding fertilizer or water; or, in the case where pests (such as insects) are limiting, pest control may be required to improve the biological potential.

When considering limiting factors, it is important to remember that:

- Satisfying the most obvious limiting factor may not solve the problem. In fact, increasing the availability of one limiting factor may reveal the presence of another (as, for example, when a forester adds fertilizer, only to discover that tree growth is limited by too little water).

- Changing existing conditions by increasing the availability of limiting factors can harm organisms that have adapted to living under the existing conditions.

- There are limits to the amounts of nutrients and other essential materials that plants can utilize. Too much fertilizer can be as detrimental as not enough.

Can environmental concepts be used in developing successful small-scale forestry projects?

By analyzing potential ecological changes that can be brought about by implementing a project, and by placing these anticipated changes (including both good and bad effects) into perspective in terms of environmental impacts, a development worker can judge the feasibility of the project with respect to possible alternatives.

Sound planning requires awareness of:

- Environmental concepts as they relate to the type of forestry project under consideration.

- A basic planning process, as outlined in Chapter 2 of this manual.

CHAPTER IV: UNDERSTANDING FORESTRY PRACTICES

In 1976, a unique afforestation project was funded by a PVO in India. It was unique because all of the land in the project area was supplied by small farmers, directly linking the fate of the farmers to the fate of the project. The idea was to plant timber and fuelwood trees on wastelands, and fruit trees on fallow and semi-wastelands. Hopefully, the trees would provide income and food, while acting to retain water in the soil. By 1980, the soil conditions had been improved, and enough income had been generated from sale of trees to distribute some of the receipts among the farmers.

Why is it necessary to have a knowledge of good forestry practices?

It is important that a development worker have some knowledge of good forestry practices to predict whether ecological changes that result from small-scale forestry activities are benefits or constraints.

This manual is not intended to be a "how to" reference on technical forestry practices. A list of references on forestry practices for use in the planning of environmentally sound small-scale forestry projects can be found in a bibliography at the end of this manual. However, a brief introduction to principles of selecting trees to grow, improving forest growth, protecting forests from destructive agents, inventorying forest characteristics, and harvesting wood products can provide helpful background in determining whether or not a given project should be undertaken.

What trees should be grown?

Natural regeneration of trees already in an area often dictates the tree species which should be grown. In these situations, a development worker may have little choice but to develop a project with existing tree species in mind. Elsewhere, artificial regeneration through planting of seeds or seedlings may be needed. With respect to artificial regeneration, a selection of tree species must be made.

The question of what tree species to plant is addressed best at the local level. Specific species of trees to be planted under specific conditions requires planting guides. Such guides, in brief, should indicate what tree species are adaptable to any given soil, exposure, and degree of erosion. Generalized planting guides are available for use in many of the forest ecosystems throughout the world. Often, those guides can be localized to assist in the planning of a project.

Below are some broad guidelines for choosing tree species. See Bibliography for specific tree selection information.

— Native tree species from the area for which biological and silvacultural knowledge is available are usually the safest choice.

— Introduced tree species should be used with some caution until their suitability has been demonstrated by testing in the area.

— Whenever possible, select seeds or seedlings of known genetic superiority.

— Tree species (native or introduced) selected for planting should meet the following requirements: ease of obtaining seed or seedlings, ease of establishment, immunity to insect or disease attacks, fast growth, production of useful forest products, social acceptability, and desirable wood-producing characteristics.

— Seasonal precipitation patterns are important determinants of tree species to grow; tree species native to winter rainfall areas usually will not thrive in summer rainfall areas, although tree species native to summer rainfall areas are likely to succeed in winter rainfall areas.

— As a general rule, tree species can be successfully moved from their home to other sites on the same parallel of latitude because of the similarity in climate; however, some tree species are so exacting in their requirements that even a very small variation in season or intensity of site factors may cause failure.

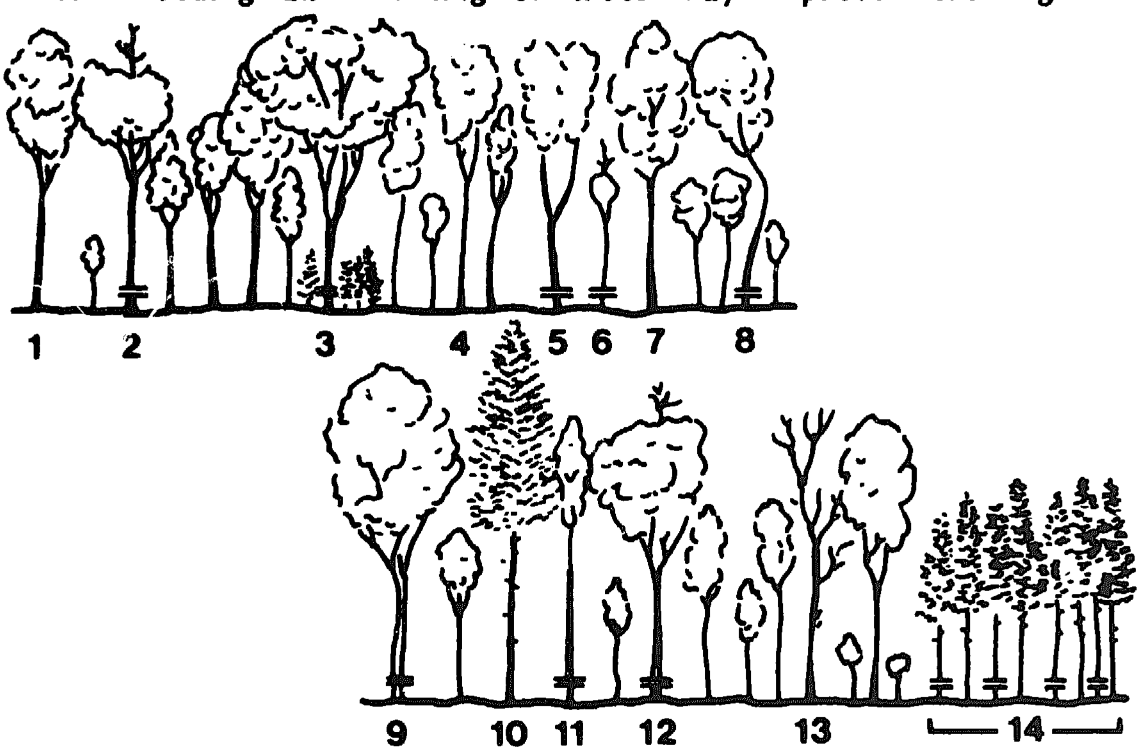
— Tree species to be planted must fit the purpose in view, whether it be saw timber, fuelwood, wind-breaks, or watershed stabilization.

To insure successful results, regardless of the tree species selected, the following considerations are important: when to plant, how to plant, site preparation and spacing, and care after planting.

How can forest growth be improved?

In many respects, a forest is like a vegetable garden -- a farmer cannot grow a good crop unless he does some weeding and thinning. It is the same in a forest. When harvesting trees for wood products, consideration should be given to improving the quality and the condition for growth of the remaining trees to get a good wood crop in the future.

The following diagrams and explanations illustrate situations where weeding and thinning of trees may improve forest growth.



— Trees 1, 4, 7, and 10 are healthy trees with full crowns and are making rapid growth. These should not be cut until they are large enough to be harvested as saw timber, if markets are available.

— Tree 2 has a dead top, is subject to disease and insect damage and will probably die soon. This tree should be cut and utilized.

— Tree 3 hinders or suppresses growth of nearby trees and reproduction underneath. It is called a "wolf tree." This tree should be removed.

— Tree 5 is a forked tree with poor form that will never permit its use in high quality wood products. This tree should be cut and utilized as soon as possible.

— Tree 6 is a suppressed tree that will never recover nor amount to anything of value. This tree should be cut and utilized as fuelwood, poles, or posts.

— Tree 8 is a crooked and poorly formed tree (same recommendation as for Tree 5).

— Tree 9 originated as a stump sprout which, quite possibly, is rotten on the inside or will be if it joins the old stump very high up. This tree should be cut and utilized.

— Tree 11 has a weak and narrow crown and not much promise as a crop tree. It is called a "whip tree." This tree should be cut and utilized before it dies, breaks off, or blows down.

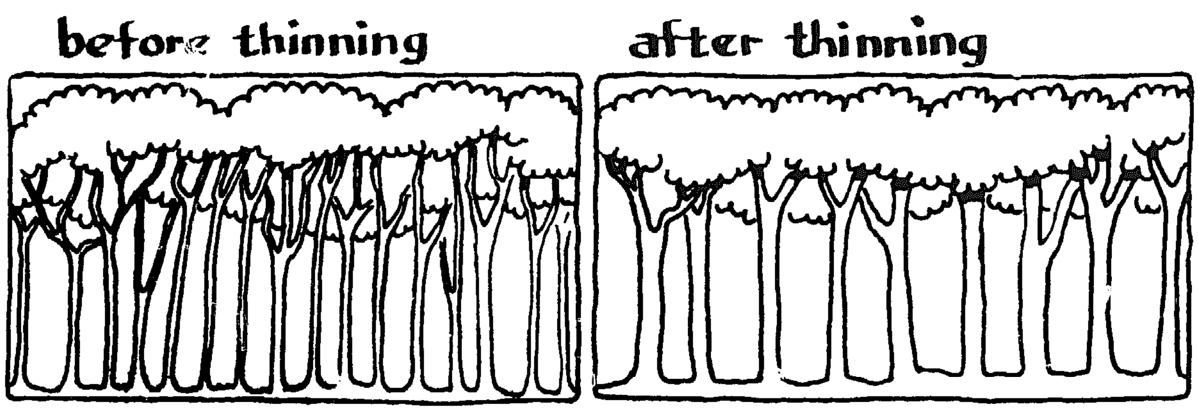
— Tree 12 is a fire-scarred tree with a decayed stem. It should be cut and utilized.

— Tree 13 is a dead tree that is probably not damaging nearby trees. If it cannot be used as a wood product, there may be no object in cutting it. Often, a dead tree may be beneficial to wildlife.

— Tree group 14 consists of trees that are small in diameter and are growing too close together. These should be thinned, leaving only the best formed and the most desirable ones, permitting their faster growth. The cut trees may have value as fuelwood, poles, or posts.

The situations illustrated above apply, in general, to forests which have not been heavily grazed by domestic animals, and which have a fairly large number of trees. In a heavily grazed forest with a few trees, the best way to improve forest growth may be through complete protection.

It is important to understand that weeding and thinning of trees will not usually cause trees to grow taller. Instead, elimination of crowding among trees will increase diameter growth, which has a greater impact on future volume and value.

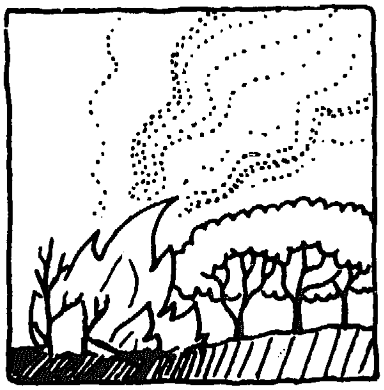


A practice that may not directly improve forest growth, but often enhances the value of commercial trees, is pruning. As used in forestry, pruning consists of cutting off the side branches of trees so that the wood subsequently formed on the stem will be free of knots. Knot-free trees are of higher value for saw timber and plywood; also, poles and posts cut from knot-free trees possess greater strength than those cut from knotty trees.

Why is it important to protect forests from destructive agents?

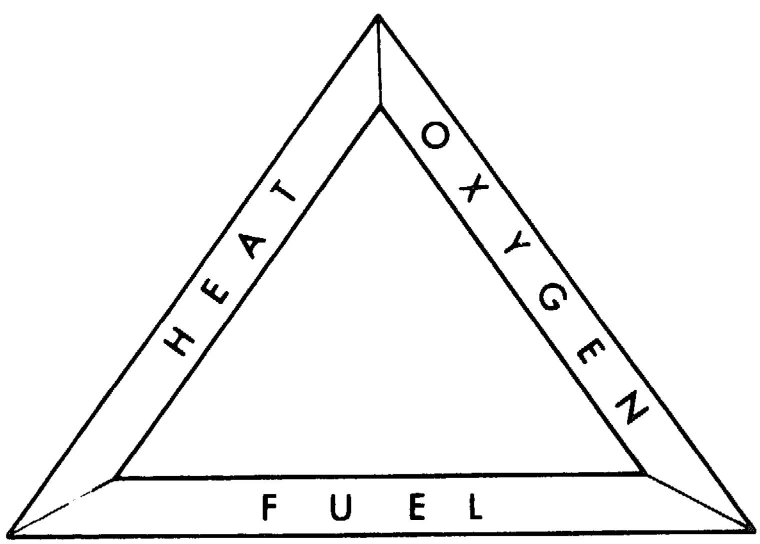
All agricultural crops have their enemies. Forests are not exceptions. In particular, fire, insects, diseases, grazing by domestic animals, and even man can destroy (or at least reduce) the productivity of unprotected forests.

Fire



In spite of public campaigns about potential fire damage, forest owners often do not heed the warnings. At times, people fail to understand that small fires burning slowly along the ground can kill small trees, even though larger trees are not killed. Only when a fire gets out of control and threatens buildings and other holdings do they become aroused.

The components of combustion - heat, oxygen, and fuel - are often pictured as a triangle. The "fire triangle," a graphical representation of the three components of combustion, is used in training people to fight fires. A fire fighter's job is to break up this combination by : removing the fuel, reducing or removing the supply of oxygen, or reducing the temperature below the kindling point.



The most important step in the control of fire is prevention; an enlightened public is the best form of fire prevention.

Under hazardous conditions, fire-breaks, or barriers, are good insurance. A satisfactory fire-break can be made by plowing a strip about a harrow wide around a forest, and then keeping it open by subsequent harrowings.

Forest fires, when they occur, are of three general types, each of which requires a different form of control:

— Ground fire, in which the organic soil is burned, can be controlled by saturating the ground with water, if available, or by digging a trench down to mineral soil around the fire.

— A crown fire, which spreads through the tops of trees, is the most difficult for man to control; in fact, about all that can be done is to check such fires to warn others of its danger.

— The most common type of fire is one that burns on the surface. It is most frequently controlled by scraping away flammable fuels immediately ahead of the fire.

While often destructive, controlled application of fire can be prescribed in certain forest ecosystems to meet specific management objectives, including:

— Fuel reduction

— Seedbed preparation

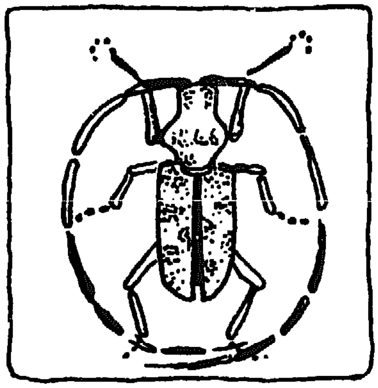
— Control of competing vegetation

— Improvement of grazing

— Wildlife habitat management

Prescribed burning must be confined to a predetermined area at an intensity of heat and rate of spread required to produce the desired effects. To achieve success, a development worker should consult with local fire management specialists in preparing an appropriate prescribed burning program.

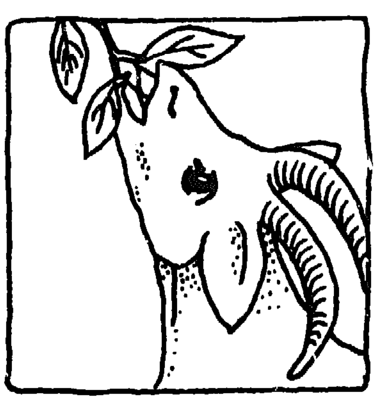
Insects and Diseases



Damage to a forest from insects and diseases is, in general, in direct proportion to the misuse of the forest. Fire, grazing by domestic animals, and even excessive cutting of a forest often lowers the natural resistance of trees, permitting insect and disease pests to get a foothold. Also, trees growing in an unsuitable environment can become weakened and invite hosts to epidemics.

When epidemics occur, there is usually no practical control except to remove and, if possible, utilize the infested or diseased trees. Artificial control measures, such as the use of insecticides, must be practiced with extreme care. In some instances, use of chemicals can be more damaging to an environment than the existence of the pest being controlled by the chemical.

