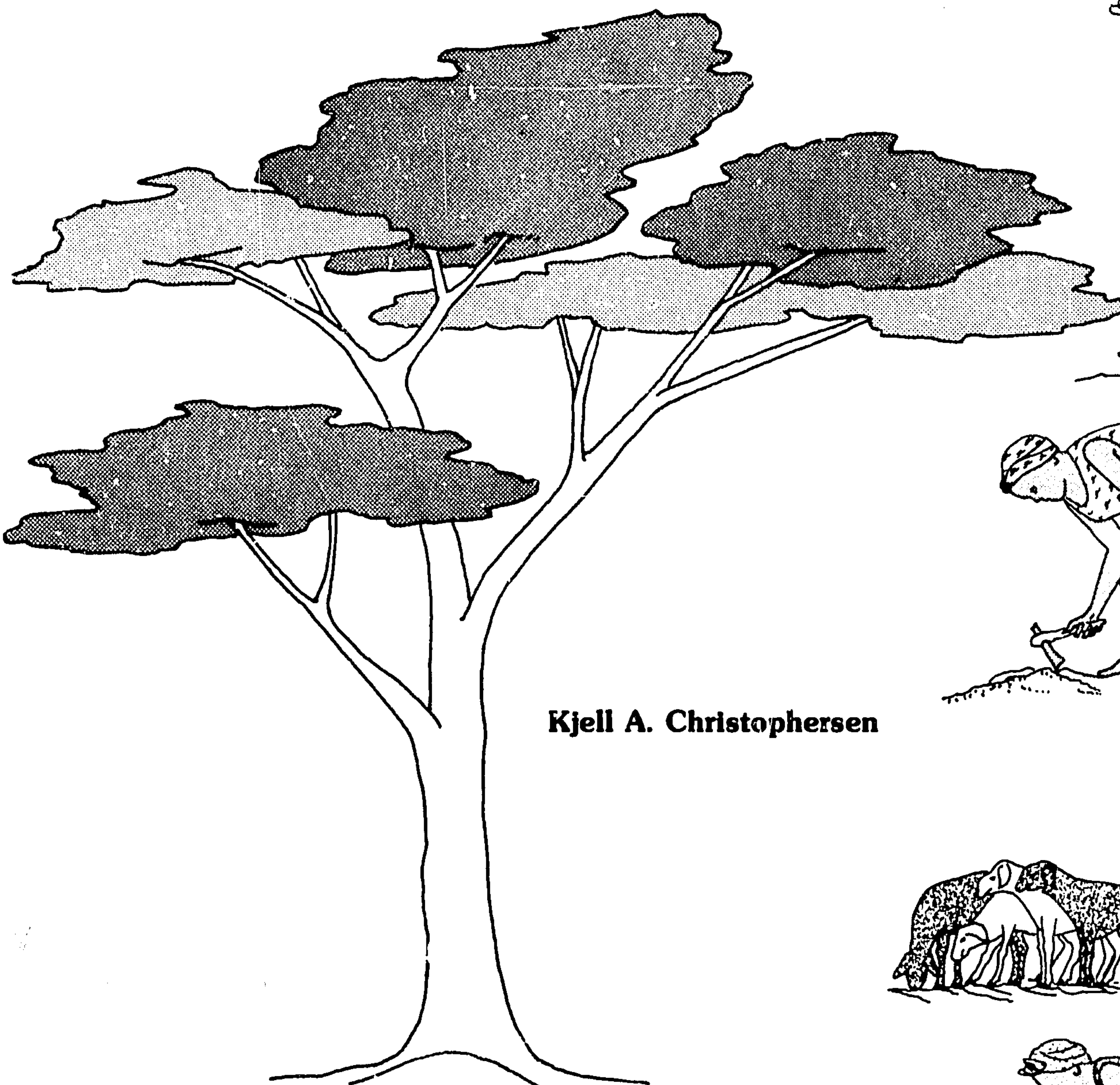
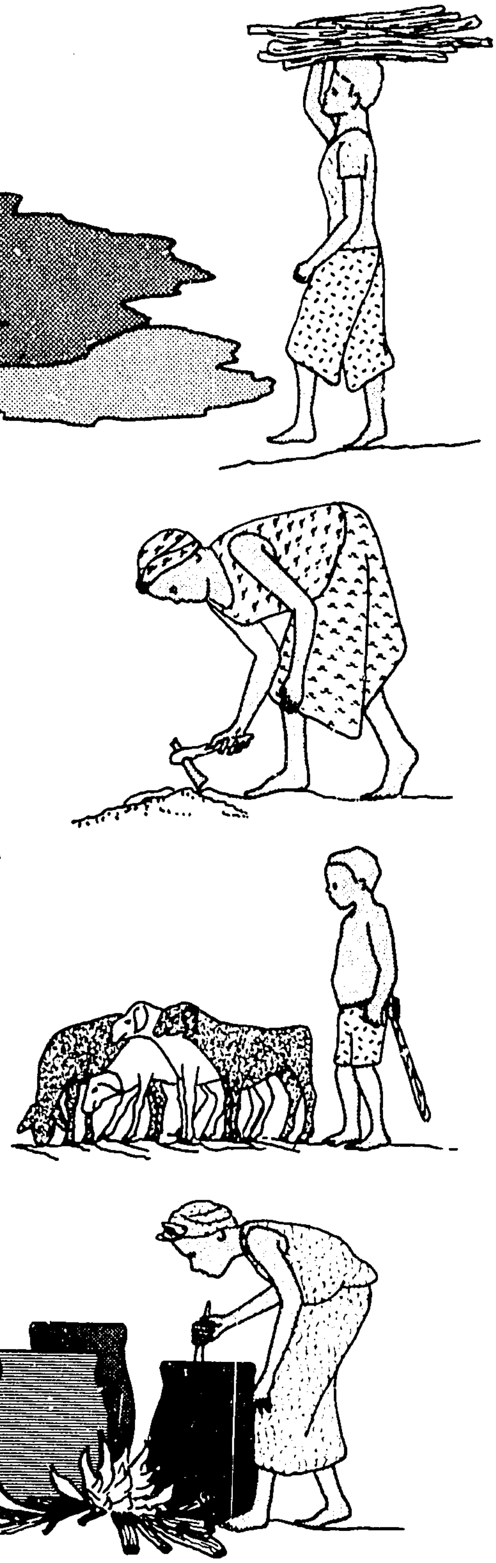
AN ECONOMIC APPROACH TO ARID FOREST PROJECT DESIGN: EXPERIENCE FROM SAHELIAN COUNTRIES





Kjell A. Christophersen

Energy/Development International e/di
U.S. Agency for International Development
University of Idaho College of Forestry, Wildlife and Range Sciences

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University of Idaho
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Energy/Development International e/di
1400 I Street Northwest
Suite 700
Washington, D.C. 20005

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PREFACE

This manual is intended for forest managers and forestry project planners of both donor and recipient communities involved in forestry projects in developing countries, focusing particularly on Sahelian West Africa. Its major objective is to make project planners and decision makers more aware of the importance of performing in-depth economic and financial analyses during the planning and implementation phases of a forestry project. The author discusses these issues in order to improve the use and appreciation of economics as a planning tool.

Economics should contribute to the planning of forestry projects at the outset of the planning process, not at the end—when all the critical decisions on what to do and how and when to do it have already been made. This manual illustrates the clear advantages of using economics to its fullest potential during both the planning and implementation phases of a forestry project, and addressing it on a level of importance equal to the biological or production sides of the project.

The emphasis in this manual is on methodology—the "how-to's" of the use of forest economics in project planning—and how the approach to economic and financial analyses among projects, donors and countries could be standardized. The author takes into account field realities: what to do if there are little or no reliable data available, how to specify assumptions, how to specify management alternatives, how to interpret results, and how to conduct sensitivity analyses.

In the process of developing this manual, the author and his colleagues with the Energy Initiatives for Africa Project (USAID, 698-0424) developed several useful computer tools/models to carry out the analyses. They include models to analyze the feasibility of forestry investments in the absence of reliable information on yield responses to management alternatives, how to determine real price and cost increases, how to derive shadow prices for fuelwood, the economics of improved cookstoves, the economics of alternative energy sources, how to determine real discount rates, recurrent cost implications of forestry investments, and others. These computer-assisted tools greatly facilitated the analyses.

CHAPTER 1: SETTING THE STAGE

1.1 Introduction

This manual is about forest economics as it has been and still is being applied in many developing countries, and as it should be applied in the future, with particular emphasis on the Sahelian countries in West Africa. Those familiar with the challenges and frustrations of forestry in the Sahel can well appreciate the problems of inadequate economic and financial analysis of forestry projects. The problems are rooted in a lack of reliable data, lack of economics expertise in the host countries, as well as a lack of appreciation of the role of economics for allocating resources. The manual addresses these concerns in eight chapters and annexes; each chapter can be considered a step toward obtaining an overall recommended and standardized methodology for analyzing forestry investments.

The first chapter sets the stage. It distinguishes between economic and financial analysis as the two fundamental "tools" to determine project feasibility, lists the problems and objectives of the manual, and provides a general overview of the basic analytical procedures to follow in the planning of forestry projects. The second chapter briefly examines the major factors and issues to consider in forestry project planning and how the application of economics could and should play a role in resolving the problems. The third chapter describes the most common evaluation techniques: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit/Cost ratio (B/C), and the special forestry application of the NPV approach, the Soil Expectation Value (SEV). The fourth chapter on field management alternatives discusses the necessity of considering a broader range of management alternatives based on biologic as well as economic criteria. The fifth chapter on investment assumptions provides a framework for the analysis, outlines how the assumptions should be specified, and discusses how to develop a base case for analytical purposes. Chapter 6 presents financial and economic analyses of several management alternatives. Chapter 7 provides the format for analyzing the sensitivity of the results to changes in the base-case assumptions. The eighth and final chapter summarizes the conclusions and offers some recommendations concerning future actions.

For the reader who is unfamiliar with economic or forestry terminology, a glossary of terms is provided in Annex 1.

1.2 Economic and Financial Analysis

The overall purpose of economic and/or financial analysis of forestry projects is to determine whether or not a proposed investment is feasible. To put it very simply, if the anticipated discounted net returns exceed or at least equal those one can reasonably expect to obtain from alternative investments, then the investment is said to be feasible. If the necessary data are available, the determination of economic and financial feasibility is a straightforward technical task involving analyses of variables relevant to the investments considered.

To distinguish between economic and financial analysis, one must regard the difference as one of perspective rather than of method of analysis. The same discounted cash flow method can be applied in both analyses. Only the assumptions and the point of view from which the analyses are made differ. Hence, the results and their significance differ. Both economic and financial analyses are necessary during the planning phase of a project.

Financial analysis is perhaps the most common and simplest way of determining project investment feasibility. It measures the net private returns on the equity contributed to the project by the investor(s) based on actual costs and revenues. The analysis does not consider whether these costs and revenues are subsidized, or fixed, how the project affects others in society, or how decisions may be otherwise distorted by various government regulations.

In economic analysis, one takes a much broader perspective by measuring the net returns that accrue to society as a whole (usually from the government's perspective), regardless of who invests and who receives the benefits. Economic analysis is neutral to the income distribution effects of the project. Taxes and subsidies, for example, are simply regarded as transfer payments within the economy and are not reflected in the cash flows of the project. In economic analysis, adjustments are made for the imperfections of the market that affect the variables in the analytical framework (such as subsidized and/or fixed costs and prices, artificially pegged exchange rates, taxes and other government controls, etc.). The adjustments are accomplished by what is termed "shadow pricing"[1], or the prices which ". . . would prevail in the economy if it were in perfect equilibrium

[1] Shadow pricing is discussed further in the fifth chapter on investment assumptions which includes some how-to examples to demonstrate how to create a base case for analysis.

under conditions of perfect competition" (Gittinger 1972).

1.3 The Problems

Having seen the disappointing results of previous forestry investments in the Sahel, there is good reason to seriously question the adequacy of the initial analyses. Almost without exception, all of the fuelwood plantation projects in Sahelian countries, whether on a large scale or in the form of village woodlots, have been economic failures. Few, if any, of the project assumptions stated originally have proven to be realistic. Actual costs have been much higher and yields much lower than those assumed at the outset. Growth and yield performance in the plantations has typically been of the order of 1 to 2 m^3/ha/year, instead of the expected 6 to 10 m^3/ha/year. In addition to the productivity shortcomings, plantation establishment costs have repeatedly exceeded, by at least three-fold, those anticipated initially.

With 20/20 hindsight, one could say that, historically, analysts greatly missed their mark in terms of predicting the economic and/or financial feasibility of forestry projects in the Sahel, even though their analytical approaches may have been correct. In the few cases where economic and financial analyses were actually carried out, they all predicted feasibility, and the projects were implemented. But, in spite of these promising predictions, nearly all of the projects ended up as economic failures.

Two possible reasons why the economic analysts may have missed their mark quickly come to mind. First, the analysts may have functioned strictly as "mechanics" in the planning phase of the project, analyzing the scenarios provided by the foresters, without having any real substantive input in the planning process. Second, the analysts may have used unrealistic assumptions on growth rates, yields, and prices to demonstrate project feasibility and thus ensure implementation of a politically favored project. While there is nothing categorically wrong with implementing projects for political reasons, the error is made if the assumptions, and, therefore, the analyses, are manipulated to fit the desired results.

Given that few, if any, of the forestry investments have succeeded economically in the Sahel, the outlook for future plantation forestry projects is certainly bleak. On the one hand, everyone agrees that forestry projects are worthwhile—indeed, crucial for environmental and other reasons. On the other hand, however, if economic and financial analyses using realistic and documentable assumptions persistently indicate that future forestry projects will not be viable given present cost and price trends, then one is faced with a dilemma: whether to implement nonfeasible forestry projects for noneconomic reasons, or whether to shift available investment funds elsewhere.

The answer is certainly not to continue the self-deception of knowingly assuming unrealistic growth and yield rates or underestimating costs or overestimating price increases in the analyses in order to show project feasibility. It is much better to recognize the limits of economic and financial analyses—that they present only a partial picture, that not all of the effects of the project can be quantified and therefore contribute to the feasibility estimates. That economic or financial feasibility cannot be easily attained is largely attributable to the fact that only partial analyses using quantifiable costs and benefits are performed. There are other benefits and costs of forestry investments, often difficult to quantify, that should still be taken into account, at least qualitatively. They include soil conservation, watershed management, increased agricultural productivity, etc., which may be difficult to quantify, but which are nevertheless real and vitally necessary. Indeed, these benefits could outweigh the extent to which the economic feasibility of the investment based on the wood benefit only is negative. A project that yields negative returns based on a partial analysis considering wood only should not be automatically rejected. Even when financial returns are negative, the economic analysis can identify the most cost-effective means of meeting the dominant criteria. Certainly, one must always be cost conscious given the scarcity of (forestry) investment funds.

The overall emphasis of this manual is methodological—how to improve the planning of forestry projects from the economic and financial points of view. As stated by Weber (1982), ". . . Many of the basic principles of project design are artificial, and in discord with local economic and ecologic realities or potentials." The approach to project planning as recommended in this manual is not new, but it will, we hope, foster a much more thorough planning process than has been the case in the past. All indications point to a great need for improvement given the following general observations:

- Analytical approaches are not standardized among projects, nor among countries.
- Investment and yield assumptions do not appear to be solidly founded on existing or known statistical information.
- Analytical distinction between real and nominal costs and prices is rarely considered. What may appear as alarming cost and price increases over time may actually be decreases if expressed in real terms. Project feasibility could change substantially

if prices and costs were allowed to vary if the statistical data so warrant.

- Only a very limited range of management alternatives is generally considered, often not allowing consideration of local socioeconomic and ecological constraints.
- Sensitivity analyses on the investment assumptions are rarely carried out.
- Because of an emphasis on fuelwood, the feasibility studies of projects have tended to consider only fuelwood, to the exclusion of a much fuller range of forest products, thus ignoring the opportunity costs between products.

These and other points are addressed in the chapters below.

1.4 The Objectives

The methodological focus of this manual is intended to enhance the understanding of economic and financial investment analyses of forestry projects. As such, the emphasis is placed on the "how-to's" of forest economics in a broad sense that allows transferability of the methodology across borders. The specific objectives of this manual are:

1. To stimulate the interest in and the appreciation for proper use of economic and financial analyses in planning future forestry interventions in Sahelian countries.
2. To identify a standard analytical procedure that resource decision makers can use to determine the feasibility of forestry interventions in Sahelian countries.

1.5 Basic Procedures: A Summary

Figure 1.1 provides an overall summary of the steps one should consider in project planning. At the top is a clear definition of the objectives, e.g., produce fuelwood, stabilize the soils, create employment, etc., or any combination thereof. The next layer is the project categories,

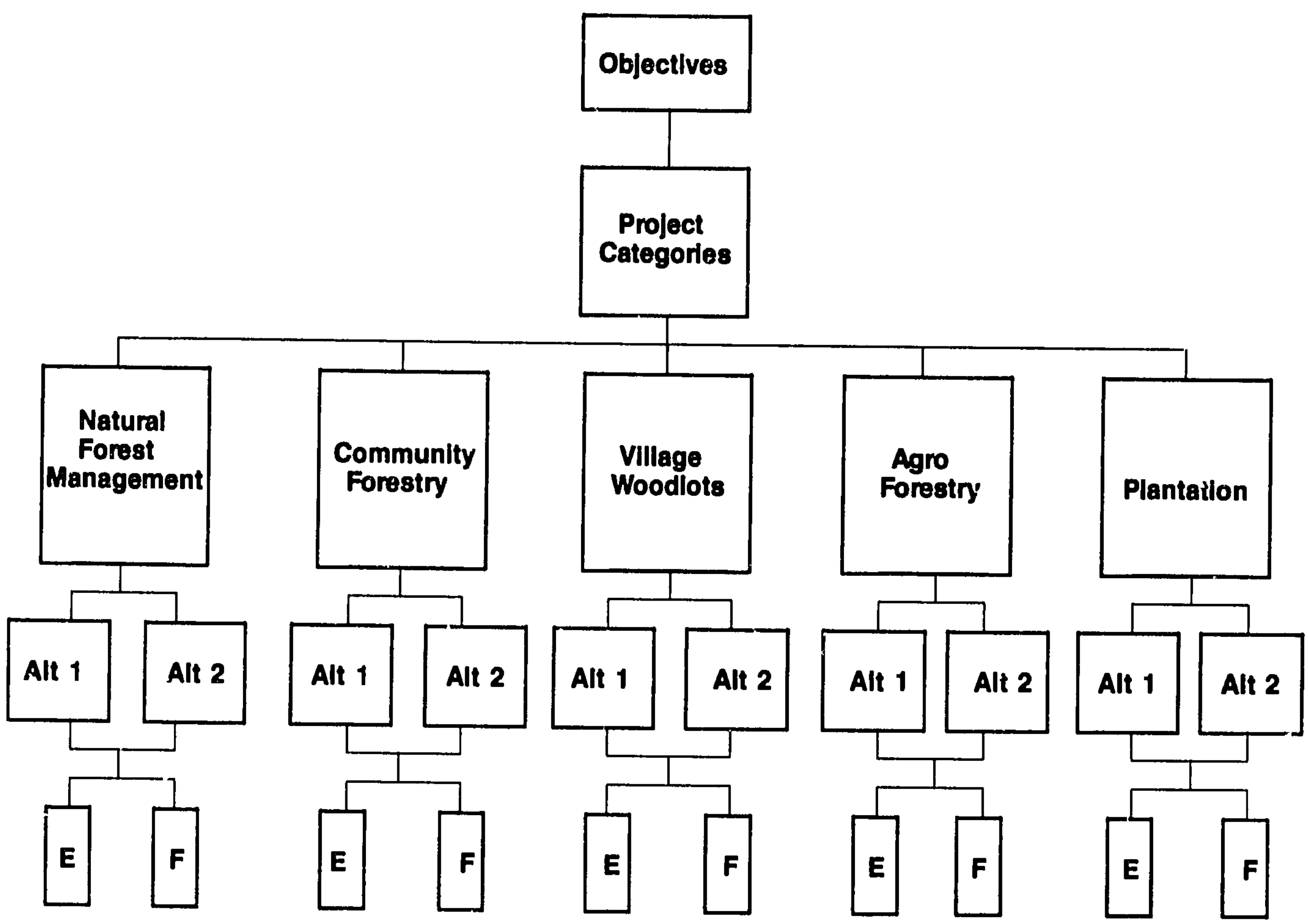

Figure 1.1. Project planning: A summary.

or different ways the objectives can be achieved. These categories range from non-intensive natural forest management to intensive plantation forestry with many variants between. (The listing of categories in Figure 1.1 is by no means exhaustive.) The third layer shows field management alternatives, e.g., capital intensive or labor intensive (the alternative 1 and 2 blocks) within each project category—how production can be achieved in different ways. The "E" and "F" blocks in the final layer of the figure signify economic and financial analyses which should be carried out for each alternative. The basic procedures for carrying out these kinds of analyses are outlined below.

1.5.1 Specify a Range of Management Alternatives (Chapters 2 and 4)

There is literally an infinite number of alternatives and combinations thereof that one could apply in a forestry project, ranging from doing nothing to conducting very intensive management. Within the range of possibilities, one should choose not only between silvicultural alternatives, such as the "Alt 1 or 2" blocks in Figure 1.1, but also between the project categories such as plantations versus natural forest management (Christophersen and Weber 1982, Taylor and Jackson 1985) and the others suggested in Figure 1.1. Too often in the Sahel, project planners have limited forestry activities to fuelwood plantations, neither considering the economics of other forest products nor whether participation by the local people in the managment of the forest might defray some of the costs.

The number of alternatives to consider, of course, must be held to a manageable level, and they should be based on economic as well as biological criteria. For example, while foresters may determine that a site is biologically best suited for planting *Eucalyptus camaldulensis* in 4- x 4-meter spacing, this would not necessarily be the preferable option. Perhaps a different spacing density or a different species or species combination or other management treatments could yield more economically attractive results.

This is not to say that the economically optimal alternative should always be chosen. It means that if the decision maker considered a wider range of alternatives, he would have more information at his disposal to enable him to make better resource allocation decisions. He still may have reasons to implement alternatives that are not economically feasible. But when he does, he will know how much economic value he gives up as a result of his choice.

1.5.2 Estimate Yield Response to Management Alternatives (Chapter 4)

To be able confidently to predict the yield response to each of the management alternatives would be ideal. However, this is often not possible, particularly in the Sahelian countries where reliable information is virtually nonexistent. Yield projections in response to treatments are normally made with yield models based on stand projection tables that are derived from sample plots. In Sahelian countries, this kind of information does not yet exist, largely because the financial means have not been made available to gather systematically the kind of information required.

If yield responses can be confidently projected, however, the basic requirements for conducting appropriate financial and economic analyses have been met. If they cannot be projected and the biological dimension of the feasibility analyses falls out, less accurate but still very useful methods of determining feasibility could be used. Two such methods, site index and break-even analysis, are discussed later.

1.5.3 State the Base-Case Assumptions (Chapter 5)

Any financial or economic analysis must be anchored to a set of assumptions or predictions about the future; however, many uncertainties exist. A base-case scenario of the most realistic assessment of the probable future behavior of variables should be developed.

The base-case assumptions should be as realistic as possible, based on the behavior, past and present, of the variables included in the analysis. The point-of-view taken depends upon the scope of the project. It could be that of the resource owner, be it a government or an individual. In this case, if a project emphasizes local participation through agricultural and/or grazing contracts, all costs and benefits are expressed from the resource owner's financial point of view. True, there will be returns to the farmers and herders who contractually participate in the management of the forest, but these costs and benefits do not enter into the project's calculations because they are external to the project. The forest owner who invites the farmers and herders to participate in the management of the forest and those who accept the invitation are assumed to do so because they all stand to benefit from the arrangement.

