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FINAL REPORT

THE ECONOMICS OF VILLAGE-LEVEL FORESTRY: A METHODOLOGICAL FRAMEWORK

by

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with

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prepared for

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Table of Contents

Page

PART ONE: The Economics of Village Forestry Programs 1

The Problem..... 1
The Need for Action..... 3
The Economics Gap..... 5
The Incentives Gap..... 6
The Economics of VLFPs..... 9

PART TWO: Methodological Framework 10

Approach to Village Level Economic Evaluation..... 10
Levels of Cost/Benefit Analysis..... 14

PART THREE: Valuation of VLFP Inputs and Outputs 23

The Physical Input-Output Table..... 23
Valuation of Inputs and Outputs (Investor Level)..... 26
Valuation of Inputs and Outputs (Social Level)..... 41
Summary of Information Needs..... 45

PART FOUR: Case Studies 48

Community Woodlots in Mopti Region (Mali)..... 48
Tree Planting on Individual Lands (Mopti Region, Mali)..... 59
Conclusions..... 69

BIBLIOGRAPHY

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INTRODUCTORY NOTE

This paper is intended to provide a framework for field analysis of village level forestry programs, and to define the key policy issues for such analysis. It is directed at non-economists as well as economists, for use within the limitations of field data availability. A number of the estimation techniques suggested could be treated more elegantly in a setting where more data was available. However, the objective of this paper is to serve as a usable working guide, and it consciously sacrifices some theoretical precision in order to satisfy this objective.

One important area of forestry benefits is not quantifiable within the scope of a village level project analysis: the external (macroeconomic) benefits of environmental stabilization. Such benefits have, accordingly, not been estimated here. However, the true value of all forestry planning and intervention is strongly linked to the value of external benefits. Many - though not all - of such benefits can be realistically estimated if sufficient time and analytic effort is devoted to the task. To do so should be a high priority of forestry policy analysis.

PART ONE

ECONOMICS AND VILLAGE FORESTRY PROGRAMS

The Problem

Deforestation in rural areas of the Third World is a problem which now threatens the already precarious subsistence of a large proportion of rural populations. This "other energy crisis"[1] antecedes the petroleum-based energy crisis and is far more menacing in its implications. Trees are multipurpose commodities, the progressive loss of which is undercutting the productive base upon which rural economic activities depend.

> Trees are useful to man in two distinct ways: as producers of a wide variety of goods, commonly called "forest products"; and as custodians of favorable environmental conditions.... Both are indisputably essential to the well-being, indeed to the survival, of man.[2]

In the majority of developing countries 70-90% of all domestic energy use is of wood. Even in the large urban centers wood and charcoal often constitute over fifty percent of household energy consumption. Increasing population pressure on fixed land resources, exacerbated by inefficient land-use practices (slash and burn, shifting cultivation, etc.), have resulted in an imbalance in wood demand and accessible wood supply. Collecting firewood is rapidly becoming the most onerous task faced by rural families. In Molepolole - a village of about 10,000 inhabitants in Botswana - it is estimated that the average villager must go 7.5 kilometers from home (on foot) to find adequate firewood for cooking.[3] In Niger, recent studies estimate travel time for wood collection at four hours per day.

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1 The term is Eric Eckholm's.

2 Gunnar Poulsen, "The Role of the Tree in Tropical Africa." P. 5 in Man and Tree in Tropical Africa, IDRC, 1978.

3 From author's personal field research.

A U.S. AID analysis of energy use in the Mopti region of Mali revealed the startling fact that women commonly travel over 30 kilometers to collect firewood: "In Gagna, Syn and Goundaka women pointed out that the physical trauma resulting from walking 15-17 km one way often renders them incapable of lactating or performing any strenuous household tasks such as drawing water or pounding millet for two or three days."[4]

In urban areas, where integration into cash economies makes firewood a commercially exchanged good, wood scarcity has been reflected by higher and higher prices. Over the last decade, prices for firewood have risen faster than for petroleum products.[5] In Old Naledi (a poor suburb of Gaberone, Botswana), from four to six weeks worth of firewood for a family costs about $27 (US). The average household in Bamako, Mali now spends over thirty percent of its income on energy, as against only seven percent in 1970.[6]

The acute hardship created by wood shortage is only the most obvious effect of deforestation. "The adverse consequences of land mismanagement manifest [themselves] in numerous ways: flash floods, landslides, soil erosion, silting of canals and reservoirs, and various forms of terrestrial degradation."[7]

Kitui District in Kenya is experiencing widespread soil erosion due to deforestation and improper land use. Recent reports indicate that agricultural production is declining at a rate of three percent per year due to soil erosion alone.[8]

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4 Theresa Ware. "Social Soundness Analysis for Mali Village Reforestation Program," U.S. AID, 1980.

5 U.S. AID, The Socio-economic Context of Community Fuelwood Projects, 1980.

6 Ousmane Sankare. Analyse de la Consommation des Besoins en Combustibles Ligneux du District de Bamako, Katibougou, 1979.

7 Pant, Madan Mohan. "Economic and Social Costs and Benefits of Forestry in Tropical Regions," Prepared for the Eleventh Commonwealth Forestry Conference, Trinidad & Tobago, September, 1980.

8 Poulsen, Bollinger and Shaikh. "Kitui (Kenya) Tree Planting Program for Ecosystem Stabilization," U.S. AID, 1980.

Throughout the Sahelian belt of West Africa, severe drought in the early 1970s, coupled with ecologically unsound herding and agricultural practices, bush fires and uncontrolled woodcutting have intensified a process which has been termed "desertification."[9] It is a process whereby marginal lands at the edges of the Sahara lose their vegetable cover - setting in motion a sequence of reduction in soil nutrients, loss of topsoil through runoff from rains and increased susceptibility to wind erosion.

The Need for Action

The idea that protection of the productive capacity of the land is among the highest of development priorities is gaining widespread acceptance in developing nations and among donor agencies. CILSS,[10] the organization of Sahelian countries attempting to combat deforestation in that area, has formulated, in coordination with the United Nations Sudano - Sahelian Office (UNSO), a long term anti-desertification plan for the Sahel. It calls for the planting of 150,000 to 300,000 hectares of trees per year - a 25- to 50-fold increase over present levels - over the next twenty years.[11]

In India, the World Bank is undertaking a major watershed development project in the lower foothills of the Himalayas to reverse environmental degradation and to protect soil fertility as well as to reduce flooding in the lower catchment areas: "If the Himalayan ecosystem is not repaired in time by extensive afforestation, it may jeopardize the entire system of the Indo-Gangetic agriculture. The fertile Indo-Gangetic belt is capable of feeding a billion people during the ensuing 25 years, but its fertility is inextricably dependent upon a balanced Himalayan eco-system."[12]

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9 UNSO, Analyse du Problème de la Desertification et Examens des Activités en Cours et Prevues pour la Mise en Oeuvre du Plan d'Action pour Combattre la Desertification en Republique du Mali,"1979, pp. 9-13.

10 Comite Permanent Interetats de Lutte contre la Secheresse dans le Sahel (CILSS), Club des Amis du Sahel, Ouagadougou, May 10, 1977.

11 Robert Winterbottom. "Talking Paper on Environmental Protection and Natural Resources Management Issues," FAO/AID, 1980.

12 Swammathan (1979) as referenced in Pant, op. cit., p. 5.

Several other donor agencies have initiated large-scale programs either for reforestation or for the dissemination of renewable energy technologies which reduce the burden on firewood resources. These include U.S. AID, the UNDP and FAO, the Beijer Institute of Sweden, German and Dutch external aid agencies, semi-public, private and charitable organizations. The United Nations and the CEAO[13] are now contemplating a jointly-sponsored, large-scale, seven-year effort to promote the production and dissemination of renewable energy technologies throughout CEAO member states.

National governments are equally aware of the problem. The Government of Sri Lanka has committed itself to a fuelwood program which is based on conservation, afforestation in catchment areas and for fuelwood, encouragement of private woodlots (including a mass-media campaign, a tree-planting campaign, and mobilization through temples, schools and other voluntary organizations), and technology development.[14]

Many governments in developing nations are in the process of redefining the traditional roles of their forestry services. In Mali, the Service des Eaux et Forets, which has historically played only a negative role in trying to discourage unauthorized tree cutting, now has an entirely new mandate: to become a cooperative extension service which works with villagers to enhance the preservation and management of forest resources.[15, 16]

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13 Communauté Economique de l'Afrique de l'Ouest.

14 Project Design and Recommendations for Watershed Reforestation and Fuelwood Development in Sri Lanka, ISTI, July 1979.

15 Private communication with M. Abou Lamine Berthè, Service des Eaux et Forets, Bamako, Nov. 1980.

16 For an insightful account of the ineffectiveness of forestry service repression of unauthorized tree cutting, see Poulsen, G. "Thoughts under a Prosopis Tree," Sylva Africana, 5, July 1979.