Grazing by Domestic Livestock



At times, uncontrolled grazing by domestic animals can be more harmful to trees (by destroying seedlings and saplings through browsing and trampling) than almost any other destructive agent. Furthermore, a farmer or herder who uses a forest for a pasture can, under certain situations, cause a loss not only to himself but to the livestock as well. Forage grown under a forest cover can be poorer, in both quantity and quality, than that grown in open pasture.

Man

Even though people may have the proper technology to practice good forestry, man can unknowingly damage or destroy forest crops. For example, it may become necessary, through continuing education and training, to reinforce the concept of protecting (and respecting) highly vulnerable young trees. Otherwise, mature and fully-stocked forests may not be attained.

The key to the problem may be motivation -- people may need to be motivated to realize the results of protection and, as a consequence, a productive forest.

How is the forest inventoried?

A forest inventory is concerned, for the most part, with measurements of individual trees, forest stands, growth rates, and site quality.

Individual tree measurements form a basis for estimating the volume of standing trees that can be harvested for wood products. The most commonly made tree measurements are:

— Diameter of the tree stem, usually taken at 1.3 meters above the ground for standardization and convenience; diameters are commonly measured in centimeters.

— Height of the tree, either total or to the top of that part that can be sold, heights are measured in terms of meters.

Techniques of obtaining diameter and height measurements are outlined in references on forestry practices at the end of this manual.

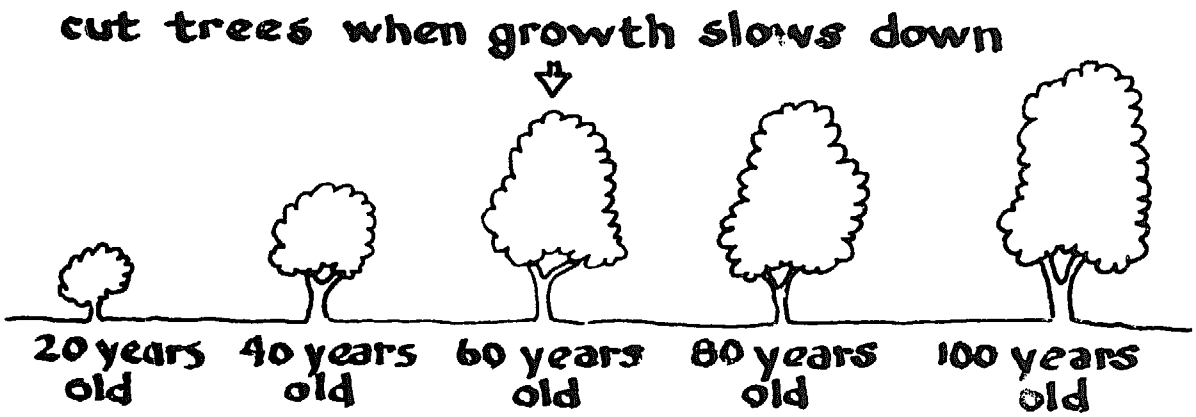
Given knowledge of diameter and height, the volume of a tree can be determined from a volume table. This table specifies the volume of a tree, usually in terms of cubic meters, from diameter and height measurements. If appropriate volume tables are not available for use, consult local or regional foresters who have specific knowledge regarding the calculation or volume of native species.

Care should must be exercised in estimating the volume of shrubby trees with crooked, multiple stems, rather than distinct ones. Often, local measurement customs may be employed in these situations.

An important objective of many forest inventories is to obtain an estimate of the number of trees in relation to the volume of trees, on a hectare basis, in a forest. Unless there are a few trees of exceptionally high quality involved in which case a complete tally may be made only a sample of trees is selected for measurement. In general, tree measurements recorded on sample areas (one-tenth-hectare plots, for example) are expanded to the total area under consideration. Many options of plot size and sampling design exist; those selected by the development worker should be consistent with the purpose of the forest inventory.

The average growth of trees is, by definition, their volume divided by their age. While the volume of a tree is relatively easy to approximate, determination of age is more difficult. In general, there are three common methods used to estimate the age of a tree -- by appearance (size, shape of crown, and texture of bark), by branch whorls, or by annual rings. Unfortunately, tree growth is not characterized by annual rings in many forest ecosystems of the world, particularly those occurring in the humid tropics.

Knowledge of average growth of trees is important in helping to determine when wood products should be harvested from trees. Typically, average growth of trees increases slowly, attains a maximum, and then falls more gradually. As mentioned in Chapter 7 of this manual, the ages at which maximum average growth is attained is often regarded as an ideal time to harvest trees for wood products.

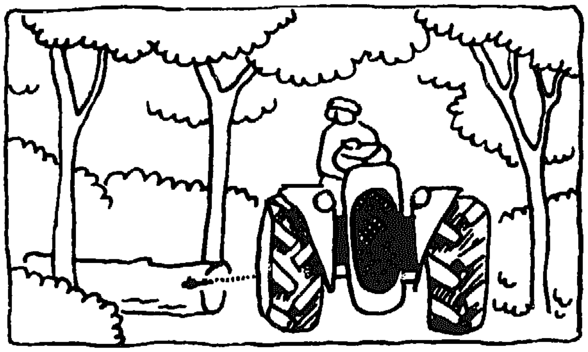


Evaluation of site quality is important in identifying productivity, both present and future, of forests. Knowledge of productivity, in turn, is useful in long-term planning. Site quality is the aggregate of all environmental factors affecting growth and survival of trees in a forest. Various approaches, too numerous to present in this manual, have been devised to evaluate site quality. The approach selected by a development worker should reflect local forest conditions and, to be useful, require only easily obtained measures for interpretation.

How are trees harvested for wood products?

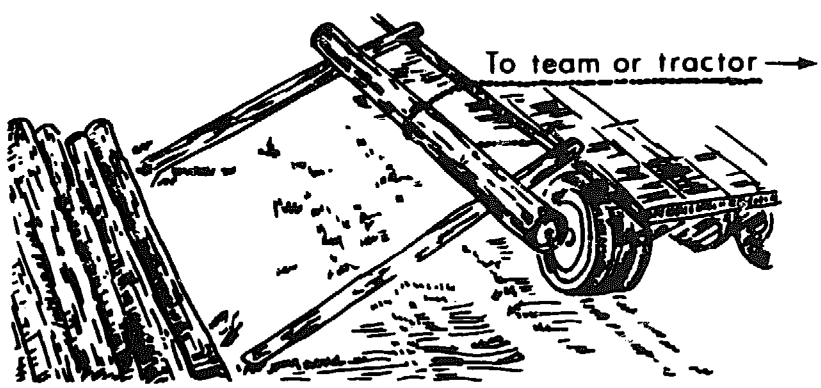
Harvesting wood products involves considerable skill, tools, knowledge and equipment to do a creditable job.

Axes, saws, wedges, and sledges are all that are necessary to fell trees and cut them into desired lengths. Power-chain saws are finding their place in many harvesting operations. However, while they make the harvesting job easier, their high cost can make them uneconomical, except in large operations.



After trees are felled and cut into desired lengths, they must be carried or pulled to a loading point. If tree lengths are too heavy to carry, a simple drag or sled can be used to pull them, using an available power source such as a tractor or a domestic animal.

A universally employed method of loading tree lengths on a vehicle is the "cross-haul" method. One end of a chain or cable is attached to the underside of the vehicle to be loaded, and the other end is placed under the tree lengths to a tractor or team of domestic animals. Two poles, large enough to bear the weight of the tree lengths, are placed against the vehicle, as shown below.



The Cross-Haul Method of Loading Tree Lengths

Harvesting trees for wood products should be done with an eye toward good forestry practices. Before a tree is cut, the following questions should be answered:

— Is the tree to be cut the size needed to be usable?

— Is the tree the best species available for the intended wood product?

— Is the tree ripe, or does it show signs of deterioration from old age or from insects and diseases? Evidence of deterioration might suggest that the tree should be cut.

— Is the tree growing rapidly, and does it have a full crown and smooth bark? If so, the tree is probably vigorous and perhaps should be retained as part of the growing stock for future harvesting.

— What kind of plant reproduction will result from the cut? It should be remembered that preventing regeneration of brush and other comparatively worthless plant species is one of the principal aims of good forestry.

Throughout many countries in the world, fuelwood is harvested not by felling and cutting trees into desired lengths, but rather by simply picking up branchwood, leaves, and other woody materials from a forest floor. Often, women and small children are responsible for fuelwood gathering, which can take them far distances from their homes.

Many secondary and other by-products of the forest, such as fruits and nuts, are also harvested through gathering efforts, again in many instances by women and children.

CHAPTER V: UNDERSTANDING INSTITUTIONAL LIMITATIONS

The Ministry of Natural Resources is the lawful Philippine governmental agency created to strike a balance between exploitation and replenishment of natural resources, and between conservation and use. The objectives of the Ministry are: to assess the status of the country's natural resources for their programmed exploitation and use; to provide for their replacement; to conserve, revitalize, develop, and manage the country's natural resources for present and future generations; and to increase the productivity of the country's natural resources in reference to their current exploitation and use.

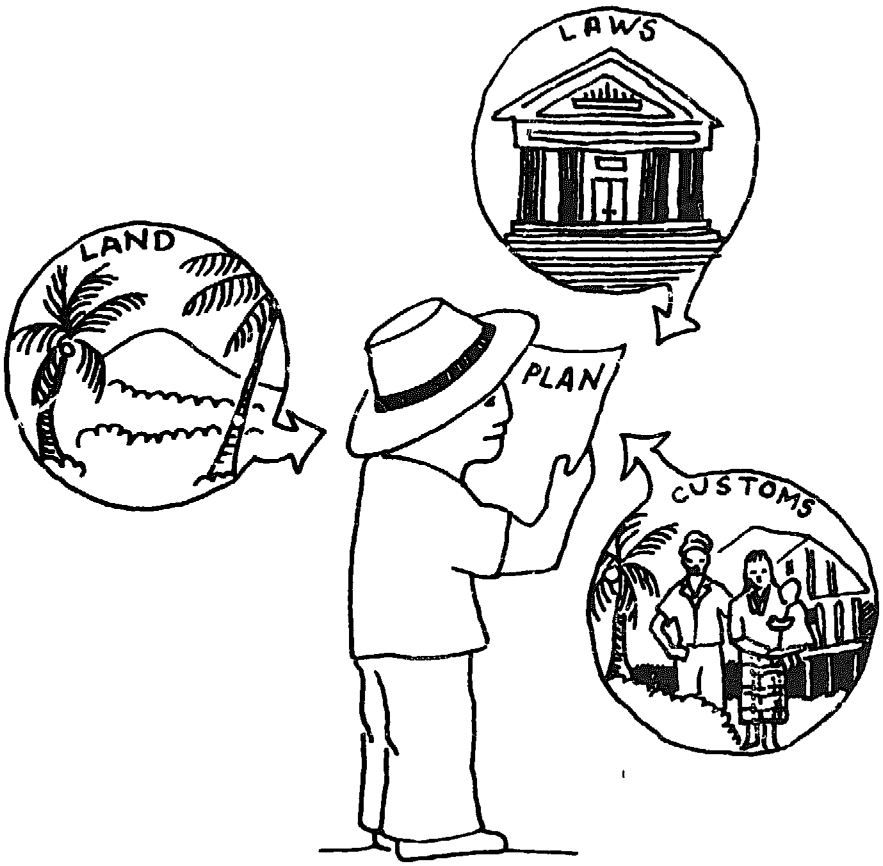
What are institutional limitations?

In reality, two sets of limitations determine the degree of success of a small-scale forestry project. First, there are natural limitations, involving biological and physical relationships. Second, there are institutional limitations to forestry activities, which are every bit as important as natural limits in the planning of an effective project.

Institutional limitations, unlike natural limitations, are established by man to meet specific conditions and, therefore, can be modified by man in response to changes in legal, social, and economic situations.

Why are legal considerations important?

Perhaps the most important of the institutional limitations of a small-scale forestry project involves legal considerations, which are limitations sanctioned by law. In general, two primary areas of law must be regarded in the formulation of a project: laws which address ownership and use of the products of natural resources, and laws which regulate the use of land or land tenancy.



A development worker should consult with local authorities to be sure that a small-scale forestry project can be implemented within the existing legal framework.

When are social considerations important?

Legal considerations, as discussed above, are "formalized rules" that guide the conduct of man. Less explicit, but equally important, are guidelines derived from other cultural features of a society — from tradition, religion and folklore. As with laws, these social considerations must be reflected in the decision-making process. Failure to do so can lead to adverse reactions that can severely restrict one's freedom.

Cultural considerations determine, in part, the options available to a planner of environmentally sound small-scale forestry projects. From the flood plains of the Mekong River Basin to the fragile desert environments of northwestern Africa, situations can be found in which social patterns restrict implementation of a particular forestry practice.

Social constraints are often difficult to assess. They are not usually susceptible to easy solution and can easily be ignored. However, to do so is folly. To increase the possibility of environmentally sound forest management, it is essential to include local people in planning objectives of the project. Training and public education are also important.

How are economic considerations incorporated into planning?

A development worker must select the best course of action in implementing a forestry practice, given alternative plans. The decision among alternatives to select often requires economic considerations. Although a part of the institutional framework, economics involves certain patterns of rational analysis, the techniques of which are well known for many situations.

To make an economic analysis of alternative courses of action, three general objectives can form a basis of choice. These objectives are:

- Maximization of benefits.
- Maximization of the returns on investment.
- Achievement of a specified "production goal" at the least cost.

Analysis of these objectives can give a development worker and local people a better understanding of the economic implications of selecting a particular course of action.

To analyze the first two objectives, responses to alternative courses of action and costs of implementation must be known. Some information can be obtained from previous local experience. If the course of action is newly adopted, the development worker can seek available prediction techniques.

To satisfy the third objective, goals should be established for various levels of production. These goals are most effective if set according to values of local residents, coupled with long-range goals derived through the political process.

CHAPTER VI: BACKGROUND FOR PLANNING: MULTIPLE-USE FORESTRY PROGRAMS

Eucalyptus is a fast-growing tree, which is also valuable for lumber and fuelwood. To plant more Eucalyptus in Upper Volta, all ground cover was cleared, including bushes with edible leaves. The primary source of food for the local people was porridge topped by a sauce made of these leaves. As it turned out, the Eucalyptus leaves are not edible. Therefore, the health of the local people was seriously impaired, as they lost an important food supply.

What is meant by multiple use?

The term "multiple use" has many different meanings. When applied to land areas, multiple use refers to the management of a variety of natural resource products and uses on a unit of land. The relation of the natural resources to one another may be:

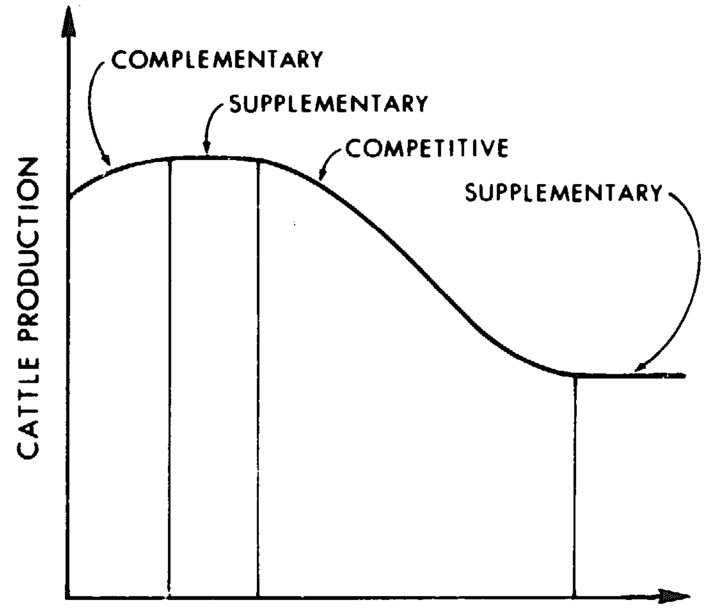
— Competitive, where one must be sacrificed to gain more of another.

— Complementary, where both increase or decrease together.

— Supplementary, where a change in one will have no influence on another.

When applied to a particular natural resource, multiple use refers to the use of the natural resource for various products and uses. For example, trees may be harvested for saw timber, fuelwood, or posts, or they may be used to produce fruit, seeds or flowers. Forage may have value as feed for domestic livestock, or for watershed stabilization. Water may be used for drinking, irrigation, or fish habitats. Here again, the use can be competitive, complementary, or supplementary.