The point of view could be that of both the owner and the participants. In this case, the analyses become considerably more complex. Not only do costs and benefits have to be estimated for the forestry component, but also for the loca. participation component. There would be two analyses from different points of view where the results would be combined to show the total return to the project.

1.5.4 Interpret the Results (Chapters 6 and 7)

This step involves the comparison of returns associated with each of the alternatives considered. One should always include a "do nothing" or "without project" option. All of the alternatives should be compared against each other as well as against the do nothing alternative. The alternative with the highest return is economically optimal. This rate of return is competitive if it exceeds or at least equals the returns one could reasonably expect to obtain from alternative investments, such as in agricultural or industrial projects or in other investment schemes.

1.5.5 Sensitivity Analyses (Chapter 7)

Sensitivity analyses cover the "what-if" questions. Although base-case assumptions are supposed to be representative and realistic, the real world is filled with uncertainties and all variables are subject to unanticipated fluctuations. What would happen to the analytical results if the price was X instead of the base-case assumption of Y? What would happen to the results if costs were higher or lower than those originally assumed, or the probability of success is less than 100 percent? These are the kinds of questions answered in the sensitivity analyses where the base-case assumptions are changed one by one, and the effects on the analytical results are determined. Where a large change in an assumption causes only a small change in the overall result, the assumption is not very sensitive and need not be as carefully monitored. Where, on the other hand, a small change in an assumption yields a large change in the overall result, this assumption is sensitive and should be carefully watched.

1.6 The Literature

The basic procedures outlined above should be followed if appropriate economic and financial analyses of forestry investments are to be made. But the literature gives little evidence that these steps are actually being followed, either in the planning or in the implementation phases of projects. Perhaps this neglect is because one has come to expect that few, if any, natural resources projects in the Sahel are economically feasible. The problems have to be addressed anyway to prevent a total and irreversible loss of the natural resource base. The tendency, unfortunately, has been to continue as before—massive infusion of donor money, while largely under-utilizing economic analysis in the planning phase.

What is found in the literature on forestry in developing countries, particularly in Sahelian Africa, is an overwhelming emphasis on the forestry and natural resource problems from which spring numerous policy and strategy papers. The papers all say, in one form or another, that the Sahel is fraught with drought and desertification problems, that the climate is harsh and that the fragile resource base is being grossly overtaxed. They all urge the donors to fund programs and projects intended to combat these problems. In response, the donors have funded many forestry projects, particularly fuelwood plantations. Almost without exception, however, these projects have failed biologically as well as economically.[2]

Although one can agree that policy and strategy statements are a necessary condition for the justification of making forestry investments in developing countries, they are not sufficient. Beyond the fact that the resource problems abound, the literature on forestry in the Sahel is largely devoid of any reference to economics. In his search of FAO documents, for example, French (1985) revealed that there is little use of "hard economics" in their forestry studies, nor does there seem to be an awareness of the important roles that economics and marketing can play in the planning of forestry projects. Of the cases and reports he reviewed, nearly all were devoid of detailed treatment of economics. Almost without exception, the reports treated the forestry issues such as research, species trials, silvicultural interventions, etc., with no reference made to economics. Other donor organizations, too, according to French, have done little more.

Over the past few years, however, there have been some hopeful developments in broadening project analyses. For example, it is now recognized that fuelwood plantations are not the only answer to the problems. There is considerable merit in considering a much wider range of possibilities. Christophersen and Weber (1982) suggested for the Forestry and Land Use Planning Project (USAID-FLUP) in Niger that the management of the natural forest might be more economically attractive than large-scale fuelwood plantations. By including the economic values of the secondary products, such as vitamins, medicines, minerals, food, and many other products that the "bush" provides in addition to the

[2] Several of the policy, strategy and other problem-listing documents are given in the bibliography, though not specifically cited here.

wood, one could show that managing the natural forest might make more economic sense than making large investments in intensive plantation forestry. This idea—natural forest management as an alternative to plantation forestry—was endorsed and further elaborated by Jackson, Taylor and Conde-Wane (1983).

Numerous references have been made in the literature to the importance of local participation in forestry projects. In the Sahel region, two USAID projects—the FLUP project in Niger and the Forestry Education and Development Project (FEDP) in Bobo Dioulasso, Burkina Faso, have placed a heavy emphasis on the importance of local participation. Heermans (1984) states that the one dominant lesson learned in the FLUP experience was the ". . . principle that villagers will effectively participate in development projects in which they have been included from the beginning and which they feel are in their best interest."

In the FLUP project, emphasis was placed on sustained yield, natural forest management carried out by village cooperatives. In the FEDP project (Christophersen 1985), emphasis was placed on fire prevention through local participation. And the efforts paid off. In Niger, the village cooperatives generate enough income to pay for all the recurrent costs of the cooperative and the management of the forest. In Burkina Faso, the farmers farm in the firebreaks and/or in recently cut-over areas, and the herders graze their cattle in the forest. This approach considerably reduced dry season grass fires.

The refreshing element in both of these projects (FLUP and FEDP) was the emphasis placed on finding different ways of managing forestry projects that fostered local approval and participation. This approach differed considerably from the more usual repressive type of management so often found in many Sahelian countries—keeping local people out of the forest. As a result, people have been resentful, fires have been intentionally set, and illegal wood cutting has been a big problem. Both projects sought, and identified, alternative management formulae that worked better than the old ones. And in so doing, the discovery was made that the economics of the projects, too, vastly improved. This has been a significant development, and it serves as a powerful argument for the need to test different alternatives, not only silvicultural ones, in the design and planning of forestry projects.

Another important development is the recent emphasis on the recurrent cost implications of donor projects in the forestry sector. The recurrent cost burden of the majority of projects has been far too high for the recipient governments to be able to continue with the activities after the donor funding stops. When this happens, of course, the true purpose of the project has been defeated. Recurrent cost problems in the forestry sector have raised the awareness of the importance of designing projects where the recurrent cost problems are kept clearly in focus. Shaikh (1984) suggested that donors gradually decrease funding for recurring costs over some period until the recipient government absorbs them all. To accomplish this, however, would require major changes in the way projects are designed. A wider range of alternatives should be considered to identify those that minimize the recurrent cost burdens left behind.

Weber (1986), in analyzing the recurrent cost implications of the proposed USAID Forestry Sector Development Project in Mali, arrived at essentially the same conclusion—that the recurrent costs implications will have to be seriously considered at the project planning stage. It is not only the annual recurrent costs that should be considered, he states, but also costs that occur on a less frequent basis, perhaps several years after the donor funding has ended, such as replacement of vehicles and equipment, relining and deepening of wells, etc.

Why fuelwood plantation projects in the Sahel may be difficult to justify economically has been addressed in the literature to some extent, although few implementable solutions have been offered. Shaikh and Karch (1984), in their "Will Wood Work?" paper on fuelwood energy shortages, question the widely held view that donors should intervene to make wood energy more abundant. They state that the ". . . policies and the projects which flow from them implicitly assume that this is the battle being waged and that the battle can be won." Their response is that the fuelwood shortage battle cannot be won because ". . . wood in the Sahel may be too valuable a resource to be used for energy." Instead of making costly investments in large-scale fuelwood plantations, therefore, a much sharper focus on energy conservation measures, such as improved cookstoves, is needed.

While the statement that wood is too valuable to burn may be true, it is also true that 90 percent of all energy needs in the Sahel are met by fuelwood. Further, it is unrealistic to assume that the dependence on wood as an energy source will diminish significantly in the foreseeable future. Therefore, in addition to wood conservation efforts, one should not lose sight of the importance of increasing the production of wood to meet energy needs. How to meet these needs becomes the crucial question. If fuelwood plantations are not the answer, perhaps natural forest management is. Again, one is confronted with the issue of what constitutes the most appropriate activity in which to invest. These, too, are powerful arguments for considering a fuller range of development alternatives during the earlier stages of the planning process.

Hagen (1986) addressed another element of this problem—the impact of wood pricing in most Sahelian countries on the feasibility of forestry investments. Based on the fact that wood is essentially a free good in the rural areas, market prices in the urban areas do not reflect the costs of growing the wood required to replace the natural stands. The natural forests now furnish nearly all of the fuelwood and charcoal used in the Sahel. The price of fuelwood is, therefore, too low at present to justify economically investments in plantation forestry projects if the feasibility is based on fuelwood values only.

The literature on the hard "how-to" economics of forestry projects in developing countries includes several basic forest economics textbooks (Hiley 1956, Johnston et al. 1967, Openshaw 1980, Gregory 1972, and Watt 1973). Several FAO booklets treating various aspects of forestry planning and economics are available (FAO forest papers SWE/TF 118, 11, 7, and 17). In addition, there are several non-forestry publications on how to conduct economic and financial analyses of projects. Among the latter, perhaps the most widely used publication is Gittinger's "Economic Analysis of Agricultural Projects" (1972). An excellent collection of articles on cost-benefit and other discounted cash flow methods, as well as a workbook on quantitative procedures and applications, has been edited and prepared by Donahue (1980). These readings present several basic guidelines for carrying out cost-benefit analyses, the qualitative differences between the different approaches, and several criticisms of the approaches. Busby (FAO 1985) provides a detailed, but limited, how-to document on analyzing investments in tree planting.

On the economics of forestry in developing countries, perhaps Gregerson and Contreras (FAO Paper No. 17 1979) have made the most notable contribution. They provide an excellent and thorough theoretical background of the economic and financial analysis of forestry projects in developing countries. It should indeed be required reading for anyone contemplating tackling the complexities of forest economics in the developing world. The paper makes the very important statement, far-reaching in its implications, that ". . . it is in the early stages of project planning that economic analysis can have its greatest impact." If economics enters late in the planning process, all the decisions will already have been made, and the economics contribution will be limited to a mechanical determination of the feasibility of predetermined scenarios.

The FAO paper, however, is an economics paper which requires a solid economics background to understand fully, and more importantly, to apply in the field. It does not take the non-economist reader through a step-by-step discussion of what to do, when, and why. Management alternatives are discussed in a general sense, not in the level of detail required to actually specify a range of alternatives and fully understand why this is important. Nor does the paper say what to do if there are no reliable data on biological growth-and-yield responses to management treatments available, which is so often the case.

The "how-to's" of economic and financial analyses in project planning and during project execution are discussed in this manual largely for the benefit of planners in Sahelian countries. Problems of no data, lack of economics expertise, and the natural resources shortages are, in general, more acute in Sahelian countries than elsewhere in the developing world. For these reasons, the approach to financial and economic analyses of forestry projects in the Sahel must be tailored to the actual field conditions—what to do if the relevant data are not available, what to do if financial or economic feasibility cannot be attained, etc. The methodologies and analyses presented below also build substantially on a study of the economics of fuelwood plantations in Sri Lanka (Medema, Hatch and Christophersen 1981), as well as on unpublished work for the FEDP in Burkina Faso (Medema et al. 1985, Christophersen 1985).

CHAPTER 2: FACTORS AND ISSUES TO CONSIDER IN PROJECT PLANNING

2.1 Introduction

Before delving into the specific "how-to's" of forest economics, this chapter elaborates further on several factors and issues to consider in the project planning stage (as first discussed in Chapter 1, Fig. 1.1, above) and the role that economics plays or could play in the planning of forestry projects. The major problems in the Sahel are well known: Desertification in the region is rapidly advancing because of overfarming, overgrazing and overcutting for fuelwood. An important step to help resolve these problems is to improve the design of forestry projects by using economics to a much greater extent than has generally been the case in the past.

Several key factors should be considered in the early design phase of forestry projects. Among them are:

- Marketing—for which purpose(s) or end products should the trees be managed?
- Alternatives—what are the different ways of addressing the same basic problem?
- Multiple-use objectives—what are the other conflicting or complementary land-use objectives?
- Recurrent costs—what are the recurrent cost implications of the activities considered?
- Wood products pricing—what are the problems associated with the legislative controls over wood products pricing in Sahelian countries?

2.2 Marketing

What are the desired end products? This fundamental question should be raised very early in the planning process. Often, however, it is not asked. In many, if not most, forestry projects in the Sahel, the desired end product has been fuelwood. Consequently, the economist determines the economic and/or financial feasibility of the project based on the projected costs and prices associated with fuelwood production.

Fuelwood, however, is a low-value product, whereas poles generally have a higher value. If the wood harvested is of polewood size and fuelwood prices are used in the feasibility analyses, the results would be erroneous since the owner of the wood would be foolish to sell it as fuel if he could get more on the pole market. The important point here is that a much broader range of forest and forest-related products should be considered, such as hay, pasturage and other marketable secondary products. That there may be acute fuelwood shortages and that desertification advances too fast because of overcutting for fuelwood are separate issues altogether. The financial and economic feasibility of the project should be based on the true values of the end products, plus the values of the other marketable (secondary) products produced as a result of the investments.

To determine the true value of the end products requires a marketing study early in the planning phase of the project. Which forest/tree and forest-related products are in demand? Where and in what quantities are they found? These are the kinds of information required. For example, if there is a strong market for teak poles, perhaps teak instead of gmelina should be planted, even though the latter may be biologically better suited to the site. If the market for hay is strong, perhaps a wider tree spacing should be considered to promote the production of hay. Without such marketing information, the tendency will be to specify alternatives only on the basis of the biological production capacity of the site. With the marketing information, the project planner would be much better equipped to specify a realistic range of management alternatives, taking into account not only the biological aspects, but the economic ones as well.

2.3 Project Categories and Management Alternatives

Having first conducted a marketing study, the planner can begin to specify a range of project categories to be considered analytically. This range should consider different kinds of options, such as forestry extension projects, natural forest management projects, and intensively managed government plantations (see the different project categories in Fig. 1.1, above). This will help identify which project category appears to be economically promising or cost effective. The planner should also specify and analyze a full range of technical and silvicultural management alternatives within each of the project categories to help identify, in the end, which project category and which technical management alternative appears to be optimal. If this process is neglected during the planning phase of forestry projects, as is so often the case, nothing will be known about the relative economic attractiveness of other, perhaps drastically different, possibilities of spending the available funds.

Economics should be used during the project design to help narrow the choices of what to implement on the ground. If decision makers then decide to implement a particular fuelwood project, they do so knowing the economic consequences, having already considered a full range of alternatives before arriving at their decision. Because (forestry) investment funds are scarce, it is important to have access to as much information as possible before decisions are made and funds are allocated.

Table 2.1 lists seven hypothetical project categories which could address the same objective—producing fuelwood and poles—and a range of technical management alternatives within each category. The categories are very different, ranging from non-intensive natural forest management (no. 6), to intensively managed fuelwood plantations (nos. 4 and 5). The nature of the investments for each category differs. For example, categories 2 and 3 would be geared toward providing extension services to and incentives for the private sector, including, perhaps, a credit program. Categories 4 and 5 would involve direct, on-the-ground investments in site preparation, planting and silvicultural management without local participation. Categories 6 and 7 would involve investments in site protection to restrict access (perhaps a fence and guards) and some site enrichment planting as in category 7.

Table 2.1. Range of Project Categories and Management Alternatives: Economic Analysis.

Project Categories	Economic NPV's[1] F CFA/ha[2]	Wood Prod. m^3/ha/yr	Ranking Economic	Ranking Wood Prod.	Ranking Total
1 Community forestry					
Mgt. alt. 1					
Mgt. alt. 2[3]	7,000	2	5	5	10
Mgt. alt. 3					
2 Agro-forestry, private sector					
Mgt. alt. 1	28,000	3	2	4	6
Mgt. alt. 2					
Mgt. alt. 3					
3 Village woodlots					
Mgt. alt. 1					
Mgt. alt. 2					
Mgt. alt. 3	35,000	2	1	6	7
4 Govt. plantation (4 x 4)					
Mgt. alt. 1	-10,000	5	6	2	8
Mgt. alt. 2					
Mgt. alt. 3					
5 Govt. plantation (3 x 3)					
Mgt. alt. 1					
Mgt. alt. 2					
Mgt. alt. 3	-20,000	6	7	1	8
6 Govt. NFM[4]					
Mgt. alt. 1	20,000	2	3	6	9
Mgt. alt. 2					
Mgt. alt. 3					
7 Govt. NFM with enrich planting					
Mgt. alt. 1					
Mgt. alt. 2	15,000	4	4	3	7
Mgt. alt. 3					

[1] Net present value (NPV), a commonly used method for determining economic feasibility, is discussed in Chapter 3 below. NPV is the value of benefits minus costs discounted to the present by an appropriate rate of discount. How to choose a discount rate is discussed in Chapter 5, Section 5.2.

[2] F CFA = currency in the majority of Sahelian countries (see glossary).

[3] NPV results are given only for the (hypothetical) optimal management alternatives within each of the project categories.

[4] NFM = natural forest management.

Having subjected each of the project categories, and management alternatives within each, to rigorous analysis in the fashion described later in this manual, the analyst will eventually identify the village woodlot category (no. 3), associated with management alternative no. 3, as most economically attractive using, for example, the net present value measure (NPV) as the common denominator (see footnote 3 to Table 2.1). The method of analysis is identical for all of the categories and management alternatives, and it generates directly comparable results. Only the nature of the inputs and the assumptions differ. With the results in hand, the analyst can rank each category and management alternative with reference to the extent to which they satisfy the specific economic and production objectives as shown in the table.

If maximizing economic returns is the most important objective, project category 3, management alternative 3, would be the choice to implement. If, however, maximum wood production were the most important goal, the decision maker would choose management alternative 3 in the fifth project category (government 4- x 4-meter tree spacing plantations) associated with a production level of six m³/ha/year. The economics associated with this alternative, however, would be dismal compared with the economically optimal alternative where the opportunity cost between the two would be 35,000-(-20,000) = 55,000 F CFA/ha.[1] On the other hand, the optimal wood production alternative would produce four more m³/ha/year of wood than would the economically optimal alternative. Again, it depends on the goal of the decision makers: Do they want to maximize economic returns, or maximize wood production?

The total column in Table 2.1 is useful in finding the project category and management alternative that best satisfies both the economic and fuelwood production goals simultaneously. This column shows the total of the ranking scores where the project categories and alternatives associated with the lower numbers better satisfy both of the objectives simultaneously than those associated with the higher numbers. In this sense, project category no. 2 (alternative 1) would be most preferable, followed by project categories 3 and 7 (management alternatives 3 and 2, respectively). The economically optimal solution would rank second out of the seven in this hypothetical example.

2.3.1 Natural Forest Management

Natural forest management as an alternative to intensive plantation forestry is a relatively neglected end of the wide spectrum of possible alternatives, particularly when the major objective is wood production. It is brought into sharper focus as a sub-issue here because of the recent emphasis in the literature about the merits of natural forest management—that it has both biological and economic advantages. The fundamental idea is that instead of bulldozing away the natural woodlands (considered useless brush) and replacing it with supposedly faster growing trees, the natural forest could be managed and protected at a low cost. Growth and yields would increase as a result, and the economics could turn out to be much more favorable than the economics of plantation forestry. The latter is true particularly if one also takes into account the economic contribution of the secondary forest/tree and forest-related products that the "bush" provides, such as medicines, vitamins, food products, and, most important, pasture and hay values (Christophersen and Weber 1982).[2]

If distinctions are sought, however, as implicitly done in Table 2.1 and Figure 1.1, one could consider an alternative to be classified as natural forest management if the site is already a natural forest and that only protection of the site (fence and guards to restrict access) and some minor silvicultural interventions are to be carried out. Another distinguishable feature of natural forest management is the presence of secondary forest-related products (medicines, vitamins, minerals, food, forage, hay and pasturage, etc.). These are the products on which local people depend in addition to the primary wood products. Their values, however, are not often readily quantifiable. Nevertheless, they are no less real than the quantifiable wood values, and they should be taken into account at least qualitatively. If an investment in the natural forest also brings about higher yields of secondary products, in addition to the wood, these additional yields are attributable to the investment (Christophersen and Weber 1982).

2.3.2 Top-Down Versus Bottom-Up Approach

Another sub-issue brought into sharper focus under the project category and management alternatives heading is

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[1] Opportunity cost is a measure of values foregone—the benefits of one alternative given up as a result of choosing another.

[2] From an analytical point of view, it should be noted that there is no difference between natural forest management and plantation forestry. Yet, the literature regards the former as a totally different dimension of forestry apart from traditional plantation forestry. At times, the distinction between these two may be difficult. For example, is it natural forest management or plantation forestry if enrichment planting with native rather than exotic species is done on a sparsely stocked natural forest site? Or, does natural forest management merely imply the absence of planted exotic species? Or, does it simply imply less intensive silvicultural management of the kind normally applied to plantations? The point is that there is really no difference analytically. One could weed, fertilize, apply pest control measures, and plant in the natural forest just as much as one could do in the plantations.

the issue of which approach to take: top-down (government decides what to do, how, when, and why, and implements the project without any input from the local people) or bottom-up (emphasis on local participation in the decision-making process)? The major reason for implementing forestry projects in the Sahel is simply that forest/tree products, particularly fuelwood, are essential and supplies have to be replenished. While this basic reason may be sound, one could question the soundness of the "solution" used so often—large-scale, government, top-down fuelwood plantations.

Generally, the top-down approaches and variants thereof have not worked well in Sahelian countries. As Weber (1985) asserts, ". . . it is a cold, hard fact that trees or any other conservation effort will not be maintained beyond the life of a foreign assistance project unless the local population takes an active part." He goes on to say that the ". . . reality in the field, however, is something entirely different. Ninety-five percent of the ongoing efforts are still centrally planned, top-down executed, and the local farmers and herders remain the involuntary recipients of most of the efforts and funds." Also, costs in these centrally planned efforts have been far too high and yields have been disappointingly low.

That the top-down approach is not working well has become increasingly evident over the years. The reluctance to change, however, has been strong. While there have been attempts to tinker with the approach by allowing local participation (village woodlots, community forestry, social forestry, etc.), the same basic idea of planting and managing forests/trees in the traditional forestry sense still prevails.

But even if the top-down approach continues to prevail, there still exist other variants of local participation that have not been adequately tested in Sahelian countries (discussed below in Section 4.4). These include contractual natural forest management, farming and grazing in the forests to achieve fire control, and using in-kind payments (with wood) for harvesting labor in lieu of using government paid labor. By considering such alternatives, the economics of a project may be drastically altered as the resource owner's cost of managing the forests changes.

2.3.3 Trees for People Versus Forests for the Population

In the majority of Sahelian countries, forestry projects are financed with donor funds through appropriate host government institutions or ministries. The projects have, at least in the past, largely consisted of exotic species plantations. At the village level, however, these monoculture government plantations are much less important than a variety of trees belonging to individual families. Trees planted in the compounds, on the way to the farm fields, and in the fields themselves often provide nearly all of the forest/tree products a family may need—fuelwood, poles, shade, medicines, vitamins, minerals, etc., perhaps even marketable products.

Where this is a reality, as in many Sahelian countries, investing in fuelwood plantations, even at the village level and with local participation incentives, may not be the appropriate activity to undertake. Instead, extension and training programs to improve on already well-established and well-functioning systems and techniques (for example—showing how trees could be managed to maximize food, fodder, medicine and wood returns and how to market the products) may be a much more appropriate investment. If the project is well designed and executed, the trees will undoubtedly be tended and managed to provide the kinds of products and/or services needed and desired by their owners in perpetuity, not only in the traditional forestry sense—at final harvest time. Fuelwood, poles and other wood products will be supplied by way of pruning, not by cutting the trees down.