The search for new strategies has only just gotten under way. It is still tentative, and it has yet to uncover options to sustain great optimism, even on paper. Certain guiding principles have emerged, however:

a. The need to respect, protect, and carefully manage natural resources - especially those which form the basis for agricultural and rural productivity;

b. The need to restore the self-sustaining nature of rural production systems, by withdrawing from excessive dependence upon imported inputs - the provision of which the central governments are no longer able to ensure;

c. The need to foster village participation, both at the community and individual levels, to assist in an effort that no other level of organization has proved capable of doing.

The Economics Gap

We are now witnessing a surge of small-scale, decentralized village energy projects aimed at either increasing energy supply, protecting the environment, or reducing demand (or some combination thereof). To date, economic analysis has neither provided the initiative for this process, nor has it it made particularly useful contributions to the evolution of rural energy strategies. These two facts, the causes of which are discussed below, have the following implications:

- Many of the newly conceived rural energy projects have yet to prove their economic merit, although they are already under way; in several cases, projects which are patently uneconomic have reached advanced stages of elaboration for lack of adequate economic scrutiny.

- Economic/energy planning, which has proceeded apace at the national planning level, has failed to fully integrate the potential of rural energy projects, the budgetary burdens they imply and their role in an integrated national energy planning framework.

- Very little is known about the economics of fuel substitution between traditional and fossil fuels (wood, charcoal, dung, kerosene), or about the interactions between the urban and rural energy crises. What information there is (and certainly some very useful work has been done) tends to be anecdotal in

nature. There is a paucity of analytic tools with which to encompass the entire spectrum of national energy uses.

To date, the lead in small-scale rural energy projects has been taken by sociologists, anthropologists, foresters, technology-specialists and rural development specialists. Benefit/cost analysis, while present, has often served as a kind of financial "signing-off." There has been little attempt to enunciate the economic criteria around which project formulation and development should occur. The role of economics has tended to be peripheral and after-the-fact.

The Incentives Gap

It naturally follows that we should ask why this "economics gap" exists. While a number of issues undoubtedly play a part, one issue merits special consideration: the traditional tools of cost/benefit analysis are not well suited to the rural, small scale project design exercises upon which rural energy policy is based. This should not be interpreted as an argument against use of such techniques - indeed, their systematic application has been sorely lacking in many rural energy projects - but rather as an attempt to widen the scope of economic analysis to include a broader range of the factors which affect economic decision-making in the rural project setting. Also, it must be recognized that community forestry projects are a relatively new phenomenon, and increasingly refined estimation techniques for costs and benefits are only now being formulated. Several useful approaches, both at the macro (environmental/economic benefits) and the micro (valuation of time, production alternatives, etc.) levels have already been defined.[17]

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17 For example, the World Bank developed means of measuring agricultural losses from flooding caused by deforestation-induced rainwater/tropical runoff into the Ganges River in India. Other innovative approaches can be found in AID's Project Paper for Watershed Development in Sri Lanka (1980) and in recent work by Weber (1979) (see Bibliography).

Nevertheless, there remain several important differences between rural projects and commercial projects to which traditional cost/benefit tools of analysis are applied. Let us consider a village-level forestry program (VLFP) in comparison with, say, an industrial project investment (IPI) in textiles:

1. In the VLFP, the initiative for the program comes primarily from planners, not from the villagers themselves. In an IPI, on the other hand, it is the potential investor who initiates the cost/benefit analysis and who is, therefore, already motivated to invest should the project be profitable.

2. In a VLFP, the planning objective is to bring about successful afforestation in a large number of villages throughout the country. The economic question is, therefore, "what characteristics of a given project design will induce and sustain village participation?"

3. In most IPIs, the principal resource an investor commits to a project is money capital. In village-level investments, to a much larger extent, village land and labor are at issue. Money capital is fungible. It can be put to a number of alternative uses. In a commercial economy, the revenue it generates can confer social or economic status quite independently of the uses to which it is put. Although a villager's land and labor are fungible also, they are much more intimately tied to his/her village social environment.

4. Items 1 to 3 above imply that a well-designed VLFP should be one which maximizes the likelihood that villagers will participate in it. A financial analysis (how profitable is it to the investor?) and an economic analysis (how profitable is it to society?) provide only partial insights on the likelihood of village participation. The program design question must also include an understanding of the non-financial motivation of villagers, the socio-economic and institutional mechanisms which affect particpation, and the costs of project

replication. In short, program design must orient itself towards leading to the afforestation of a large number of villages, not just towards the costs and benefits of a specific village forestry project. The need to design socially and economically attractive projects is further accentuated by the need to bring about relatively short-term reversal of environmental degradation in many parts of the world. In much of Africa, for example, forestalling major economic and energy disruptions involves designing and implementing successful environmental stabilization programs within the decade.

5. VLFPs are the planner's alternative to the energy/environmental crisis. From a given villager's perspective, however, this solution may have to compete with other options which are more advantageous to him. A number of factors may widen the gap between individual and social attractiveness of the forestry project. These include, from a villager's standpoint, insecurity of land tenure, long lead times, uncertainty of anticipated benefits, opportunities for emigration and the fact that individual investors do not reap the "external" benefits of environmental stabilization (these issues are discussed in greater detail in Parts Two and Three of this paper).

There is no clear-cut means of successfully addressing all of the above issues in the methodological approach to the economics of VLFP design. However, certain important conclusions emerge:

- The policy problem is to halt environmental deterioration or to manage the environment so as to protect the productive base of the rural economy.
- The project issue is to increase wood supply to village as a means of reducing pressure on the environment.
- The economic question is to devise projects which are attractive enough to a large enough number of villages to realize the policy objectives - within a relatively short time frame and within budgetary and institutional constraints.

- Financial analysis of VLFPs must depict a broader range of incentives than is captured in traditional cost/benefit analysis.

- Economic analysis must think through the mechanisms through which individual projects will be replicated within the time frame for achieving policy objectives.

The Economics of VLFPs

Parts Two and Three of this paper develop a framework for carrying out an economic analysis of a village forestry project. The approaches and tools developed are meant to be applicable within the village project setting, and are therefore limited to the constraints of village data availability. Frequently, theoretical categories have been compromised in order to devise estimable measures of costs or benefits.

PART TWO

METHODOLOGICAL FRAMEWORK

I. Approach to Village Level Economic Evaluation

"Economics" exists only in the minds of those who have a definition for it. Particularly in a subsistence village setting, that activity which we call economic is a largely undifferentiated part of an ongoing process. Land, and its ability to sustain life, is at the center of that process. It is at the core of the rural production system and of social relations as well. Village-level forestry - be it communal or individual - depends upon land and its uses. It is, therefore, inextricably linked to social, productive and judicial systems, the interplay of which have a significant bearing on "economic" decisions. This is more than the simple statement that village forestry investments also depend on social factors.[18] Rather, that the very act of projecting economic costs and benefits to an investor is contingent upon understanding the institutional constraints which affect his/her ability to make investment decisions in the first place and to appropriate the fruits of that investment. In this respect, forestry projects are more complex than rural technology projects. Improved cookstoves, for example, would be used by women, would directly benefit them, could be acquired upon the decision of those women and, in general would require an investment in cash and time by the very same women. In forestry projects, the levels at which costs, benefits and decision-making authority occur do not always coincide as conveniently. Many of the complexities of forestry project evaluation merit close examination in this respect.

1. Several levels of investment normally occur in a village level forestry project (VLFP). The villager or village unit undertakes an investment; some level of government, however, must support it with

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18 In which case it would be sufficient to have an accompanying sociological analysis, which is normally done.

extension/training and more importantly, with nurseries and other infrastructure support. Government may also have either to bear or to finance cash outlays, especially in the early years.

2. Several levels of benefit flow from a village forestry project: direct and indirect benefits to investors, benefits accruing to society as a whole, and "externalities" which benefit entirely separate social groups. Moreover, these benefits may be prioritized differently at different levels. For example, the overriding social objective in reforesting areas of the Himalayan foothills is to protect the vast Ganges Delta agricultural system from flooding. Yet the incentive system for those who would have to plant the trees has little or nothing to do with the Ganges Delta. Finally, both costs and benefits may occur in several different forms: cash, labor savings, environmental protection (windbreaks), improved leisure (shade), consumables (fruit), and so on, all of which need to be valued on some uniform basis.

3. Within a given village and its land use system, the distribution of incentives and of decision-making authority may not coincide. For example, a survey of villages in the Mopti region of Mali found the following: when the village as a unit was asked about tree planting priorities, the male village leaders - who had the effective decision-making authority - said yes, they wanted fruit trees and shade trees, primarily. Male heads of households, who have similar decison-making authority over their own lands, expressed the same preferences. Women, on the other hand, walk 10-15 km each way in search of firewood, but are not authorized to make the land allocation decisions that tree planting requires. Their first priority was to have trees for firewood. This would not be a serous failure if the men allowed tree planting which they thought of as being for fruit and shade, while the women got firewood as a secondary benefit. The problem is that if village elders, for example, are only motivated by fruit and shade, the intensity of those needs may not be sufficient to cause trees to be

planted in the first place. The existence of women's intense need for firewood, therefore, may not necessarily be expressed in the decision to allocate land for planting trees.