In practice, multiple use often involves both units of land and natural resources. Demands on a particular natural resource (trees) for a specific use (fuelwood) place demands on the land area where the natural resources are produced (forests).



Competitive, Complementary and Supplementary Relationships Between Cattle and Timber Production

When should multiple-use forestry be practiced?

From a biological, social, and economic standpoint, multiple-use forestry should be practiced whenever possible. A basic objective of multiple-use forestry is to manage the natural resources of a forest for the most beneficial combination of present and future uses. The idea of maximizing the benefits derived from the natural resources of a forest is not new, but it has become more important as people's demands for limited and often interrelated natural resource products and uses increase.

It is important to keep in mind that multiple-use management of forests can be achieved by any one of the following options, or by any combination of the three:

- Concurrent and continuous use of the natural resource products and uses obtainable from a forest which ensures production of different goods and services from the same area.

- Alternating or rotating uses of natural resources for specified periods of time.

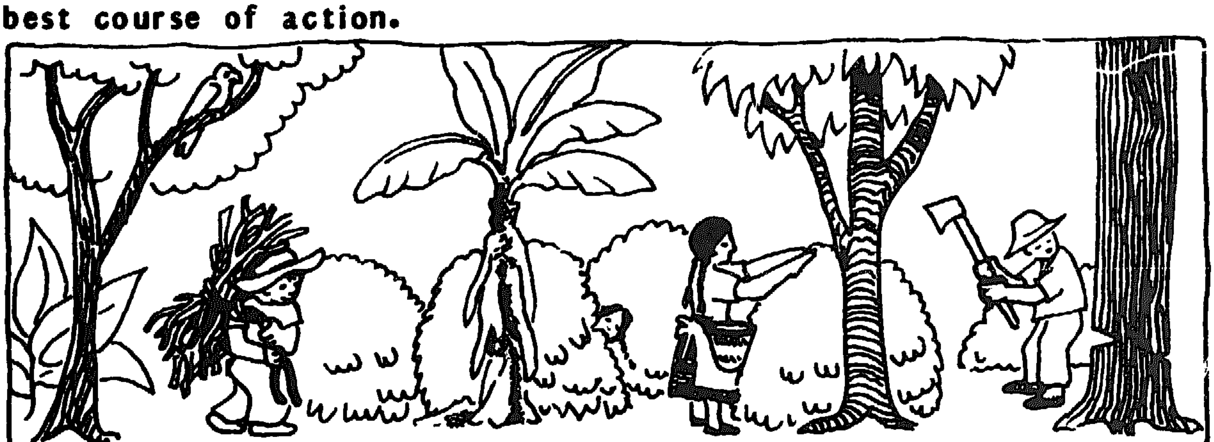
- Geographical separation of uses so that multiple-use is practiced across a mosaic of strata in a forest.

All of these options are valid multiple-use forest management practices which can be applied in the most suitable combinations.

From society's point of view, multiple-use forest management can involve a broader set of requirements than concern an individual person. Generally, society is more interested in preserving benefits for future generations, while an individual often makes decisions based on desires to satisfy relatively short-term needs. If possible, effective multiple-use forestry projects should accommodate the full spectrum of today's needs and provide for tomorrow's requirements.

How are multiple-use benefits and costs measured?

Deciding whether or not a project is worthwhile requires measurements of anticipated benefits derived from all of the natural resource products and uses of a forest and of costs that will to be incurred in implementing the project. Measurement and analyses of benefits and costs associated with alternative projects may be necessary before a development worker can select the best course of action.



Measurement of Benefits

Benefits include those obtained from fuelwood, timber, forage for animals, both domestic and wild, water production, recreation, etc. Estimates of these anticipated benefits can be obtained from earlier work, from local experience, or through prediction techniques.

Measurements of natural resource products and uses can be summarized in a table form, known as a "product mix." Such a table describes multiple-use by quantitatively presenting all of the products and uses obtained from a particular area. A product mix developed before a project is implemented can form a reference for comparison with product mixes representing conditions after implementation. These comparisons show what is gained and lost in multiple-use terms and therefore provide a basis for determining project feasibility.

TABLE 1

Product mix for alternative forestry practices being considered for implementation in a hypothetical temperature forest ecosystem.

Item	T_0 As is	T_1 Convert	T_2 Uneven-aged	T_3 Even-aged
Timber cut (m^3)	0.0	9.0	4.9	3.8
Timber growth (m^3)	4.2	2.5	5.5	5.2
Livestock (kg gain)	0.068	0.48	0.0045	0.27
Wildlife (number of deer)	0.021	0.034	0.032	0.033
Water (cm)	15.0	22.0	16.0	18.0

* On one hectare, if things remain as they are (T_0), the annual output will be 4.2 cubic meters (m^3) of timber growth, enough forage for 0.068 kilograms (kg) of livestock gain, 0.021 deer, and 15 centimeters (cm) of water. No timber will be cut.

* With conversion of moist sites to grass (T_1) the annual output will be 2.5 cubic meters of timber growth, enough forage for 0.48 kilograms of livestock gain, 0.034 deer, and 22 centimeters of water. Approximately 9.0 cubic meter of timber will be cut on each hectare.

* Columns T_2 and T_3 contain the elements of uneven- and even-aged forest management systems, respectively.

* It is important to note that, if T_0 was judged as best by assessing the advantages and disadvantages in natural resource product and use response, the existing management system should be continued.

It may be necessary to convert physical expression of what is gained and lost in multiple-use terms to corresponding expressions of monetary or other economic value. If information is available, this conversion can be achieved by simply multiplying physical units by appropriate monetary values on a per unit basis. In most cases, it may not be possible to assign specific monetary values to the products and uses. However, other indicators of economic worth can possibly be assumed through personal judgements of local situations.

Measurement of Costs

Costs of implementing small-scale forestry projects usually reflect a given economic situation over time. Information on costs that reflect local conditions may be available and, if so, can be used to estimate costs of implementing various projects. Otherwise, a development worker may have to:

— Estimate necessary inputs of labor time, equipment time, supervision time (if required), and materials.

— Determine overall costs by multiplying the above inputs by current wage rates, machine rates, and material costs, and then summing the product.

Here again, monetary values may have to be approximated from personal judgements of local conditions and customs.

Economic Analysis

As mentioned in Chapter 5 of this manual, to make an economic analysis of a project, such as a small-scale multiple-use forestry project, general objectives are usually considered to form a basis for choice. In reality, an economic analysis of such projects consists of several economic analyses, each of which is designed to help a development worker and local people make a better decision.

Individual economic analysis may yield a "one-answer solution" to the problem of selecting a project that maximizes returns to the land. A group of economic analyses, based on different criteria, will result in an array of items for decision-making. Such an array could include the following:

- Estimates of multiple-use production (such as cubic meters of saw timber or kilograms of forage) associated with alternative small-scale forestry projects.
- Estimates of implementation costs of project alternatives.
- Least-cost solutions for different goals of multiple-use forestry.
- Gross and net benefits associated with a range of possible project alternatives.
- Investment returns and benefit-cost ratios associated with different project alternatives.
- Project cost over time by using carefully selected discounts and interest rates which will be applied for the entire length of the rotation.

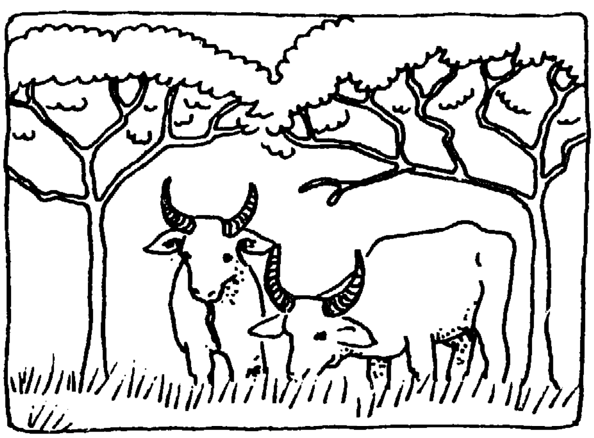
Consult Bibliography for additional information.

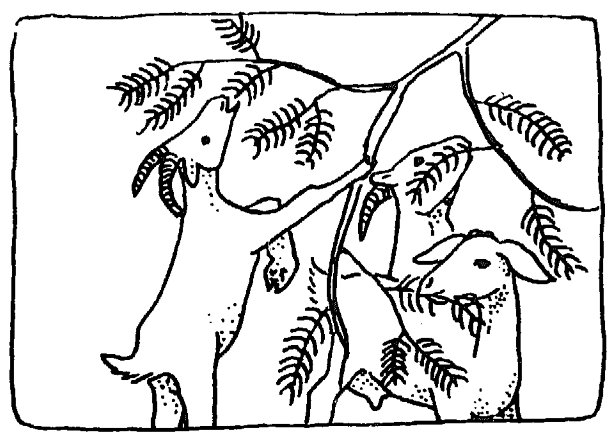
When is multiple-use forestry environmentally sound?

With careful planning, and consideration of all of the possible natural resource products and uses obtainable in a forest, multiple-use forestry can be practiced in an environmentally sound manner. Perhaps the concept of planning for multiple-use can be illustrated with an example.

Under certain conditions, harvesting of wood products and grazing domestic animals are two uses that can occur together, making full use of many forest ecosystems. Harvesting trees for wood products reduces the forest cover, which can improve forage in terms of quantity and quality. With improved forage, it may be possible for additional domestic animals to be grazed. In these situations, it can be to the advantage of a development worker and local people to consider potential multiple benefits from both uses, and plan accordingly.

However, it should also be remembered that in other situations, particularly in arid ecosystems, forage can only grow in the shaded micro-environments underneath trees, as survival is not possible in the open. Here, it may become necessary to favor one use as dominant, even though multiple-use may be a desired goal.





Whether harvesting (and more generally, growing) trees and grazing by domestic animals can be joint uses of a forest also depends, in large part, on the kinds of animals being grazed. A development worker should realize that:

— Grazing by cattle can be harmful in forests comprised of seedlings and young succulent trees; cattle often browse and trample these trees.

— Grazing by goats and sheep, which eat almost anything, is particularly damaging to forest ecosystems. Therefore, use of a forest by these animals may have to be limited.

— Similarly, grazing by hogs can be quite destructive, as they uproot seedlings and young succulent trees to eat the fleshy roots.

In general, when forests are used for harvesting trees for wood products and grazing by domestic animals, carefully planned harvesting operations can be carried out in conjunction with controlled grazing to minimize detrimental environmental consequences.

Are there alternatives to multiple-use?

Early use of forests, either natural or man-made, usually emphasized a single product -- such as a particular wood product. Although these forests had the potential for other uses, little attention was paid by local people to those natural resource products and uses that were abundant.

As development takes place in Third World countries, peoples' tastes change and cash income becomes available or increases. Primary products and uses resulting from forests being managed for a single product may not meet demand. Consequently, pressure is on the planner of small-scale forestry projects to recognize multiple-use possibilities and to effectively maximize the various possible uses of the forest in planning projects.

CHAPTER VII: BACKGROUND FOR PLANNING: HARVESTING TREES FOR WOOD PRODUCTS

Under the direction of the Food and Agriculture Organization (FAO) of the United Nations, new forest plantations were created in Andhra Pradesh, India. Plans called for these plantations to be fenced in until ready for harvesting. However, local farmers who were desperately in need of lumber and fuelwood, and not aware of the possible future benefits of the plantations, poached so heavily that the new crop of trees was destroyed.

What wood products can be made?

Forests can be managed in a manner that is similar to agricultural croplands, although forestry is a long-term business while agricultural crops are usually grown on annual seasonal rotations. Like other crops, trees for wood products are harvested and used locally or sold for profit. Considerations in harvesting trees for wood products involve recognition of the various products possible, understanding the specifications and quality standards of the products, and knowledge of when to harvest and when to market the products.

The discussion below focuses on a selection of wood products commonly produced in Third World Countries. For a more detailed discussion of the subject, see the bibliography at end of this manual.

Fuelwood

As discussed in Chapter 8 of this manual, an increasingly important use of the forest is for fuelwood. In general, most reasonably well seasoned tree species can be used for fuel. However, the value of a tree for cooking and heating purposes is roughly equivalent to its weight. For a given volume, heavier woods generally produce greater amounts of energy. Usually, there are no specifications or quality standards for fuelwood, except those established locally.

Charcoal

Charcoal is the carbon residue of partially burned wood. (In making charcoal, enough air is admitted to a kiln to burn the gases driven off by the burning wood, but not enough to consume the residue.) The process of making charcoal is complex and requires technical information beyond the scope of this manual. See Bibliography.

Poles, Posts and Pilings

Poles, posts and pilings are examples of round wood products. Soundness, straightness, and a gradual taper from butt to top are general requirements for good round wood products. Sizes are variable, depending upon specific uses and local demands. Some tree species do not decay or are termite-resistant; others are not. When poles and posts are to be cut from trees subject to decay or termites, treatment with chemical preservatives may be required. If chemical preservatives are used, care must be exercised to prevent harmful effects to both the environment and the handlers of the products. Chemicals should be chosen carefully and warnings on the labels observed.

Saw Timber

Tree lengths intended for sawing into boards, planks, or other construction materials are known as saw timber. Many tree species that grow to sufficient size are potentially usable. General criteria for saw timber are:

- Tree lengths up to 30 centimeters and larger in diameter, and at least 5 meters to the nearest branch of appreciable size.

- Tree lengths that are reasonably straight and sound.

There are many saw timer specifications and quality standards in practice. The development worker should start with local customs and marketing opportunities, and then by working with the community, improve standards and create new markets.

Pulpwood

Wood that is converted into paper products is known as pulpwood. Not all tree species can be used for pulpwood, although the yield of pulp is higher in the heavier woods. Establishing a pulp and paper mill requires guaranteed sources and quality of wood. Such projects generally do not provide a market for small producers.

Other

Local demands for other wood products may also exist, and a development worker should be aware of these production and marketing possibilities. Other wood products include bolts for handles, mine timber, excelsior.

Are secondary and other by-products important?

Oils, resins, gums and pharmaceutical materials can play a role that is as important (if not more so) to local people than sawtimber, pulpwood, and other more marketable wood products. Also, many fruits and nuts from forest plants provide foodstuffs for both local consumption and sale.

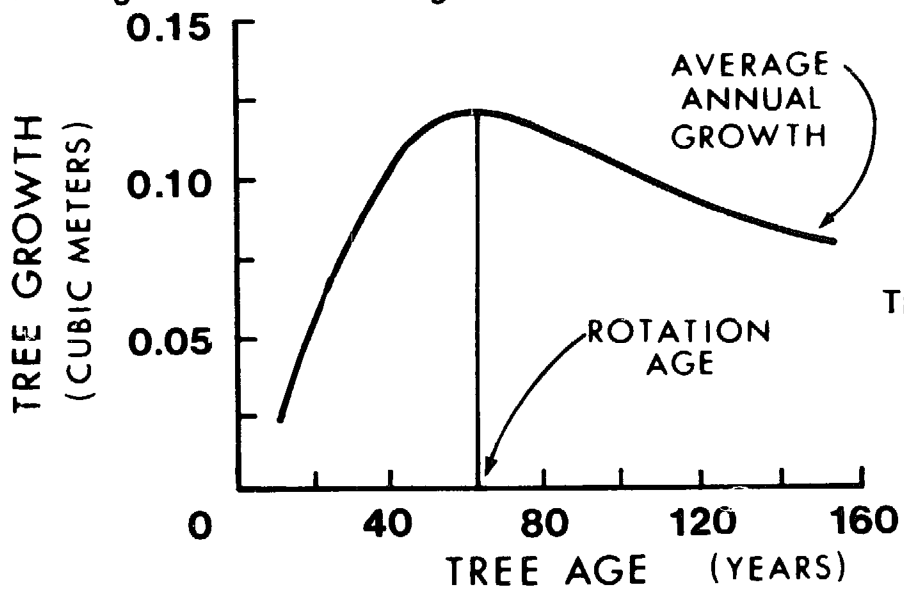
The value of these secondary and other by-products of forests is often overlooked in small-scale forestry activities. Therefore, a development worker, in consultation with local people, should include the demand for these products in planning.

When should trees for wood products be harvested?

Regardless of the wood product, both biological factors and economic considerations dictate when trees should be harvested for a particular wood product.

From a biological standpoint, trees should not be cut until they have grown at least to the minimum size required for product utilization. However, after attaining minimum size, the question is what is the optimum or most advantageous size for harvest?