All the above examples illustrate the importance of considering several widely different alternatives in the project design phase. If, for example, the provision of trees for individuals and families is a more appropriate development goal than large-scale fuelwood plantations, then the donor investments should instead be directed towards training and extension.

2.4 Multiple-Use Objectives

A major issue confronting resource planners today is the issue of multiple land-use objectives. This was not of much concern a few years ago when fuelwood plantation projects were being implemented everywhere in response to the perceived fuelwood crisis. Now, however, environmental impact and other land-use objectives must be considered in the planning process.

There are several ways of accounting for multiple-use objectives in project planning; some are very costly and others are not. However, in the context of the discussion above, it is important to consider several widely different project categories and management alternatives in the project planning stage; and it stands to reason to opt for an inexpensive, cost-effective method. One such method is the ranking method introduced briefly in Table 2.1, above. Table 2.2 adds the economics associated with other land-use objectives—soil conservation and wildlife habitat—to the alternatives listed in Table 2.1. As before,

Table 2.2. Hypothetical Economic Tradeoff Matrix: Adding Environmental Objectives.

Proj. Ctg.	Optimal Mgt. Alt.	Economic NPV's F CFA/ha	Wood Prod. m³/ha/yr	Ranking				Total of Ranking
				Economic	Wood Prod.	Soil Cons.	Wildlife	
1	2	7,000	2	5	5	4	4	18
2	1	28,000	3	2	4	1	3	10
3	3	35,000	2	1	6	7	5	19
4	1	-10,000	5	6	2	6	6	20
5	3	-20,000	6	7	1	5	7	20
6	1	20,000	2	3	6	2	1	12
7	2	15,000	4	4	3	2	2	11

based on the NPV criterion, project category 2 (alternative no. 3) is economically optimal. The impacts that the seven project categories and management alternatives have on these two environmental objectives, however, are not quantified. Instead, they are ranked, perhaps in a subjective fashion, by experts, with reference to their relative capacity to satisfy the objectives. While it may be possible to measure the impacts directly, to do so for all of the categories and alternatives in the project planning stage would be far too costly and time consuming.

With this ranking method, if soil conservation were considered more important than economic returns, the choice of which category and alternative to implement would change to project category 2 (management alternative 1), which has a NPV of 28,000 F CFA/ha. The economically optimal alternative (no. 3 in project category 3) is ranked least attractive from the soil conservation point of view. The economic difference between these two (35,000—28,000 = 7,000 F CFA/ha) is a measure of the tradeoff, or opportunity cost between them. One can say that the price tag of choosing to implement the optimal soil conservation alternative is 7,000 F CFA, or the economic value foregone as a result of opting for alternative 1 (in project category 2) instead of alternative 3 (in project category 3). The tradeoffs between all of the categories and alternatives can be determined in a similar fashion.

If the project category and management alternative to implement is chosen on the basis of satisfying all the objectives simultaneously, the choice would again be project category 2 (management alternative 1), associated with the lowest number in the total ranking column. The economically optimal option would rank fifth out of the seven under this criterion.

2.5 Recurrent Costs

Externally funded projects have in the past generally failed to take into account the ability of governments to continue project activities once the funding has stopped. The donors have over the years showered massive amounts of money, expatriates, vehicles and equipment onto recipient government institutions ill equipped to absorb the recurrent cost burdens. The key issue here is how to spend money in forestry in the future so as to avoid repeating the mistakes made in the past.

Projects should always be designed with the clear objective in mind: The recipient countries should gain independence from external funding while still being able to continue the project's activities once donor funding has ended. This can be achieved if project designers always keep the local conditions and recurrent cost implications in mind. As shown by the recurrent cost ranking in Table 2.3, some project categories and management alternatives have higher recurrent cost implications than others. If minimizing recurrent costs were the major objective, the decision makers would opt for project category 3 (alternative 3), which in this case is also the economically optimal alternative. The total column shows that project category 2 (alternative 1) best satisfies all of the objectives simultaneously.

2.6 Weighting

In the process of deciding among project categories and management alternatives, governments may choose to apply different weights to the benefits associated with different land uses. For example, as shown in Table 2.4, decision makers may, perhaps for political or noneconomic reasons, decide that wood production should be given a weight of 1 signifying it is most important, soil conservation a weight of 2, recurrent costs a weight of 3, economics a weight of 4, and wildlife a weight of 5. A

Table 2.3. Hypothetical Economic Tradeoff Matrix: Adding Recurrent Costs.

Proj. Ctg.	Optimal Mgt. Alt.	Economic NPV's F CFA/ha	Wood Prod. m³/ha/yr	Ranking					Total of Ranking
				Economic	Wood Prod.	Soil Cons.	Wildlife	Recurrent Costs	
1	2	7,000	2	5	5	4	4	5	32
2	1	28,000	3	2	4	1	3	3	13
3	3	35,000	2	1	6	7	5	1	20
4	1	-10,000	5	6	2	6	6	6	26
5	3	-20,000	6	7	1	5	7	7	27
6	1	20,000	2	3	6	2	1	2	14
7	2	15,000	4	4	3	2	2	4	15

Table 2.4. Hypothetical Economic Tradeoff Matrix: Unequal Weights.

Proj. Ctg.	Optimal Mgt. Alt.	Economic NPV's F CFA/ha	Wood Prod. m³/ha/yr	Ranking					Total of Ranking
				Economic	Wood Prod.	Soil Cons.	Wildlife	Recurrent Costs	
1	2	7,000	2	5 (4)	5 (1)	4 (2)	4 (5)	5 (3)	68
2	1	28,000	3	2 (4)	4 (1)	1 (2)	3 (5)	3 (3)	38
3	3	35,000	2	1 (4)	6 (1)	7 (2)	5 (5)	1 (3)	52
4	1	-10,000	5	6 (4)	2 (1)	6 (2)	6 (5)	6 (3)	86
5	3	-20,000	6	7 (4)	1 (1)	5 (2)	7 (5)	7 (3)	95
6	1	20,000	2	3 (4)	6 (1)	2 (2)	1 (5)	2 (3)	33
7	2	15,000	4	4 (4)	3 (1)	2 (2)	2 (5)	4 (3)	45

Note: The numbers in parentheses are the weights given to each of the objectives.

new total column can then be calculated by applying these relative weights to the rankings. Again, the lowest number best satisfies all of the objectives simultaneously, in this case project category 6 (alternative 1), the low intensity natural forest management category. In Table 2.3 (where no weights were applied) the best all-around project category was no. 2 (alternative 1) associated with the lowest score of 13 in the total column.

By applying weights to different objectives in this fashion, the decision of which project category and management alternative to implement may change entirely. It allows decision makers and planners to attach relative importance to their many development objectives and choose accordingly. Under the ranking scheme in Table 2.4, the economically optimal project category ranks as low as fourth out of the seven analyzed. Which category and alternative to choose still rests with the decision makers. But, with these kinds of tradeoff matrices, they would be in a position to make much better resource allocation decisions.

2.7 Fuelwood Pricing

There are two cases to consider: where wood is traded, mainly in urban areas, and where wood is "free," principally in the rural areas. In the urban markets, fuelwood has a price that reflects some, if not all, of the costs of felling, extraction and bringing the wood to market, but generally not the cost of replacing the wood harvested in the natural forests or in the plantations. In the rural areas, fuelwood is a "free" good available to anyone spending time gathering it. In both cases, investment in intensive forest management is discouraged.

If fuelwood prices in the urban areas are controlled (to supply the urban population with an essential energy source at a low cost), this, too, adds to the disincentive to replant. Unless replanting is heavily subsidized, intensive fuelwood production in Sahelian countries simply is not an attractive opportunity for investment.

In the rural areas where fuelwood is essentially a free good, the situation is worse. A zero price implies that there is no financial incentive to invest in fuelwood plantations because the local people would not pay for something they can get free anyway. Even if it takes them a long time to gather the "free" wood, the opportunity cost of time is often very low. However, as stated previously, investments may be justified on the strength of the presence of other benefits (perhaps difficult to quantify), such as food, fodder, medicines, and soil/water conservation.

It is interesting to note that in Sahelian countries fuelwood will always be a free good, at least for as long as the natural forests last, and for as long as rural people are permitted to gather dead wood in the bush. At present, rural people freely gather the wood, keeping a portion for home consumption and stacking the remainder at the roadside to be sold to truckers who haul the wood to the city. The trucker is usually the wood entrepreneur who holds all the necessary permits.

The fuelwood price in the market reflects all the costs incurred by the buyer from stump to the final consumer, including a profit margin. But the wood itself has a zero value. It is a free good to the gatherers. They recover their collection costs when the wood is sold at roadside. Thus, when the buyer arrives, he buys the wood for a price that includes the labor costs plus profits to the collectors, but pays nothing for the wood itself. Now adding the roadside price he paid for the fuelwood, permit fees, loading, transportation, unloading, selling costs and a profit margin, the entrepreneur arrives at the final market price. This is the price paid by the final consumers in the urban markets.

Now, if fuelwood is also supplied from a plantation project, the situation is different. In this case, production costs will have been incurred during the rotation period, which will have to be recovered if the project is to be profitable. This wood can no longer be a free good. One could now visualize a wood seller harvesting his plantation-produced stand of trees at maturity and stacking it roadside for sale, alongside the wood harvested by the rural people from the natural forest. What will happen? The natural forest wood, a free good plus the labor cost of bringing the wood roadside, is much more attractive to the wood entrepreneur than plantation-produced wood where production costs probably already exceed the final market price. The trucker will probably buy all of the natural forest wood and leave the plantation wood behind, unless the plantation owner is willing to sell his wood for the same price as the natural forest wood. This is the situation in reality.[3]

If wood production costs cannot be included or contained within the final market price (and they probably cannot as long as the harvesting of free dead wood in the bush is permitted), then one often-proposed solution is to raise the price of fuelwood and thus make it possible to include at least some of the costs of producing the wood. This could possibly be done over time to some extent by increasing permit fees and/or transportation fees, which would, in turn, raise the prices in the final market. Of course, any increase in fee revenues would have to be channeled back into forestry if this solution is to work.

The extent to which fuelwood prices could be increased in this fashion depends on the availability and prices of substitute energy sources such as butane and kerosene. Assuming that the different sources of energy are perfectly substitutable, fuelwood could be increased up to, but not beyond, the price of the nearest available substitute. This (theory) naturally assumes that increases in fuelwood prices will not be accompanied by black market activities in the fuelwood sector. Unfortunately, however, experience has shown that such markets do indeed develop when fuelwood prices are increased.

Politically, of course, a decision to increase the price of fuelwood in this fashion would not be a popular decision. But the overriding issue is that wood pricing presents a formidable constraint to the feasibility of plantation projects, particularly financial feasibility. French (1984) concludes that reforestation, by way of intensive plantation forestry, is economically difficult to justify. Faced with the low price problem, the governments cannot afford such projects unless massive subsidies are available. Nor will farmers participate, since devoting time to the production and care of cash crops is almost always more profitable.[4]

Thus, the fuelwood gap will inexorably widen unless the costs of producing wood through natural forest management can be covered without unduly raising the price of fuelwood (i.e., beyond the point where black markets will develop). The FLUP project in Niger has demonstrated that this is possible through the establishment of woodcutters' cooperatives. The objective is sustained yield natural forest management where the cooperative members harvest and sell the wood to the wood entrepreneurs. The profits are divided between the

[3] It should be noted that attempts to artificially fix the price of fuelwood based on production costs have resulted in black markets and frauds.

[4] It should be noted that although reforestation projects may be economically difficult to justify in dry, high-cost areas, it is probable that the situation will be entirely different where growing conditions are much improved.

forest service and the cooperatives according to a negotiated contract. The forest service spends its portion of the profits on forest management. Experience thus far has shown that the existing profit margins are sufficiently high to cover the recurrent costs of sustained yield natural forest management without having to increase fuelwood prices. This "formula" for producing fuelwood, as opposed to plantation forestry, provides strong justification for detailed and careful use of economics in the planning phase of a forestry project. The emphasis should be placed on identifying the conditions that must exist if a forestry project is to be economically or financially feasible given the fuelwood pricing constraint. This issue is brought into sharper focus in Chapter 6.

CHAPTER 3: PROJECT EVALUATION TECHNIQUES

3.1 Introduction

This chapter briefly discusses the analytical framework for a forestry project and the most common project evaluation techniques used—Net Present Value (NPV), Benefit/Cost ratio (B/C), Internal Rate of Return (IRR), and a special forestry application of the NPV technique, Soil Expectation Value (SEV). The NPV, B/C, and IRR techniques are the most extensively used. The SEV is used less frequently, although it is the most correct approach, in the writer's opinion, particularly in short rotation forestry investment analysis, if all the necessary information is available. All of the four are discounted cash flow techniques, but with subtle differences. All are well documented and described in numerous textbooks and reports and will not be repeated at the same level of detail here.

3.2 The Analytical Framework

The analytical framework for a project is never easy to define. It depends on what is included and/or excluded in the analytical "spread sheets." Should primary benefits and costs only be included, or both primary and secondary benefits and costs? The question is what is legitimate to include under which circumstances—where does one draw the line? The impact of a forestry project certainly does not end with only the primary benefits and costs. The project may generate employment; it may increase downstream agricultural productivity; it may improve wildlife habitat, and it may change the recreational values of the area, and so on.

Yet, despite the fact that a project may generate far-reaching secondary impacts, there is reason to question whether such impacts should be included in the economic and financial evaluations. Primary benefits and costs are noncontroversial in that they are the "raw materials" for determining the economic efficiency of a project. The argument against including secondary benefits and costs, however, is that they may easily be used to dominate or overshadow an otherwise economically inefficient project. The temptation will always exist to rely on secondary benefits to justify otherwise economically inefficient proposals.

Furthermore, however secondary benefits are identified and evaluated, accurate quantification is difficult. The perceived benefits lack precise definition, thus making their measurement questionable. Even though a clear idea of the physical quantities may be involved, the frame of value is often indeterminate. People have different value perspectives for a given secondary benefit. Most secondary effects are difficult to define properly and are, therefore, difficult to quantify. For example, to quantify the extent to which agricultural productivity increases in an area as a result of a forestry project upstream in the watershed would be a major and costly undertaking. It would entail, first, defining the impact area, which is no easy task, and, second, deriving a documentable and believable multiplier effect that accurately quantifies the economic secondary benefits attributable to the project. The cost of gathering information for the purpose of planning the forestry project and designing management alternatives might in this case be prohibitive.[1]

For the above reasons, and to simplify matters, the analytical techniques demonstrated below and the analyses presented in the later chapters are based on economic efficiency (primary costs and benefits) criteria, undisturbed by secondary effects. Legitimate secondary effects, however, should be identified and discussed qualitatively. This should not be interpreted as a de-emphasizing of the importance of secondary effects or of the impact of the project on other land-use objectives.

Also, as part of the analytical framework, each of the technologies described below uses one hectare as the basic unit of analysis. As such, the results are expressed on a per-hectare basis, not on the total project area. This one hectare is assumed to be representative of all the hectares with similar site productivity characteristics within the project area. To determine the feasibility of the total project is a simple process of aggregating the results of the analyses carried out for different quality sites within the project area which have been subjected to different sets of management alternatives.[2]

[1] This argument, of course, is not applicable when designing an agricultural project which includes a cost component for planting trees for the purpose of increasing agricultural productivity.

[2] The one-hectare approach to natural forest management must be figured on an average yield/cost basis given the diversity one encounters when considering large tracts.

3.3 The Techniques

To illustrate the differences between the analytical techniques (NPV, B/C, IRR, and SEV) a very simple and hypothetical investment example is considered in Table 3.1. The table shows the projected benefit and cost cash flows associated with one management alternative of a forestry investment using constant real prices and costs in the NPV, B/C, and SEV cases, and a real, risk-adjusted discount rate of five percent[3,4]. For the sake of simplicity, this hypothetical example does not distinguish between economic and financial analysis nor are environmental or other secondary impacts considered. The problem: Is the investment economically attractive compared to alternative investment opportunities?

The NPV is calculated as follows:

$$NPV = \sum_{t=0}^{r} \frac{B_t - C_t}{(1 + i)^t}$$

Where:

B_t = Benefits received at time t
C_t = Costs incurred at time t
t = Time in years
r = Length of the site occupancy period in years
i = Discount rate

NPV = Sum of discounted benefits - sum of discounted costs

Table 3.1. Hypothetical Investment Example: F CFA/ha.

Years(*)	Treatment	Costs: CFA/ha	Benefits: CFA/ha
0	Site prep., plant (incl. seedlings)	100,000	
1	Weeding	30,000	
5	Commercial thinning		10,000
7	Harvest		90,000
8	Weeding	30,000	
12	Commercial thinning		10,000
14	Harvest		90,000
15	Weeding	30,000	
19	Commercial thinning		10,000
21	Harvest		90,000

* Note the assumption that the investment begins in year 0 or the present. Many prefer to assume, however, that the investments take place in year 1 instead. The results will differ depending on which year the investments begin. Early events have a much greater impact on present values than later events. If it is year 0, the project will be less attractive in a present value sense since the initial investment costs will not be discounted by one year. Which year to choose depends on when the actual investments will take place.

3.3.1 Net Present Value (NPV)

In the NPV approach, a stream of future benefits and costs is converted into a single present value figure indicating how much money would have to be invested today at the interest rate given in order to realize the future benefits. In the example, the stream consists of the costs and benefits associated with the events given in the assumptions. If the NPV is positive (greater than zero), economic feasibility of the investment has been achieved if the discount rate used reflects the rates of return one could reasonably expect from alternative investment schemes.

(Com. Thin + Fin. Harvest Rev) - (Plant + Weeding Costs)

$$= \left(\frac{10,000}{(1.05)^5} + \frac{90,000}{(1.05)^7} + \frac{10,000}{(1.05)^{12}} + \frac{90,000}{(1.05)^{14}} + \frac{10,000}{(1.05)^{19}} + \frac{90,000}{(1.05)^{21}}\right)$$

$$-\left(\frac{100,000}{(1.05)^0} + \frac{30,000}{(1.05)^1} + \frac{30,000}{(1.05)^8} + \frac{30,000}{(1.05)^{15}}\right)$$

= 159,083 – 163,307

= - 4,224 CFA/ha[5]

[3] In the "real world," neither costs nor prices remain constant. As will be shown in later chapters, there is usually ample justification for increasing (or sometimes decreasing) costs and prices in real terms.

[4] The real discount rate differs from the nominal rate by the average rate of inflation. If the real rate is 5 percent and the average annual inflation is 15 percent, the nominal rate would be 1.05 times 1.15, or 20.75 percent.

[5] Note that the exponents in the denominator of the equation are 5 and 7, etc. This is equivalent to the 6th and 8th years in the rotation because year 0 counts as one year in this example.

The result in this case is negative (less than zero), so the investment is not attractive based on the assumptions. Higher returns can probably be obtained elsewhere.

3.3.2 Benefit/Cost Ratio (B/C)

The B/C ratio is simply a ratio of discounted benefits divided by discounted costs. If it is greater than 1, the investment is feasible, again, if the discount rate used reflects the rates of return from alternative investment schemes.

The B/C ratio is calculated as follows:

$$B/C = \frac{\sum_{t=0}^{r} \frac{B_t}{(1+i)^t}}{\sum_{t=0}^{r} \frac{C_t}{(1+i)^t}}$$

Where the notation is the same as above

B/C = Sum of discounted benefits/Sum of discounted costs

= 159,083/163,307 (from NPV example above)

= .974

The ratio is less than 1, so the investment is not attractive.

3.3.3 Internal Rate of Return (IRR)

The IRR approach expresses the results in percentage terms—the rate of return on the investment. Instead of choosing a discount rate, however, as done in the other approaches, the IRR method looks for the discount rate that sets the equation (below) equal to zero.

The IRR is calculated as follows:

$$NPV = \sum_{t=0}^{r} \frac{B_t - C_t}{(1+i)^t} = 0$$

The notation is the same as above; i is the discount rate to be determined,

IRR = Set sum of discounted benefits - sum of discounted costs equal to zero and solve for the discount rate

$$= \left(\frac{10{,}000}{(1+i)^5} + \frac{90{,}000}{(1+i)^7} + \frac{10{,}000}{(1+i)^{12}} + \frac{90{,}000}{(1+i)^{14}} + \frac{10{,}000}{(1+i)^{19}} + \frac{90{,}000}{(1+i)^{21}}\right)$$

$$-\left(\frac{100{,}000}{(1+i)^0} \quad \frac{30{,}000}{(1+i)^1} \quad \frac{30{,}000}{(1+i)^8} \quad \frac{30{,}000}{(1+i)^{15}}\right)$$

The rate that sets the equation equal to zero is found in an iterative fashion. From the examples given above it is certain that the rate must be less than 5 percent. A 4-percent rate gives a positive result, which means that the IRR must lie somewhere between 4 and 5 percent, since the result was negative at the 5 percent rate. In this example, the IRR is approximately 4.7 percent, which is lower than the five-percent rate assumed to reflect the attractiveness of alternative investments.[6] Note that all of the three approaches show that the investment is not attractive vis-a-vis alternative investment opportunities.

3.3.4 Soil Expectation Value (SEV)

The NPV, B/C, and IRR approaches as described above calculate the investment feasibility of the hypothetical plantation project over one cycle of three rotations—21 years. Forestry, however, is but one of several uses to which the land may be put. In the economics of land use, one is concerned with the optimal value-generating potential of the land, not only for the 21-year period indicated in the example and for forestry only, but *ad infinitum* and for a much wider range of possible uses of the land. Since land derives value from the goods it produces (fuelwood, poles, agricultural products or any other goods), the true value of the land—the Soil Expectation Value or SEV—is reflected by the NPV of the flow

[6] One should be very cautious when using the IRR approach. Under certain cash flow patterns (for example, positive cash flows followed by negative cash flows) it is possible that the IRR approach produces multiple answers.

of potential net revenues generated from it over an infinite number of rotations. The SEV associated with the highest valued land use is the true value of the land at a particular discount rate.

In the SEV approach, the frequency and magnitudes of benefits and costs are brought into the analytical framework by means of a generalized Faustmann (1849) formulation, a mathematical method of compounding and discounting cash flows in analyzing forestry investments. SEV determines the optimal financial rotation of a stand of trees over an infinite number of rotations, assuming that the highest and best potential use of the land is reflected in its present usage.[7]

The rotation age of maximum discounted revenue at a specific discount rate is found when the NPV reaches a maximum, as shown in Figure 3.1. The horizontal axis measures time (rotation age) and the vertical axis measures the NPV. The two curves represent two management alternatives, each associated with different streams of costs and benefits at a given rate of discount. For alternative 1, the area between points A and C shows a positive "bare land value," and the curve itself reflects the present values at different points in time. At point B the curve reaches its highest point, which identifies the SEV. Point B is therefore the financial rotation age, or the age where the financial returns of the investment are maximized.[8] The lower curve, alternative 2, illustrates the financial yields for a lesser valued species, perhaps, and a more costly management regime. Here the present value of costs exceeds the present value of benefits and the SEV is negative (Christophersen et al. 1978).