4. The economic incentive to participate in a communal woodlot project will be strongly influenced by the means in which work burdens and output are allocated. It is widely accepted that solutions to this woodlot "management" problem must occur largely at the local level. However, this raises problems of equity and of incentive. Nothing in village power structures guarantees that burdens will be equitably distributed among groups, classes or sexes. How should we judge the economic viability of a project (especially the economic incentive to participate) if we have no idea in advance of how these structures will evolve?*

5. Property rights and land tenure relationships can have a sizable impact on the willingness and ability to undertake as long-term an investment as tree planting. James Thomson[19] points out that the landless poor - who may in fact not even have usufructory rights - face substantial insecurity of tenure and that this uncertainty effectively undercuts the expected value of tree planting benefits. Other sociologists interviewed by this author suggest that in the Sahel at least, it is not clear that these tenant farmers even have the right to plant trees.[20] A means of circumventing this problem which has been suggested is to have projects only in villages without landless peasants. This is clearly a project solution, not a development solution.

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* Marilyn Hoskins has done some very interesting and useful work on this question. She proposes a partial solution - that a project management plan be discussed, agreed upon and signed by all parties involved in the project at its outset. See Hoskins, Marilyn V. "Community Participation in African Fuelwood Production, Transformation & Utilization," in D. French and P. Larson, Energy for Africa, September, 1980.

19 J. Thomson, "Firewood Survey: Theory and Methodology," in D. French and P. Larson, Energy in Africa, U.S AID, August 1980

20 Gerald Cashion, U.S. AID Mission, Bamako, Mali; Theresa Ware, Sahel Development Program, Bamako, Mali.

6. Even when tree planting activities have been recognized (by a villager) to be a preferred solution and there are no institutional barriers, specific resource scarcities may prevent attainment of the preferred solution. One such scarcity is clearly land, the commitment of which involves considerable risk. Let us consider this from the peasant's perspective:

- he is asked to commit 5% of his land (for example) for tree planting (agroforestry);
- he is told he will thereby get wood, by-products and probably increased yields on the remainder of his land (after several years);
- he is sure that he will be losing the yield of that 5% of land;
- he does not now know whether the foregone output will be surplus, since he does not know what kind of harvest he will have. In other words, he cannot now judge what the marginal utility of that output will be. If he has a bad year, that 5% could be crucial. He is asked to bear this risk, not for one season, but for many;
- he does not now know whether his trees will grow (survival rates are often as low as 10-20%) and whether in 5-7 years his yields in agriculture will increase as promised.

Economic theory has some rather elegant and useful techniques for predicting "rational" behavior under this kind of uncertainty.[21] What they say, in effect, is that the amount of riskless income (5% of the yield) you are willing to trade against uncertain gain (trees, increased yields in 7 years) depends upon the size of the potential gain multiplied by the likelihood (or the expectation) of receiving it. It is not immediately clear that a rational farmer should - given the risks he perceives - in fact follow the recommended course.

The foregoing issues merely point to the number and the complexity of the factors involved in determining the economic viability of a VLFP. Explicit recognition of them should be seen as a positive act which affirms a belief in the ability of project design to address such issues rather than ignore them.

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21 See the body of microeconomic theory on insurance, gambling and risk.

II. Levels of Cost/Benefit Analysis

Three economic judgments are necessary in order to determine that a VLFP is an economically sound undertaking:

- it should be financially attractive for the purchaser or investor - after consideration of all factors, including those raised in the preceding section;
- it should be in the economic interest of society;
- its results should be replicable within reasonable constraints of budget and other resources.

This last point merits elaboration. There is a pressing need to do something to reverse the woodfuel crisis in the Third World. It is rapidly undercutting the productive base for herding and farming. At the same time, it imposes a crushing burden in the form of time spent collecting wood. In the absence of successful programs to combat these problems, the situation in many rural areas of the Third World will be simply untenable within the decade. VLFPs are the individual components of the solution to this larger problem. The basis on which government or donors support an individual project must therefore be consistent with affordable levels of support for hundreds of future VLFP projects. A project which does not meet this criterion may not be "uneconomical" per se nor should it necessarily be rejected; it will, however, not be part of the solution set to the environmental/woodfuel crisis. This, in turn, implies the need to identify different projects which are part of that solution set.

It is obvious that a simple cost/benefit judgment will not capture the range of economic information needed for project evaluation at the village level. The methodological approach proposed here makes full use of the techniques of investment analysis, but at the same time incorporates them into a broader framework. This information is integrated into a systematic, though less formal, economic analysis. The outcome of this analysis is not a single rate of return that serves as

the trigger mechanism on which economic judgments are made. Rather, it is a range of economic information which forms the basis for a better informed decision on project feasibility.

Three levels of economic analysis are proposed:

- the investor perspective
- the social perspective
- the project efficiency perspective.

Each of these is further subdivided as developed below.

1. The Investor Perspective

There are four steps to the economic analysis at this level.

(a) Financial Analysis, which relies on the traditional financial tools: projections on revenue, cost, project life and discount rate. It should be kept in mind that a sizable part of inputs and outputs in a VLFP will occur in non-monetary terms. Their monetary values in the financial analysis will be estimated on the basis of valuation techniques which are frequently indirect.

(b) Sensitivity Analysis, which determines how sensitive results of the financial analysis are to changes in key assumptions.

(c) Scarce Resources Analysis, which examines the likelihood that specific resource limitations may prevent investment in a project, regardless of its overall attractiveness. For example, the unavailability of sufficient cash (or access to credit) may block an otherwise viable project investment.

(d) Incentives Analysis, which examines those economic factors which are the principal determinants of an individual's desire to participate in a VLFP. Factors to be examined include:

- allocation systems
- correspondence of incentives and decision authority
- the effects of uncertainty on village perceptions.

2. The Social Perspective

The steps in the economic evaluation at the social level are as follows:

(a) Economic Analysis, using the same techniques as in the financial analysis, but with several input substitutions:

- shadow wages are used to reflect the social opportunity cost of time;
- shadow discount rates reflect social preferences as to present vs. future income;
- social costs are included in the economic analysis. These encompass such things as extension costs and support infrastructure.
- social, or macroeconomic benefits are added to those benefits already estimated in the financial analysis.[22]

(b) Sensitivity Analysis, which determines the stability of project results with respect to key assumptions.

(c) Scarce Resource Analysis, which examines the likelihood that resource scarcities at the social (regional, national) level will inhibit the success, not just of a given project, but also of other similar projects in the future.

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22 For a discussion of valuation problems associated with external (macroeconomic) benefits, see Part Three.

(d) Evaluation of national policy objectives which may influence a project's economic value to society.

3. The Project Efficiency Perspective

From a national standpoint, the principal objective of VLFPs is to redress environmental imbalances with regard to wood and trees, and thereby to restore the stability of rural production systems. It follows that no individual project can lead to the full benefits which are eventually desired. From a policy standpoint, the measure of a project's worth will be the degree to which it contributes to the efficient realization of policy objectives.

The central issue here is of replicability. To be a genuinely useful program, a VLFP should be built upon individual projects which can be replicated nationwide within institutional, budgetary, and time constraints. The issue of replicability can, in turn, be broken down into two components: first, in theoretical terms, what should the public sector (government/donors) be prepared to contribute to any given project? Second, what can the public sector afford to contribute? We will refer to the first as the "allocation problem" and to the second as the "budgetary problem." For reasons discussed below, neither question can give rise to precise quantitative answers. Nevertheless, they are the context within which a working definition of project efficiency must be formulated.

The Allocation Problem

Village reforestation does not just benefit villagers directly, but is also in the national interest. How then, should the costs of a given VLFP be distributed between village and government? Put differently, what level of non-reimbursed public sector expenditures for a specific project should be considered economically justifiable?

We can define the theoretical (though not quantifiable) upper bound of the acceptable level of government support as being when:

$$\frac{\text{budgetary burden of project}}{\text{external benefits from project}} = 1 \quad (23)$$

That is, government should be willing to subsidize a project up to that point at which the subsidy equals the external benefits from the project. The obvious economic justification for this is that "external" or "macroeconomic" benefits are precisely those which do not accrue to the investor, but rather to other members of society (or to "society as a whole"); government is the vehicle through which these non- participants in the investment pay for the benefits they derive.

This, of course, leaves open the question of what the lower bound should be. If a project were extremely profitable for a village (or individuals within it) without any government subsidy at all, should villagers be asked to bear all costs? There is no clear-cut answer, but the key issue involved concerns incentive. Up to the upper bound, the value of public subsidy will be to increase village incentive to participate. The decision of whether to have some minimum level of non-reimbursed government contribution depends upon:

- whether that level of contribution is consistent - given budgetary limitations - with replication of project results nationwide.
- the adequacy of village incentives to participate in the absence of government subsidy.
- the existence of suitable allocation mechanisms to repay a portion of government costs to bring it to any desired minimum bound.