Often, foresters are guided by average growth rates of forests in determining when to harvest trees for wood products. As mentioned in Chapter 4 of this manual, trees should not usually be allowed to grow beyond the point of maximum average growth, which is the age of maximum growth productivity. Foresters call this age the rotation age.



The Rotation Age

Biological factors, in addition to average growth rates, must often be considered by a development worker when determining the time to harvest trees for wood products. These factors include:

— Pathological factors, which affect the growth of forests both in terms of mortality and the amount of defect in living trees. As forests increase in age, they become increasingly subject to diseases such as heart-rotting fungi.

— Entomological factors, which affect growth of forests in a manner similar to pathological factors; also, entomological factors direct attention toward forest composition, age structure, and vigor. Forests comprised of a single tree species, all of which are essentially the same size, are particularly susceptible to attack by destructive insects. In addition, as trees get older and decline in vigor, they become more susceptible to attack.

— Silvicultural factors often influence decisions as to time of harvesting. Among the more important silvicultural factors are seed production characteristics, methods of obtaining regeneration, competition from less desirable tree species, and maintenance of desirable soil conditions.

Economic considerations also help determine when to harvest trees for wood products. For example, if the decision is based solely on market factors, the time to harvest is when profit is maximized. Profit is maximized when returns generated from harvesting wood and selling a wood product minus costs incurred in harvesting and processing the wood, are the greatest. The age at which profit is maximized is often less than the rotation age determined through biological considerations.

Other factors that one may need to consider in deciding when to harvest trees for a particular wood product include:

— Local harvesting techniques, which could limit the handling of large tree lengths.

— Available manpower, which could restrict the extent of a harvesting operation.

— Existing market outlets, which dictate the kind of wood required for wood products and affect demand on particular kinds of trees.

In general, the time when trees should be harvested for wood products is quite variable. Rotations of 8 to 12 years, for example, can be prescribed for fuelwood plantations in arid regions; on the other hand, rotations approaching 100 years are often followed in more temperate forests set aside for saw timber production. Rotation ages are unknown in many tropical forest ecosystems, such as mangrove.

Can trees for wood products be harvested without environmental damage?

Serious environmental consequences result when harvesting is done without regard for other potential forest uses. Many desirable environmental effects can be achieved, however, through a well-planned harvesting operation that is conducted correctly.

To plan an environmentally sound small-scale harvesting operation, in which wood products are obtained with minimum damage to the environment, the development worker should recognize that forests may also serve other purposes such as soil protection and water production, grazing by domestic animals, wildlife habitat, and recreational activities.

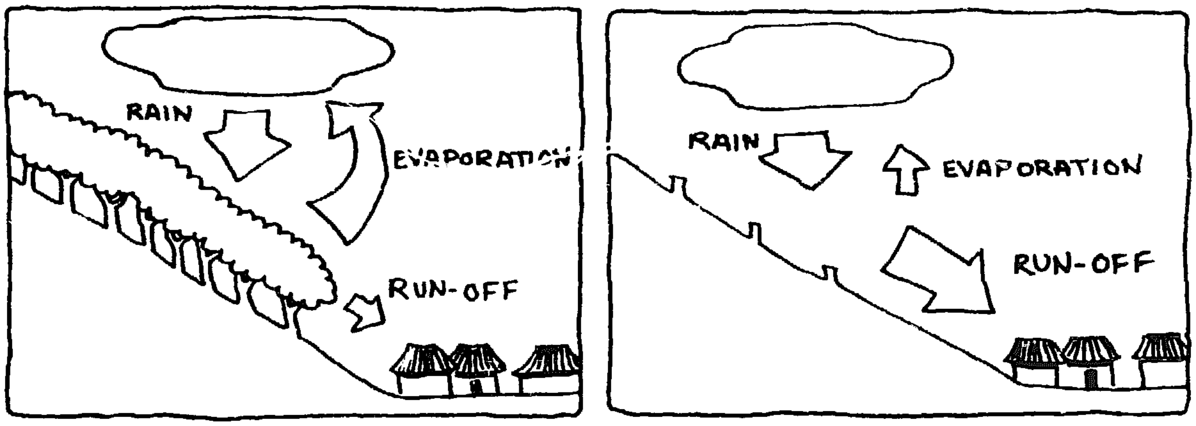
Soil Protection and Water Production

Harvesting of wood products may have to be curtailed or modified when soils are in such a critical position that they require a forest cover to hold them in place. In such situations, the value of protection is usually greater than the use of trees for wood products.

Similarly, if substantial erosion will develop as a result of harvesting operations, subsequent costs of stabilizing the soils could make harvesting trees for wood products excessively expensive. Again, harvesting may have to be restricted to prevent environmental damage.

In many forest ecosystems throughout the world, it has been demonstrated that water production from upstream watersheds can be affected by forestry practices. In certain situations, water yields are increased after the removal of forest cover, with the increase attributed to a decrease in evapotranspiration. The increased water, in turn, can be beneficial to people living in areas of limited water supplies.

Uncontrolled removal of forest cover can also increase peak water flows in streams (especially following major storm events), causing the flooding of valuable downstream lands. In addition, these large volumes of water frequently accelerate erosion processes and carry increased sediment loads.



Therefore, it is important that harvesting operations be carefully planned when soil protection and water production goals are included in the project. To obtain a proper balance:

— Forego harvesting trees for wood products on sites where a forest cover is necessary to hold soils in place, or where the removal of the forest cover will result in harmful erosion. (Quite often, so-called "protection forests" are found on steep slopes or in such inaccessible places that harvesting is very difficult.)

— Take care to minimize detrimental impacts on soils when it does become necessary to harvest trees for wood products on the above sites; this can be accomplished by harvesting only when soils are relatively stable and not subject to erosion (either by wind action or by the movement of water); by using light equipment to pull tree lengths to a loading point; and by imposing practices to remove debris left after harvesting that minimize the disturbance to soil surface.

— Harvest trees for wood products as well as increase water production by exercising good forestry practices. Keep in mind that forests can be managed to reduce evapotranspiration, thereby increasing water yields; this can be accomplished by a reduction in forest densities, converting from a forest cover type to an herbaceous cover type (grasses, forbs, or shrubs) that uses less water, or by a combination of both.

— Do not remove all of the forest cover from extensive areas (particularly those on steep slopes with shallow soils), especially if downstream lands are subject to flooding. Also, leave some forest cover in areas subject to wind exposure.

Grazing by Domestic Animals

As mentioned in Chapter 6 of this manual, growing trees for wood products and grazing by domestic animals can occur together in many forest ecosystems. In these situations, it can be advantageous to consider possible benefits from both uses.

Grazing may have to be eliminated (or at least restricted) during actual harvesting operations, particularly in environments with unstable soils that are subject to erosion. If not curtailed, the combined impact of harvesting trees for wood products and continued grazing by domestic animals can result in serious environmental damage.

Also, it may become necessary to limit grazing during the period immediately following a harvesting operation, if the area is to be reforested by planting seeds or seedlings soon after harvesting. Once the trees have become well established and beyond the reach of animals, controlled grazing can usually be resumed.

Wildlife Habitat

Another possible use of forests compatible with growing trees for wood products is wildlife production, whether or not for food. As trees grow in size, more shade is cast onto the ground-cover, altering plant species composition and density. With changes in ground-cover conditions, wildlife populations often change in kind and amount.

By harvesting trees for wood products with an eye toward specific food and cover requirements for wildlife, desired game and non-game habitats can be maintained or created. For example, careful planning and execution of harvesting operations, according to good forestry practices, creates multiple edges and otherwise increases diversity in forests which, in turn, can increase the abundance of game and non-game animals.

Recreational Activities

Certain areas, depending upon their natural qualities, should not be disturbed. As long as harvesting operations are in accordance with good forestry practices, however, recreational activities will probably not be jeopardized. Opening up roads and, if necessary, installing bridges to remove wood products can enhance recreational opportunities but may also lead to increased colonization by subsistence farmers.

What alternatives exist?

Forest owners who raise trees for wood products do so because they expect returns in excess of expenditures of money, time, and effort necessary to grow the trees. When returns are large, the owner is usually interested in growing more trees and in maintaining the forest in a productive condition. However, if returns are small (or if there are no returns at all), the owner may decide to abandon the commercial forestry enterprise altogether.

Wood products are often considered to be a principal operation in forestry. Therefore, the value of the trees is often realized only when they are harvested. For commercial projects such as these, there is no real alternative. But, as discussed in Chapter 6 of this manual, the development worker and the local people must keep in mind that forests should be managed for the most beneficial combination of present and future uses, including both tangible uses (such as deriving wealth from the selling of wood products) and intangible uses (including soil protection, water production, and wildlife habitat).

CHAPTER VIII: BACKGROUND FOR PLANNING: FUELWOOD MANAGEMENT PROGRAMS

A fuelwood plantation program implemented by the Government of India was spared the resentment and sabotage that afflicted many other programs because it took the local farmers into account. It educated the people about the need for leaving the plantations intact, appointed them "guardians of the forests" and employed them in various positions as part of the project. Not only did the local people leave the new plantations unmolested, but they guarded them from other poachers.

Why is fuelwood management important?

Throughout the world, demands for fuelwood are increasing. Many households and even whole communities in Third World countries are entirely dependent upon wood for cooking and heating.

With increasing demands for fuelwood, both natural and man-made forests are often subjected to environmentally unsound harvesting practices, including complete deforestation. Frequent and continuous harvesting of fuelwood and other forest biomass for energy poses dangers of soil compaction, soil erosion, and nutrient and organic material depletion. Environmental consequences of these dangers include dislodging of plant, animal, and human populations, degradation of soils and site productivities, and reduction of genetic diversities of native species.

Over time, it is likely that even more people will become dependent on fuelwood for energy. If properly managed, use of woody materials as energy, has obvious advantages: a dependable and renewable supply of energy; an even spread of developmental activities through reforestation of marginal lands; and the generation of employment opportunities in rural areas which are invariably closer to forests.

The world stands to gain from the use of fuelwood and other forest biomass for energy, necessitating environmentally sound planning.

What is the heat content of wood?

The heat content of wood is proportional to the density (or weight per unit of volume) of wood. Laboratory tests have shown that the heat content of a kilogram of wood, regardless of the tree species, is nearly 21,000 kilojoules. A joule is a unit of energy approximately equal to 0.24 of a small calorie, the latter being the amount of heat required at a pressure of one atmosphere to raise the temperature of one gram of water one degree Celsius.

With the information outlined in the diagram on the following page, the heat content of a cubic meter of wood can be estimated.

How are energy input and output relationships used in planning?

Converting wood energy for human use also requires an energy input, the latter being a human effort or the use of other fuels. In an energy balance calculation, this energy input should be subtracted from the total energy to determine the energy gain through wood utilization.

Some forest ecosystems require energy input only at the time of fuelwood harvesting and during its transportation to the point of use. Other forest ecosystems require a continuous energy input from the beginning to the end of a rotation; additional energy is also needed in harvesting, transporting, and (if necessary) processing the crop.

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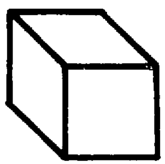
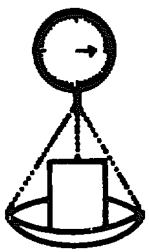
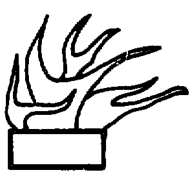
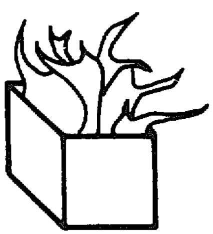
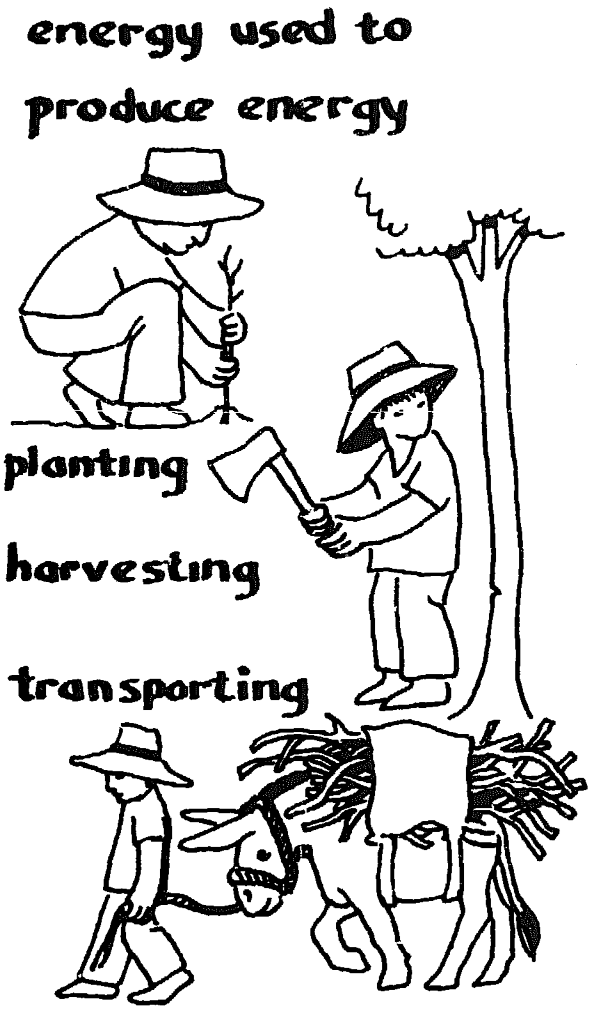
	CUBIC METER OF WOOD	DIRECT MEASUREMENT
	KILOGRAMS PER CUBIC METER OF WOOD	MULTIPLY CUBIC METER OF WOOD BY DENSITY OF WOOD (KILOGRAMS PER CUBIC METER OF WOOD) OR DIRECT MEASUREMENT
	KILOJOULES OF HEAT PER KILOGRAM OF WOOD	APPROXIMATELY 21,000 KILOJOULES OF HEAT PER KILOGRAM OF WOOD, AS DETERMINED FROM LABORATORY TESTS
	KILOJOULES OF HEAT PER CUBIC METER OF WOOD	MULTIPLY KILOGRAMS PER CUBIC METER OF WOOD BY 21,000 KILOJOULES OF HEAT PER KILOGRAM OF WOOD

Heat Content of Wood



To plan an environmentally sound small-scale fuelwood management program, and a program that produces a net energy gain, a development worker and the local people should recognize the relative advantages and disadvantages associated with fuelwood management in different kinds of forests.

Natural Forests

A Natural Forest

Natural forests usually have a mixture of native tree species and ages over a relatively large area. In terms of producing woody materials for energy, these forests have several advantages:

- Humans need invest no energy in the establishment of the forest, since the forest regenerates itself naturally.
- Less energy is usually needed to maintain the forest in an acceptable growing condition.
- Net energy production in these forests can be quite high, particularly in young stands.

A Natural Forest

Disadvantages of managing natural forests of a multiple tree species are well known, and include the facts that:

— Little information is available to describe overall growth rates.

— Forest management is relatively complex, and techniques are only partially developed.

— Harvesting wood for wood products, including fuelwood, is frequently difficult.

— Reproduction of shade-intolerant trees, if desired, can present a problem.

A major energy investment from human sources occurs at the end of a rotation, primarily for harvesting, transporting, and processing the crop.

Man-Made Forests

Man-made forests usually consist of an age sequence of one-aged blocks of a single tree species, often planted with uniform spacing. As a source of fuelwood and biomass for energy, these forests seem to be an attractive proposition because:

— Management can be prescribed relatively precisely and be carried out by skilled workers.

— Growth over a rotation can be forecasted relatively accurately, and the rotation length can be adjusted to give maximum or optimum production to meet specified energy needs.

- Net energy production is relatively large (larger than for natural forests in many situations).

- Management and utilization can be mechanized more easily than in natural forests

- Management of man-made forests, particularly in temperate zones, is founded on a long history of research. There is a growing body of information on management of arid forest lands and tropical rain forests.

Questions about the use of man-made forests as a source of energy arise from the following concerns.

- They can present a greater risk of fire, insects and disease, and loss of soil fertility.

- Aesthetic, wildlife, and recreational values may be diminished.

- Quite often, there is a heavy investment of financial resources and energy in establishment and maintenance.

- Once planted, options for alternative land and natural resource uses are restricted.