The SEV is calculated as follows:

$$SEV = \frac{\sum_{t=0}^{r} B(1+i)^{r-t} - \sum_{t=0}^{r} C(1+i)^{r-t}}{(1+i)^r - 1}$$

Where:

B = Benefits (from the commercial thinning and final harvests)

C = Costs (planting and precommercial thinning costs)

r = Cycle of three rotations (21 years)

t = Time of occurrence

i = Discount rate (5 percent)

SEV = Sum of benefits compounded to rotation end – sum of costs compounded to rotation end, divided by an infinite rotation discount factor (Faustmann 1849)

$$\text{Benefits} = 10{,}000\,(1.05)^{21-5} + 90{,}000\,(1.05)^{21-7} + 10{,}000\,(1.05)^{21-12} + 90{,}000\,(1.05)^{21-14} + 10{,}000\,(1.05)^{21-19} + 90{,}000\,(1.05)^{21-21} = 443{,}400$$

$$\text{Costs} = 100{,}000\,(1.05)^{21-0} + 30{,}000\,(1.05)^{21-1} + 30{,}000\,(1.05)^{21-8} + 30{,}000\,(1.05)^{21-15} = 454{,}400$$

$$SEV = \frac{443{,}400 - 454{,}400}{(1.05)^{21} - 1} = -6{,}667 \text{ F CFA/ha}$$

Another simple method of deriving the SEV is as follows:

$$SEV = NPV + \frac{NPV}{(1+i)^r - 1}$$

$$SEV = -4{,}224 + \frac{-4{,}224}{(1.05)^{21} - 1}$$

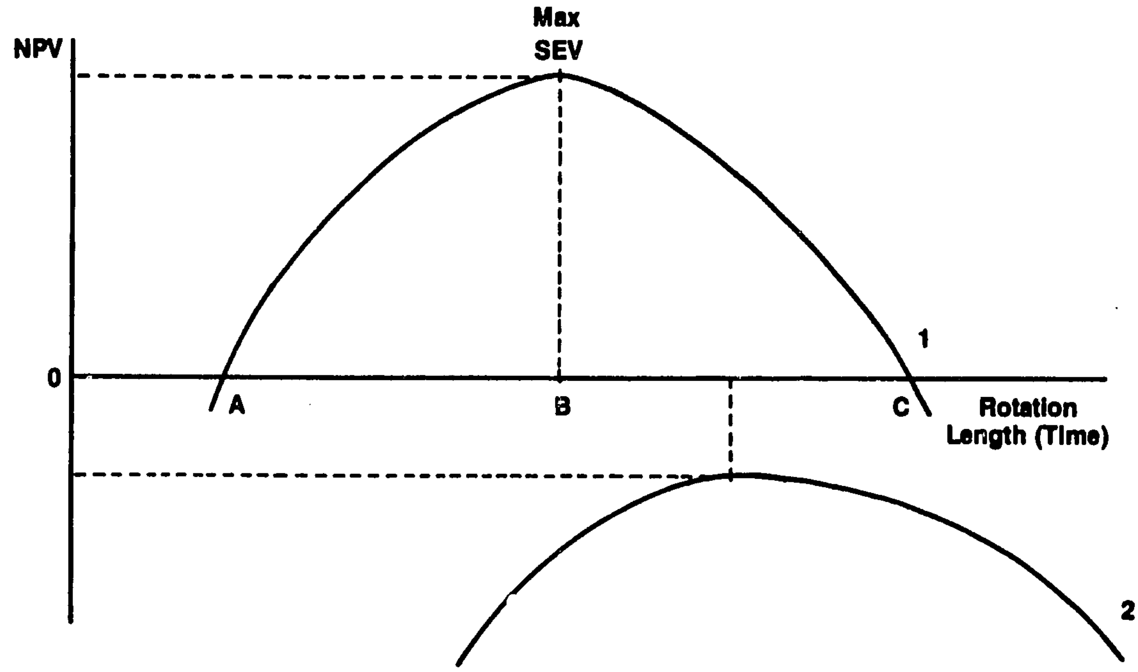
$$= -6{,}597$$ [9]

The NPV in this formula is the net present value of one cycle as calculated above. This formula, which will generate the same results, clearly shows the impact of the SEV approach vis-a-vis the other approaches. Note that both formulae use an infinite number of cycles in

[7] In many Sahelian countries, at least as far as the national forests are concerned, forestry is "decreed" by the governments to be the highest and best use of the land. This makes the task simpler in that it permits ruling out many alternative land uses.

[8] It should be noted that the maximum NPV (and IRR) does not necessarily always generate the highest money returns. It depends on when the maximum financial yield occurs in relation to the maximum mean annual growth increment. If a stand is harvested at financial maturity at eight years, it may return a smaller amount of money than if the harvest were delayed two years to biological maturity. The key is that the lower amount of money is received two years earlier and is available for reinvestment at the opportunity cost of capital. It is the proceeds from the reinvestment that will eventually exceed the returns obtained from harvesting the stand at biological maturity (see Openshaw 1980).

[9] The difference in the result between the two formulas is due to rounding error.



Note: Curves 1 and 2 are based on one discount rate. Other discount rates will generate different curves.

Figure 3.1. SEV ove⁻ :'me (source: Christophersen et al. 1978).

the calculations and therefore produce a different result than the NPV only. For long rotations (70 - 80 years or more as in the temperate zones) and/or for high discount rates, the NPV approach is often a good approximation of the SEV. For shorter rotations, however, as in the present example, the NPV approach is not adequate. In this short rotation case, the SEV would be the correct approach to use.

The contributions of the second and all subsequent growing cycles, *ad infinitum*, in the hypothetical example is:

$$-6{,}597 - (-4{,}224) = -2{,}373$$

The SEV in this case is lower than the NPV because it includes the negative contributions of all future rotations that also generate negative returns and because a discount rate assumed to reflect the rate of return obtainable from alternative investment schemes was used. Recall that at this rate the investment was not feasible.

Although the SEV approach is the correct one to use in short-rotation forestry, it is limited in its practical applicability in most developing countries. It would be difficult to apply, for example, to natural forest management alternatives where the resource base is varied and heterogeneous. Its use would be largely limited to the analyses of even-aged stands starting with bare land, not analyzing the feasibility of making additional investments in stands that have already been established.

3.4 What If the Data Were Not Available?

The use of any of the techniques described above presumes availability of the data required to do the analyses—that the magnitudes of costs and benefits associated with each management alternative tested are known. It would be a perfect world indeed if the probable biological response to planting density, fertilization, thinning, pruning or any combination of treatment regimes proposed were known. One would then be able to weigh the costs and benefits of the treatments to determine which alternative is optimal. With this information, one could build stand prognosis models from which yield functions for each management alternative could be generated.

However, the situation in the majority of Sahelian countries is far from ideal. Reliable information on the growth and yield responses to the alternatives to be tested is generally not available. Therefore, an accurate measure of benefits to use in any of the evaluation technique formulas cannot be obtained.[10] Although there are exceptions to this, they are few and far between. The exceptions are found in closely controlled, donor-financed forestry projects where the means are available to monitor growth and yield every year. Also, there are research plots scattered about where annual growth and yield measurements are taken. Since these are closely controlled research conditions, they do indeed give reliable growth and yield figures in response to different management treatments.

But unfortunately, as has been seen so often, the funds dry up when the donors leave, and the constant care and maintenance of the production forests that made it possible to realize the current growth and yield figures will not continue. Without the donor support, there will probably be few investments made in the maintenance and care of the stands, even if the additional cost of that maintenance is economically worthwhile. Thus, the growth rate will decline. The point is, unless the government is prepared to assume the recurrent costs (investments) required to maintain current growth rates, it would not be prudent to project well-financed research growth and yield results into the future.

Which analytical options remain if the data to measure benefits accurately are not available? To give up should not be an option. One could still use any of the techniques above to determine feasibility of projects, although the results would be less accurate and should be interpreted cautiously. Two, perhaps suboptimal but certainly pragmatic, approaches are suggested below.

3.4.1 Site Index

Instead of the "luxury approach" represented by stand prognosis models, one could use a site index approach to rank the biological productivity among unequal sites. This approach relates the height of the trees in a stand to the age of the stand. The taller the trees for a given base age, the more productive the site. Figure 3.2 illustrates the kind of modeling strategy one can use to project the development of stands. Figure 3.2 (A) shows hypothetical site index curves of 7, 9, and 11 for a plantation species using a base age of six years. The site index numbers show the height of the trees in meters at the base age of six years. Having thus estimated the site index curves, using sampled plantation data, one can also estimate age/volume relationships as shown in Figure 3.2

[10] Benefits are composed of two parts: Price × Quantity. If quantity is not known, benefits cannot be accurately measured.

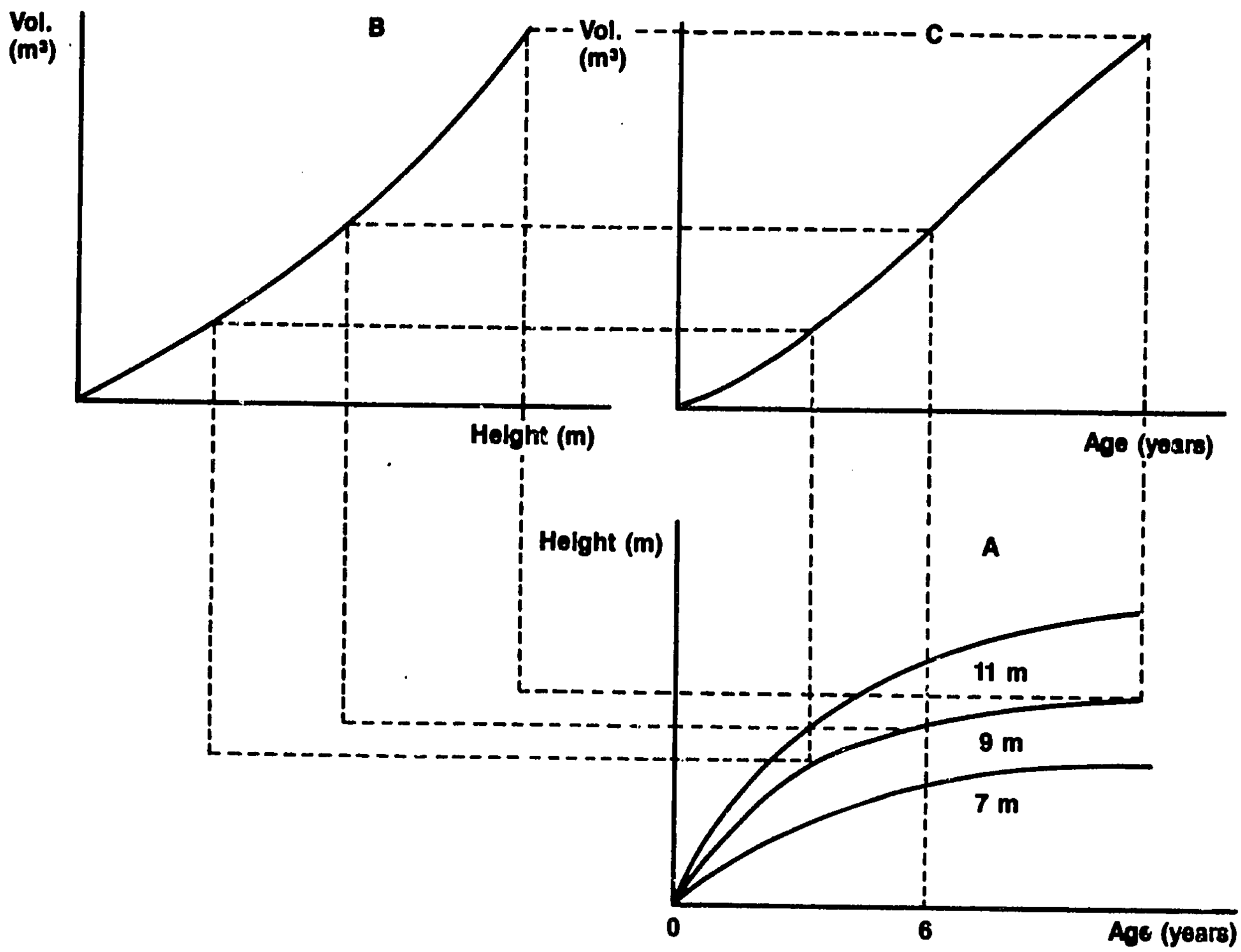


Figure 3.2. Hypothetical site index and volume estimation curves (source: Medema et al. 1985).

(B) and (C) (shown for site index 9 only) to generate the yield functions (C).

This approach is limited, however, since it only works well for even-aged stands when the stand age is known. And, furthermore, estimating the yields associated with different management alternatives would be possible only if the sampled stands, preferably located nearby, reflect the same management alternatives as those to be tested. Or, less preferable, one could use secondary growth and yield information collected from plantations located far away, perhaps in other countries, with site conditions perceived to be similar to those on the project site.

3.4.2 Break-Even Analyses

The second approach, and perhaps the most realistic to use in the absence of reliable data, consists of two variants of a break-even approach: (1) how much wood must be produced per hectare per year in order to break even on the investment, given a set of assumptions; or (2) how high would the price of wood have to be to ensure financial and/or economic feasibility given an assumed productivity level. In the first case, the break-even quantity of wood is found given an assumed price. In the second case, a break-even price is found given an assumed quantity.

Both break-even approaches are pragmatic, sometimes laden with subjective judgments, but they are useful for purposes of determining the general economic differences between management alternatives.[11] They counter the propensity to give up if the data on the biological yield response to treatments are not available. If this is the case, there is a tendency to ignore financial and economic analysis altogether. The answer is simply that working with the information that is available is always preferable to ignoring the problem. And, there is a good deal of information on the costs associated with each proposed management regime. If planting is considered, one could derive estimates on labor costs, how many skilled and unskilled workers it would take to do the job, seedling costs, and equipment and other costs. The same could hold for the other management treatments considered. With the cost dimension covered, one would be able to carry out financial and economic break-even analyses using any of the evaluation techniques described above. If the assumptions were specified by someone familiar with the forest or site in question, particularly its productive capacity, he would be able to say with some authority whether the break-even quantity of wood exceeds or falls within the productive capacity of the site. Or, in the case of the break-even price, he would be able to say whether the prices that would have to exist in order to ensure financial and/or economic feasibility are lower or higher than the actual prevailing prices. Both break-even approaches are used in a detailed fashion in Chapter 6 below.

[11] See Chapter 5, Section 5.6 for a demonstration of the use of the break-even approach.

CHAPTER 4: FIELD MANAGEMENT ALTERNATIVES

4.1 Introduction

This chapter takes a closer look at management alternatives for the field operations. These are the "Alt 1 and 2" blocks in Chapter 1, Figure 1.1 above. The economics associated with each of the field management alternatives will not only help determine which one is economically or financially optimal within each project category, but also between project categories. If different field alternatives are analyzed for each project category, one will eventually be identified as economically optimal. This, however, is only the semifinal step. The final choice of which alternative to implement in the field could be made on the basis of comparing the economic results of alternatives between the several different project categories suggested in Figure 1.1.

There are several basic questions to answer in the process of determining an appropriate range of field management alternatives within any of the project categories. They can be grouped into three broad areas: (1) what to do; (2) when to do it; and (3) how to do it. Each category is discussed below.

4.2 What To Do

For any of the project categories listed in Figure 1.1, the most common management practices that would apply to forest sites in the Sahel include:

- Site preparation
- Planting and replanting
- Fire management
- Stump sprout selection after coppicing
- Weeding
- Pruning
- Fertilization
- Pest control measures
- Precommercial and commercial thinning
- Final harvest
- Access restrictions (fence, guards, etc.)

Any of these treatments could be applied in different levels of intensity.

The financial and economic attractiveness of each of these operations, or combinations thereof, most of them silvicultural, can be determined. The problem, however, is the sheer number of possible combinations one could end up with if all of the possibilities and combinations were considered. Suppose, for example, that the planner wants to test two ways of preparing the site (perhaps manually versus mechanized), two planting densities, and two alternatives for all of the other treatments listed. There would be over 8,000 possible alternatives to test. Clearly, this is far beyond the realm of manageability.

It is necessary, therefore, to reduce the number of alternatives to a manageable level. The condition of the site, the costs of the treatments, and the forestry legislation in the country are but a few of the factors to consider in delineating a set of realistic alternatives. Sound judgment should be exercised in the selection of the range of alternatives that best reflects what one could reasonably expect to implement given the constraints.

The list of management practices are briefly discussed below.

4.2.1 Site Preparation

Whether or not and how to prepare a site for tree planting are the questions to answer. Meticulous site preparation with heavy equipment may result in higher yields, but it is also very costly. Manual site preparation where the brush is cleared only in the immediate vicinity of each seedling could result in lower yields, but it is also much less costly. The management alternatives could reflect different ways of preparing the site.

4.2.2 Planting and Replanting

If a tree planting option is considered, one should test the economics of at least two spacing densities instead of only the one that appears the most biologically suited to the productive capacity of the site. Tree planting is costly, and a different spacing density may yield more attractive economic results than the biologically optimal density. Also, the wider the tree spacing in a plantation, the more the site becomes a candidate for agroforestry activities.

The economics of several different species, both exotic and native, could also be tested. Which species to choose depends not only on its biological adaptability to the site, but also on its marketability.

Replanting is an option to consider if the initial percentage rate of mortality exceeds a certain prespecified level. If the mortality is higher than this level, one could still choose not to replant for economic reasons.

4.2.3 Fire Management

The objective of fire management is to maximize wood production through preventive and precautionary methods to protect trees from intense dry season fires. In addition to firebreaks around managed forests, three other basic methods of controlling fires within the managed forests may be applicable in Sahelian countries: controlled burning, intercropping and grazing. Each will be discussed in greater detail in Section 4.4 below. Not applicable in Sahelian countries as far too costly is fire management done in the same fashion as in the U.S. or in Europe, where large investments in fire-fighting equipment and infrastructure are made.

4.2.4 Stump Sprout Selection

Many species, native as well as exotic, produce coppice crops after a harvest. New shoots, up to 12 shoots per stump, sprout immediately after harvest. Once these coppice shoots have reached a height of 2-3 meters, they will have to be thinned back to three or four shoots per stump—if poles are the desired end product—in order to promote growth. All poorly developed shoots inadequate for the intended end product are removed. If, on the other hand, fuelwood is the end product, coppice shoots should probably not be removed. From the economic point of view, however, stump sprout selection may be expensive and the decision to do it should not be automatic.

4.2.5 Weeding

There are two basic weeding methods applicable in Sahelian countries: manual and controlled burning. Chemical weeding is rarely if ever used. Manual methods (hoes) are very effective but expensive when laborers are hired directly. Controlled burning can be used when manual methods prove too costly and when the trees are too tall or close together. Weeding does promote tree growth, but is also costly. If it is to pay off, the present value of the increase in benefits in response to the investment must exceed the present value of the costs. Therefore, alternatives with and without weeding should both be tested in cases where weeding is clearly biologically desirable but not absolutely essential.

4.2.6 Pruning

Whether or not to prune depends on the market for the end product. If, for example, gmelina is grown on a 12-year rotation for match production, pruning at least twice is essential. Otherwise the wood cannot be used for match production. Pruning, however, can be a costly process, and the value of the end product must be sufficiently higher to justify the compounded costs.

4.2.7 Fertilization

Whether or not to fertilize is also a yes/no decision, even if it is perfectly clear from research and field experiments that fertilization generates a high-yield response. The question is, how much of a yield response would be necessary in order to outweigh the investment costs incurred.

It should be noted that fertilizer application may be a more attractive proposition in natural forest management. After a harvesting and/or enrichment planting operation in the natural forest, the new, young growth will have to be protected by guards against livestock damage. However, if the growth rate is substantially increased by the use of fertilizer, the guards can be removed earlier, as the trees become less susceptible to damage.

4.2.8 Pest Control Measures

This is less of a yes/no situation than the other treatments. If there is a pest problem, everything could be lost unless some action is taken. The management alternatives could include a pest control alternative even if the problem is not now present. This is particularly the case in areas with a high propensity for pest problems.

4.2.9 Precommercial and Commercial Thinning

By definition, precommercial thinning implies only costs and no revenues; i.e., there is no known market for the thinned materials, and the treatment is recommended to promote the growth of the stand. The returns to the practice show up in the growth and quality of the remaining trees. In the cases where precommercial thinning is judged biologically necessary, one could also test a no precommercial thinning alternative. Although yields will probably be lower, costs too will be lower.

Commercial thinning implies a net revenue; i.e., the costs of the operation are accounted for in the stumpage price (price of the tree on the stump, before it is cut). The management alternatives, as in the precommercial thinning case, could reflect with and without commercial thinning options in the cases where the operation is clearly biologically desirable.

4.2.10 Final Harvest

The final harvest is clearly not a yes/no situation. The question is when—what is the rotation age for which end product? There is a biologically optimal rotation age (the point of maximum mean annual increment) and a financially optimal one, and the two rarely if ever coincide. The financial rotation age usually occurs earlier than the biological rotation age. If the decision is to harvest at the financial rotation age, then financial and economic returns have been maximized, but the site has probably been under utilized. If the decision is to harvest at the biological rotation age, less discounted value is generated, but wood production has been maximized, and the site probably has been utilized closer to full capacity.

Typical of economic analyses of forestry projects in developing countries has been the prespecification of a rotation age, i.e., to harvest in, say, year 10, the biologically optimal rotation age for this particular stand of trees. Using the NPV approach, it would be a simple task to figure out the economic feasibility of this given rotation. To answer the question about the financially optimal rotation age, however, other rotation ages would have to be tested.

4.2.11 Access Restriction

This is a very important consideration in most Sahelian countries where the deforestation problems are rooted in overfarming, overgrazing, and overcutting for fuelwood. One way of restoring the resource base is simply to restrict human and animal access to an area, perhaps by means of paying for a fence and hiring guards, to allow the area a much needed rest.

4.3 When To Do It

After having decided what to do, the second question is: When during the first rotation and during the coppice rotations should the treatments be applied? In a present value sense, the timing of events is extremely important. Earlier events have a much greater impact on present values than later events. For example, the present value of 10,000 F CFA to be received in two years at 10 percent is 8,264 F CFA. If received in five years, the present value drops to 6,211 F CFA. The "when" question requires a detailed scheduling of all management actions to be carried out during the entire project period.

It is emphasized in the "when" question that projects do not always start from scratch—with bare land ready for planting. In fact, most projects begin with a resource base already in place, and the more appropriate question may be to ask what to do with it given its present condition. If the forest is already stocked with plantations, or is presently a natural forest, or is a combination of both, one could begin the project with a thinning operation, a clearcut operation, or any of the treatments listed above. One does not always begin the project with planting in year zero followed by all of the other treatments in subsequent years. The existing plantations could be managed for additional growth, harvested immediately, or even be converted to a natural forest.

4.4 How To Do It

Having decided what to do and when to do it is not the end; there is still the question of how to do it. As already mentioned, for example, a site can be prepared manually with shovel and picks, or it can be done with heavy equipment. Fires can be fought with government-paid workers and equipment or through contractual local participation, whereby farmers are invited to cultivate crops in the firebreaks or in recently cut-over areas, and herders are invited to graze their livestock in designated areas of the forest. Harvests can be accomplished with wage labor or through local participation whereby the participants (villagers) are paid in-kind with an agreed upon percentage of the wood for the work performed. The important point is that things can be done in different ways to achieve the same ends. From the economic point of view, the cost, and hence the economic results, differ depending on the way things are done.

The following are some of the possible how-to-do-it alternatives. They all boil down to one basic heading—local participation. This includes farming and grazing to achieve fire control, in-kind payments for using village labor in thinning and harvesting operations, as opposed to government-paid labor, and natural forest management through the establishment of woodcutter cooperatives.

4.4.1 Fire Management

One of the most bothersome problems in Sahelian forestry is fire. The natural forests that do not burn each year are few. When the dry season sets in and the grasses are tall and dry, the fires invariably start, and they are usually intentionally lighted. They burn hot and wreak incalculable damage on the forest. Trees that survive are more often than not severely stunted in their growth.