The Budgetary Problem

Even if the above ratio is less than or equal to one, it may not be budgetarily possible to mount the effort required to replicate results nationwide. Therefore, we need to confront the issue of the

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23 Clearly, it is the denominator of this ratio which is not always quantifiable in field economic evaluations. External benefits from a project equal all benefits which do not accrue to the project investors, most of which are difficult to quantify.

expected budgetary burden within the given policy time frame, and to determine if this burden seems reasonable - or if it is in keeping with the assumptions underlying project design.

In theoretical terms, we should like to be able to compare a project's percentage contribution to the national policy objective with the percentage of the budget available for that purpose which is used up. That is, where:

T_p = trees to be planted by project (per year)

T_n = number of trees needed (per year) to meet national objectives

B_p = budgetary outlay for project

B_n = total budget available for national objectives

The ratio we seek is: $\frac{B_p B_n}{T_p / T_n}$

As in the case of the ratio of budgetary burden to macrobenefits, there is, unfortunately, no way to quantify this ratio. Even if we could estimate the other variables, B_n (budget available for policy implementation) cannot be known - it depends only on the amount of funding which is succesfully obtained.

What realistically measurable criteria can be devised to capture the information contained in these ratios? The following specific analyses are proposed at the Project Efficiency level:

(a) The Economic benefits ratio

This ratio is defined as:

$$\frac{\text{Present Value of Budgetary Burden for Project}}{\text{Incremental Economic Benefit from Project}}$$

The denominator is defined as follows:

Economic Net Present Value (exclusive of external benefits) minus Financial Net Present Value.

In other words, the denominator measures that portion of quantifiable project benefits which does not accrue to the individual investors.

This ratio is identical to the one defined in the "allocation problem" discussion above, except that the denominator leaves out non-quantifiable external benefits. Since we know these to be a central component of the benefits which society derives from VLFPs, what then is the value of this "economic benefits ratio"?

- if the economic benefits ratio is less than one, we know the public commitment of funds is safely within the limits of social benefits derived.
- if the ratio is at or just above one, we know that the non-quantifiable external benefits probably cover the excess of public expenditure over quantified social benefit.
- if the ratio substantially exceeds one, the "efficiency" of the project - measured in terms of how much of the scarce budgetary resources it uses up - is in question.

A precise number is neither possible nor necessary here. The economic benefits ratio is not intended to serve as some mechanical cut-off point for project efficiency. Rather, it provides feedback as to the budgetary implications of a specific project design. It is most useful when used as a comparative measure between two alternative project designs, rather than as an absolute indicator.

(b) Changes in the Economic Benefits Ratio Over Time

Are there likely to be economies of scale in replicating projects of a given design? Will information on varieties, planting techniques, protection and so on be disseminated through either structured or informal social process? Will large-scale nationwide (or regional) programs bring down the unit costs of nursery, infrastructure and extension support? Or will costs per project rise as less socially profitable projects are undertaken? The basic issue here is whether there are lower, higher or equal costs associated with project replication as compared with the original project.

(c) Annual Policy Cost

Even if budgetary commitments are within the range of social benefits derived from a project, we must know if the government can afford it. We must confront the annual budgetary implications of replicating a project of the design being evaluated. Specifically:

$$\text{Annual Policy Cost} = \frac{\text{Per Capita Budgetary Burden x Target Population}}{\text{Policy Time Frame}}$$

Whether or not a government can sustain a given annual policy cost depends upon the social opportunity cost of budgetary resources. The usefulness of this number should be judged in the following terms: let us suppose that a project is financially and economically viable, and that the economic benefits ratio is less than one; but to reach the target population would require a $30 million program per year for ten years. If such a resource commitment is not possible, then it makes little policy sense to initiate the first - even if it is profitable on its own terms. Unless one takes the extreme position that no profitable and replicable alternative exists, it would seem preferable to design a project whose replication is affordable, even if it meant sacrificing some potential benefits for each project.

Conclusion

The main focus of this methodology is to capture and effectively use a wider range of information on economic costs, benefits and motivation than is encompassed by the conventional tools of financial analysis. The output of this approach should not be a simple positive or negative number, but a range of information which provides feedback as to a technology's feasibility, including information on specific economic characteristics and constraints which influence that feasibility.

In VLFPs, one of the principal obstacles to determining project feasibility is the difficulty of measuring the external benefits of a project. Yet these benefits can, to a large extent, be successfully measured if adequate resources are devoted to the effort. Already, components of such a quantification have been undertaken by various sources. The World Bank, in a recent analysis of the effects of deforestation in the Himalayan foothills on the Ganges agricultural system, developed reasonable measures of the cost of lost agricultural output as a result of flooding. In an analysis of deforestation in Sri

Lankan catchment areas, a team of consultants to AID used time series data to quantify the relationship between loss of vegetative cover and loss of topsoil from rainwater runoff as a means of estimating the economic costs to agriculture in the area. Similar efforts should be intensified and brought into a systematic effort to determine the "macro benefits" of afforestation for major ecological zones. This information will provide invaluable feedback on the true long-term costs of inaction or project failure.

Finally, particular attention should be paid to the snowballing effect of environmental decline. The budgetary cost of redressing environmental imbalance does not remain fixed over time.

PART THREE

VALUATION OF VLFP INPUTS AND OUTPUTS

I. The Physical Input-Output Table.

The first step in valuing inputs and outputs is to identify, on an annual basis, all physical inputs and outputs of the project. Labor should be further specified as being required at peak agricultural seasons or off-peak times. Table 3.1 lists all expected inputs and outputs of the project, broken down into categories as shown. Table 3.2 shows how these inputs and outputs are distributed over the project life.

"Investment Inputs" in Table 3.2 have been condensed, because the are all assumed to occur in the same year and hence can be detailed in a separate table at the point at which total investment costs are valued. For any given project, several specific inputs or outputs may not arise at all. If this is the case, they should be excluded from the analysis.

TABLE 3.1

Physical Inputs and Outputs
of Village Reforestation Project
(Hypothetical)

INPUTS	OUTPUTS
Investment Inputs	**Direct Outputs**
Land (in hectares)	Firewood (cubic meters)
Land Clearing Labor	Building Lumber
. peak season	Animal Fodder
. off-peak season	Marketable By-Products (fruit, (gum, etc.)
Planting Labor	Time saved in wood collection/ transport
. peak season	
. off-peak season	
Training Labor	
Fencing	**Indirect Outputs**
Seedlings	Increased agricultural yields
Fertilizers	"External" (macroeconomic) benefits
Other Capital Inputs	
. construction	
. tools	
Recurrent Inputs	
Water	
Seedlings	
Fertilizers	
Maintenance and Supervision Labor	
. peak season	
. off-peak season	
Management Labor	
. peak season	
. off-peak season	
Harvesting Labor	
. peak season	
. off-peak season	
Collection and Transport Labor	
. peak season	
. off-peak season	

TABLE 3.2

Time Distribution of Inputs and Outputs
Village Reforestation Project
(Hypothetical)

INPUTS	0	1	2	3	4	5	6+
Investment Inputs							
Equipment							
Land and Raw Materials							
Labor							
• peak							
• off-peak							
Recurrent Inputs							
Water							
Seedlings							
Fertilizers							
Maintenance Labor							
• peak							
• off-peak							
Management Labor							
• peak							
• off-peak							
Harvesting Labor							
• peak							
• off-peak							
Collection and Transport Labor							
• peak							
• off-peak							
Direct Outputs							
Firewood							
Building Lumber							
Animal Fodder							
Marketable By-Products							
Indirect Outputs							
Increased Agriculture Yields							
• soil stabilization							
• nutrient cycling							
• etc.							
External Benefits							
• environmental stabilization							
• soil protection							
• reduced river siltation							
• etc.							

II. Valuation of Inputs and Outputs (Investor Level)

A. INPUTS

Inputs into the village forestry project may be of two types: market inputs, which are as a rule commercially exchanged, and which have identifiable market prices; and non-market inputs, including those items which will be contributed to the project against the expectation of some future benefit, but which are not bought or sold at market prices. The principal categories of non-market inputs are land, labor and water.

1. Market Inputs

The market inputs to be considered - as identified in the Physical Input-Output Table (Table 3.1) - are:

- seedlings
- fertilizers
- fencing
- other capital inputs (construction, tools, etc.).

In addition, in some projects, certain items which are normally non-market may be considered as market inputs. For example, if the land for the project is subject to a market pricing mechanism and it is to be bought and paid for in money by the investor, then it is a market input. Similarly, any labor which will be employed on a salary basis by the investor at some market wage will be considered a market labor input.

All market inputs will, for the financial analysis, be valued at their market prices.

Information needed to value market inputs is summarized below:

INFORMATION/SOURCE SUMMARY - MARKET INPUTS

Information needed

Market prices for market inputs

Sources

Suppliers
Local Markets

2. Non-Market Inputs

There are three principal categories of non-market inputs to be evaluated: land, labor and water. As discussed in the previous section, these may in some cases enter the project as market inputs, in which case the following valuation exercise would be unnecessary.