A major investment of energy from human sources is required for rotation, and to harvest, transport, and process the crop.

Agro-Forestry

As discussed in Chapter 9 of this manual, growing of trees in conjunction with production of agricultural crops and, at times, with grazing by domestic livestock is called agro-forestry. Trees grown within many agro-forestry systems can be utilized as fuelwood. Advantages of agro-forestry in fuelwood management are:

- Tree species are either self-regenerating or readily available for planting.

- Maintenance and protection costs are usually minimal.

- Energy output is profitable at the level of the village, even for the farmer.

- No major capital investments are needed.

- Transportation costs are minimal.

There are also disadvantages:

- Planting trees in conjunction with agricultural crops may reduce the yield and quality of both crops, in some cases.

- Soil fertility may be reduced, particularly in "slash-and-burn" situations.

Which trees should be grown?

As mentioned in Chapter 4 of this manual, a development worker may not have a choice in the tree species which will be grown, particularly in natural forests. When a selection can be made, however, there are desirable characteristics that should be stressed for choosing tree species to grow for fuelwood. However, the question of what specific tree species should be grown can best be answered on a local basis. Some desirable characteristics are:

- Tree species with relatively high wood densities (meaning, high weights per unit volume) and energy yields should be favored whenever possible.

- A relatively short rotation period is often an objective of fuelwood management programs -- when this is so, selection of rapidly growing tree species (especially in the establishment and initial growth stages) should be made.

— Production of wood for energy is sometimes a by-product. With some species of prosopis, for example, branches are harvested for firewood although the trees are used to provide live fencing.

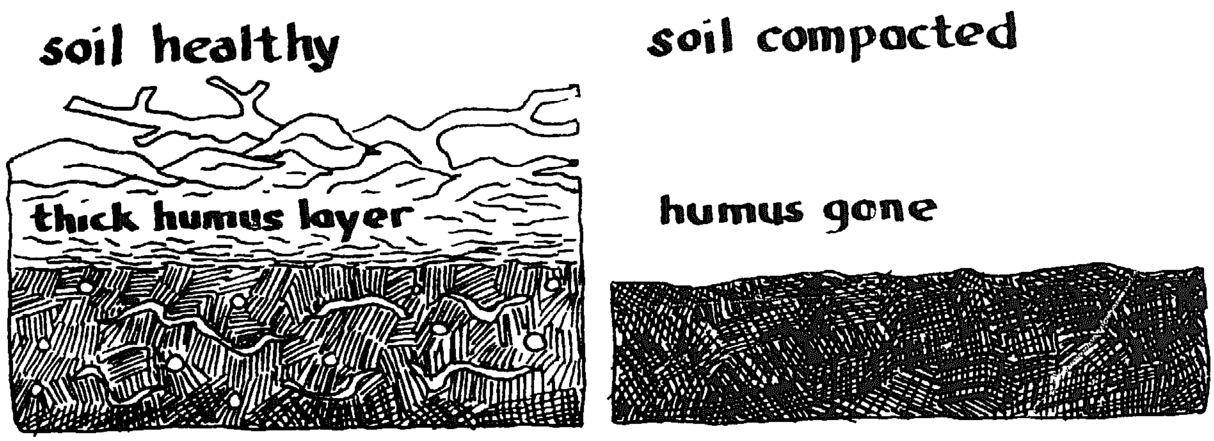
Also, as mentioned in Chapter 4 of this manual, if a tree species is to be introduced, in this case for fuelwood, it is important to test its suitability before making a commitment to a large scale planting.

How does fuelwood management affect the environment?

Effects on the environment from harvesting fuelwood (specifically, a total exploitation of forests for energy purposes) are essentially the same as those resulting from a total forest removal for saw timber, pulpwood, or other wood products. What follows is a brief discussion of some of the more important environmental impacts which might be expected when natural and man-made forests are intensively harvested for fuel, and proper management is lacking.

Natural Forests

Removal of trees and dead organic materials for fuel also removes nutrients from a site, withdraws food from soil micro-organisms upon which the nutrient cycle depends, and reduces the productivity of soils. Other consequences may be increased soil compaction, loss of soil porosity, an increase in erosion, leaching and nutrient loss, and a reduction (or even complete suppression) of natural regeneration. Intensive gathering of fuelwood and other forest biomass for cooking and heating may result in a loss of nutrient capital and, therefore, a loss of productive capacity. Whenever possible, a balance should be achieved between a demand for fuelwood and the need to maintain site productivity.

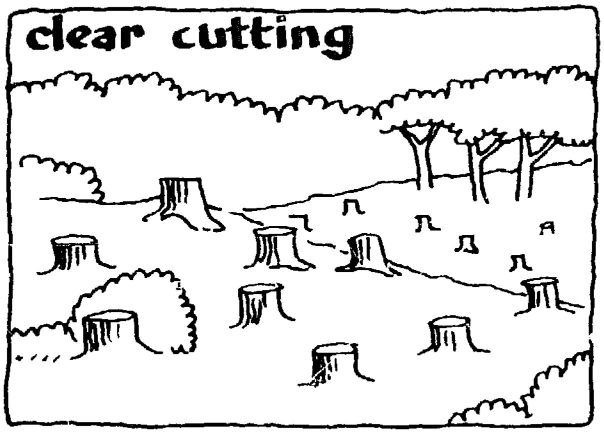


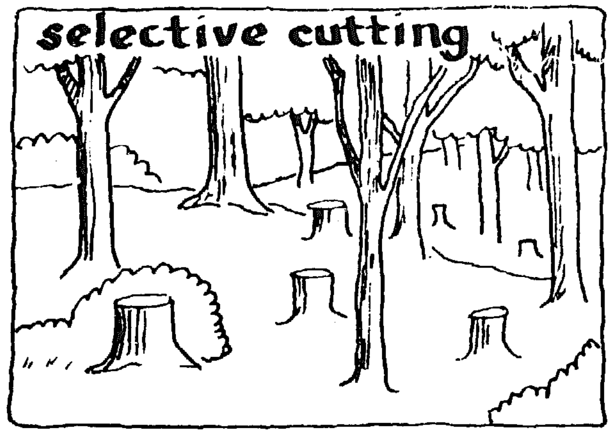
Removal of dead organic materials from a forest floor (such as residues from harvesting other wood products) is often a practice in areas of high fuelwood use and may result in much harsher climates near the ground. Removal of these materials can increase solar radiation and re-radiation, cause extreme temperatures, result in a drier soil surface and reduce the subsequent accumulation of biomass.

It should be mentioned, however, that by not removing at least some of the large amounts of residues of harvesting operations, these materials will become fuels for wildfires. Here, controlled removal and use of residues for energy can have desirable consequences.

Removal of forest cover by intensively harvesting fuelwood can result in destruction of habitats for certain wildlife species, causing many of these species to migrate to other areas. Damage is greater where forests are cleared, although even where selective cutting is practiced, wildlife species are adversely affected.

Again, selective, as well as clearcut harvesting for wood products often results in accumulations of residues that may discourage regeneration and make forest management for high quality wood products more difficult. Regeneration of forests, both naturally and artificially, can be facilitated by the removal of these residues for energy use.





Removal of residues of harvesting operations can improve local acceptance of cut areas, since regeneration occurs sooner and use of forests for many other purposes is established more quickly after cutting. Clearcut areas may be marginally more acceptable if residues are removed than otherwise.

The quality of regeneration may be improved by removal of unmerchantable, small, and otherwise defective trees for energy use, provided that suitable seed sources are available and planting is undertaken.

When weeding and thinning are practiced to improve the quality and the condition for growth of the remaining trees, use of the cut trees for energy is often a custom. In general, finding a use for weedings and thinnings can make this practice more attractive.

Man-Made Forests

In many Third World countries, man-made forests that are maintained for continued fuelwood production are probably desirable. Many of the environmental impacts that have already been discussed with respect to the exploitation of natural forests are applicable to short rotations of man-made forests, but often with greater intensity (such as 10 to 20 years).

Short rotation tree crops, such as those undertaken in fuelwood management, provide a quickly recurring harvest of biomass devoid of aesthetic and organic benefits associated with natural forests. However, by satisfying urgent needs for fuelwood, man-made forests can furnish a safety valve against local pressures to exploit natural forests in energy-short societies.

Can fuelwood managemen be integrated with other forestry activities?

It is entirely possible, a d in many instances quite appropriate, to integrate fuelwood man... ent with other forestry activities. The development worker should encourage such an integration whenever feasible. However, in encouraging integration, it is important to consider the following points.

- Identify, disseminate, and apply existing knowledge of the management and use of forests (both natural and man-made) for sustained and maximum energy yields, with consideration given to environmental effects, such as prevention of soil erosion in the tropics and control of desertification in arid and semi-arid zones.

- Take into account the most important social and economic impacts, including the problem of increasing distances required to secure domestic fuels.

- Develop new silvicultural and forest management systems to maximize energy yields within the framework of multiple-use. The most promising options appear to be short rotation forestry, whole tree utilization, growing coppice forests (in which renewal of a newly cutover area depends primarily on vegetative reproduction like sprouting), and intermixing of so-called high energy crops (such as sugar cane) with tree species.

- Encourage local (particularly rural) communities to accept new forest management practices and technologies. There is an indispensable need to bridge the gap between theoretical insight and practice. Social and cultural understanding is a key element. Coupled with environmental education, appreciation of local practices can lead to implementation of effective forest management and use.

CHAPTER IX: BACKGROUND FOR PLANNING: AGRO-FORESTRY PROJECTS

With problems of deforestation in mind, and with an appreciation of Panama's needs for fuelwood and new agricultural lands, the Agency for International Development (AID) of the United States mounted a carefully planned and coordinated program of agro-forestry, forest resources, and agriculture. This integrated program has been considered one of AID's most successful environmentally-sound development of projects, as it relates directly to the needs of local people.

What is agro-forestry?

The forest ecosystems of the world, and particularly the Third World, are being subjected to ever increasing pressure by subsistence farmers and herders. Agro-forestry offers a means of bringing the activities of rural people into greater harmony with the forest environment by developing a complementary association between trees and agricultural crops.

Agro-forestry is the integration of forestry and agriculture. It combines growing trees with production of agricultural crops and, in some agro-forestry systems, grazing by domestic livestock simultaneously or sequentially on the same unit of land. The objective of agro-forestry is to create sustainable land management strategies which increase the overall yields of the land, and which are also compatible with the environment and local cultural practices.

Properly applied, agro-forestry is a system that is both productive and environmentally sound and it has the potential not only to increase food, fuel, and income for farmers or herders on marginal lands, but also to help stop destruction of the world's forests lands.

Is there a general agro-forestry system?

There is no universal agro-forestry system. Each set of conditions found in a particular forest ecosystem require a different agro-forestry system. Often, more than one agro-forestry system can be applied to any single set of conditions.

Some of the many agro-forestry systems are listed below:

- Agri-silviculture systems -- the management of land for the production of agricultural crops and forest products.

- Silvo-pastoral systems -- the management of forests for the production of wood, as well as for raising domestic livestock.

- Agro-silvo-pastoral systems -- the management of land for the production of agricultural crops, forest products, and domestic animals.

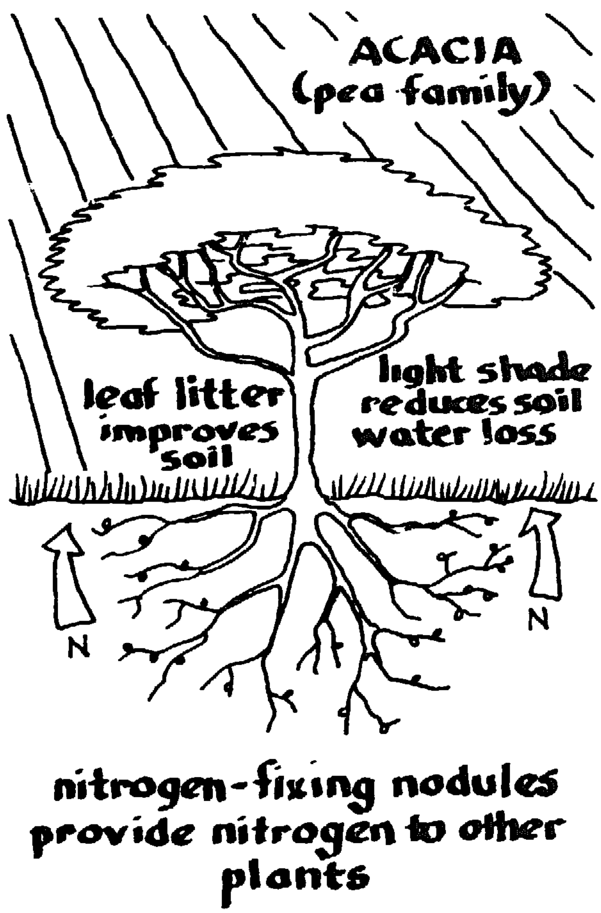
- Multi-purpose forest tree production systems -- the regeneration and management of forest tree species for wood, leaves, and quite often, fruits that are suitable for food and/or fodder.

Primitive agro-forestry has been practiced by forest dwellers for thousands of years. It is only recently that scientific attention has been focused on these practices. This has occurred because forest ecosystems are being heavily impacted by ever increasing populations and because of a realization that western agricultural methods are usually inappropriate.

Ideally, an agro-forestry landscape would be dominated by trees. Trees would be in woodlots, in the middle of agricultural plots, dotted on pastures, or in rows on the perimeters of fields to serve as fences and wind-breaks. With such a system, a farmer could produce his energy needs, building and fencing materials, as well as improving the soil fertility, fodder, and food supply. Wildlife would be sustained to supply extra protein. A surplus for market might even be produced.

Below are some case examples of agro-forestry systems:

— In Indonesia, the state forest corporation has a program for developing forests, not only as providers of wood and protectors of the environment, but as sources of food, medicinal herbs, resin, and silk. This system also involves growing rice between young tree plants; it has more than doubled paddy production within two years.



— Bangladesh has a pilot scheme underway to settle 300 families on 600 hectares to grow bamboo and practice horticulture.

— In the highlands of Colombia, cattle are grazed on Kikuyu grass under alder plantations. Alder roots fix nitrogen in the soil which increases forage yields.

— It was found in Senegal that millet yields (an important grain staple), when grown under nitrogen fixing Acacia trees, were increased as much as 250 percent and were 350 percent higher in protein.

— Farmers in Central America imitate the structure and diversity of tropical forests by planting a variety of crops with different growth habits. Plots as small as 0.1-hectare may contain a dozen or more species, each with a different form: coconut or papaya with a lower layer of citrus, a shrub layer of coffee or cacao, tall and low annuals such as corn and beans, and finally a spreading ground cover of squash.

- New Zealand sheep ranchers have found that their animals are able to maintain their body temperatures with less energy loss in the modified climate of pastures in open tree stands. The combined production of timber and sheep provides a greater net profit than does either forests or pasture alone.

Although there may be social, economic, and physical constraints on the proper development of a forest ecosystem, with imagination and careful study, the potential benefits of agro-forestry can be great.

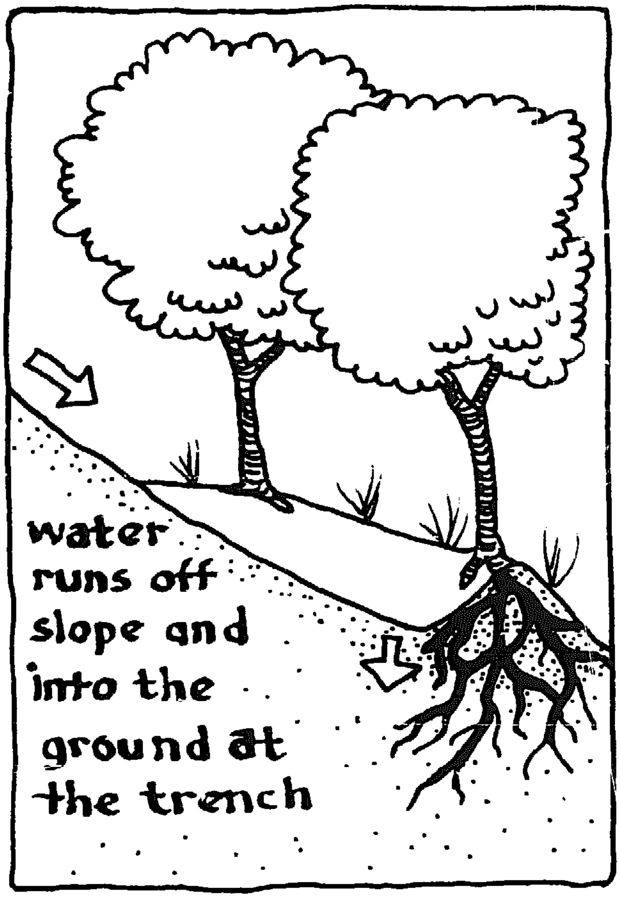
What are the environmental benefits of agro-forestry projects?