It is important to note that there are ecological arguments against prevention of naturally caused fires. Natural fires serve as pest control, promote the production of grasses during the dry season, and are likely to cause much less damage than the intentionally lighted fires. In Sahelian countries, however, fires are rarely naturally caused. They are almost always started by people for a variety of reasons ranging from resentment of forest service activities to facilitating hunting by exposing the animals, and they seem to be started at the worst possible time during the dry season.

How to achieve prevention against intentional ignition in the Sahel is a big problem. Governments typically cannot afford to invest in fire-fighting equipment, pay salaries for fire crews and incur the additional administrative costs that would be required. The funds simply are not available in the national budgets, and costly fire control is largely ignored.

But there are some low-cost alternatives, as has been shown in a few isolated cases throughout the Sahel, most notably in the Dinderesso National Forest near Bobo Dioulasso, Burkina Faso. By means of carefully designed and executed contracts with farmers to cultivate in firebreaks and cutover areas, and with herders to graze their cattle in predesignated areas of the forest and carry out supervised prescribed burning in the forest, the Dinderesso Forest had no dry season fires in 1984 (Christophersen 1985). There is truth in the saying that trees in a farmer's field never burn.

In the specification of management alternatives, one could include three possibilities: no fire control at all (for lack of a national budget, or because it may not be ecologically advisable), fire control paid for with government funds (if the funds are available in the national budget or from external sources), and fire control through local participation programs. Under the "no fire control" option, yields could be considerably lower because of the probability of damaging fires. In the analyses, such a probability should be specified. Under the two fire control options, the cost structures would differ. If the owner (government) pays, there will be higher labor and equipment costs. If, however, a local participation scheme (farming and grazing under contract in the forest) is considered, the owner's fire control costs will be lower. But this will carry with it different sets of management problems, including higher administrative costs to pay for contract monitoring.

4.4.2 In-Kind Payments

For all of the thinning and harvesting treatments one may wish to do, the option of using local village labor and paying them in kind, with wood instead of wages, is probably available. If, for example, a stand is to be thinned or harvested, an agreement could be drawn up between the resource owner and nearby villagers, whereby the villagers do the work under supervision by representatives of the resource owner (e.g., the government), using their tools in exchange for a certain negotiated percentage of the wood transported to their village. Although in the end the owner will have less wood to sell, he will not have to incur any cash outlays for direct wages. The villagers will benefit from receiving larger quantities of wood transported to the village without the nuisance of having to collect the fuelwood on a daily basis. As far as the resource owner is concerned, which way to go is an economic question. If what he loses in terms of wood value is less than what he gains in terms of savings from not having to pay direct wages, he is clearly better off choosing the local participation route.

4.4.3 Cooperatives

Management of the national forests by way of village cooperatives is another form of local participation that is working successfully in Niger under the auspices of the FLUP project. The business of the cooperative is to harvest and sell fuelwood and hay from the forest. The Government of Niger (GON), through the forest service, is a partner in this arrangement. Foresters designate areas to manage and mark the trees to be cut in selective cutting operations. The harvesting is carried out by members of the cooperative.

The cooperative members receive a price of 850 F CFA for each stere they cut and deliver to the cooperative collection center. The center resells the wood to the wood merchants (truckers) for 1,500 F CFA per stere. The profit, 1,500 less 850 F CFA, or 650 F CFA per stere, is divided 75/25 percent between the forest service and the cooperative. The forest service is required to spend its 75-percent portion of the profits on management of the forest. In addition, cooperative members earn 4 F CFA per kilo of hay harvested in the forest.

The difference between the cooperative approach and the old ways of supplying fuelwood is basic. Before, the prevailing mandate was to protect the national forests, not manage or exploit them. Growth rates stagnated as a result, and intentionally lighted fires and illegal cutting became problems because of the repressive emphasis on "keeping people out of the forest." Villagers were permitted to harvest dead wood only. As total fuelwood consumption increased over time in response to population growth and migration to the cities, however, the supply of dead wood reasonably near population centers was soon exhausted. When this happened, people began to cut live trees, both illegally and indiscriminately, to continue to supply the urban areas. The result was rapid deforestation.

With the cooperative approach, however, the emphasis is placed on managed, sustained yield exploitation of the national forests. This means that cooperative members can cut live trees in areas under management, under forest service supervision, without having to hunt for dead trees far away. The negotiated 850 F CFA per stere is adequate compensation to the cooperative members; the 1,500 F CFA price to the wood merchants allows them to continue to supply the urban market without having to increase the price to the final consumer; the profits are plowed back into forest management; and the residual stand is released for more vigorous growth.

It should be added that these concepts of local participation as discussed above have not been applied on a wide scale in Sahelian countries. However, as has been demonstrated in the FEDP project in Burkina Faso and the FLUP project in Niger, the idea has considerable merit. The local population has much to gain from a well-organized, contractual and legal use of the national forests, as do the governments. If the national forests are to be exploited only for and by the governments, the governments must, in turn, also bear all the costs, including the costs of protecting the forests against illegal exploitation. If, on the other hand, local people participate in the management of the resources, the government costs will change, as will the financial and economic results.

4.5 Synthesis

Tables 4.1 and 4.2 illustrate the range of management alternatives that could be considered in the planning process. For purposes of this illustration only, it is assumed that the project under consideration is a polewood plantation where fuelwood is produced as a by-product. There is some flexibility in the selection of species, their planting density and other management treatments (weeding, fire management regimes, stump sprout selections, etc.), and in who will do the work—the resource owner or villagers through local participation. From the list of possible treatments given above, several may be excluded if they are not applicable to or needed by the project for various reasons. To this effect, pruning, fertilization, pest control, and precommercial thinning treatments and access restriction investments have been excluded from further consideration.

Ten alternatives are developed in Table 4.1. They include two species—one with a high growth rate and another with a lower growth rate, but perhaps more marketable; two planting densities—4 x 4 and 5 x 5 meters—replanting, coppice sprout selection, and options with and without local participation.

Table 4.1. Hypothetical List of Management Alternatives.

	Site Prep.		Planting Regimes					Fire Mgt.[1]				Harvests[2]	
			Species 1		Species 2								
Mgt. Alt.	Manual	Hvy. Equip.	4x4	5x5	4x4	5x5	Replant (Mortality) >30%	Local Part.	Govt.	Coppice Sprout Selection	Weeding	Local Part.	Govt.
1													
2	x		x				x	x		x	x	x	
3	x		x						x	x	x		x
4	x			x			x	x		x	x	x	
5	x			x					x	x	x		x
6		x	x				x		x	x	x		x
7	x				x		x	x		x	x	x	
8	x				x				x	x	x		x
9	x					x			x	x	x		x
10		x		x			x		x	x	x		x

[1] Fire control is assumed achieved through local participation in the forms of grazing and farming in the forest.
[2] Local participation for the harvests assumes that the workers are paid in-kind with a percentage of the wood. The owner keeps the rest.

Table 4.2. Timing of Management Alternatives.

Management Activities	Timing: When Treatments Will Occur
Site preparation	Year 0
Planting	Year 0
Replanting	Year 1
Fire mgt./Admin.	Annual maintenance
Coppice selection	Years 8, 15, and 22
Weeding	Years 1 and 2, 8 and 9, 15 and 16, 22 and 23
Final harvest	Years 7, 14, 21, and 28

Note: Rotation age is assumed to be seven years followed by three coppice rotations.

Note in Table 4.1 that alternative 1 is the "do-nothing" alternative against which all of the other alternatives should be compared. The net benefits accumulated over time from investment in a forestry project are benefits that would not have occurred if the investments had not been made. For example, investing in the silvicultural management of a stand will presumably hasten the growth and yield of that stand vis-a-vis similar stands where no silvicultural investments are made.

The increases in growth and yield as a result of any investments should be measured with reference to likely changes on the project site without the investment, as illustrated in Figure 4.1. The vertical axis measures the project benefits, and point A represents the value of the site or stand as it exists today (year 0). Under the "do-nothing" alternative, the site could develop along any of the paths AE, AB, or AC over time. If the development is likely to occur along the AE path, the benefits attributable to the investments (represented by AD) would be the area AED, not ABD as one would intuitively assume. Similarly, if the development under the "do-nothing" alternative is likely to occur along the AC path, the benefits attributable to the investments would be the smaller area ACD (Christophersen and Weber 1982).

Table 4.2 shows the assumed timing of management treatments in this hypothetical example. The rotation age for the plantation is assumed to be seven years, followed by three coppice rotations, for a total analytical time horizon of 28 years. Additional discussion on the make-up of each management alternative and how to estimate the costs and benefits associated with each one will be presented in the following chapters.

Base-case financial and economic assumptions for the list of management alternatives given in Tables 4.1 and 4.2 are developed further in Chapter 5 below. The financial and economic analyses of each alternative are carried out in Chapters 6 and 7.

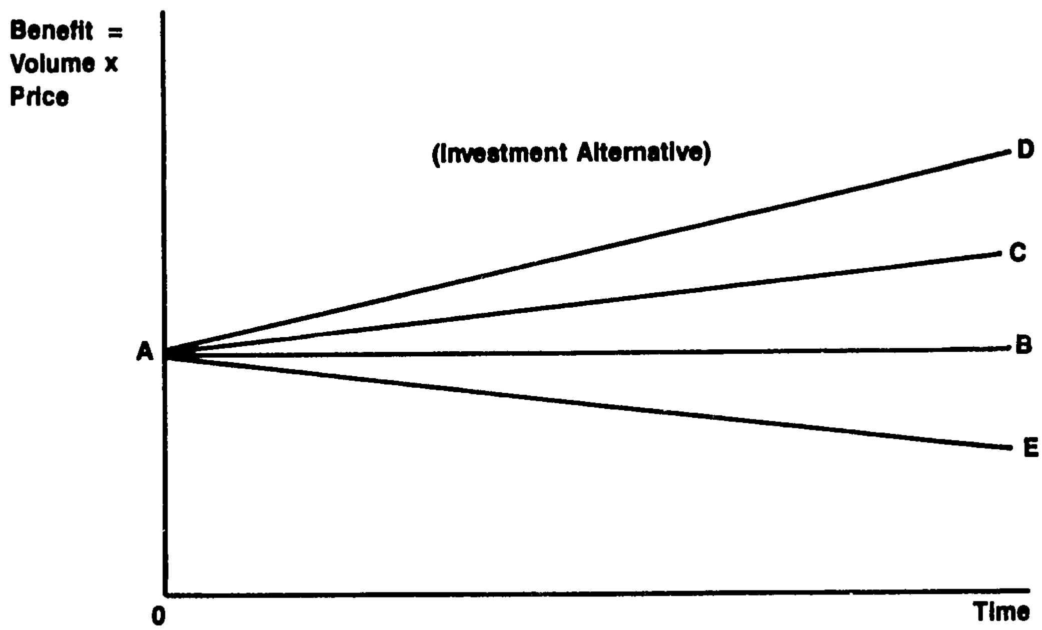


Figure 4.1. Estimation of benefits.

CHAPTER 5: THE INVESTMENT ASSUMPTIONS—BASE CASE

5.1 Introduction

This chapter looks at what constitutes a base case and describes how best to derive a set of realistic investment assumptions for both economic and financial analyses. Assumptions are developed for the 10 management alternatives given in Tables 4.1 and 4.2 in the previous chapter.

To undertake investment analyses, assumptions must be specified for all of the relevant price and cost variables. In this chapter, the development of the assumptions covers the "what," "when," and "how" categories discussed in Chapter 4. Note that when the stage of specifying a base case has been reached, the marketing information needed to establish practical limits on the number of alternatives to test should already have been obtained.

When one is developing a base case, it is important to estimate as realistically as possible the values of the assumptions one has to make in order to carry out the analyses. This is the case for both the economic and financial analyses. In fact, two base cases have to be developed—one with the economic assumptions, the other with the financial assumptions. It is probably easier to begin with the financial assumptions, since they represent the actual prices and costs confronted in the marketplace. These financial assumptions can be adjusted to shadow prices for the economic analysis as the market imperfections, whatever they are, are taken into account.

For these assumptions, the problem is, of course, how best to project their probable future values. They must somehow be estimated. To do this, one has to examine the past to see how costs and prices have behaved and then to make reasonable, justifiable and documentable projections for the future. The purpose of this chapter is to argue the importance of creating a realistic base case that is solidly founded on documentable assumptions and projections. Each base-case assumption is discussed below.

5.2 Discount Rate

The determination of an appropriate rate of discount is, at best, a difficult undertaking. As suggested in economic theory, the discount rate should reflect the investor's opportunity cost of capital, or the rate of return one could reasonably expect to obtain from alternative investment schemes. But to determine the return from alternative investments is difficult, so the selection of an appropriate discount rate often ends up being an arbitrary and controversial undertaking.

It is arbitrary because there is a tendency simply to pick a rate of, say, 10 percent, without any background justification, and without indicating whether the rate is real or nominal. Perhaps this is because the 10-percent rate has been so widely used that it has become a standard by which investment feasibility is measured. It is arbitrary also because planners often fail to take into account that the rural poor would probably apply a discount rate which is much higher than the 10 percent or whichever rate they end up using in the analyses. As stated by French (1979): "For an impoverished villager, a year from now is very far away. Consciousness must be focused on a present in which the margins for survival are extremely narrow." There are indeed realistic barriers to change among villagers and peasants who are used to a subsistence level of living. They tend to be reluctant to change from that which they know works, even though it provides only subsistence, unless the promise of a reward in the future is very high. The implicit discount rate that a peasant places on making changes (such as allocating some of his agricultural land to tree farming) is therefore high. The bottom line here is, if the true economic feasibility of projects is sought, that the chosen discount rate should reflect real risks and cautions expressed by the local people for whom the project benefits are supposedly intended.

The choice of a discount rate may be controversial because most proposed natural resources projects have both proponents and opponents. A low discount rate generates high net present values, which favors the proponents of the project, whereas a high discount rate has the opposite effect.[1]

[1] A government can also manipulate the discount rate, perhaps to strengthen the economics of a proposed project. For example, it may place a high priority on forestry by lowering the discount rate to make the investments appear more attractive. A government may also be in a better position to justify lower discount rates than the private sector. It can afford to attach a lower risk premium on forestry investments because the risks can be spread over a much wider and more diversified total investment portfolio than is possible for the private sector.

Despite the difficulties in specifying a rate agreeable to everyone, one should still try to uncover as much background justification as possible for the rate eventually chosen. To begin, and as a recommendation, real instead of nominal discount rates (as well as real price and cost appreciation rates) should be used. A real rate is not disturbed by the influence of inflation. For example, although the price of a good may have increased nominally by 10 percent per year, the real price will actually have declined if the average rate of inflation during the same time period was higher than the average nominal price increase.

The discount rate can be determined empirically if basic secondary statistical information on the annual rate of inflation is available (such as consumer and wholesale price indices, interest rates charged by the central bank and other banks in the country for different kinds of loans, and interest rates paid for savings). These statistics/rates, however, are usually quoted in nominal terms and should be adjusted to real rates as follows:

$$\text{Real rate} = \left(\frac{1 + \text{nominal rate}}{1 + \text{inflation rate}} - 1\right) \times 100$$

For example, if the nominal and inflation rates were 12 and 10 percent, respectively, the real rate would be:

$$\text{Real rate} = \left(\frac{1 + .12}{1 + .10} - 1\right) \times 100 = 1.8 \text{ percent}$$

Financial Analysis

The process of determining the financial analysis discount rate is illustrated in Table 5.1 using hypothetical data. It is emphasized that this is but one simplified example. It is the availability and reliability of the data that determine the degree of detail to include in the specification of an appropriate rate of discount. The first column in the table shows the hypothetical price index for all commodities between 1978 and 1984 with 1980 as the base year. The annual changes in the price index are calculated in the second column, and give an average rate of inflation over the time period of 8.1 percent. The average annual bank lending and savings rates are 14.43 and 11.86 percent, respectively, or 5.86 and 3.48 percent in real terms using the conversion formula given above. Since the lending and savings rates are the actual rates used, they include inflation and are therefore nominal rates.

Table 5.1. Determination of a Real Discount Rate.

Year	Price Index	Inflation %	Lending Rate %	Savings Rate %
1978	94		12.00	10.00
		> 3.19		
1979	97		12.50	10.00
		> 3.09		
1980	100		13.50	11.50
		> 19.00		
1981	119		14.00	12.00
		> 9.24		
1982	130		16.00	12.50
		> 15.38		
1983	148		16.50	13.50
		> -1.33		
1984	160		16.50	13.50
Average	%	8.10	14.43	11.86
Real rates	%		5.86	3.48

With this kind of information (which is probably available in most countries), at least the lowest possible real discount rate one could use in the analyses has been identified. It would be somewhere within the 5.86- to 3.48-percent range. But planners should also take a risk factor into account. Normally, for example, the rate paid by banks for savings accounts is guaranteed for deposits and is riskless. Also, the loan rates charged by the banks are based on generally low-risk kinds of ventures.

Investments in forestry, however, are not riskless. In fact, they are quite risky because of the comparatively longer time span between the original investment and the returns. During this time period, the growing forest is faced with the risks of fire, pest attacks, illegal tree felling, or other calamities that may result in the loss of a portion or all of the investment.

How much of a risk factor to include in the discount rate is a matter of judgment. There is no well-documented estimate of the risk premium applicable to forestry, certainly not in developing countries. Nevertheless, the base-case discount rate should include an appropriate risk factor of at least 3 percent at the very minimum. Therefore, if the riskless rate is 5.0 percent (within the 5.86 and 3.48 range), the base-case discount rate is 8 percent, or 5 percent plus the 3-percent risk factor.[2]

[2] It should be noted and emphasized that if the project is designed with the purpose of having the local beneficiaries (villagers) eventually take over the investment burdens themselves after project funding has ended, the real discount rate will probably be much higher for reasons mentioned earlier in this section.

The purpose of this exercise has been to show that there is indeed a process planners should complete before choosing a parameter as important as the discount rate. It is not sufficient to anchor all analyses to the ever-present 10-percent rate (not saying whether it is a real or nominal rate) if the actual financial real rate were in fact 8 percent, as in the example given above. If at all possible, project planners should document and back up their choice of a discount rate, instead of picking some unfounded, undocumented different rate that will give erroneous results.

Economic Analysis

The opportunity cost of capital is the true (shadow) value of the discount rate. Only by knowing the rates of return from alternative investment schemes will it be possible to compare investment alternatives. If the opportunity cost of capital is lower than the composite value of bank lending and saving rates (the financial analysis rate), then the discount rate to use in the economic analysis should also be lower than the financial rate. On the other hand, the higher the returns one can expect from alternative investment schemes vis-a-vis the rate of inflation, the higher is the justifiable real discount rate to use in the economic analysis. The economic discount rate assumed for purposes of the analyses in Chapter 6 is 6 percent.

5.3 Costs

There are two basic cost categories: capital (investment) and operating costs. Capital costs include the major investments of a non-recurring nature which must be made to get the project underway.[3] They include plantation establishment costs and infrastructure investments such as buildings, roads, vehicles, and firebreak construction, etc. Operating costs are of a recurring nature and include labor, silvicultural treatments, and administrative and other miscellaneous costs.

For the sake of simplicity, all of the heavy initial capitalization costs, such as buildings and vehicles, that are often part and parcel of forestry projects in a donor aid context have been ignored. It is assumed that all the infrastructure and equipment are already in place. The following summarizes the process by which planners could derive the financial and economic analyses base-case assumptions for all of the cost categories discussed earlier.

5.3.1 Labor Costs

In Sahelian countries, the majority of management interventions in forestry projects are labor intensive. Every activity requires some skilled (supervisory) and unskilled (field workers) labor. The management interventions listed in the "what to do" section in Chapter 4 all require labor. The questions now are: how much labor, when, how often, and how much does labor cost?

How much labor it takes to prepare a site, to plant, to weed, to fertilize, to prune, to fight fires, to conduct precommercial thinning, and to select the stump sprouts to thin is a matter of judgment on the part of the experts who are intimately familiar with forestry in the country, as well as with the project site. Also, how much labor it would take to complete these tasks depends on the extent to which the operations are to be mechanized. Site preparation, for example, can be accomplished faster mechanically with bulldozers and other heavy equipment and fewer workers than can be done manually. There are economic tradeoffs between options.

The base-case assumptions should reflect the lessons learned from past experience and not be based on the analyst's best guess. If one is assuming that the work can be done with 10 workers and past experience has shown it requires 15, the base-case assumption should be closer to the latter, unless there are strong and justifiable arguments for a different assumption.

The "how much labor" question has another dimension. In addition to determining how much labor a particular activity will require, the important question is who pays for this labor. If an activity requires 15 workers, they may be put on the resource owner's payroll, or the activity may be accomplished by way of local participation. Fire control, for example, can be accomplished by hiring fire crews to fight fires, or through contractual arrangements with farmers and herders, as has been discussed earlier.

The "when" and "how often" questions are answered once the management alternatives have been identified (see the hypothetical example in Tables 4.1 and 4.2 in Chapter 4 and below in the analysis chapter).

The "how much does labor cost" question requires some additional research before the base-case assumption can be specified. Published statistics on wages and salaries for skilled and unskilled labor by profession and sometimes by region are usually available on a time series basis in most countries and should be used to document the base-case assumptions.

[3] Defined here as any expenditure that has to be incurred less frequently than annually.

Financial Analysis

For the financial analysis, the base-case assumptions for skilled and unskilled labor should be based on the anticipated project out-of-pocket costs. If it is anticipated that X workers will be hired to carry out Y tasks, project planners can count on a certain payroll burden during the life of the project. These are actual costs to be incurred by the project.

Economic Analysis

In all probability, labor costs would be shadow-priced at a level lower than the actual costs in the economic analysis. How much lower would depend on the rate of unemployment in the country and the season when the work is to be carried out. If there is high unemployment, the shadow price for labor will be lower because there are usually few employment alternatives available; there is no productive outlet for the energies of the unemployed surplus workers in the country. In economic terms one says ". . . that the marginal value product of such labor—the amount that it adds to the gross domestic product—is zero." And, ". . . if we take labor away from a farm community where it is producing nothing and put it to work producing something, then we do not have to forego any production in order to realize the new product" (Gittinger 1972). From an economic analysis point of view, this previously unproductive labor now made productive in reality costs society nothing. The true wage is zero, because that is what this labor would otherwise produce. Therefore, under this extreme case, the appropriate cost to charge the project in economic analysis—is zero, which, of course, will make the project look more attractive than capital-intensive, labor-saving projects.

The seasonality of the work, too, is important. Planting activities, for example, often take place at the beginning of the rainy season, when farmers are busy getting their crops established. When these times coincide, planners could still use a shadow price for labor if there is still unemployment, but at a level closer to the market wages than in the extreme case just discussed. If the resource owner schedules his project efforts at a time of very high unemployment, a shadow price for labor of zero is warranted. If he schedules the work to be carried out during times of near full employment, perhaps a shadow price of only 75 percent of the market price used in the financial analysis would be warranted. This 75-percent level is the base-case assumption used in the analyses presented in the following chapter.

5.3.2 Materials Costs

Three of the management activities listed require materials with project cost implications: planting and replanting require seedlings, fertilization requires NPK or some other kind of fertilizer, and pest control requires chemical products.

Financial Analysis

The financial base-case assumptions for these materials would be the project out-of-pocket costs, whether the materials are produced domestically or are imported.

Economic Analysis

Shadow prices for domestically produced materials would be in order if they were produced and/or sold subject to subsidies or price-fixing schemes. For example, if the true market value of tree seedlings were 35 F CFA each, whereas the government, to promote tree planting, has fixed the price at 20 F CFA each, the correct shadow price to use in the economic analysis would be the true value measure of 35 F CFA. The financial assumption would be the 20 F CFA per seedling.