In general, non-market inputs require some indirect means of estimating their value, so that we may have a means of converting them into monetary units of measure (dollars, francs, etc.) which are in common with other inputs and outputs. The guiding principle in the estimation process is the notion of opportunity costs. Every economic resource has several potential uses. Employing a resource for one activity necessarily implies foregoing its use in other activities. The opportunity cost of a given resource use, then, is the value of the most fruitful activities foregone. The specifics of how this prinicple is to be applied are developed below.

a. Labor

What is the opportunity cost of labor? The answer depends upon:

- The general income level and standard of living in the area;
- The alternative production uses to which labor might be put;
- The extent to which project labor impinges upon other activities.

Off-peak labor

If the labor required for a project occurs during times of normal productive activity in the village, it can be assumed to have a value equal to or less than the average hourly income in the area.

(i) If the regional (or local) per capita income is known, it can serve as a starting point. Let us consider a hypothetical case:

- regional income per person (per year): $250,
- average household size in village: 10 people,
- average ratio of household size to economically productive household members: 2,[24]
- average income per economically productive household member: $250 x 2 = $500,
- average hourly income (assuming 50 weeks per year, 6 days per week, 8 hours per day): $500/2,400 = $0.208

(ii) If there is a local market for labor, the going wage rate for similar categories may be used as an approximation. However, there are pitfalls associated with this: cash scarce local areas may undervalue labor in terms of cash, even though its productive value is higher; labor markets may be seasonal and may therefore be unrepresentative. It is wise, in performing this estimation, to compare results from both steps (i) and (ii) before reaching a conclusion.

(iii) If only the national per capita income is known, the same steps as in (i) can be applied to the national figure, with the following exception: the national figure should first be scaled down to reflect the much lower average incomes in rural areas. This scale

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24 This implies that only half the household memebers are engaged in economically productive activity; the others are too old, too young or infirm. The ratio of 2, while serving here as an example, also strikes the author as a reasonable estimate.

factor should probably go as low as 0.5 for most developing countries. It should be based on the best judgment of the project team (not necessarily just the economist) and local officials.

The resulting figure estimates the value of adult labor time. The value of child labor (where it occurs) can be scaled down on a judgmental basis. A scale factor in the range of 0.5 or less is likely to be appropriate in many areas, although specific values should be made for each case.

The information to be gathered can be summarized as follows:

INFORMATION/SOURCE SUMMARY - OFF-PEAK LABOR

Information needed

1. regional per capita income, or national per capita income
2. local labor market wage rates
3. average ratio of household size to number of economically productive household members[25]

Sources

a. national or regional economic statistics (1)[26]

b. local labor markets (2)

c. village interviews (3)

d. demographic statistics (3)

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25 If this information cannot be gathered or estimated, the national ratio of total population to economically active population should be used. The latter figure is readily available in all national demographic statistics.

26 The number in parentheses following each source refers to the corresponding information item.

Peak season labor

In the rural areas of many African nations, one of the effective constraints to greater agricultural production is the shortage of peak season agricultural labor. Hence any tree planting or growing activity which impinges upon labor time during peak activity seasons in agriculture will have an extremely high opportunity cost for labor, measured in terms of lost agricultural output.

The valuation of peak season labor will depend upon a number of factors:

- the extent of idle labor available (if any)
- the value of crops being sown for a given crop season
- the degree to which non-agricultural tasks can be deferred

There is no clear-cut means of forming this estimation. Elaborate theoretical formulations will not necessarily result in a more meaningful answer at the village level; in any case, they will strain the credibility of what meagre data exist. A step-by-step approach, with the explicit recognition that judgment decisions will be called for along the way, is the most appropriate way to proceed.

(i) The loss of agricultural output: We can suppose that crops not planted during the planting season will not grow. As a simplifying assumption, we can further suppose that the number of crops planted is a linear function of the hours spent in the fields during planting season. On this basis, let us consider the following example:

- during peak planting season, economically productive villagers spend 8 hours per day, 7 days per week, in the fields or performing related agricultural activities;
- tree planting - during the early years of a village woodlot - requires an average of 1/2 hour per day from each villager during planting season;
- the estimated loss in agricultural output would be 6.25% (0.5/8.0) of the value of that season's crop.

(ii) Opportunity cost of peak season labor: the estimated loss in crop output in (i) is only a starting point. It very likely overstates the opportunity cost of peak season labor. We will want to adjust it in the following ways:

- for excess labor during peak season, or
- for other tasks (certain domestic chores, building and maintenance, etc.) which could be deferred

Peak season labor should then be valued at less than the estimated loss of agricultural output. This adjustment factor - let us call it "g" - will, in a field situation, depend entirely on the judgment of the evaluator.

The essential point that must come through, however, is that loss of peak season labor entails (in some measure) loss of agricultural output for the entire season.

There may, of course, be different peak seasons for different crops. The analysis can easily be applied on a crop-by-crop basis.

Finally, it should be recalled that peasants are not unaware of their own self-interest. We may, for purposes of financial evaluation, value their peak-season labor inputs into a forestry project in terms of the value of lost agricultural output. They on the other hand, may react much more rationally, by simply withholding their labor from non-agricultural pursuits during peak planting periods. Valuation techniques do not address this issue, yet it is an essential component of project success.

INFORMATON/SOURCE SUMMARY - PEAK SEASON LABOR

Information needed

1. average daily time (per economically active person) for planting during peak season.
2. average daily time required for forestry project during peak season.
3. number of hectares of each agricultural crop being sown.
4. average output per hectare for each crop.
5. average unit prices (market) for each crop.*
6. extent of underemployment of productive villagers during peak season.
7. extent to which non-agricutlural tasks can be deferred during peak season.

Sources

a. village surveys (interviews) (1) (3) (6) (9)

b. project technical personnel (2)

c. agricultural/production studies (4)

d. local/regional agricultural markets (5)

e. agricultural statistical bulletins/crop marketing boards (5)

b. Land

Land devoted to woodlots or other forms of tree planting may have alternative uses. We first consider the case of potential agricultural land which is to be set aside for tree growing, and then examine land which either has no agricultural potential or which need not be withdrawn from agriculture even while trees are planted on it.

* Even if crops are not traded by the individual village household, there should be known market prices for them.

Potential agricutural land

If agricultural land is to be set aside for growing wood, it must be valued in accordance with the agricultural output foregone. If ten hectares of sorghum growing land is to be put aside for wood, how should the land be priced? We need to know:

- the output per hectare of sorghum - say 650 kg
- the proportion of land which would normally lie fallow - say 50%
- the market value of sorghum - say $0.25
- the cost of inputs - say $0.10 kg.

Therefore, with appropriate inputs over time, the 10 hectares of land (with 5 hectares fallow) could produce $487.50 worth of revenue every year, in perpetuity. The standard method of determining the present value of an asset which generates a fixed income stream in perpetuity is to divide the value of the annual income by the annual rate of interest (or discount rate). The discount rate we will use for this purpose will correspond to that being used for the remainder of the analysis. For example, the village level analysis (financial) assumes villagers have a very high discount rate (20%). The social/ national level analysis (economic) assumes a discount rate in the order of 10%. In valuing the 10 hectares of land for the financial analysis, therefore, we proceed as follows:

$$\frac{488}{.20} = 2{,}440 = \text{present value of the 10 hectares}$$

This number can then be inserted into the investment costs estimate, along with the market input items.

Here again, a note of caution must be injected. We can estimate the present value of the income foregone, but that present value may have no bearing on a peasant's (or a village's) willingness to divert land from agricultural uses. If there is no agricultural surplus, then the woodlot represents food foregone - and in any rational village framework, it will simply not be foregone. This issue is further developed in Part Three.

Non-Agricultural Land

If the proposed land for woodlots or tree planting has no alternative uses at present, its opportunity cost may be close to zero - both from the investor's and from society's point of view. Two observations are in order, however:

- If such land is far from the village (as it commonly is) the low land value will be compensated by the high cost in recurrent labor time required to go back and forth. This may, in turn, reduce many of the benefits of woodlots as seen from the villagers' perspective.

- Tree planting (agroforestry) which occurs on existing agricultural land without replacing the agricultural crop will involve little land cost in terms of agricultural output foregone. It may, in fact, enhance agricultural productivity as well, although farmers may not always perceive these benefits.[27]

INFORMATION/SOURCE SUMMARY - LAND INPUTS

Information Needed

1. Number of hectares needed for project
2. Expected location of land
3. Output per hectare (for each agricultural product)
4. Market prices for each product

Sources

a. Technical specifications of project (1)
b. Agricultural production studies (3)
c. Village interviews/discussions (2)
d. Local/regional markets (4)
e. National agricultural statistics/crop marketing boards (4)

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[27] For an excellent discussion of the role of trees in nutrient cycling when combined with agriculture, see Poulsen, Gunnar. "Shifting Cultivation: Soil and Vegetation, Nutrient Pumps and Nutrient Cycling," in Man and Tree in Tropical Africa, IDRC, 1978.

c. Water

There are few readily available indicators by which to estimate the value of water. The following options may be available:

- If a well is dug and operates exclusively for a woodlot, the water from it need not be valued separately. It has no opportunity cost and its "production costs" are already included in the cost of labor and capital inputs associated with procuring it.