Among the environmental benefits of many agro-forestry systems are:

- Recycling of nutrients by trees when their leaves, flowers, fruit, and branches fall to the ground and decompose. This addition of biomass also provides mulch which can reduce tillage and lower evaporation rates.

- Tapping of moisture and nutrients by trees at depths not reached by agricultural crops or pasture plants.

- The ability of trees to more efficiently extract and recycle nutrients from soil through the activities of



mycorrhizae (the structure formed when a beneficial fungus invades a tree root, generally improving the roots ability to function). Phosphate-releasing ability of some tree-root mycorrhizae can also be of advantage in providing the essential nutrients to associated agricultural crops. Most legumes and the plants of some other families fix nitrogen from the air in a form available for plant use.

— Protection against erosion by the perennial roots of trees. Tree roots can also improve soil permeability by favoring the formation of stable aggregates and by penetrating tight soils and some types of hardpans.

— Improvement in the quantity and diversity of wildlife by providing a greater variety of ecological niches. Predators of harmful insects and rodents are particularly desirable.

— The provision of support for some types of climbing crops (black pepper, for example).

— An increase in diversity and spatial arrangement of plant species which can sometimes deter insect proliferation.

— Manipulation of light by pruning tree crowns to control flowering or fruiting of associated crops and of the trees themselves.

— Modification of a microclimate favorable to reducing temperature extremes, raising humidity, lowering wind velocities, and reducing rainfall energies.

— An approximation of natural ecological systems that more effectively use vertical space and capture solar energy more efficiently.

What are the social and economic benefits of agro-forests?

A major problem facing subsistence farmers and herders in many Third World countries is obtaining a steady supply of food or income throughout the year, as agriculture only produces at irregular harvesting intervals. Conventional forestry practices are usually unattractive to farmers because of problems of cash flow and the long investment period. Agro-forestry offers opportunities for subsistence farmers and herders to diversify production of wood and non-wood products to maintain regular employment and income during periods between harvests of agricultural crops.

There is considerable scope in designing agro-forestry systems with high productivity by utilizing plant and/or animal species most acceptable to local people. Specific social and economic benefits include:

— Economic insurance provided by the store of saleable wood.

— Lessening of the danger of catastrophic losses that can occur with monocultures which are dependent upon the vagaries of climate, markets, pest outbreaks, and the availability of fertilizer, machine parts and pesticides.

— Direct economic benefits of fuelwood, fence posts, poles, sawlogs, fruits, fodder, honey, medicinal products, and other forest products, without having to transport or buy them from other sources.

— The presence of trees which usually reduces weeding costs.

— Use of trees to mark property boundaries, and sometimes to serve as shelterbelts (see Chapter 10 of this manual) or as a guard against land usurpation.

— Increased opportunity to move from destructive land uses which return profits over the short term to environmentally sound practices with long-term benefits without diminishing productivity.

— Early reduction of the economic investment of establishing tree crops by the proceeds of thinning and tree crown manipulation to produce fodder, fence posts, and fuel.

What problems might arise in developing agro-forestry projects?

An aim of a small-scale agro-forestry project is to develop a desirable replacement that at least matches the productivity of any existing or alternative system. There are some potential disadvantages that should be considered in planning an agro-forestry project for a specific area.

Environmental Considerations

— Shading by tree crowns can lower the yields and quality of associated agricultural crops beneath the trees.

— Competition between trees and associated crops for nutrients and water can reduce production of either or both crops.

— Competition for space both below and above ground can reduce overall yields.

— Tree harvesting can cause mechanical damage to associated crops.

— The presence of trees can make mechanization or tilling by hand difficult.

- The moisture content of the air layer at the level of the associated agricultural crops may be increased and favor fungal and bacterial diseases.

- Trees take up and store nutrients over long periods of time. There can be a loss of nutrients from site when the trees are harvested.

- Trees retain part of the precipitation in their crowns, which can be important in dry areas of light rains. In some cases, stemflow can adversely redistribute precipitation from heavy rains.

- The environment of an agro-forestry system may promote populations of animal pests.

Social and Economic Considerations

- In some cases, economic yields of agro-forestry systems can be lower than for monocultures, even though the long term environmental advantage may be great.

- In other cases, the combined value of trees and associated agricultural crops may be eventually higher than that of a monoculture. Where population densities are high in relation to land resources, survival often depends upon agricultural crop cycles. There may be resistance by the rural poor to planting and managing trees whose products can only be realized over much longer cycles.

- Agro-forestry involves complex associations and, therefore, is less amenable to experimentation and analyses than are monocultures. This problem is compounded by the scarcity of trained personnel for improving existing or developing new systems.

- There is generally a lack of knowledge of the potentials of agro-forestry on the part of decision makers. Consequently, they may be reluctant to release funds for experimentation. Without adequate experience, there is a danger of creating resentment at both the rural and decision making levels from unsuccessful projects based on insufficient information. The development of projects based upon reports of "miracle trees" is an example.

What are the elements in planning environmentally sound agro-forestry projects?

Agro-forestry projects can vary in complexity from simple schemes to improve the practice of shifting cultivation to intensely managed intercropping systems. An ultimate goal of agro-forestry projects, however, is the conservation of the forest ecosystem while satisfying the needs of local farmers for goods and income.

Planning any type of agro-forestry project will require:

— Surveys of needs, customs, and abilities of local people; these needs might also include the possibilities of developing cottage industries.

— Study of both existing and potential markets for future development.

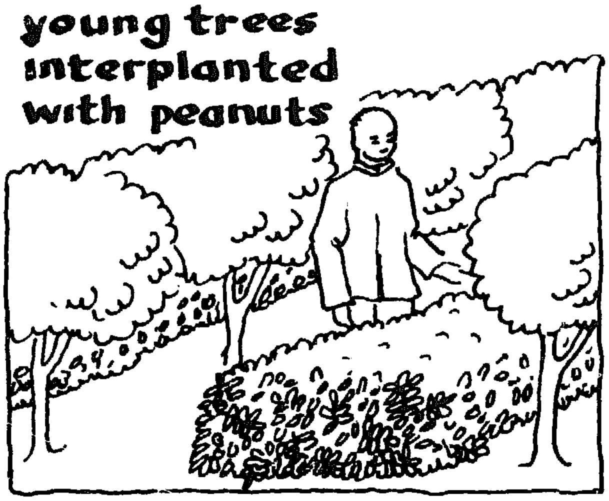
— Examination of constraints of economics, infrastructure, and the organization of local community working groups.

— Decisions on which agro-forestry systems would be most appropriate for local community needs, the ecological setting, and existing markets.

— Selection of management techniques, including planting and harvesting schedules, to maximize yields of both trees and farm crops.

— Provisions for monitoring production and changes in soil fertility; this information should be used as feedback to improve the system.

For intercropping (agro-forestry systems designed for a mixture of trees and farm crops), careful consideration must be given to the following:



— Optimum mixtures and spacing patterns of trees and farm crops, which maximize the production of both. (Particular care should be given to possible complementary and conflicting relationships between species.)

— Foliage characteristics and leaf fall of the various species, and their influence on competition for solar energy and nutrients.

— Shade tolerance of agricultural species and the effect of forest species on energy levels at the forest floor.

It is important to keep in mind that any agro-forestry project depends not only on the quantity and quality of joint products that may be produced, but also largely upon the socio-political strategies built into the project.

CHAPTER X: BACKGROUND FOR PLANNING: SHELTERBELT AND WIND-BREAK PLANTINGS

In the 1970's when the drought began in Mauritania, nomads settled on the green dunes of Nouakchott. They naturally chopped down the surrounding Euphorbia bushes and Mesquite trees. As the number of people increased, the remaining vegetation was trampled. Without trees, and as the drought became worse, the dunes became destabilized and the sands began to shift. In response to this situation, a PVO funded a project to replant indigenous Euphorbia bushes and Mesquite trees as wind-breaks. These plant species survived remarkably well, considering the shortage of rainfall.

What are shelterbelts and wind-breaks?

Shelterbelts are barriers of live vegetation, usually trees and shrubs, planted in one or more rows at right angles to the direction of prevailing winds. Their primary purpose is to reduce the velocity of winds across agricultural crops and pastures or around buildings and livestock enclosures.

Shelterbelts have been used successfully in temperate climates since the middle of the 19th century. They have been effective in improving the microclimate, reducing wind erosion, increasing crop and livestock yields, reducing heating costs, and providing fodder, fuelwood, and other wood products. It has also been demonstrated that shelterbelts can be even more effective under the harsher conditions of arid lands. On these lands, the value of thrifty tree species may be even higher than that of other products of land use.

A distinction is often made between shelterbelts and wind-breaks, but there is no consistent agreement on differences in the terms. The term shelterbelt is most often used to describe wind barriers around agricultural fields and pastures, while the term wind-breaks is commonly used to describe wind barriers around buildings, gardens, and orchards. Both shelterbelts and wind-breaks serve the same purpose and the terms are often used synonymously, as they are in this manual.

Planning a shelterbelt operation requires a development worker to consult with local inhabitants to determine goals of establishment and management, and to provide a foundation for long-term development.

How do shelterbelts function?

When wind approaches a shelterbelt, its velocity is moderated on both sides of the shelter. When the shelterbelt is dense and not very permeable to wind, most of the flow is deflected upward. Pressure on the down-wind side is reduced, causing turbulence which greatly reduces velocity, but only for a relatively short distance down-wind of the shelter.

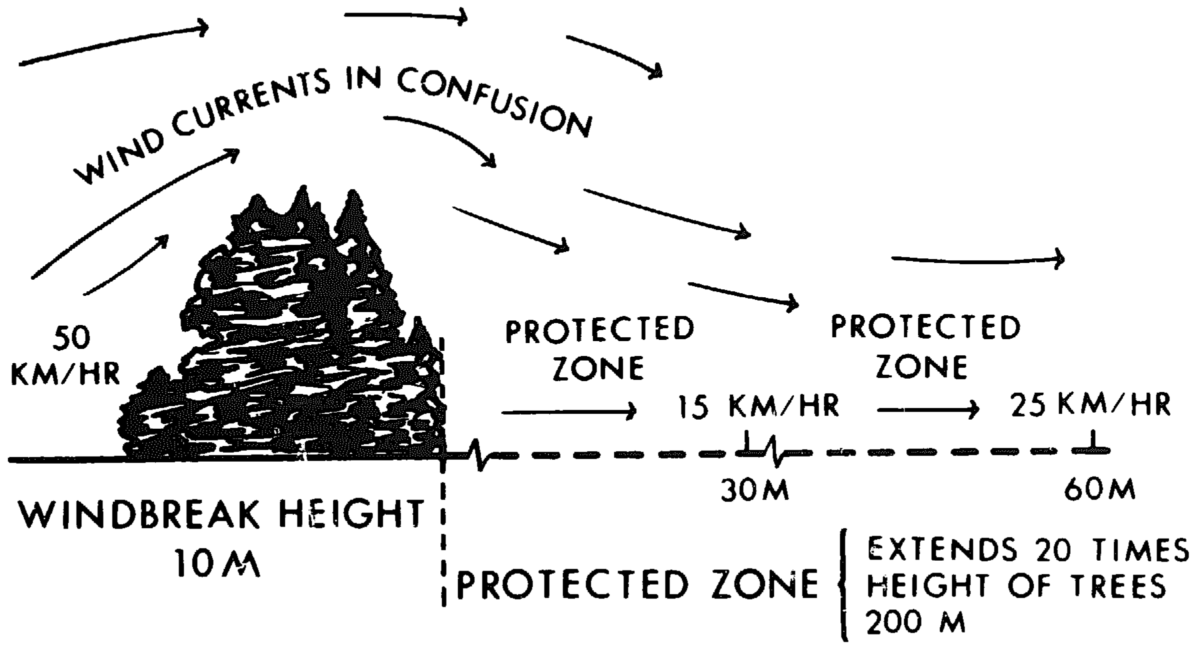
If a shelter is more permeable to wind, the wind flow is divided — part of the flow is deflected upward (as with the less permeable belt) and part penetrates through the belt. There is usually less turbulence and the reduction in velocity is felt a greater distance down-wind.

For both permeable and impermeable shelterbelts, the effect on wind velocity is related to the height (H) of the tallest trees in the belt and is expressed in multiples of this height. Normally, the effect is felt at distances of 20H to 40H. Therefore, shelterbelts should:

— Be permeable with a vertical crown density of about 50 to 60 percent, but no greater than 80 percent.

— Have the greatest height possible for tree species adaptable to the area.

— Have a suitable width and structure.



Effect of Shelterbelts on Wind Velocity

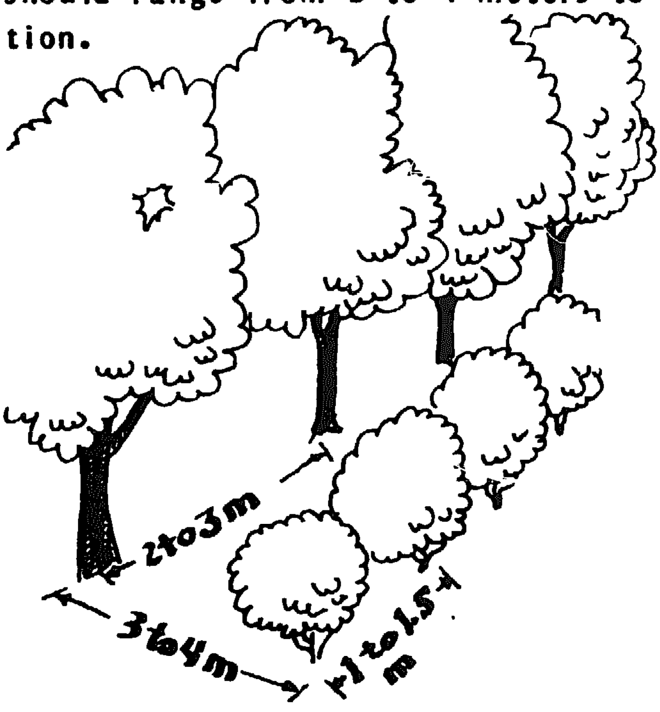
How should shelterbelts be structured?

Shelterbelts are most often planned so that they will develop a triangular cross section, with the highest trees in the center flanked by shorter trees and shrubs on the edges. However, rectangular cross sections are quite adequate for shelterbelts of two to four rows, provided that at least two of the rows have foliage down to the ground.

A decision on how wide a shelterbelt should be depends upon the amount of land which can be economically devoted to planting, and the minimum number of the rows required to maintain the desired permeability. Actually, narrow shelterbelts of moderate density are just as effective as wide belts.

Shelterbelts of five rows are generally efficient in both humid and dry climates, and they are not difficult to maintain. However, in considering economic worth, account must be taken of possible multiple-uses of the shelterbelt. For example, wood products, shelter for animals and bees, food and cover for wildlife, and fodder for livestock may be important considerations in addition to wind protection. For these considerations, shelterbelts of more than five rows may be desirable. One-row shelterbelts are risky since holes may develop and funnel the winds.

Spacing within rows depends in part upon the tree and shrub species planted and the type of management to be followed once the plants mature. In general, seedlings are planted close together to obtain early closure. As the plants mature, every other one is removed. Final spacing within rows should be from 1 to 1.5 meters for shrubs and 2 to 3 meters for trees. Spacing between rows should range from 3 to 4 meters to allow for subsequent cultivation.