Imported materials, which usually include fertilizer and pest control chemicals in Sahelian countries, contribute to the drain on foreign exchange. If the foreign exchange rate is pegged at a level lower than the free market established rate (which it usually is in most Third World countries with soft currencies), then an importer ends up paying less than what the free market rate would have him pay. In economic analysis, therefore, the imported goods should be valued according to the market foreign exchange rate instead of the pegged rate. For example, fertilizer costing 100 F CFA per kilo according to the pegged rate may be shadow priced at 120 F CFA per kilo at the free market rate.

5.3.3 Annual Administrative Costs

The estimated annual administrative cost burden per hectare should be considered by the project planners. These include prorated office expenses, forest agent salaries, and other miscellaneous expenses that occur annually. A total of 10,000 F CFA/ha/year is assumed for both the financial and economic analyses presented below.

5.3.4 Other Costs

This category covers the management alternatives using labor-saving, mechanized techniques. For instance, site preparation could be done much quicker, and probably better, with bulldozers and other heavy equipment as required. In fact, this was how most of the exotic species plantations in Sahelian countries were established.

Financial Analysis

The base-case assumption for the financial analysis should reflect the market price for heavy equipment rental per hour, or, alternatively, if the equipment is owned, the out-of-pocket cost of the fuels, maintenance, and depreciation.

Economic Analysis

As a general rule, the base-case assumption for the economic analysis would be close to or the same as the financial assumption. Shadow pricing of components of this cost, however, may be warranted. For example, if fuel is imported, payments must be made from the foreign exchange account. As such, this component could be shadow priced. However, if this is a relatively small component, the process of shadow pricing it could be too time consuming and little precision in the assumptions would be gained.

5.3.5 Access Restriction Costs

Access restriction costs are usually incurred in natural forest management. The investments made are for restricting access (fences, guards) to the site the planners wish to protect. If access is to be effectively restricted, investment in some physical barrier must be made.[4]

Financial Analysis

For the financial analysis, the out-of-pocket costs for the fence, its installation, and the guards are assumed. The protection costs should be figured for the entire site, perhaps several hundred hectares, and be quoted on a per hectare basis. Note that the configuration of a site makes a big difference in fence costs. For example, a rectangular 200-hectare site measuring 500 x 4,000 meters would require 9,000 meters of fencing, whereas a square site of 200 hectares would measure 1,414 x 1,414 meters and require only 5,656 meters of fencing.

Economic Analysis

Whether or not to shadow price the cost of the fencing would depend on the type of fence used. If the fence is a three-strand barbed wire, imported fence, then a shadow price would certainly be appropriate. If it is a fence made with local materials, or perhaps even a live fence, shadow pricing would not be required. Shadow pricing for the guards and any other labor input would again depend on the rate of unemployment in the country.

5.4 Stumpage Prices: Project Benefits

The direct benefits of a forest production project are the quantity of wood produced multiplied by the price of the wood at the time of harvest, be it from a commercial thinning regime or a final harvest, discounted to the present. There are three product categories assumed in the 10 alternatives (from Table 4.1) to be analyzed: high- and low-quality poles and fuelwood.[5] There are different stumpage prices for each product category.

5.4.1 How to Derive Stumpage Prices

Stumpage prices are benchmark values generated as a result of the investments at a specific point during the product life. The correct way to find them is to consider two basic perspectives—buyer and seller (Gray 1983). The buyer's perspective begins with the price for the end product, which is used to determine the minimum amount he would be willing to pay for the trees before they are cut. He would have to deduct all of the costs associated with bringing the end product to market. The residual—the difference between the price for the end product and all of the costs deducted—is the stumpage price from his perspective. For the seller, the stumpage price represents the minimum amount he would be willing to accept for the wood, taking into account his costs of producing it. If he has incurred high production costs, the stumpage price, too, will be high if he is to recover his costs, and vice versa if his production costs are low.

There must be an overlap between the buyer and seller stumpage prices for a market to exist. For example, if a buyer determines that he can afford to pay up to 1,000 F CFA/m^3 for the wood before it is cut and the seller needs at least 700 F CFA/m^3 to recover his costs, there is overlap between the two; the buyer is willing to pay more than the minimum amount the seller is willing to accept. The true stumpage price would be somewhere between 700 and 1,000 F CFA/m^3, perhaps at the midpoint, or 850 F CFA/m^3. If, however, the seller's minimum acceptable stumpage price were 4,000 F CFA/m^3, there would be no overlap between buyer and seller. The

[4] Access restriction costs are not considered in the analyses carried out in the following chapter.

[5] In a natural forest management project, benefits could also include hay, food, medicines, and other secondary forest-related products.

maximum amount the buyer could afford to pay would be far below the minimum amount the seller could accept if he were to recover his costs.

If there is no overlap between buyer and seller stumpage prices for the intended end product, the next logical step is to consider alternative markets for the wood. If the wood can be sold for more in a different market (for tool handles, for example), and the costs do not change much, the stumpage price, too, will be higher. It may approach and perhaps move into a region of overlap with the minimum acceptable stumpage price for the seller. If an overlap cannot be reached, the seller will eventually have to sell at a loss.[6]

The input assumptions required to derive the stumpage prices include estimates on production costs from planting to harvest, production costs from harvest to final market, and the final market prices. If any of these variables change, so do the stumpage prices. Their magnitudes depend directly on the final market prices for the end products, on the intensity of the management alternative, on the productive capacity of the site, and on how these variables interact in the overall analysis.

The easiest way to develop the assumptions on production costs from planting to final harvest (from the seller's perspective) for each of the management alternatives is probably to use and update the cost information that is already available from and documented in other forestry projects. How to develop these cost assumptions associated with the 10 alternatives has been discussed in several of the sections above in this chapter.

The (hypothetical) production costs from stump to final market and the final market price assumptions are given in Table 5.2. The table gives a breakdown of the individual cost components that make up the final market price.

5.4.2 The Importance of Stumpage Prices

In financial and economic analyses of the majority of forestry projects in Sahelian countries, the concept of stumpage prices has been treated far too lightly. Usually, only the buyer side (points 1, 2, and 3 above) is considered. Often, only the cutting permit fee is used as an estimate of the stumpage price. This is because the fee is the only component of the buyer's cost structure collected by the seller. Therefore, it could be considered an appropriate measure of the stumpage price from the seller's perspective (Baah-Dwomah 1983).

Table 5.2. Price and Cost Components (F CFA/m³): Financial and Economic Analyses.

Prices and Costs	Financial	Economic
FINAL MARKET PRICES		
Fuelwood	9,000	19,262[1]
No. 1 poles	18,000	18,000
No. 2 poles	14,000	14,000
PROD. COSTS (from stump to market)		
Permit fee (cutting)	200	200
Bucking/felling	1,000	750[2]
Forwarding costs	500	375
Roadside loading	400	300
Transportation (roadside to market)	4,060	4,060
Unload (final market)	400	300
Selling costs (10%)	1,075	1,107[3]

[1] See Table 5.3 below.

[2] Based on 75 percent of market wages (see Section 5.3.1 above).

[3] Figures are based on all costs incurred from planting to final market associated with management alternative no. 2. This figure will change as production costs change with the different management alternatives.

However, considering the buyer side only is not enough. The only time when this would be appropriate is when the wood on the stump is essentially a free good. In fact, the final market price for fuelwood in most Sahelian countries is based on wood harvested from an endowment or a "savings account" of natural forests where virtually no production costs have been incurred. But the situation is entirely different for a project to be implemented over several years. Why? Because all of the activities and alternatives proposed will cost money which should be recovered if the project is to be feasible. Costs have to be incurred in order to generate anticipated future values. In other words, there is no "free" natural forest savings account to draw on. It is important to understand, therefore, that both buyer's and seller's perspective must be considered. The analyst should identify all relevant buyer's and seller's prices and costs and final market prices that would have to exist in order to ensure a buyer/seller overlap.

Financial Analysis

The information needed to determine stumpage prices is often not readily available. From the buyer's perspective, planners should look at the most accessible

[6] See additional discussion on this point in Section 6.4 in the following chapter.

source of information—the retail wood prices in the urban markets—and work backwards from there to buyer's stumpage price. Published statistics on retail wood prices in urban markets are available in many countries because wood is often sold through government retail outle or through organized wood markets. Where no pubiisned statistics are available, it will be necessary to conduct wood price surveys.

Economic Analysis

For the economic analysis, however, there could be ample justification for using a different stumpage price for wood as a direct input than the price derived for the financial analysis. If, for example, wood prices are closely controlled, or fixed at a level different from the free market price, then shadow pricing to reflect an undistorted market price would be in order. The F CFA/m³ retail price for fuelwood could be a government-fixed price, whereas the true economic price could be considerably higher if an unhindered free market were allowed to function.

Further, if the assumption is made that wood energy is perfectly substitutable for other energy sources (charcoal, kerosene, biogas, electricity, etc.), then shadow prices may be derived by equalizing their costs in terms of delivered energy content and impact on foreign exchange. If accepting this assumption, a shadow price for fuelwood reflecting its value as an energy source vis-a-vis alternative energy sources, one can often point to substantial foreign exchange savings as homegrown wood replaces imported energy products. Openshaw (1982), for example, showed a dramatic increase in fuelwood price, from .31 Kenyan shillings (Kshs) to a shadow price of 2.16 kshs per kilo, when taking into account the energy content of the wood vis-a-vis other energy sources and improved stove efficiency. Such a large increase in the price of fuelwood certainly will make a project much more attractive economically.

Table 5.3 illustrates the process by which shadow prices for wood are derived if wood and kerosene can be considered perfectly substitutable energy sources. Kerosene is generally imported and payments must be made with foreign exchange. Wood, on the other hand, can be grown at home and can be used as a substitute for imported kerosene, thus saving foreign exchange.

The first order of business in this process is to determine if there is an official exchange rate between the local currency (LC) and the U.S. dollar (or any hard currency) that differs from the true market values of the currencies. If so, the price of the imported products should be adjusted according to the latter. A rate officially pegged at a level less than parity vis-a-vis the dollar, for example, means that buyers pay less for the product than they would if the currencies were allowed to float freely against each other. They have to convert their LCs to dollars (foreign exchange) at a favorable rate to them in order to pay for the imports. Thus, if the official rate is 1 U.S. $ = 200 LC (local currency) and the free market rate is 1 U.S. $ = 220 LC, the official rate gives a value of U.S. $1.10 per dollar. As a result, imports are encouraged.[7]

Table 5.3. Fuelwood Shadow Pricing Based on Imported Kerosene as Substitute.

	Kerosene	Fuelwood
Retail price (F CFA/l)	130	NA
Economic price	130	NA
Calorific values	8,500/l	3,800
Kilos of solid wood/m³	NA	580
Total calorific value of wood/m³	NA	2,204,000
Shadow prices, F CFA/m³: 100 % owner		
No improved wood stoves		7,705
With improved wood stoves		19,262
Assumptions:		
1. Pegged exchange rate:	1.0	
2. Kerosene stove efficiency:	35 %	
3. 3-rock stove efficiency:	8 %	
4. Improved wood stove efficiency:	20 %	

The second order of business is to compare the energy values of kerosene and wood. In Table 5.3, kerosene is assumed to have a calorific value of 8,500 kcal per liter. A solid m³ of wood is assumed to have in excess of two million kcal's. The third order of business is to estimate the amount of usable energy obtained from both kerosene and wood and compare the two. If kerosene is used for cooking, the efficiency of the kerosene stove must be considered and compared with the efficiency of the traditional 3-rock wood stoves. If the project in question has no improved wood stove component, the shadow price for the fuelwood is 7,705 F CFA/m³. If one is counting on an improved wood stove program to retain as much of the energy in the wood as possible (as assumed for the analyses below), the shadow price increases considerably, to 19,262 F CFA/m³ as shown in the table given the assumptions.

[7] In Table 5.3, the foreign exchange rate is 1.0 (not pegged), since the F CFA is a hard currency tied to the French franc. There is no black market rate for the F CFA vis-a-vis the U.S. dollar.

It is strongly emphasized that the approach to shadow pricing just discussed should be used with extreme caution and not, in effect, to cover up for or justify an otherwise financially inefficient project. As shown, the price will increase dramatically as a result of the calculations based on the assumptions stated in Table 5.3. It should not be taken for granted that wood is perfectly substitutable with other energy sources, nor that an improved wood stove program will be successful if made part of the proposed forestry project.

5.5 Price and Cost Appreciation Rates

To determine price and cost appreciation rates, project planners will have to refer to various consumer and wholesale price indices with time series information. Such indices may also be available for wood prices. These indices may be published on an annual, quarterly, or even on a monthly basis. The ones to use should be converted to annual rates, and they should be expressed in real terms. One example of how to determine real appreciation rates is given below in Table 5.4. These indices have been obtained from secondary sources—consumer price, fuelwood price and labor cost indices. All of the indices have been converted from nominal to real numbers to determine the real changes over time. In this example, based on the data available to the analyst, it is assumed in the base case that stumpage values and labor costs increase by 1.5 and 1.2 percent per year, respectively, in real terms.

5.6 Yield Responses to Management Alternatives

Table 5.5 presents the final set of assumptions required to carry out the analyses. It shows the expert forester's best judgement on the productive capacity of the site under each alternative. This is a standard against which feasibility is measured. Also shown in the table are the assumed poles versus fuelwood volumes associated with each alternative.

Table 5.4. Determination of Real Price and Cost Appreciation Rates: A Hypothetical Example.

Year	Consumer Price Index	Fuelwood Price Index	Real Fuelwood Price Index	% Change Fuelwood Price Index	Labor Cost Index	Real Labor Cost Index	% Change Labor Cost Index
1978	85	86	101.2		87	102.4	
				4.2			4.0
1979	93	98	105.4		99	106.5	
				-5.1			-6.1
1980	100	100	100.0		100	100.0	
				16.1			18.8
1981	112	130	116.1		133	118.8	
				3.4			-0.3
1982	125	150	120.0		148	118.4	
				-7.5			-4.5
1983	146	162	111.0		165	113.0	
				-2.0			-4.9
1984	160	174	108.8		172	107.5	
Average Real Increase (Decrease)				1.5			1.2

Base Year: 1980 = 100

Table 5.5. Assumed Yield Response to Management Alternatives and Pole Versus Fuelwood Volumes.

Mgt. Alt.	Assumed Yield Response m³/ha/yr	% Volume Fuelwood	Total	% Volume Poles No. 1	% Volume Poles No. 2
1	"Do-nothing" alternative				
2	4.0	55	45	40	60
3	3.5	60	40	35	65
4	3.5	60	40	35	65
5	3.0	65	35	30	70
6	4.5	50	50	45	55
7	3.5	60	40	35	65
8	3.0	65	35	30	70
9	2.5	70	30	25	75
10	3.5	60	40	35	65

Note: The above yield responses and percentage breakdown among product categories are benchmark figures to be used in the analyses. In the absence of research data, they could be determined subjectively by expert foresters familiar with their sites. However, it would be much preferable if the numbers were taken from research results or were documented in the literature.

CHAPTER 6: THE ANALYSES

6.1 Introduction

This chapter presents the financial and economic analyses of the series of 10 management alternatives first presented in Chapter 4, Tables 4.1 and 4.2. All of the assumptions are documented in the fashion demonstrated in the previous chapter, either with existing statistical published information and/or by (unpublished) past experience. The assumption for the financial discount rate was developed in Table 5.1. Price and cost appreciation rates came from Table 5.4. The remaining assumptions (labor costs and labor requirements, seedling costs, and heavy equipment costs) are the figures the analyst should derive in his or her research. How to derive stumpage prices was discussed in the previous chapter and will be illustrated for the 10 alternatives below in this chapter.

For the economic analysis, shadow price assumptions for fuelwood are given in Table 5.3. Shadow prices for poles were not considered. Shadow prices for the discount rate, labor costs, etc., are based on the analyst's judgments given the realities in the field. Tables 6.1 and 6.2 summarize the financial and economic base-case assumptions. Table 6.1 recalls the listing of management alternatives from Table 4.1. Table 6.2 lists the assumptions as derived in the previous chapter that do not vary with the 10 management alternatives. A more detailed summary of the assumptions for each alternative is given in Annex 2.

6.2 The Break-Even Approach

To be realistic, and for the sake of simplicity, it is assumed that no solid information on the probable biological response to management treatments is available. Therefore, the two variants of the break-even approach discussed initially in Chapter 3, plus a third—payment in-kind—are used to determine economic and financial feasibility. They are: (1) How high do wood prices have to be in order to break even on the investments, holding quantity constant at the assumed productive capacity of the site, given the assumptions summarized in Tables 6.1 and 6.2? (2) How much wood/ha/year must be produced holding final market prices constant at their present market level, given the assumptions? (3) How much wood can the seller afford to pay in-kind instead of salaries for harvesting and handling work performed given the assumptions?

In the first break-even analysis, the objective is to compare the break-even price with the price that actually exists in the marketplace. If the break-even price is lower than or equal to the actual price, the project is feasible. In the second case, the objective is to compare the break-even quantity with the quantity of wood the site is assumed capable of producing, given the intensity of the management alternative. If the quantity required is lower than or equals the productive capacity of the site, the project is feasible. In the third case, the objective is to determine how much product value the seller can afford to give up as payment for work and still be in the region of feasibility.

6.3 Analytical Steps

Before presenting the results of the break-even analyses of the 10 alternatives, this section briefly summarizes the required analytical steps. First, there are several "how-to" steps in finding the stumpage prices. The objective is to determine whether there is overlap between the maximum amount buyers are willing to pay and the minimum amount sellers are willing to accept:

1. Determine final market prices for end products (this was done in Table 5.2).
2. Determine all costs incurred between final market price and the stump, i.e., permit fees, harvesting costs, forwarding costs, loading and unloading, transportation costs and selling costs (this was done in Table 5.2).
3. The difference between the market prices and all costs incurred between stump and final market (points 1 and 2 above) is a measure of the buyer's stumpage price or the maximum amount he would be willing to pay for the wood.
4. Determine the discounted production costs for the entire project duration for each management alternative specified. This is the seller's stumpage price or the minimum amount the seller is willing to accept for the wood.
5. Compare points 3 and 4. If the discounted production costs (seller perspective) are lower than the buyer's maximum willingness to pay, there is overlap between buyer and seller.

Second, there are "how-to" steps to follow in determining economic and/or financial feasibility, given the actual final market prices for the end products:

6. Estimate the approximate yield response (m^3/ha/year) of each management alternative specified. This can be

Table 6.1. Hypothetical List of Management Alternatives.

Mgt. Alt.	Site Prep.		Planting Regimes					Fire Mgt.		Coppice Sprout Selection	Weeding	Harvest	
			Species 1		Species 2								
	Manual	Hvy. Equip.	4x4	5x5	4x4	5x5	30%	Local Part.	Govt.			Local Part.	Govt.
1													
2	x		x				x[1]	x		x	x	x	
3	x		x						x	x	x		x
4	x			x			x	x		x	x	x	
5	x			x					x	x	x		x
6		x	x				x		x	x	x		x
7	x				x		x	x		x	x	x	
8	x				x				x	x	x		x
9	x					x			x	x	x		x
10		x		x			x		x	x	x		x

[1] The replanting alternatives are based on choosing to replant 30 percent of the original plantation in Year 1.

Table 6.2. Summary of Base-case Investment Analysis Assumptions That Do Not Change With Management Alternatives.

Assumptions			Financial Analysis	Economic Analysis
Discount rate (real)			8.0 percent	6.0
Real appreciation rates:				
Prices (stumpage)			1.5 %/yr	1.5
All cost			1.2 %/yr	1.2
Labor costs:				
Skilled (supervisory)			2,500 F CFA/day	1,875
Unskilled			1,000 F CFA/day	750
Seedling costs (both species)			20 F CFA/ea	35
Administrative costs			10,000/ha/yr	10,000
Labor (PD/ha)	**Skilled**	**Unskilled**		
Site preparation:				
Manual	2	20	25,000 F CFA	18,750
Heavy equipment	1	5	7,500 F CFA	5,625
Planting:				
4 x 4	2	25	30,000 F CFA	22,500
5 x 5	2	20	25,000 F CFA	18,750
Replanting (30% of planting costs)				
4 x 4			9,000 F CFA	6,750
5 x 5			7,500 F CFA	5,625
Fire management:				
Owner	3	30	37,500 F CFA	28,125
Local participation	4	0	10,000 F CFA	7,500
Coppice selection	2	15	20,000 F CFA	15,000
Weeding	1	10	12,500 F CFA	9,375
Heavy equipment	**Rent: F CFA/hr**	**ha/hr**		
Bulldozer	12,000	.2	60,000 F CFA	60,000
Grader	9,000	.2	45,000 F CFA	45,000
Subsoiler	4,000	.1	40,000 F CFA	40,000

done with stand prognosis models if the information is available, with a site index approach as discussed in Chapter 3, above, or in a less objective fashion through expert judgments (educated guesses) from people intimately familiar with the site in question.

7. Holding the actual final market price fixed at its present market level, adjust the quantity of end product that would have to be produced in order to break even on the investment to the point where buyer and seller overlap is achieved.
8. Compare points 6 and 7. If the quantity of wood production required to break even on the investment exceeds the assumed productive capacity of the site, the project is not feasible.

Third, the "how-to" step in determining economic and/or financial feasibility given the estimated yield responses to each management alternative is as follows:

9. If the estimated yield responses to each management alternative are fixed, adjust the final market price until buyer and seller overlap is achieved. This is the break-even price. If it is higher than the actual market price, and no steps can realistically be taken to increase the market price (increased taxes, fees, etc.), the project is not feasible.

Fourth, the "how-to" step to determine the final harvest, local participation break-even points is as follows:

10. Having determined the price of wood required to break even on the investment, given the fixed quantity (point 9 above), adjust the percentage of how much wood the owner retains to the point where overlap is achieved. The wood value given up as payment in-kind is offset by the lower harvesting, forwarding, and handling labor costs. The percentage break-even point describes a point of indifference between using local participants and paying market salaries for the work. If the seller can negotiate a deal where the percentage he retains is higher, then he is clearly better off choosing the local participation route. It is important to note here that the break-even price of wood must be lower than or equal to the actual market price in order for the in-kind payment option to be valid.

6.4 The Results

The results of the break-even analyses are presented in terms of: (1) The break-even final market prices, (2) The break-even quantities, (3) The break-even level of in-kind payments. The results are presented in Table 6.3 for the financial analyses and 6.4 for the economic analyses.

6.4.1 Financial Analysis

Based on the assumptions given, none of the project management alternatives considered are financially feasible. A private investor interested in maximizing profits would not be attracted to make the investments. The break-even quantities of wood required, given that the market prices are held fixed at their actual market level, are all much higher than the assumed yield responses to silvicultural treatments given in Table 6.3. For example, given the financial assumptions for alternative 2, 9.1 m^3/ha/year of wood would have to be produced in order to break even on the investment. This is far above the assumed productive capacity of the site (4.0 m^3/ha/year), according to the experts who know the site, and the investment is therefore judged to be not financially feasible given the information available.

Alternatively, the market price of fuelwood would have to be as high as 13,818 F CFA/m^3, or much higher than the actual market price, holding the quantity produced fixed at the assumed yield responses to each of the management alternatives. There are similar gaps between actual market prices and the prices required to break even for the poles.

The maximum amounts of wood the owner can afford to give up as in-kind payment to the workers are given as percentages in the last column of Table 6.4. Since none of the alternatives are financially feasible, however, the in-kind payment options fall out. In effect, the owner cannot afford to forego any of the wood, and he retains the full 100 percent. The in-kind payment options are valid only when both final market prices and quantities are fixed at their actual, realistic levels and overlap between buyer and seller is still achieved.