- In regions near nomad routes, water is frequently sold to herders on a per head of livestock basis. These prices can easily be converted into unit prices and used as estimates of water value.

- In the absence of any other alternative and where water scarcity is in fact a problem, reference may be made to prices charged in other projects (agricultural projects, for example) or in neighboring regions with similar water availabilities, or indeed, in neighboring countries.

If the key water problem is not the availability of groundwater, but rather the transport needs in getting water from wells to the trees, then the problem becomes a labor valuation issue, as well as a logistical and technical problem for the project.

INFORMATION/SOURCE SUMMARY - WATER

Information needed

1. Price of water in local area

2. Price of water in neighboring cities or regions

Sources

a. Village/area surveys (1)

b. Public water agencies (2)

B. OUTPUTS

1. Direct Outputs

a. Market Outputs

These include any wood which is sold commercially, as well as other forest products (fruit, gum, etc.) which have a known market price. Even where villagers themselves do not purchase firewood, surplus wood may be sold as a means of generating cash income for the project. All such items may be valued at their market prices.

b. Non-Market Outputs

Firewood is the principal non-market output to be considered. As indicated above, fuelwood may in some projects be sold to villagers for cash, and may thus be treated as a market output. However, the proportion of fuelwood not sold, but rather distributed by some other allocation mechanism, should be treated as below.

Firewood

In or near many villages in the Third World, there is a market for firewood, and firewood prices are known. It is tempting to say that these prices should be used as the estimates of the value of fuelwood provided villagers, even if they do not buy it in cash. This option can be adopted only under the following condition: that the villagers in question were, prior to the project, buying fuelwood commercially rather than collecting it themselves.[28] If, on the other hand, they were previously doing their own collection, then:

- the revenue (or benefit) from the villagers' standpoint is not the wood itself (they were already getting it), but rather the time saved in collecting wood.
- The opportunity costs of the labor saved in wood collection (including peak season) can be converted into monetary units

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28 However, if most villagers were already buying wood commercially, then the project should anticipate selling its output - thereby making fuelwood a market output of the project.

using the same valuation as for labor inputs into the forestry project. The project analysis is thereby put on a uniform basis.

Time saved in wood collection should be valued in exactly the same manner as were the labor inputs into the project. Special attention should be paid to two points: first, that a proportion of child or young adolescent labor may be used in wood collection; second that during peak planting seasons commercial wood purchases may supplant personal collection, and/or peasants may draw on stores of wood built up in advance of the peak period.

INFORMATION/SOURCE SUMMARY - DIRECT OUTPUTS

Information needed

1. Quantity of market outputs (by product)
2. Unit prices for market outputs (by product)
3. Average number of hours currently spent collecting wood (per household - broken down between peak and non-peak seasons).

Sources

a. Project technical specifications (1) (4)

b. Local markets (2)

c. Village surveys (interviews) (3)

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2. Indirect Outputs

The principal indirect outputs at the level of investor (financial) analysis are the "environmental benefits" accruing to the individual or village. These include reduced soil erosion as a result of wind and water damage and increased fertility through more efficient cycling of soil nutrients, application of leaf mulch, etc.

When trees are not distributed on agricultural land, but rather are concentrated in woodlots which are exclusively devoted to wood production, then, in general, none of these benefits will occur at a micro level.[29] While the quantity of trees may be sufficient, their spatial distribution will not normally be appropriate to either protect agricultural land from erosion or enhance its fertility.[29]

Trees planted as part of an agro-forestry system (dispersed at intervals in agricultural land) will often lead to increased agricultural yields, over time. The best estimate of the impact of this benefit will come from technical personnel (foresters/agronomists) who are able to estimate the yield increases from a specific agro-forestry program. These estimates will be related to a number of non-economic factors: type of land, type of trees, type of crops, planned tree spacing, etc. A quantitative (percentage) estimate by technical specialists of expected improvements in agricultural yields should be the point of reference for valuing this indirect micro-level output.*

Equivalently, in areas where soil erosion is a substantial problem, the long-term impact of erosion on agricultural yields can be estimated (however crudely) by technical staff for the project. For example, a recent study of reforestation programs in Kitui District of Kenya estimated that agricultural productivity is declining by 3% per

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29 They will, of course, have macro-level benefits, e.g., reducing the pressure on natural forest reserves (see preceding section).

30 There may be certain exceptions, especially in sloping terrain where a properly placed woodlot can affect water run-off.

* It is important to note that the technical specialist's estimate of increased agricultural yields from agroforestry does not necessarily correspond to the farmer's (investor's) perception of agroforestry benefits. The implications of this fact are discussed elsewhere in this paper.

year as a result of soil erosion.[26] The value of windbreaks, for example, can then be estimated from that figure.

To recapitulate:

- Estimates of a percentage increase in soil fertility (j) can be obtained from technical personnel. These can then be applied to the land where agroforestry is being used. The surface area taken up by the trees themselves should be deducted from the base to which "j" is applied.

- Estimates of the annual percentage rate of soil erosion (k) can be crudely approximated by technical personnel. By applying this rate to the value of agricultural output on lands being protected from erosion, we derive an estimated annual benefit from tree planting.

In all cases, indirect benefits should only be imputed to lands specifically benefitting from tree planting, and not to all agricultural holdings of the farmer or village.

In estimating the amount of land benefitted it should further be noted that only seedlings which survive to maturity will generate the benefits being discussed. This implies, on the one hand, that there is a substantial time lag before benefits begin. On the other hand, only a small portion of the trees planted will in fact survive (seedling survival rates in such projects are often as low as 10% to 20%).

The valuation techniques and the expected results at the level of indirect outputs involve a great deal of gray area. Even the best technical estimates will have a very wide margin of error. All estimates will be, and should be, open to debate. The important fact, however, lies in understanding the structural relationships at work and in trying to depict them in our analysis. Indirect outputs should be included in a financial analysis mainly when direct costs and benefits do not themselves yield a clear picture of a project's economic viability. In addition, indirect outputs should be evaluated as a sensitivity factor, in order to judge the order of magnitude of their potential impact on rates of return.

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* Poulsen, Bollinger, Shaikh, op. cit.

INFORMATION/SOURCE SUMMARY - INDIRECT MICROECONOMIC OUTPUTS

Information needed

1. Number of hectares devoted to agroforestry
2. Number of hectares protected by windbreaks
3. Types of crops planted
4. Yield per hectare per crop
5. Unit prices for crops
6. Technical estimate (j) of increased agricultural yields from agroforestry
7. Technical estimate (k) of reduction in soil erosion from tree planting
8. Tree survival rates

Sources

a. Project specifications (1) (2)

b. Technical personnel in agriculture/forestry (7) (8)

c. Village surveys (3)

d. Agricultural production studies (4)

e. Local/regional markets, national statistics, crop marketing boards (5).

III. Valuation of Inputs and Outputs (Social Level)

In determining the valuation of inputs and outputs at the social level (economic) analysis, there are only two areas of divergence from the investor level (financial) analysis. One concerns non-market inputs, and the other concerns indirect outputs.

A. INPUTS

1. Market inputs

All market inputs will be valued at the same market prices used in the financial analysis.[31]

2. Non-market inputs

Land and water, both of which have already been valued at their economic opportunity cost at the financial level, will be valued at the same prices for the economic analysis.

Peak season labor has been valued in the financial analysis at its opportunity cost in terms of agricultural output. Accordingly it will be valued the same way for the economic analysis. This is based on the premise that the value of lost agricultural output is the same to the village as it is to society.

Off-peak labor may, however, be valued differently at the social level than at the investor level. Society is likely to value labor at considerably less then do private individuals,

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31 It may be argued that shadow prices should be used. For items being considered, valuation would be very cumbersome, local village market would have little data to work from, would have little relevance in a setting of such isolated markets and would probably have a minor impact on the rate of return. In short, it isn't worth the effort in an actual village analysis situation. Commodities purchased on national or international markets (fencing, equipment, etc) should, however, be shadow priced using established economic techniques.

since during times of labor surplus some of the village labor pool may be idle. The social value (shadow wage) of this off-peak labor will probably be in the range of 50% of the private value. Here again, it is a matter of how much free time is available and what the alternative time uses are. The above figure is not intended as an "average" to be used in analysis. The shadow wage used in each case should be carefully estimated from available information.

It should be kept in mind that in much of Africa there is a sizable out-migration of adult male labor during the dry season. Thus labor supply dwindles to compensate for decreased demand. The opportunity cost of the time of remaining household members may, therefore, remain higher than it would otherwise have been.[32]

B. OUTPUTS

All direct and indirect outputs included in the financial (investor level) analysis will be given the same values in the social level analysis. In addition, the following indirect outputs will be included at the social level.