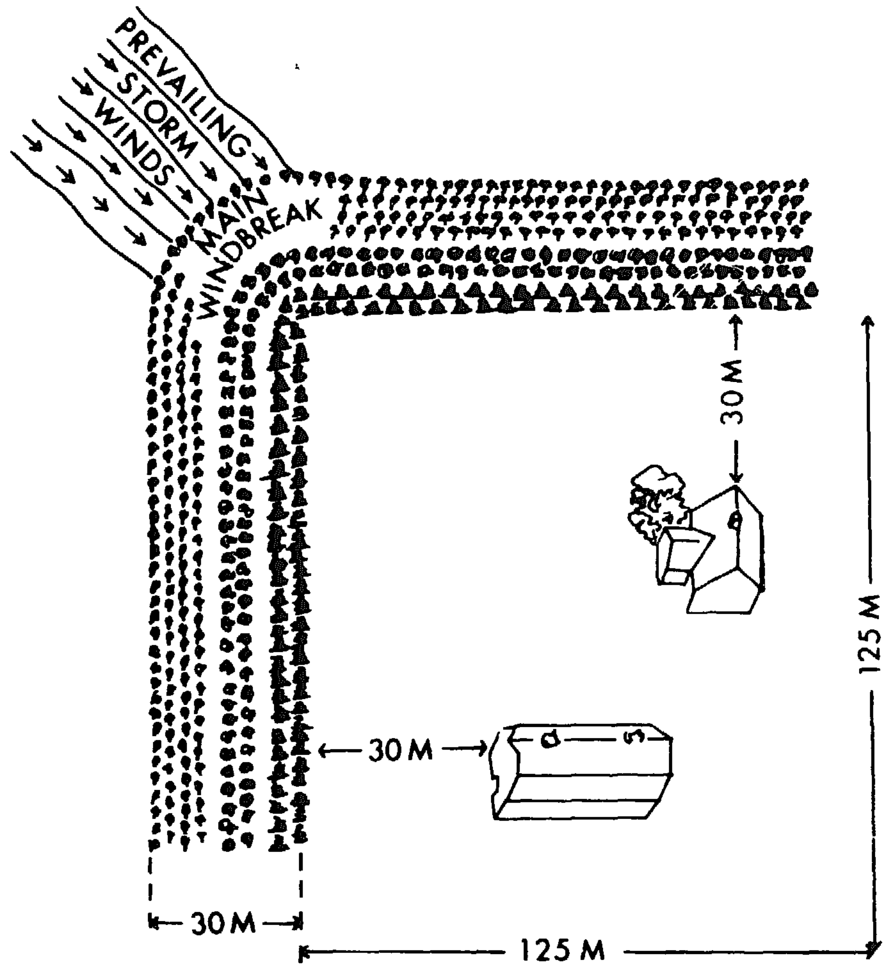
windbreak plant spacings

What patterns should be considered?

Design of shelterbelt systems largely depends upon the velocities and directions of local winds. If there are definite prevailing winds, a series of parallel shelterbelts should be established, preferably at right angles but no less than 45 degrees to the direction of the winds. More often, winds blow from various directions which would require a checkerboard pattern. In some cases, dense shelterbelts may be planted across the major wind directions and less dense belts planted across minor directions.

In irrigated areas, shelterbelts should be located mainly along irrigation channels. In rolling topography, shelterbelts are more effective if planted along ridgetops. Therefore, a compromise is sometimes necessary to take into account both the direction of winds and the cultural and physical characteristics of the area.

For sheltering livestock, a compact shelterbelt in a U, V, X or square configuration can be used. Shelterbelts around buildings are often planted in L-shaped pattern across the prevailing winds.



Shelterbelt Planting in an L-shaped Pattern

Shelterbelts should be planted a suitable distance from buildings to prevent excessive snow accumulation due to downdrafts on the leeward side of the shelter in cold climates. In the case of permeable shelterbelts, snow accumulations extend from about 10H to 25H.

In hot and dry climates, dense shelterbelts placed too close to buildings may result in oppressive heat. These belts should be permeable and located at least 30 to 45 meters (but no greater than 90 to 120 meters) from the buildings.

What spacing should be used between shelterbelts?

Planning the spacing of shelterbelts depends upon site factors, climatic patterns, and growth rates of the tree and shrub species. Normally, shelterbelts should be spaced at about 20 times the height of the tallest trees, particularly across the major wind direction. If a checkerboard pattern is used, shelterbelts across minor wind directions may be spaced up to 60 times the height. Since height growth of arid land species is not great (only 10 to 15 meters under irrigation), the best that one can plan for in those areas is an average of 200 to 300 meters between major shelterbelts.

What characteristics should the plant species have?

Native and introduced tree and shrub species which have proven their adaptability to the soils and climate of the region should be used in shelterbelt plantings. In addition to the characteristics listed in Chapter 5 of this manual, plants selected should have certain other characteristics, including:

— Resistance to the force of winds.

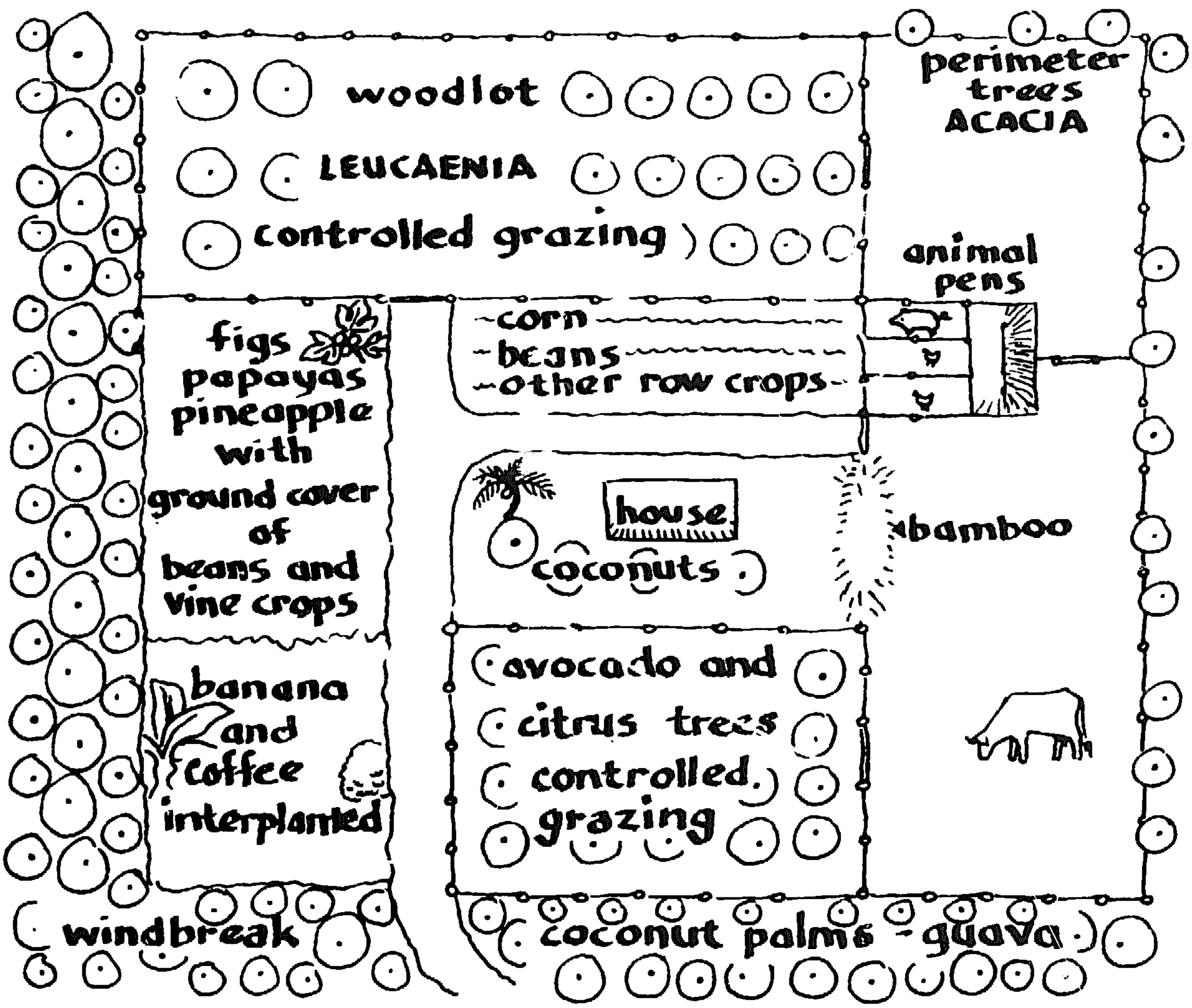
— Strong tap roots. (Lateral rooted tree and shrub species will compete with fields and pastures they are supposed to protect).

— Dense, uniform crowns, thrifty growth, perennial foliage, and adequate height.

— Resistance to disease, and insects, and cold or heat.

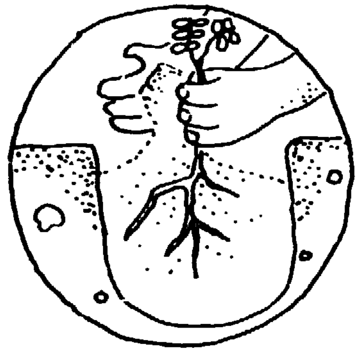
— Value for wood or other products (such as forage).

Although use of a single tree or shrub species simplifies management, it is not often that one plant will have all of the above attributes. Often, two or more species will be required to develop a shelterbelt that will provide adequate protection. For example, the low growth form of acacia makes it useful for planting in the outer rows of shelterbelts in dry climates; the inner rows may consist of tamarisk, casvania, and eucalyptus. Single plant species, particularly those that sprout after cutting (such as eucalyptus), can sometimes be managed to provide full vertical shelter by alternately cutting the outer rows of trees and allowing the cut trees to complete the shelter.

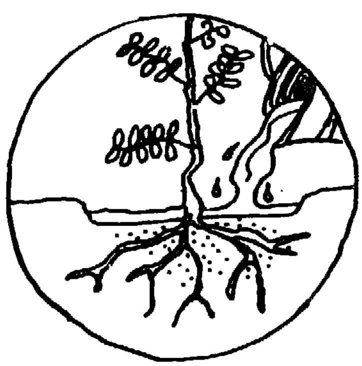


How are shelterbelts established?

The first step in planning a shelterbelt system involves identification of the need for the technique by local farmers. Following need identification, a commitment to undertake such a project should be accompanied by training and formation of a community organization. Cooperative efforts are essential to set goals, purchase or grow planting stock, obtain equipment, organize work crews, and to carry out management objectives.


planting

Technical essentials include site preparation, careful handling of planting stock from the nursery to the planting site, protection against fire and grazing animals, and cultivation after planting at least several times each season. Source of seed is, of course, equally important in the growing of planting stock for any locality. Terracing and contour planting may be necessary in some areas. Often, a soil-improving crop of legumes may be grown between the rows of plantings in the belt for the first few years to foster growth of the belt.


watering

In dry climates, irrigation after planting is necessary. The soil should be well prepared and a permanent source of water should be assured. A water transportation and application system must be planned. The number of waterings and the amount of water applied depends upon climate, species, and soil. For example, in a sandy loam area receiving 150 to 200 millimeters of rainfall with a dry season of 8 months, about 6 applications of 10 liters for each seedling is probably sufficient to assure survival. In both dry and humid climates, survival of 90 or 95 percent is considered necessary for shelterbelts.

At least two cultivations must be planned during the first few years following establishment, and at least one cultivation must be made during the following two or three years. Heavier soil will require more intensive cultivation. Root pruning of some species which have spreading root systems, such as eucalyptus, must also be planned. These roots can grow into adjacent fields and compete with crops.

How should shelterbelts be managed?

Properly managed shelterbelts can yield products from thinnings, sanitation cuts, prunings, and rotational cuts without greatly reducing the barrier effects. Indeed, cuttings are often necessary to maintain the structure and vitality of the shelterbelt. For example, to stimulate height growth and the formation of straight stems, pruning of the lower branches early in the development of the belt is advisable. Coppicing trees will require the greatest amount of pruning. To stimulate diameter growth, thinning can be required. For some tree species, thinning could be started during the fourth or fifth year. Sanitary cuts and thinnings will occasionally be necessary during the life of the shelterbelt to remove dead, diseased, or insect-infested trees.

Rotational cuts will provide the greatest quantity of wood products. Each successive cutting can be done so that at least half of the rows are left standing. Therefore, half of a five-row shelterbelt can be cut; meanwhile, the other half should furnish the necessary protection until the regrowth of the first cut reaches the desired density. It should be planned that the first cut is done on the down-wind side at about half the normal rotational age. Starting with the second cut, a normal period of rotation could be followed. Replanting, of course, follows each cut. In the case of two-row shelterbelts, one row is cut and the second is left standing.

The cutting cycle for shelterbelts depends upon the growth rate of the trees and shrubs. However, a rough estimate for tree species used for wood products is 15 to 20 years (roughly the same as the rotation cycle).

What are the environmental effects of shelterbelts?

The effects of shelterbelts are almost without exception beneficial to the environment. Major effects include:

- Lessened evaporation and transpiration, increased water available for plant use, and reduced water stress.
- Increased snow catch in cold climates and improved soil moisture relations.
- Decreased wind damage to plants and animals.
- Checked wind erosion and lessened sand movement and its abrasive action.
- Controlled air temperature by leveling out extreme fluctuation.
- Provision of organic material for soil handling and improvement.
- Provision of an aesthetic value in areas where trees are scarce.

In arid regions, where water is limited and where shelterbelts must be watered, favorable environmental effects must be carefully weighed against the value of water. Adverse environmental effects can also occur if the trees harbor birds, insects or disease organisms which are harmful to the crops. Any symbiotic relationship (in which two dissimilar organisms live together in close association) between diseases of specific crops to be grown and the alternate hosts of the diseases should be studied before shelterbelt species are selected.

CHAPTER XI: BACKGROUND FOR PLANNING: REFORESTATION AND AFFORESTATION PROJECTS

To improve the natural forest, the Government of Malaysia has conducted a cooperative tree-planting program with local villagers. As local people were hired to do the planting, they were quite protective of the plantations. As a result, poaching and grazing damage have been minimal.

What is meant by reforestation and afforestation?

The term reforestation is normally used when an area that once supported forests is to be reforested; this includes areas such as abandoned agricultural lands, bush lands, or areas already forested but poorly stocked or stocked with inferior species that should be replaced with more productive species. The term afforestation is generally applied to projects whose goal is to plant areas previously devoid of trees. Most often, the term is used for forestry projects in arid regions.

Actually, differences between the two terms are slight and need not be belabored. The term reforestation will be used in this manual to mean planting treeless areas, changing the composition of existing forests, or converting from other land uses to environmentally sound forest production.

When is it important to plan reforestation projects?

Throughout most of the Third World countries, native forests have been greatly depleted, and in many cases, completely eradicated. Plans for the reforestation of these areas cannot be made too soon. Forests are essential to the quality of life and, in most cases, to life itself and the life support system.

As the number of people living in these areas increases, the quality of the land on which they must live simultaneously declines. Unless solutions are implemented, the impact will be felt not only locally but globally. The consequences of not initiating effective solutions immediately are accelerated soil loss and land deterioration, environmental degradation, and further impoverishment of the world population.

As mentioned in Chapter 3 of this manual. if undisturbed for a long time, forest ecosystems will evolve through successional steps into a climax type. Once established, no other tree species can naturally invade and replace the climax, except if the type is subjected to some external form of disturbance. Forest succession is one of the basic concepts of ecology.

Practical implications of forest succession in tree planting means that climax tree species cannot be grown successfully on severely degraded sites; conversely, pioneer species, if planted on good sites, will eventually give way to climax species. This principle is especially important in planning reforestation of depleted sites. The original vegetative cover of these sites has been stripped and the topsoil is gone. To attempt to reforest with climax types may be difficult or impossible even though the land may once have supported magnificent forests. Conditions may be so bad that the area will only support shrubs and other pioneer plant species. Reforestation might require planning a series of successional vegetative stages to arrive at a desired forest cover.

What environmental factors are important?

In planning a reforestation project, forest successions should be studied by a development worker -- this includes studies of historical records and interviews with local inhabitants. Physical and climatic factors prevailing in the area can also be very important. Some that should be considered are:

— Soils -- texture, structure, depth, water holding capacity, and fertility as they may affect plant species adaptability.

— Precipitation -- amount and distribution through the seasons and how they may affect planting and survival.

— Temperature — seasonal fluctuations and extremes which may affect transport, storage, and planting of seedlings.

— Site factors -- aspect, slope, topography, and geology as they may affect plant species selection.

— Wind -- direction, velocity, and dryness as they may affect survival in certain areas.