It is interesting to note that the three alternatives that best approach financial feasibility (nos. 2, 4, and 7) are the local participation alternatives. In addition to the in-kind payment options (which is one form of local participation), these alternatives also provide for local participation to ensure fire control (see Table 6.1). Based on the assumptions, fire control can be achieved for a lot less out-of-pocket expense than maintaining salaried fire control crews (see the difference in Table 6.2 where salaried fire crews costs 37,500 F CFA/ha/year, whereas local participation costs only go as high as 10,000 F CFA/ha/year). This cost difference exerts a significant impact on the overall results. The no-local-participation alternatives require almost twice as much wood to break even on the investments.

The only (just) financially feasible alternative is the "do-nothing" or "without project" alternative (no. 1). To obtain this result, however, different levels of expendi-

Table 6.3. Break-Even Financial Analysis.

Mgt. Alt.	Max. Yield Response m³/ha/yr	Market Prices (F CFA/m³) 9000 Fuel-wood	18000 1 Pole	14000[1] 2 Pole	Stumpage Prices (Derived Below) Fuel-wood	1 Pole	2 Pole	Break Even m³/ha/yr	In-Kind Payments % Retained By Owner[2]
1[3]	.8	9000	18000	14000	487	975	758	.8	NA*[4]
2	4.0	13818	27635	21493	4846	9692	7538	9.1	100
3	3.5	23382	46764	36371	8389	16779	13050	17.4	NA
4	3.5	15320	30640	23830	5323	10646	8280	9.6	100
5	3.0	27056	54111	42085	9685	19370	15065	18.7	NA
6	4.5	20266	40531	31523	7618	15236	11850	17.2	NA
7	3.5	15584	31169	24242	5447	10895	8473	9.9	100
8	3.0	27305	54610	42473	9798	19596	15241	19.0	NA
9	2.5	25027	50055	38930	8389	16779	13050	20.7	NA
10	3.5	26150	52300	40676	9688	19376	15070	20.0	NA

[1] Market prices are taken from Table 5.2.
[2] The in-kind payment column shows the break-even percentage of wood retained by the owner when the prices are varied and the quantities are fixed at their maximum yield response levels.
[3] Alternative 1 is the "do-nothing" alternative.
[4] Asterisk indicates financial feasibility.

Table 6.4. Break-Even Economic Analysis.

Mgt. Alt.	Max. Yield Response m³/ha/yr	Mkt Prices (F CFA/m³) 19262 Fuel-wood[1]	18000 1 Pole	14000 2 Pole	Stumpage Prices (Derived Below) Fuel-wood	1 Pole	2 Pole	Break Even m³/ha/yr	In-Kind Payments % Retained By Owner
1	.8	8086	7561	5863	624	583	423	.1	NA*[2]
2	4.0	16303	15243	11819	4736	4428	3210	3.0	84.1*
3	3.5	25150	23515	18234	7892	7379	5350	5.2	NA
4	3.5	17198	16080	12469	5169	4883	3504	2.9	85.4*
5	3.0	18797	17575	13628	5186	4849	3515	2.9	NA*
6	4.5	23967	22409	17376	7268	6795	4927	6.2	NA
7	3.5	17549	16408	12723	5322	4976	3608	3.0	85.8*
8	3.0	28010	26189	20307	9220	8621	6250	5.1	NA
9	2.5	31999	29919	23200	11080	10360	7511	5.0	NA
10	3.5	28191	26359	20439	9214	8616	6246	6.0	NA

[1] Shadow price for fuelwood is taken from Table 5.3.
[2] Asterisks indicate economic feasibility.

tures would have to be estimated and different information would have to be obtained, as follows:

1. Determine the productive capacity of the site without the project. This could be done using aerial photos to determine the vegetative changes on the site over time. With this kind of information, one can document the changes in productivity over time and extrapolate the information into the future.
2. Second, a "do-nothing" alternative is not cost free. Some administrative and harvesting costs must be incurred during the relevant time period. Assumptions for these greatly reduced costs and benefits should be developed in the same fashion as the costs and benefits for each of the other alternatives and analyzed in the same fashion.

If the analysts estimate that the site will produce no more than .8 m^3/ha/year at the end of the time horizon, without the project, this figure should be compared with the probable yields associated with all of the project management alternatives tested. Under alternative 2 (the alternative that best approaches feasibility), approximately 4 m^3/ha/year would be produced. The net wood benefits attributable to this alternative vis-a-vis the "do-nothing" alternative, therefore, would be at least 4.0 – .8 = 3.2 m^3/ha/year of wood.

6.4.2 Economic Analysis

The economic analysis results are presented in Table 6.4. In addition to the "do-nothing" alternative, there are four economically feasible investment alternatives as indicated by the asterisks. In each of these cases, the quantities required are lower than the estimated maximum yield responses associated with each management alternative. In each of the cases also, the market price required to break even on the investments falls below the actual market prices. This is because the assumptions have changed and several parameters have been shadow priced.

Of all the alternatives, it appears that no. 2 is economically optimal because it shows the greatest difference between the assumed yield response (4 m^3/ha/year) and the break-even level of production (3.0 m^3/ha/year), or 1.0 m^3/ha/year. Similarly, the break-even market price of the fuelwood (16,303 F CFA/m^3) is below the 19,262 F CFA/m^3 assumed shadow price for fuelwood as shown in the table. In the economic analysis, therefore, alternative 2 is preferable to the do-nothing option.

The in-kind payment options are valid for the economic analysis where economic feasibility has been achieved given the assumptions. For alternative 2, the owner must retain at least 84.1 percent of the total wood volume to be indifferent between hiring and paying cash to workers for harvesting and handling the wood or hiring local villagers and paying them with a percentage of the wood in-kind. The owner would be better off with the latter option if he could negotiate a percentage to retain more than the 84.1 percent shown in the table.

6.5 Discussion of Results

In Sahelian countries, it is generally the rule rather than the exception that the costs of forest plantations have far exceeded the market price for the end product, particularly fuelwood. As a result, there has been little financial incentive on the part of the governments to invest in plantations. That fuelwood prices are low is often a result of resource management policies in Sahelian countries. Fuelwood is a basic necessity, and governments have had to ensure that supplies are made available at affordable prices on a continuous basis. To do this, however, they have over several decades allowed the "mining" of the endowment of natural forests without making any provision to replace that which is removed. If the replacement costs associated with intensive plantation projects were included, it would not be unreasonable to expect that the final price of fuelwood would have to increase substantially, perhaps beyond the realm of affordability for the majority of consumers.

Although the analyses were done with hypothetical figures, the results are not at all unrealistic. That there is, in the Sahel, a great discrepancy between market prices and costs to produce wood in intensive fuelwood plantations is an undisputable fact. Such forestry projects simply will not pay for themselves in the Sahel on the basis of the wood values alone.

What can be done? More plantations are clearly not the answer. If this route is chosen, wood prices would have to increase to better reflect wood scarcity. Presently, the market price of fuelwood reflects only the cost incurred by the buyer between the market and the stump. The production cost side of the wood supply question is not considered because the natural forests are being depleted without any significant scale provision made to replace the volumes removed in any of the Sahelian countries. The one component of this cost that represents a payment for the wood is the permit fee. This fee is controllable and could be increased.

But this possibility, according to Shaikh (1984), has practical limits. He suggested that wood prices could be influenced by the governments to some degree, but not nearly enough. To increase cutting permit fees will affect the cost of wood in the urban areas, but not in the rural areas where the wood is essentially free anyway. And, as emphasized by Shaikh, permits and taxes are but a small fraction of the total retail price for wood. Therefore, even a very drastic increase (10-fold as suggested in the paper) in the permit fees would lead only to a relatively small increase in the retail price. There appears, therefore, to be practical limits to influencing wood fuels prices by fiscal means. However, he adds, fees should nevertheless be gradually increased to the maximum extent possible.

A second, and probably much preferred possibility, is natural forest management by way of local participation, particularly the cooperative approach as discussed in Section 4.4.3 above. If the successful Niger (FLUP project) experiment with local participation could be replicated on a large scale throughout the Sahel, sustained natural forest management would be possible to adequately supply the urban areas with fuelwood.

A third possibility that may generate additional revenues is to ensure that existing forestry legislation is enforced through intensified surveillance. Fourth, there is considerable potential for encouraging conservation in urban areas through improved cookstoves projects and/or substitution with alternative energy sources such as kerosene or butane.

On the improved cookstove potential, however, there is controversy, too. Weber (1982), in criticizing the flurry of cookstove activities, illustrates the limited potential of improved cookstoves as follows:

- assume that an improved stove is estimated to save as much as 30 percent of the wood consumed in the traditional 3-rock stove;
- assume that only 50 percent of all households change from the 3-rock stove to the improved stove;
- assume that 70 percent of all meals are cooked on the improved stoves (different dishes and other reasons, etc., will not permit this figure to be any higher);
- assume that 15 percent of wood burned is for purposes other than cooking;
- assume that only 50 percent of deforestation or desertification is due to over-cutting for fuelwood.

Then, the net effect of the improved cookstove program on the environment will be: .30 x .50 x .70 x .85 x .50 = 4.4 percent, which is negligible when compared with the original 30 percent savings often claimed by the stove proponents.[1]

Despite the difficulties in attaining financial and/or economic feasibility of forestry investments in Sahelian countries, the analyses carried out above clearly demonstrate the utility of using economics to its fullest potential when planning and designing forestry projects. Assumptions were properly documented and defendable; none were manipulated to accommodate any preconceived desired outcome. A reasonably wide range of possible and realistic alternatives were specified and systematically analyzed. The results, therefore, are as realistic and honest as possible.

The results also clearly demonstrate the importance of the difference between financial and economic analysis. From the financial perspective, none of the alternatives would attract any private investors. From the economics perspective, however, several feasible options were determined. If these kinds of analyses had not been carried out, decision makers would not know that there are feasible options, nor would they have the opportunity to measure the economic tradeoffs between the alternatives and thus be able to make better resource allocation decisions.

[1] It should be noted that the 30-percent wood savings assumed in this example is still very significant for individual households. And, if the improved cookstoves are well designed, inexpensive, and acceptable to the users, the adoption rate is likely to be rapid. The cost of the stoves will be only a small fraction of the cost to replace the amount of wood that would be saved through the use of the stoves. The purpose of the above example is only to demonstrate that improved cookstoves should not be regarded as the panacea to the desertification problem.

CHAPTER 7: SENSITIVITY ANALYSES

7.1 Introduction

In this chapter the analyses are taken a step further—to looking at how sensitive the results are to changes in the assumptions. A sensitivity analysis estimates the magnitude of change from the base-case result attributable to a given change in the assumption. It is the "what if" dimension of the analysis–what if prices and/or costs were not behaving as specified in the base case, how would the results differ?

The magnitude of change, per se, is not the critical factor or the reason why sensitivity analyses are done. What is critical is whether a small change in an assumption triggers a large change in the results, or entirely changes the preferred course of action identified in the base case. If this occurs, the sensitivity analysis has identified an assumption that should be closely evaluated and monitored by the decision makers.

Sensitivity analyses are done because individual perceptions of how key costs and benefits are likely to behave in the future are certainly less than perfect. The best one can do is to specify a base case as realistically as possible, based on available statistical information, on unpublished project experience, and on intuitive, pragmatic knowledge of what is likely to work and what is not. In addition to that, one can do little else but sensitivity analyses covering a range from pessimistic to optimistic assumptions to identify which would really make a difference if they were changed. Illustrations of both graphical and tabular sensitivity analyses based on varying one assumption at a time are given below.

7.2 Graphical

A major use of sensitivity analysis is to interpolate or extrapolate results associated with alternative assumptions, as demonstrated graphically in Figures 7.1 and 7.2. Figure 7.1 shows the sensitivity of the economic results (NPV or SEV) to changes in the base-case assumptions, and Figure 7.2 shows the sensitivity of the break-even quantities of wood to changes in the base-case assumptions. The former assumes that measurements on yield responses to management treatments are available, so that NPV's or SEV's can be calculated. The latter assumes that such information is not available; therefore, the quantities of wood required to break even on the investments are calculated instead.

In both cases, the horizontal axes are calibrated so that the three curves—the discount rate, stumpage prices and costs—coincide at the base-case assumptions. Any of the assumptions can be tested in a similar fashion. Note that the changes in assumptions affecting the values of revenue and cost items in Figure 7.1 have a linear impact on base-case results. Changes in the discount rate, however, have a non-linear impact because of the geometric relationship between the results (NPV, B/C, IRR or SEV) and the discount rate. In Figure 7.2 the discount rate and stumpage price curves are non-linear. The stumpage price curve approaches the axes asymptotically, but does not cross over. Note also that the slopes of all of the curves in Figure 7.2 are the reverse of the slopes in Figure 7.1. The reason is that, in Figure 7.1, the NPV will increase as the discount rate decreases–they are inversely related. For the break-even case in Figure 7.2, however, a lower discount rate means that the quantity of wood required to break even is also lower; they are directly related.

By means of interpolation (within the bounds of the sensitivity assumptions) and extrapolation (outside the bounds of the sensitivity assumptions), both of the graphs can be used to trace what happens to the base-case results as literally an infinite number of assumptions are changed. The extent to which the results change is determined by selecting the changed value for the assumption on one of the three horizontal axes, holding all other assumptions constant, and reading the corresponding result on the vertical axis.

Continuing now with the analyses carried out in the previous chapter, the optimal base-case economic analysis alternative (no. 2), which requires a production level of 3.0 m3/ha/year in order to break even on the investment, will be subjected to sensitivity analyses. The assumptions associated with this particular alternative are repeated in Table 7.1 below.

The sensitivity of the assumptions are shown graphically in Figure 7.3. The curves represent the parameters considered to be the most critical—discount rate, market prices, and costs. The cost curve is an aggregation of all the costs. As mentioned above, the sensitivity of any of the assumptions could be graphically shown in the same fashion as in the figure. For illustrative purposes, only the sensitivity curves of the aggregate costs, the discount rate, and market prices are displayed.

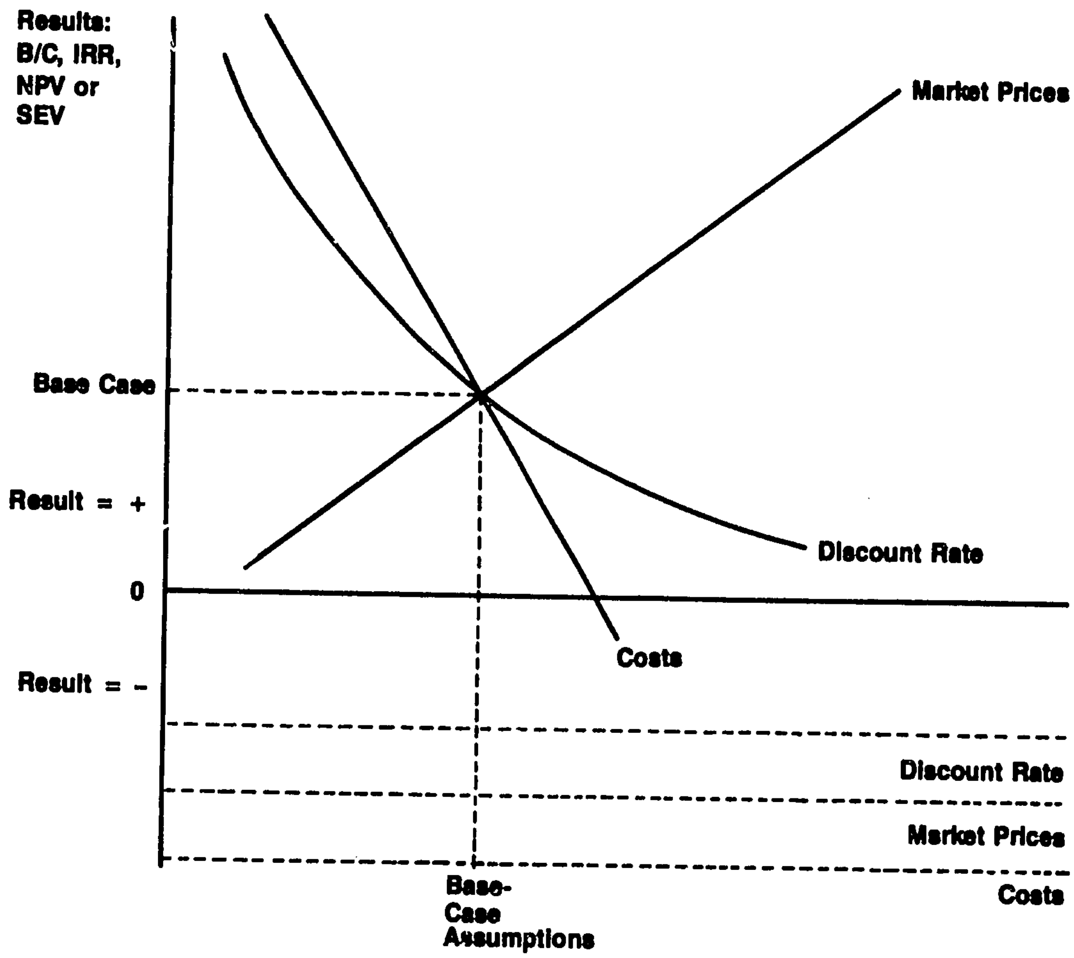


Figure 7.1. Graphical illustration of sensitivity analysis on economic results.

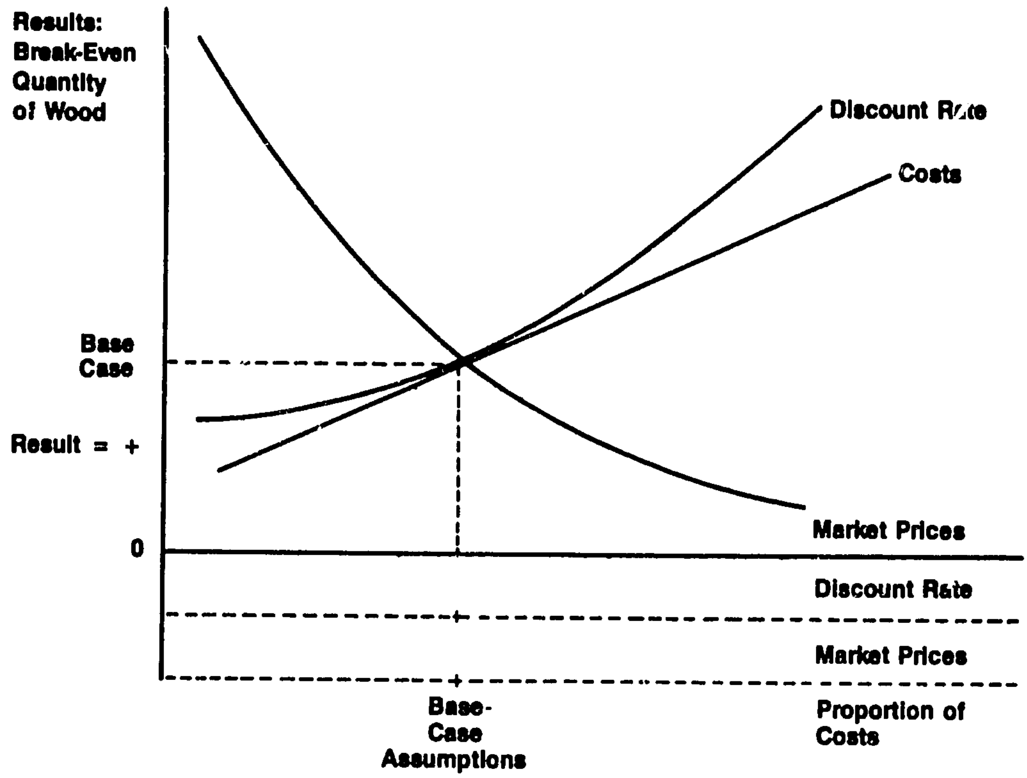


Figure 7.2. Graphical illustration of sensitivity analysis on break-even results.

Table 7.1. Assumptions Associated With Management Alternative 2, Economic Analysis.

What To Do	How	When	Total Cost Per Treatment F CFA/ha
Site Preparation	Manual	Year 0	18,750
Planting	4 x 4	Year 0	44,375[1]
Replanting 30 percent	Manual	Year 1	13,313[2]
Fire management	Local Participation	Annually	7,500
Coppice selection	Owner	Years 8, 15, 22	15,000
Weeding	Owner	Years 1 and 2, 8 and 9, 15 and 16, 22 and 23	9,375
Final Harvest	In-kind payments	Years 7, 14, 21, and 28	NA[3]
Other Assumptions:			
Discount rate		6.0 percent real	
Price appreciation rate		1.5 percent/year real	
Cost appreciation rate		1.2 percent/year real	
Rotation		7 years. + 3 coppice crops	
Market prices, F CFA/m³			
Fuelwood			19,262
1 Pole			18,000
2 Pole			14,000
Administrative costs, F CFA/ha/yr			10,000

[1] Labor plus the cost of seedlings (35 F CFA each).
[2] 30 percent of planting cost.
[3] NA = Not Applicable.

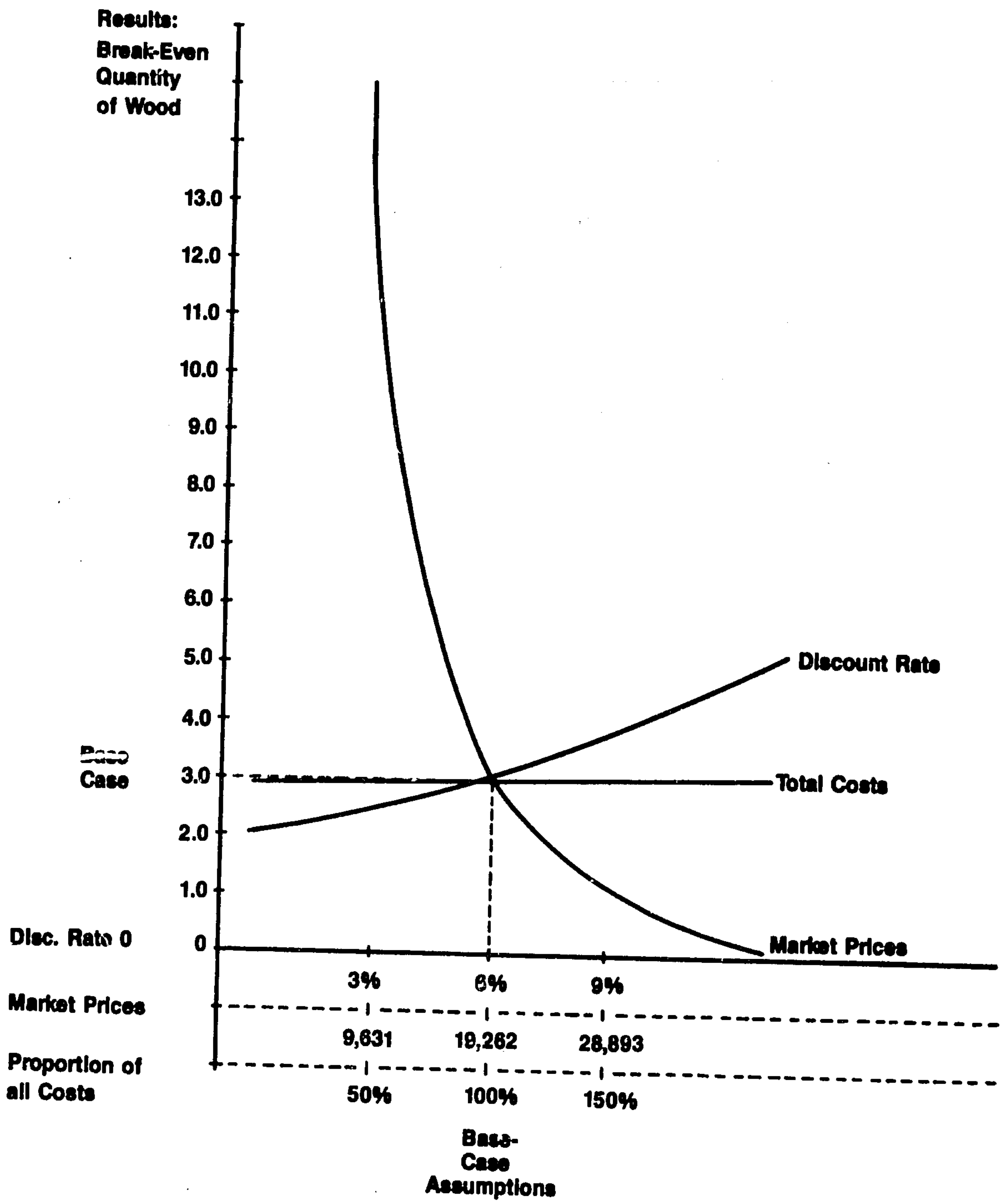


Figure 7.3. Sensitivity analysis of costs, prices, and discount rate: Economic analysis alternative 2—break-even quantity of wood.