External benefits

This category of outputs includes the beneficial environmental and soil fertility impacts of increased vegetative cover. They are considered externalities because they are not directly recoverable project outputs and, unlike the indirect micro economic benefits discussed earlier, they do not accrue to any specific individual or group. Often their impact is greatest on groups which have nothing to do with the forestry project under consideration. For example, if a village woodlot reduces pressure on the surrounding natural enviornment, that may benefit nomads (non-villagers) whose herds survive on the region's

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32 This point particularly addresses the frequently used assumption that male labor is available at off-peak times and that its social opportunity cost is close to zero.

vegetative matter. To take another example, if reforestation in up-river catchments reduces water run-off, this may reduce flooding and soil erosion thousands of miles down river.

External costs of deforestation may take several forms:

- increased soil erosion from rainfall runoff;
- increased stream/river siltation, affecting
  - hydroelectric potential,
  - irrigation potential,
  - navigability potential;
- increased flooding down river, with attendant losses in soil fertility and agricultural output;
- loss of wildlife species;
- compacting of soil from loss of micro-organisms, with consequent loss of soil fertility;
- loss of animal fodder for pasturalists;
- population displacements (disruptions due to above);
- desertification (temporary or permanent).

Not all of these effects will occur in a given location. In the Sahel, for example, desertification, loss of animal fodder for herders and population displacement are the key factors. In Sri Lanka, runoff, soil erosion and river siltation are more important. In the Himalayan foothills, runoff and siltation are important for flooding and loss of agricultural output in the Ganges Delta - thousands of miles down river.

These external effects are, furthermore, subject to a cumulative and mutually reinforcing intensification.

A number of options exist for valuing external benefits from forestry projects. Examples of such options include:

- estimated loss in soil fertility from rainwater runoff can be correlated (using time-series data) with the amount of rainfall, runoff, loss of topsoil and changes in vegetative cover

in order to obtain a measure of the impact of deforestation.[33]

- benefits from reduced flooding can be measured in terms of lost agricultural output in flood zones. Informational requirements would include size of potential flood zone, types of crops planted, seasonal changes in water levels, rainfall levels, etc.

- macro benefits -- to herders -- of reduced environmental degradation can be estimated from study of grazing patterns, size of herds, forage requirements, regenerative capacity of natural forests, wind and water erosion and the rate of acceleration of forest depletion.

Similarly, other techniques can be applied to estimate most of the key external benefits of village reforestation. However, it is obvious that the tools and the effort required for such analysis to be meaningfully undertaken greatly surpass the resources available when doing a field evaluation of a single VLFP. Therefore, as a practical matter of field evaluation, the following approach is offered:

(a) Wherever possible, national or regional analysis (or ecological zone analysis) should be conducted to establish, for an entire area, the range of external benefits which can derive from village reforestation, to attempt to quantify those benefits and to determine the key parameters which will influence the extent to which those benefits will be realized by (can be imputed to) any specific project.

(b) Where such "macroeconomic norms" have been established, their values can be inserted into the economic analysis on the same basis as other project benefits.

(c) When such norms do not exist, it may be useful to utilize an indirect approach.[34] It consists of including non-quantified external (macroeconomic) benefits in the economic analysis, but entering "X" for their value. The system can then be solved for the value of "X" which makes the investment economically worthwhile. From here we can make a crude judgment as to whether the macrobenefits can reasonably be expected to be in the range of "X".[35]

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33 See Sri Lanka paper referenced in footnote 14.

34 Developed in French, David. "Economics of Renewable Energy Technologies," U.S. AID and al Dir'iyyah Institute, 1979.

35 Clearly only one benefit - or one group of benefits - can be evaluated at a time in order to have a determinate solution.

IV. Summary of Information Needs.

Table 3.3 summarizes all information needs for performing an economic analysis of a VLFP, based on the estimation and valuation techniques developed in this Section.

TABLE 3.3

Summary of Information Needs

Information Needed	For Estimation Of
1. market prices for market inputs	market inputs
2. regional per capita income, or national per capita income	off-peak labor
3. local labor market wage rates	
4. average ratio of household size to number of economically productive household members[20]	
5. average daily time (per economically active person) for planting during peak season	peak season labor
6. average daily time required for forestry project during peak season	
7. number of hectares of each agricultural crop being sown	
8. average output per hectare for each crop	
9. average unit prices (market) for each crop	
10. extent of underemployment of productive villagers during peak season	
11. extent to which non-agricultural tasks can be deferred during peak season	
12. number of hectares needed for project	land inputs
13. expected location of land	
14. output per hectare (for each agricultural product)	
15. market prices for each product	
16. price of water in local area	water
17. price of water in neighboring cities or regions	
18. quantity of market inputs (by product)	direct outputs
19. Unit prices for market outputs (by product)	

TABLE 3.3 (continued)

Summary of Information Needs

Information Needed	For Estimation Of
20. Average number of hours currently spent collecting wood (per household - broken down between peak and non-peak seasons).	
21. number of hectares devoted to agroforestry	indirect micro-economic inputs
22. number of hectares protected by windbreaks	
23. types of crops planted	
24. yield per hectare per crop	
25. unit prices for crops	
26. technical estimate (j) of increased agricultural yields from agroforestry	
27. technical estimate (k) of reduction in soil erosion from tree planting	
28. tree survival rates	

PART FOUR

CASE STUDIES

I. Community Woodlots in the Mopti Region (Mali)

Project Description

To create a community-run woodlot which will serve the firewood needs of a village of two hundred inhabitants in the region of Mopti (Mali).

Per capita domestic fuel consumption is estimated at the equivalent of 270 kilograms of wood per year.[36] At present, approximately fifty percent of this need is satisfied by wood collected from natural forests surrounding the village, and 50% is satisfied by burning agricultural residues. The project is designed to meet half of the total domestic energy needs of a village of 200 inhabitants (27,000 kgs/yr).

In addition to establishing a woodlot, the project foresees disseminating more energy efficient wood burning stoves as a means of reducing energy demand in the village. For purposes of this analysis, however, we assume that energy demand will remain at current levels. This is based on the hypothesis that present energy consumption is constrained by the inaccessibility of firewood, and will rise somewhat after the project begins, thereby offsetting the improvements in efficiency brought about by improved cookstoves.

Key inputs and outputs are summarized in Table 1. The following assumptions should be underscored with regard to the base case:

- Wood is the only useful output of the woodlot. No provision is made for fruit trees or other income-producing activities (intercropping, etc).
- Commercial fencing rather than live fencing, will be used to protect the woodlot.

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36 Mali Village Reforestation Project, U.S. AID Project Paper.

TABLE 4.1

Inputs and Outputs of Village Woodlot
(Mopti Region, Mali)

INPUTS

Investment Inputs

1. Land: 18 hectare plot*

2. Labor:

   non-peak season: 2,400 days adult labor for clearing, site preparation, laying out and digging holes, and weeding; 100 days adult labor in training.

   peak season: 300 days adult labor for planting

3. Fencing:

   The project assumes fencing of four-strand barbed wire:

   900 meters, 766,000 MF

4. Seeds: provided at no cost to the village

5. Other Capital Inputs:

   tools: No special tools, other than those villagers already own, will be required.

   well: The project assumes no well will be needed for the community woodlot. Costs of well construction (labor and materials) have been included in a sensitivity analysis.

   construction: none.

* based on a 4 m x 4 m spacing, with no intercropping

TABLE 4.1
(cont'd)

Recurrent Inputs

1. Labor:

non-peak season:
- 125 days/year (adult labor) for "management"
- 1,095 days per year for guarding the woodlot (3 shifts per day, 8 hours per shift, 365 days per year), for maintenance and harvesting
- 462 days per year collection and transport.* Of this, 50% is assumed to be child labor**

peak season:
- 115 days for collection and transport (50% child labor, 50% adult labor)

OUTPUTS

1. Firewood: 27,360 kgs/yr (valued in terms of labor saved in collection)
2. Labor saved in wood collection:

non-peak season: 1,390 days/yr of adult labor***

peak season: 345 days/yr of adult labor

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* Assuming 25 households, and one hour round-trip each day (including collection), 4 days per week.

** Adult labor is used in wood collection when distances are greater and significant effort is required. Access to a woodlot within the village would greatly enhance the use of child labor, on a casual basis.

*** Assumes one member of each household spends, on average, 4 hours per day, 3 days per week, collecting wood. Thirty percent child labor is assumed. Twenty percent of total collection is assumed to occur during peak season.

- The project assumes that no well will be required, and that trees will depend entirely on rainwater (with some storage in microcatchments). In areas where a well is necessary, a very substantial addition to capital costs should be foreseen.

- The project will yield 40% of full output by Year 3, and will achieve full production by Year 6.

1. Investor Perspective

(a) financial analysis:

We make the following assumptions:

- Non-peak adult labor time is valued at MF 230/day.

- Peak season labor is valued at 2,580/day.

- Child labor is valued at 60% of adult labor rates.