All factors that influence the water balance are critical for survival and growth of every plant. This is particularly true in arid regions. Attention should be given to lower valleys and flats that receive runoff and soil materials from higher up, since these sites may receive water several times the natural rainfall. Therefore, these areas may have the potential for growing higher value species than have the upland sites of the area to be reforested.

Activities of man and his animals usually have the greatest impact on a forest ecosystem and can be severe constraints on reforestation. Questions to ask in planning are: Is fire now being used in agriculture or for range improvement? Are grazing lands held in common and how heavy is land use? What are the foraging habits of grazing animals (browsers, bark eaters, and grazers)? Is it customary for the area to be reforested to support herds of domestic livestock with a variety of food preferences?

Answers to these and other questions may require control of both human and animal activity, enforcement of rules limiting access to the area to be reforested, and development of a fire control program.

What tree species should be selected?

In addition to the general criteria listed in Chapter 5 of this manual, the choice of tree species to be planted should be made on the basis of adaptability to the local environment, and ability to meet the needs of local inhabitants.

Generally, native species growing in the area and conforming to local needs and traditions are the safest choice for reforestation. However, there may be no native trees, or the native species may not produce the products desired in some areas. In such instances, the possibilities of introducing tree species with characteristics superior to those of native species should be considered.

Generally, introduced species should be used with a great deal of caution until their performance has been demonstrated by trials in the area. Transfer of either native or introduced species from one locality to another should be governed primarily by similarity of climate and soil in the new area within the natural range of the species.

Erosion control is often used as justification for reforestation projects. Certainly, this is a worthy objective, but projects can fail unless they also yield other products of direct value to the local inhabitants. Careful thought must be given by a development worker to the properties of the wood and the growth characteristics of the tree species which make them valuable to local economies.

When trees are grown for lumber, qualities such as straightness, strength, and workability are desirable. Posts and poles require durability in addition to strength and straightness. Fuelwood species should have a high caloric value and low water content, and produce large volumes of wood. Trees with dense wood make the best charcoal. Deciduous trees without spines and with leaves high in nutrients (such as many legumes) make good forage species. If gum extraction is one potential use of the forest, high yield species and varieties will, of course, be preferred.

In certain cases, it is possible to select trees which will serve several purposes, such as tall trees with flowers which will attract bees, or good charcoal producing shrubs bearing essential oils or leaves for fodder. More often, two or more species will be necessary to provide the products desired and to take advantage of differences in planting sites within the area to be reforested.

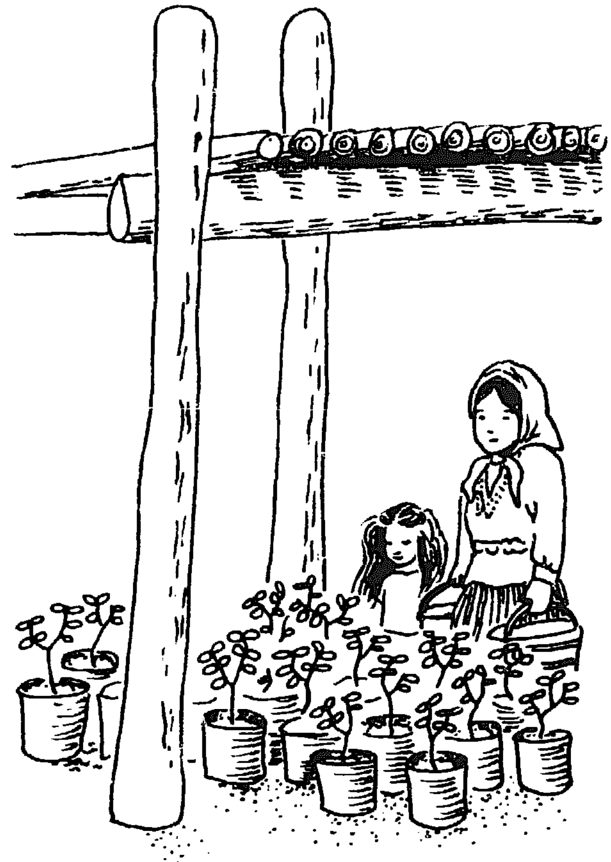
What should be considered in obtaining planting stock?

In undertaking a small-scale reforestation project, it is safest to obtain seedlings from a permanent nursery in the region. However, if the nursery is too far from the planting site or if none exists, establishment of a small temporary nursery may be the only alternative. The closer the nursery is to the planting site, the better. Elaborate site preparation for such a nursery is not required and temporary buildings as shelter will suffice. Plans for a dependable supply of water (preferably a gravity system) are critical.

Persons working at the nursery should have training. At a minimum, this should include a permanently employed overseer and several assistants if only on a temporary basis.

Unless it is planned to use bare root stock for reforestation, the temporary nursery site need not be located on fertile soils. Instead, the seedlings can be grown in containers filled with soil. There are any number of containers which can be used. These range from unfired, hand made clay pots to compartmentalized styrofoam trays and individual containers made of peat (both of which are produced commercially). Bag or tube containers made of inexpensive plastic film and filled with soil are very popular in many parts of the world. Growing seedlings in containers is labor intensive, but great efficiency may not be an important consideration for small scale operations.

Plastic film and other types of containers minimize damage to the seedling and drying out of the root system; they also do not require temporary storage facilities at the planting site as do bare root stock. However, the labor of transporting containerized seedlings to the planting site can be great. If flexible containers are used, a source of cohesive (but not too heavy), soil must be used.



Where should seeds be obtained?

If it is necessary to establish a small nursery, the origin of seed for the tree species to be planted is of utmost importance. A source of high quality seeds must be found early in the planning stages. Failures have often occurred by using seed from inferior trees or from trees which grow in unsuitable environments. The following principles should be considered:

— Seed collection should be based on the similarity between the climate of the collection zone and the planting zone.

— If native species are to be used, collection should be limited to local seeds of known origin. Generally, the safest choice should be seed trees within about 200 kilometers distance and within 500 meters elevation of the planting site.

— In the case of introduced tree species, seeds should be collected under environmental conditions as similar as possible to those of the area to be reforested. It is important when seeds are ordered from abroad to consider the exact geographic location of the source. For example, the seeds of eucalyptus from one province in Australia may be more resistant to salinity than those from another origin.

— Seeds should not be collected from each tree in a forest stand, only from carefully selected, superior trees which are distinguished by such qualities as straightness, fast growth, and branching habit.

Planning may require provisions for training local people in seed collecting. Once the seeds are collected, provision must be made for extracting, cleaning, and drying. Most tree species do not produce seeds each year but have abundant seed years 2 to 5 years apart. For that reason, plans should include storage facilities. Seeds of some species may require refrigeration. Other species can be stored at room temperatures for extended periods without losing viability.

What is necessary in planning site preparation?

Site preparation will probably have to be considered in reforestation. In humid climates, preparation is usually minimal, particularly on abandoned agricultural lands. On brush lands, the shrub species present must either be removed or subdued by cutting and/or burning until the newly planted seedlings can become established. Where there are undesirable tree species, girdling or cutting may have to precede planting.

In dry climates, site preparation can be more complicated. It may be necessary to consider massive treatments (such as deep plowing or the construction of terraces) to hold the limited water from precipitation. Other less intense land treatments could include furrows, trenches, pits, or berms constructed along contours. In very dry areas, it may be necessary to plan water harvesting systems in which runoff from a larger catchment area is diverted onto a smaller area where trees are planted.

On severely eroded land that is heavily gullied, whether in humid or in dry climates, extensive site preparation may have to be considered. Soil conservation structures (including gully plugs, rock dams, or temporary brush dams) may have to be planned.

In severe cases, preparation of these sites may have to precede planting by several years.

Use of grasses to help stabilize the site until trees become established may be necessary. Reforestation of these lands may require careful planning from aerial photos, if available, or maps to locate suitable points for control structures. The structures should then be designed to maintain the stability of the site until the trees can take over. In humid climates, the time required may only be one or two growing seasons; in dry climates the time may extend up to a decade.

Trees have been replanted on the Algerian slopes by a PVO in an attempt to stop the incursion of the Sahara. Algerian peasants engaged in the project were furnished seedlings, and given wages and food. They were also educated about the need for reforestation and involved in all stages of planting, terracing, and road building. Since Algeria is an oil exporting country, the need for fuelwood is not as acute as in other places -- as a result, of the 100 million trees planted, about 80% survived. Where local farmers were involved, they protected the new plantations, and the incidence of poaching was negligible. In areas where local involvement was slighted, hardly any trace of the project remains.

Are small-scale forestry projects not discussed important?

Absolutely -- this manual cannot mention the full range of small-scale forestry projects that could be considered for a given locale. Instead, examples of some of the more common projects have been discussed. It is important that development workers and others interested in planning, implementation, or management of these projects thoroughly explore all possibilities for creatively using a particular forest ecosystem in the most beneficial manner.

Regardless of the small-scale forestry project to be undertaken, it is necessary to keep in mind the need to plan environmentally sound projects that are responsive to the needs and well being of local people.

Is additional information available?

Yes -- depending upon the specific project being considered and the particular forest ecosystem involved, additional reference information may be available to assist development workers in planning environmentally sound small-scale projects. To this end, the bibliography at the end of this manual could provide background information for the initial stages of a planning process.

APPENDIX: ECOLOGICAL GUIDELINES FOR COMMUNITY DEVELOPMENT PROJECTS

Mini-Guidelines

The following short-form version of the CILSS/Club du Sahel Ecologic Guidelines has been developed to meet the needs of development workers at the community level. The original version is available at cost from the CODEL Office, Environment and Development Program. This paper is a response prepared by Fred R. Weber as a result of discussions with PVOs at CODEL workshops on Environment and Development.

In its basic form, the guidelines presented will permit analysis of proposed activities and a design that will minimize negative impacts. It is designed for small-scale projects under $250,000. The Mini-Guidelines is being circulated to PVOs to invite reaction and response. It is hoped agencies will try out the Mini-Guidelines in the field and report back on the experience. Responses should be addressed to Mini-Guidelines, Environment and Development Program, CODEL, 79 Madison Avenue, New York, New York 10016. All communications will be forwarded to Fred Weber.

The general approach is the same as for the complete CILSS/Club du Sahel Ecologic Guidelines. Methods and procedure, however, have been condensed in a form that is less time consuming and can be carried out by project design personnel not formally trained or experienced in environmental analysis.

Introduction to the Guidelines

Begin with any project in the community development area: wells construction, school gardens, poultry raising, village woodlots, access roads, and so forth. Any community activity will, in one form or another, affect the environment somehow. Especially if "environment" is regarded in its broadest form, not only the physical aspects are affected but also health, economics, social and cultural components.

The objective of this exercise is to try to predict as far as possible, the various impacts the proposed activity will have in both negative and positive terms. A project normally is designed with specific results in mind. An attempt is made to provide well- defined, "targeted" inputs to bring about some improvement to the people in the field. What is less clear is the nature and extent of incidental consequences these activities might bring about that are less desirable, in fact often adverse or negative.

In reality, more often than not, the good will have to be taken with some bad. Choices often involve trade-offs. The trick then consists of developing a system where these trade-offs ultimately are as favorable as possible in terms of the people involved.

Instructions

To identify areas where possible adverse effects may occur, the basic questions that should always be asked, is:

How Will Proposed Project Activities Affect ____________________ ?

If we insert in this question the components that together make up the environment, we will get answers (and possible warning flags) for those situations where otherwise negative consequences "inadvertently" may result.

Explanation of Columns

1. In the table on page 100, ask yourself the basic question for each of the 18 lines (described below) and assign the following values in Column 3.

   Very positive, clear and decisive positive impact........ + 2

   Some, but limited positive impact......................... + 1

   No effect, not applicable, no impact...................... 0

Some definite, but limited negative impact............... - 1

Very specific or extensive negative impact............... - 2

2. A brief explanation of the factors in columns 1 and 2:

Surface Water -- runoff: peak and yields. How does the project activity affect runoff? How does it affect the peaks (flood discharges)? How does it affect the amount of water that will flow (yield)?

Groundwater -- Its quantity, recharge rates, etc. Also, does the project alter its chemical composition?

Vegetation — Accent on natural vegetation. Will natural cover be reduced (bad) or increased (good)? How will natural regeneration be affected? Will there be additional (or fewer) demands on trees, bushes, grass, etc.?

Soils -- Will the project increase or drain soil fertility? Where land surfaces are affected by the project, is "optimal" land use affected favorably or adversely? Will erosion be more or less likely?

Other — Basic questions dealing with improvement or deterioration of factors such as wildlife, fisheries, natural features. Also does the project follow some existing overall natural resource management plan?

Food — Will people have more food and/or a more complete diet?

Disease vectors -- A very important point and one that is often overlooked: Will the project create more standing water? Will the project increase (or create) fast flowing water? How will it affect existing water courses?

Population density -- How much will population density increase as a result of the activities? What contamination conditions will be altered? How? Will more Health Care

Services be required?

Other -- Toxic chemical, exposure to animal borne diseases, etc.

Agricultural productivity -- Per capita food production (staples or cash crops), yields.

Volume of good or services -- Will the project provide more goods (food, firewood, water, etc.) or less?

Common resources -- (Water, pasture, trees, etc.) Will the project require people to use more or less water, pastures, etc.? Will it eliminate any of these resources now available? Will it restrict access to these resources?

Project equitability -- How are benefits distributed? Who will profit from these activities? Special segments of the population? How "fairly" will the benefits be shared.

Government services, administration -- Will the project demand more work, "coverage" of government services? Will it cause an additional load on the administration: more people, recurrent costs, etc.?

Education and training -- How will it affect existing education/training facilities? Strain or support? Or will it provide alternates? What about traditional learning (bush schools, etc.)?

Community Development -- Will it encourage it, or will it affect already on-going efforts? If so, is this good or bad?

Traditional land use -- Will it restrict existing use, harvesting, grazing patterns? Many projects promote "better" land use but at the (social) cost of some one or some group being restricted from using land, vegetation, water the way they have been used to.

Energy -- How will the project affect the demand for (or supply of) firewood? Will it increase the dependency on fossil fuels?

3. Column 4: This is an arbitrary number based on experience.

4. Column 5: Choose an adjustment factor between 1.0 and 5.0 depending on whether a large number of people and/or large areas are affected. If a large segment of the population is affected (say: over 1,000 people), use a factor of 2.5. If 1,000 hectares or more are involved, use 2.5 also. If both large numbers of people <u>and</u> extensive area are affected, combine the two: use up to 5.0. Never use a factor less than 1.0.

5. Compute the adjusted score by multiplying columns 3, 4 and 5. Enter result in column 6. Make sure to carry positive and negative signs.

6. In Column 7: List all impacts that are positive.

7. In Column 8: List all impacts that are negative.

8. Now take another look at Column 8. Here you'll find a summary of the negative aspects of your proposed activity. Beginning with the largest values (scores), determine what measures you can incorporate into your project, what alternate approaches can be followed to reduce these negative values, one by one. This may not always be possible, but try to modify your plans so that the sum of all negative impacts will be as small as possible. (Tabulate the new, improved scores in Column 10.)

Modify, adjust, redesign your project so that the total of all "negative impacts" is an small as possible. This is the essence of "ecologically sound project design."

Table

ECOLOGIC GUIDELINES

(1)	(2)	(3) BASIC SCORES	(4) MULTIPLIER	(5) PEOPLE SURFACE FACTOR	(6) ADJUSTED SCORES= 3 x 4 x 5	(7) POSITIVE IMPACTS	(8) NEGATIVE IMPACTS	(9) Measures to add which will reduce negative impact scores (and/or which will increase total positive impact)	(10) REVISED SCORES
PHYSICAL ENVIRONMENT	SURFACE WATER		2						
	GROUNDWATER		1						
	NATURAL VEGETATION		2						
	SOILS		2						
	other		3						
HEALTH	FOOD		1						
	DISEASE VECTORS		4						
	POPULATION DENSITY		3						
	other		2						
SOCIO-ECONOMIC	AGRIC. PRODUCTIVITY		1						
	VOLUME OF GOODS, SERVICES		1						
	USE OF COMMON RESOURCES		1						
	PROJECT EQUITABILITY		1						
	GOVMT SERVICES, ADMIN.		1						
CULTURAL	EDUCATION, TRAINING		1						
	COMMUNITY DEVELOPMENT		1						
	TRADITIONAL LAND USE		1						
ENERGY	ENERGY		2						

THE BASIC QUESTION:

How will the proposed project activities affect the factors listed above? (Range from + 2 to - 2)

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