Judging from the slopes of the curves, it appears that the results are most sensitive to changes in the market price assumptions, particularly on the downward side. If the price of fuelwood falls much below the shadow base-case price of 19,262 F CFA/m³, the required wood production to break even on the investment increases drastically. The results appear to be least sensitive to changes in total costs, as evidenced by the flat slope of the curve. This is largely attributable to the low capital intensity and relatively low-cost input of the alternative. The results are somewhat sensitive to changes in the discount rate, as evidenced by the moderately steep curve. The discount rate, however, tends to play a much more important role when the project is capital intensive with a heavy initial investment burden, which is not at all the case with management alternative 2.

To trace how the results change as the assumptions are changed, pick the value on the scales at the bottom of the figure, connect it with the corresponding curve, and read the result on the vertical axis.

7.3 Tabular

To best display the sensitivity of results as a result of changing assumptions, simply bracket the base-case assumptions on either side by a desired range reflecting both pessimistic and optimistic scenarios, as illustrated in Table 7.2. The table brackets the base-case assumptions on either side by a maximum of plus and minus 50 percent.

As in the graphical illustration, the market prices are by far the most sensitive to changes. A 50-percent reduction in the market price of the fuelwood means that more than four times the amount of wood would have to be produced in order to break even on the investment, holding all of the other assumptions constant at the base-case level. Approximately a 20-percent reduction in the market price for fuelwood can be tolerated while still remaining within the range of feasibility. This is based on the assumed yield response to the silvicultural treatments for alternative 2 (4.0 m³/ha/year as given in Table 5.5 in the previous chapter). The alternative will also tolerate more than 50-percent increases in both total costs and the discount rate before moving into the range of non-feasibility. The numbers within the bold lines of Table 7.2 represent the range of feasibility given the sensitivity assumptions tested.

Table 7.2. Sensitivity Analysis: Costs and Benefits, Economic Analysis Management Alternative 2.

Costs and Benefits	m³/ha/yr Required to Break Even						
	-50%	-25%	-10%	Base Case	+10%	+25%	+50%
Total Costs	2.9	2.9	2.9	3.0	3.1	3.1	3.1
Discount Rate	2.5	2.8	2.9	3.0	3.2	3.4	3.7
Market Prices	13.6	5.0	3.6	3.0	2.6	2.2	1.2

CHAPTER 8: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary

This manual has presented a format that resource planners in developing countries can use as a pattern for analyzing proposed on-the-ground investments in forestry projects. Chapter 1 states the objectives as follows:

1. To stimulate the interest in and appreciation for proper use of economic and financial analyses in planning future forestry interventions in Sahelian countries.
2. To identify a standard analytical procedure that resource decision makers can use to assess the feasibility of forestry interventions in Sahelian countries.

These objectives have been addressed in Chapters 1-7 of the manual. Chapter 1 discussed the problems associated with the lack of proper use of forest economics in the appraisal of ongoing and proposed forestry investments and outlined the basic methodological framework for economic and financial analysis. Chapter 2 addressed the major issues associated with forestry project planning in Sahelian countries and how economics could and should play a role in resolving the problems. The most common project evaluation techniques, including B/C, NPV, IRR, and the special forestry application of the NPV approach—SEV—were discussed in Chapter 3. Chapter 4 discussed the importance of considering a wider range of silvicultural management alternatives, not only those based on biological considerations, but also those based on economic considerations. Chapter 5 elaborated on specifying the assumptions in a base case. The assumptions should not be picked out of thin air, but be solidly founded on what is known, either in published statistics or through past, unpublished experience with similar projects, and through intuitive knowledge of what is likely to work and what is not. Chapter 6 described how the economic and financial analyses were carried out and presented the analytical results. Chapter 7 presented the sensitivity analyses—the process of testing how sensitive the results are to changes in the assumptions.

The manual itself may satisfy at least the second objective. How well the first objective is satisfied remains to be seen. That depends on how the donors and host countries act on the suggestions and recommendations made. If this manual has succeeded in raising the awareness of the importance of the proper use of economics in the project planning and implementation phases, it would not be unreasonable to expect to see more trained forest economists in Sahelian countries and much improved project designs.

8.2 Conclusions

The major lesson learned from observing forestry projects as they are being planned, implemented and subsequently evaluated in Sahelian countries is that the economics dimension has not been adequately considered. The major problems have been lack of adequate data and lack of trained forest economists. The donors, too, have not used forest economics at the project planning stage nearly as much they could have. The major conclusions drawn are as follows:

1. The treatment of economics in project planning and evaluation in Sahelian countries has been less than adequate and often erroneous. If this continues, resources will most certainly continue to be misallocated. This manual offers a standardized approach to economic and financial analyses of forestry projects to be applied during the project planning phase. If followed, this standardized approach will provide the mechanism by which more and better information will be made available to project planners and decision makers. The availability of more and improved information will allow decision makers to determine the economic tradeoffs between management alternatives.
2. Economic and financial analyses can be carried out even if data on biological yield responses to silvicultural treatments are not available. It would be ideal to have the growth and yield responses to the treatments proposed in the alternatives so that benefits can be estimated. More often than not, however, this information is not available. This manual has shown that economic and financial analyses can still be carried out using cost data only. There are data available on the costs associated with the management alternatives to be tested. Therefore, break-even analyses on how much wood would have to be grown and sold in order to break even on an investment, given a series of assumptions, can be carried out. The foresters who are intimately familiar with the site would be able to say whether the break-even quantities fall within or outside what they perceive to be the productive capacity of the site. Alternatively, the manual also provides a methodology for determining how high the market

price of wood has to be given the productive capacity of the site in order to break even on the investments.

3. Implementation of forestry projects based only on biological criteria is costly. Forestry projects designed to maximize the production of wood fiber—plantations of "fast-growing" exotic species, e.g., eucalyptus, neem, gmelina, etc.—have generally failed both biologically and economically. Had well-researched and well-documented figures been used in the economic and financial analyses beforehand (if indeed economic and financial analyses were carried out at all), there would in all probability not have been nearly as many plantation projects in Sahelian countries. Instead, the available funds would perhaps have been spent in a different mix of forestry projects—perhaps for agroforestry, natural forest management, or local participation projects, or for something of a different nature than pure plantation forestry.
4. Intensive plantation forest management, as has so often been recommended and implemented in Sahelian countries, is not always desirable. The tendency on the part of foresters and/or forest planners is to make intensive forest management synonymous with good forestry. More often than not, however, this notion detracts from economic and financial productivity. If intensive forest management to maximize growth and yield is practiced, substantial costs will have to be incurred in the beginning and during the rotation, while the investor waits for several years for the returns. True, there will probably be more wood to harvest after a series of intensive silvicultural interventions, but the costs may have far outstripped the gains in benefits over the rotation period in a present value sense. Again, if more thorough financial and economic analyses were carried out, decision makers would be able to trace the economic consequences of the course of action they wish to implement and also be in a much better and more informed position to make mid-course project corrections as costs and benefits change over time.
5. To decide for or against a forestry project only on the basis of economics is not recommended. There are other objectives to consider—objectives satisfied by benefits which cannot be easily quantified and included in the analytical "spreadsheets." Economics should play an important role in the decision-making process, but it should not be the sole criterion. A good rule of thumb is that although planners cannot expect to attain economic feasibility in most cases, they should always try to approach it.

8.3 Recommendations

1. Institute a standardized analytical approach concerning the use of forest economics in project planning and evaluation between donors and host countries, between projects, and between countries. Such a standardized approach is suggested in this manual.
2. Institute a program of forest economics training, probably financed by the donor community, either by way of short-to-medium-length seminars/courses or as an integral part of the curriculum for longer-term degree programs.

   A long-term objective is to help provide an ability on the part of resource decision makers in developing countries to carry out economic and financial analyses of forestry projects. To accomplish this, it is anticipated that key staff foresters will have to undergo short, intensive training courses to bring them up to at least a workable knowledge of how to carry out proper economic and financial analyses. These training courses should emphasize standardizing the analytical techniques, identifying key variables to consider, and training in how to carry out the analyses.
3. Substantially improve collection of data on growth and yields in response to management treatments. Projects that are underway should be required to document carefully which management activities are implemented in the field and measure growth-and-yield responses. If this information is collected over a long time period, it will be possible to eventually develop stand prognosis models.
4. Conduct market study during the early phase of project planning. Establish a range of forest and forest-related products that would market easily locally or regionally, or that could be exported. Why? Because it would make little sense to grow gmelina if there were no market for gmelina, even if the site is best adapted for growing gmelina. The site will also support other perhaps less adaptable species that would sell better. A market study will give a better indication of the end products for which the resources should be managed. If gmelina is grown despite the lack of a market, only the deforestation problem may have been helped somewhat. But to grow the products that are more marketable also generates more revenues for the forestry sector.

   Fuelwood is not the only forest product of consequence. The perceived "fuelwood crisis" has so taken over center stage that the benefits of other forest and forest-related products have been given a much less important role. Few economic and financial analyses of forestry projects in the Sahel have taken into account the fact that resource owners will not harvest eucalyptus trees and sell them as fuelwood if the market is stronger for poles. What the analysts have called benefits in the spreadsheets is the volume of wood multiplied by the fuelwood price at harvest time. Economic and financial analyses should recognize that a stand of trees moves into different markets as the average tree diameter increases.

5. Having established the range of marketable products, proceed with the economic and financial analyses of several management alternatives, taking into account not only the economic feasibility objectives, but also other land-use objectives. Measure the economic tradeoffs associated with the alternatives. This step requires collaboration among the economists and the foresters and whichever other professional disciplines (wildlife, agriculture, etc.) are involved. Together they should decide which alternatives to test and why.

6. The outcome of the analyses should be the project planning document, with economics involved in every step. Economics should help mold the decisions rather than being added as an afterthought.

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ANNEX 1: Glossary

Asset: Anything of value (or useful) which is owned by people, i.e., a factor of production.

Capital: The tools of production, or the real value of total assets.

Cash flow: The net profits of the enterprise in a period of time (difference between total revenues and total costs).

Compounding: The process of converting future income flows to a measure of wealth at some future time.

Discounting: The process of converting future income flows to a measure of wealth at the present (or earlier period).

Economic analysis: Public projects. Measures economic attractiveness of a project to society as a whole, regardless of who receives the benefits or pays the costs. It is neutral to income distribution and capital ownership. Taxes, subsidies and debt servicing are project costs and benefits but are not treated as cash flow items since they are transfer payments within the economy.

F CFA: Francs Communaute Financière Africaine.

Financial analysis: Private projects. Measures economic attractiveness of a project to investors. It takes income distribution and capital ownership into account. Taxes, subsidies and debt servicing are real project costs and benefits to the investors and are treated as cash flow items.

Income: Payments received by a factor of production.

Inflation: An upward change in the value of the medium of exchange (money).

Interest: Payment for the use of money capital over time.

Investment: The acquisition of the means of production.

Opportunity cost: Benefits foregone of choosing one alternative over another. If alternative A is chosen over B, the benefits of B are foregone.

Rate of interest: The percent of premium paid for use of money capital at one date in terms of money at another.

Stumpage price: The price of the wood on the stump, before it is cut.

ANNEX 2: Summary of Investment Assumptions

Table A.1. Financial Analysis Assumptions.

INPUT ASSUMPTIONS THAT CHANGE WITH ALTERNATIVES

Inputs/Alt	1	2	3	4	5	6	7	8	9	10
Stumpage prices										
Fuelwood	487	4846	8389	5323	9685	7618	5447	9798	8389	9688
1 pole	975	9692	16779	10646	19370	15236	10895	19596	16779	19376
2 pole	758	7538	13050	8280	15065	11850	8473	15241	13050	15070
Plant density	NA	4x4	4x4	5x5	5x5	4x4	4x4	4x4	5x5	5x5
Planting Labor										
Skilled PD/ha	NA	2	2	2	2	2	2	2	2	2
Unskilled PD/ha	NA	25	25	20	20	25	25	25	20	20
Replant (yr 1)	NA	30%		30%		30%	30%			30%
Site prep labor										
Skilled PD/ha	NA	2	2	2	2	1	2	2	2	1
Unskilled PD/ha	NA	20	20	20	20	5	20	20	20	5
Weeding labor										
Skilled PD/ha	NA	1	1	1	1	1	1	1	1	1
Unskilled PD/ha	NA	10	10	10	10	10	10	10	10	10
Fire mgt. labor										
Skilled PD/ha	NA	4	3	4	3	3	4	3	3	3
Unskilled PD/ha	NA	0	30	0	30	30	0	30	30	30
Coppice selection labor										
Skilled PD/ha	NA	2	2	2	2	2	2	2	2	2
Unskilled PD/ha	NA	15	15	15	15	15	15	15	15	15
Heavy equipment										
Bulldozer	NA	0	0	0	0	60000	0	0	0	60000
Grader	NA	0	0	0	0	45000	0	0	0	45000
Subsoiler	NA	0	0	0	0	40000	0	0	0	45000

INPUT ASSUMPTIONS THAT DO NOT CHANGE WITH ALTERNATIVES

Discount rate	8.0 % real
Price appreciation rate	1.5 % real per year
Cost appreciation rate	1.2 % real per year
Rotation (yrs)	7 years from planting to first harvest
Coppice crops	3 coppice crops, 7 years apart for alternative 2-10. One harvest only after 20 years for alternative 1
Total time horizon	28 yrs (1st rotation + 7 yrs x 3 coppice crops)
Administrative costs	10,000 F CFA/ha/yr, alternative 2-10, 800 F CFA/ha/yr alternative 1
Labor F CFA/day:	
Supervisory	2,500 F CFA/person day (PD)
Unskilled	1,000 F CFA/person day (PD)
Seedlings costs	20 F CFA each
Year of occurrence	
Site preparation	Year 0
Planting	Year 0
Weeding	Years 1 and 2, 8 and 9, 15 and 16, 22 and 23
Fire management	Every year
Coppice selection	Years 8, 15, 22

Table A.2. Economic Analysis Assumptions.

INPUT ASSUMPTIONS THAT CHANGE WITH ALTERNATIVES

Inputs/Alt	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Stumpage prices										
Fuelwood	624	4736	7892	5169	9082	7268	5322	9220	11080	9214
1 pole	583	4428	7379	4833	4849	6795	4976	8621	10360	8616
2 pole	423	3210	5350	3504	3515	4927	3608	6250	7511	6246
Plant density	NA	4x4	4x4	5x5	5x5	4x4	4x4	4x4	5x5	5x5
Planting Labor										
Skilled PD/ha	NA	2	2	2	2	2	2	2	2	2
Unskilled PD/ha	NA	25	25	20	20	25	25	25	20	20
Replant (yr 1)	NA	30%		30%		30%	30%			30%
Site prep. labor										
Skilled PD/ha	NA	2	2	2	2	1	2	2	2	1
Unskilled PD/ha	NA	20	20	20	20	5	20	20	20	5
Weeding labor										
Skilled PD/ha	NA	1	1	1	1	1	1	1	1	1
Unskilled PD/ha	NA	10	10	10	10	10	10	10	10	10
Fire mgt. labor										
Skilled PD/ha	NA	4	3	4	3	3	4	3	3	3
Unskilled PD/ha	NA	0	30	0	30	30	0	30	30	30
Coppice selection labor										
Skilled PD/ha	NA	2	2	2	2	2	2	2	2	2
Unskilled PD/ha	NA	15	15	15	15	15	15	15	15	15
Heavy equipment										
Bulldozer	NA	0	0	0	0	60000	0	0	0	60000
Grader	NA	0	0	0	0	45000	0	0	0	45000
Subsoiler	NA	0	0	0	0	40000	0	0	0	45000

INPUT ASSUMPTIONS THAT DO NOT CHANGE WITH ALTERNATIVES

Discount rate	6.0 % real
Appreciation rates:	
Stumpage prices	1.5 % real per year
All costs	1.2 % real per year
Rotation (yrs)	7 years from planting to first harvest
Coppice crops	3 coppice crops, 7 years apart for alternative 2-10. One harvest only after 20 years for alternative 1
Total time horizon	28 yrs (1st rotation + 7 yrs x 3 coppice crops)
Administrative costs	10,000 F CFA/ha/yr, alternative 2-10, 800 F CFA/ha/yr alternative 1
Labor F CFA/day:	
Supervisory	1,875 F CFA/person day (PD)
Unskilled	750 F CFA/person day (PD)
Seedlings costs	35 F CFA each
Year of occurence	
Site preparation	Year 0
Planting	Year 0
Weeding	Years 1 and 2, 8 and 9, 15 and 16, 22 and 23
Fire management	Every year
Coppice selection	Years 8, 15, 22

ANNEX 3: Forest Economics Computer Models

Energy/Development International, Inc. (E/DI), through the EIA/Abidjan project staff, has developed several useful and pragmatic computer models, i.e., analytical tools, that greatly facilitate the economic and financial analyses of forestry projects. They are all developed on LOTUS 1-2-3 spreadsheets, and they include models that describe many intricate and complex relationships among variables, as well as simple one-screen models designed to carry out only specific and well-defined tasks. Although the models are complete and functioning, they are being revised and improved and tailor-made to specific situations on a continual basis. The models are briefly described below.

FRAP: Forest Resources Assessment and Planning

FRAP is a macro-tool designed to help analysts and policy makers:

- Assess the demand and supply for wood, principally fuelwood.
- Develop projects and investment programs to decrease wood demand, to increase wood supply, or to substitute alternative fuels for wood.
- Design and evaluate wood-related surveys and studies.

FRAP allows the analyst to specify, in detail, all major factors that determine the demand for and supply of wood in up to 20 separate regions for a 20-year period. FRAP calculates the wood demand and supply that these factors imply. The analyst can then design up to nine separate investment programs for each region and observe the individual or aggregate effects of these programs on wood demand and supply.

The results of wood demand-and-supply projections and investment programs can be viewed either graphically or in tabular form. Graphs can be printed using the normal conventions of Release 2 of LOTUS 1-2-3, while FRAP data input and output tables can be printed using commands embedded in the FRAP model.

BREAKEVEN

There are several versions of the Breakeven model. Some fit the capabilities of a computer with only 256K of memory capacity and using Release 1 of LOTUS 1-2-3. The new version of the model is much more versatile and thus requires a computer with 640K of memory and the Release 2 version of LOTUS.

The Breakeven model was developed to allow analysts to perform economic and financial analyses of forestry projects when there is no reliable information available on the growth-and-yield response to management treatments. It determines how much wood would have to be produced to break even on the investments, given a certain set of cost and price assumptions. If the quantity of wood required exceeds the perceived productive capacity of the site, one can conclude that the management treatment considered and analyzed is not economically and/or financially feasible.

The new version of the model allows not only for the determination of the break-even quantity of wood, but also for the break-even market price and for the break-even amount of wood the owner can afford to pay in-kind to local participants in lieu of salaries for harvesting work. The model determines how high the market price of wood would have to be in order to break even on the investments given a set of cost and price assumptions, given the productive capacity of the site. Further, it derives (rather than inputs) the stumpage prices for both the buyer (the difference between final market price and the harvesting, handling and transport costs incurred between the stump and the final market) and the seller (total production costs) and compares the two. If the buyer stumpage price (maximum he would be willing to pay for the wood) is equal to or less than the seller stumpage price (the minimum he would be able to accept for the wood in order to recover his costs), there is a market where the buyer and seller can trade. The local participation break-even points describe how much wood value the owner can afford to give up to be indifferent between hiring and paying cash to workers for harvesting and handling the wood, or hiring local villagers and paying them in-kind for the work. If the owner can negotiate to give up less than the break-even quantity, he would be better off.

RECURRENT COSTS

The recurrent cost model is designed to determine the recurrent cost implications of a forestry project. It takes into account the recurrent cost implications of all investments made with project funds (installed capacity), such as infrastructure (buildings, vehicles and replacement vehicles, equipment), training, personnel, and administrative and operating costs, for a period of up to 20 years after the project has ended. The recurrent cost implications are shown both as aggregate discounted sums and annually by each cost category. The model is uesigned for use during the planning phase of a project where the recurrent cost implications of each management alternative could be determined.

IMPROVED WOOD STOVES

This is a very simple one-screen model that uses the manufacturing costs and retail prices of improved wood stoves, relative stove efficiency, wood consumption per capita, time spent to collect wood, and wood prices to determine:

- Wood savings per year.
- How many months it will take to pay off the investment in the improved stove with the wood savings generated.
- How much time will be saved in wood collection.

CHARCOAL

The charcoal model is menu driven. It determines charcoal production efficiency and profitability given a set of assumptions on wood inputs, wood and charcoal transportation requirements, labor requirements, capital investment requirements, operating costs, and many other variables. The model was originally developed to analyze the production efficiency and economics of the Casamance kiln, but has since been expanded to allow the analyses of capital intensive kilns as well.

SHADOW PRICING

The shadow-pricing model is a one-screen model designed to determine the shadow price for fuelwood based on its energy content vis-a-vis other imported energy sources. It takes into account the energy values of the wood and the imported energy product (kerosene or butane, for example), the impact of a pegged foreign exchange rate, and the relative efficiencies of the cookstoves associated with each of the energy sources to determine the value of the wood, if grown for the purpose of replacing imported energy products.

ALTERNATIVE ENERGY SOURCES

This one-screen model compares the attractiveness to the final consumer of several different energy sources. It takes into account the energy values of each source, the efficiency of the cookstoves required for each source, the investments required to upgrade to different levels of cooking efficiency, and the final market prices of each energy product to determine which of the energy sources is economically most attractive to the final consumer.

APPRECIATION RATES

In economic and financial analyses of forestry projects, several price and cost assumptions have to be specified. To do so, the analyst usually researches historical price and cost trends to determine if there have been any measurable real (as opposed to nominal) changes over time, and if there is cause to project these real changes into the future. This one-screen model facilitates determining real price and cost appreciation rates over time, taking into account information on consumer and wholesale cost and price indices, etc., or the kinds of statistics that tend to be readily available in most developing countries.

DISCOUNT RATE

Similar to the Appreciation Rate model, the one-screen Discount Rate model facilitates the determination of a real (as opposed to nominal) discount rate. It takes into account the trends over time in major bank borrowing and savings interest rates.