- The discount rate villagers apply to future benefits is 20%. This high figure can be justified on the grounds that villagers have an extremely limited surplus over current needs, and therefore place a high priority on current (vs. future) income.

- Agricultural land will be used for the woodlot. Most land sufficiently close to the village to lead to sizable time saving in wood collection is likely to have alternative agricultural uses, particularly in the Malian environment of flat terrain and relative uniformity of land characteristics in the vicinity of a given village.

- Average agricultural output foregone on the woodlot is worth MF 42,250 per hectare.

- Sixty-six percent of the land (on average) would normally lie fallow at any given point in time.

- The value of output foregone is therefore:

  42,250 x 18 x .34 = MF 258,570/yr.

- The land used for the project is, accordingly, given a value of MF 1,292,850 based on the present discounted value of future income foregone.

- project life is twenty years, with a terminal value of 50% of the initial capital investment. [37]

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[37] This high terminal value reflects the fact that the trees will continue to exist.

(a) Financial Analysis

Table 4.2 shows the estimated costs and benefits for the project, calculated for each of the twenty years of project life.

The project, as described, is not financially viable (from the perspective of the investors). The Net Present Value is -2,652,000 MF.

(b) Sensitivity Analysis

Several key sensitivity factors have been analyzed. They are:

- A change in the discount rate from 20% to 10% (Case 2). As the 20% rate is based on a specific hypothesis regarding villagers' perceptions, it is useful to determine its impact on the outcome of the financial analysis.
- A reduction in fencing costs, on the assumption that live fencing can be used in place of the costly commercial fencing now envisaged (Case 3).[38]
- A reduction of land costs to zero, to reflect the assumption that non-agricultural land (which has no alternative economic uses) can be devoted to the woodlot (Case 4).
- A 20% higher wood yield per hectare with the increment being sold commercially at 40 MF/kg (Case 5).
- The assumption that in addition to producing wood for village needs, the woodlot yields 1,000 kgs of fruit (valued at 100 MF/kg) per hectare per year for commercial sale (Case 6).[39] This case involves a 20% increase in maintenance and harvesting labor, and an increment of 50 days of non-peak labor for commercialization of fruit.

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38 Alternatively, commercial fencing could be "loaned" to a village until trees reached maturity - and then passed on to another village.

39 This amounts to the very conservative assumption that the average yield per tree is 1.5 kgs/yr - in effect, that only a small percentage of the wood producing trees on the woodlot are also fruit bearing. This figure is not intended to serve as a technical estimate; rather, it is merely illustrative of the contribution of marketable byproducts to financial viability.

TABLE 4.2

Annual Revenue and Costs of Village Woodlot
(Mopti Region, Mali)
10^3 Malian Francs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
REVENUES	0	0	426	639	852	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065
CAPITAL COSTS																				
Land	1293	-																		
Labor	1349	-	-		230										230					(1704)
Fencing	766	-	-																	
RECURRENT COSTS																				
Peak Labor	238	238	238	238	238	238	238	239	238	238	238	238	238	238	238	238	238	238	238	238
Off-Peak Labor	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366
NET REVENUES	(4012)	(604)	(178)	35	18	461	461	461	461	231	461	461	461	461	231	461	461	461	461	2165

RESULTS

The results of Cases 1-6 are presented below:

CASE	NET PRESENT VALUE 10^3MF
Case 1 (Base Case)	-3,510
Case 2 (10% discount rate)	-2,115
Case 3 (live fencing)	-2,814
Case 4 (free land)	-2,287
Case 5 (20% commercial wood)	-2,885
Case 6 (commercial by-product: fruit)	+ 339

The results of Cases 1-6 clearly suggest that the community-based woodlot remains unprofitable, from a financial standpoint, under most reasonable scenarios, except when some marketable by-product is introduced. In other words, although it may be socially worthwhile to plant more trees, the incentives of villagers to do so will be heavily influenced by the degree to which those trees can serve as income producing assets. Even under a severe cost-cutting scenario (a combination of Cases 3 and 4), the woodlot would fail to be profitable from a financial standpoint.

(c) Scarce resources analysis.

The principal scarce resources to be analyzed are water, peak-season labor and cash/credit. Of these, the first two are not subject to formal economic analysis, although they warrant the following observations as to their economic implications.

- The project does not foresee digging and equipping a well at the woodlot. The capital costs of providing a well are estimated to range from a few hundred dollars to five thousand dollars - depending upon the depth of the watertable and the sophistication of waterdrawing/pumping techniques. Only a project with marketable by-products has any appreciable prospect of being able to support the costs of a well.

- Both AID sociologists and Malian forestry officials have related conversations with villagers which suggest a reluctance to undertake any tree planting efforts which impinge upon peak-season agricultural activity. In a bare subsistence economy, villagers are reluctant to jeopardize food output - even if the financial returns were attractive on paper. Therefore, the incentive to participate will be greatly enhanced to the extent that tree planting can occur at non-peak times. The extent to which this is technically feasible - particularly using mini-catchments and dams - should be explored.

The cash/credit constraints can be examined more straightforwardly. The issue is as follows: cash is an extremely scarce resource in rural areas. Non-cash revenues (such as labor saved) cannot easily be converted into income flows with which to repay cash outlays. Therefore, in order to be viable, a project should generate enough cash revenues to offset any cash investments or recurrent costs.

The base case assumes a cash outlay of 766,000 MF for fencing, as well as a present value investment of 1,293,000 MF of cash-equivalent income foregone (for land). Yet the project provides no cash income. On the other hand, either assumption regarding introduction of commercializable by-products (Cases 5 or 6) makes the cash-cost/benefit balance highly favorable. Case 5 yields a net cash income of 213,000 MF per year, while Case 6 yields 1,738,000 MF of net cash income annually. The importance of this fact should be seen in light of the aggressiveness with which small farmers in many parts of the world have sought to get cash benefits, even when the return on investment on an imputed value of land and labor basis is not attractive.

(d) Incentives analysis

The Mali Village Reforestation Project is still at an early stage in its development. As only secondary sources of field research were available for this analysis, it is impossible to judge the village economic incentive structure in any depth. The following observations are in order, however:

- The primary decision-makers on village land allocation are male village elders. The primary beneficiaries of village woodlots (in the Base Case) are village women. Therefore, if the

project were analyzed from the perspective of the investment decision-maker, it would be significantly less attractive than the financial analysis reveals. Cash or other by-product incomes have the advantage of accruing to those who control land allocation - thereby increasing the likelihood that the project investment will, in fact, be undertaken.

- All of the cost items in the cases analyzed represent fairly certain outlays of time or money. The revenue side, on the other hand, is uncertain; it is contingent upon project success. Projects fail for any of a number of reasons, including improper execution by villagers and improper design by planners. From the village standpoint, the expected value of benefits is much lower than the nominal values assigned in financial/economic analysis. Where the margin for error is slim, the risks associated with the project may seem quite high.

- Several avenues are available for alleviating perceived economic risk. In many instances, these lie outside the scope of economic analysis. Examples include increasing a sense of control, improving pre-project education and sensitizing, and so on. Potential economic mechanisms for reducing perceived risk are not well defined, and should be explored further. Alternatives include insurance mechanisms, temporary income support, and "revolving funds," among others.

2. Social Perspective

(a) Economic analysis

For the analysis from society's economic perspective, we introduce the following assumptions:

- Off-peak adult labor is valued at 115 MF per day. Off-peak child labor is given an economic value of 0.

- Peak season labor is valued at the same rates as in the financial analysis.

- The social discount rate is assumed to be 10%.

- The social capital costs of providing seedlings, nursery support, extension and related infrastructure are 55 MF per surviving tree, or 653,400 MF (55 x 660 trees x 18 hectares).

This figure is based on estimated costs for nursery operations in a similar project in the Kitui district of Kenya.[40]

- The recurrent social costs of infrastructure and technical support to the project are 100,000 MF per year in the first 5 years, and 50,000 MF annually thereafter.

- External benefits from the project are not estimated directly, but rather are compared to the residual value necessary to make the projects profitable (see Part Three for methodology).

In the absence of macroeconomic ("external") benefits, the project yields a NPV of -3,302,000 MF. If a value of 53 MF (approximately US 12.5 cents) is assigned to the annual macroeconomic benefits deriving from each tree, then the project just becomes viable from an economic perspective (NPV = ±0). Given the severity of environmental deterioration in Mali, with effects on soil fertility, animal husbandry, migration and climate, 53 MF per year certainly seems to be an acceptable minimum bound for macroeconomic benefits. Therefore, we can judge that, given reasonable valuation of "macroeconomic benefits," the project is economically viable.

(b) Sensitivity analysis

The same sensitivity factors applied in Cases 3, 4, 5 and 6 of the financial analysis are relevant to the economic analysis. In all cases, the already acceptable economic rate of return is enhanced, with Case 6 (commercialization of by-products) being, by far, the most attractive.

(c) Scarce resources analysis

No resource constraints at the social level have been analyzed.

(d) National policy objectives

The clear national policy objective served by this project is to halt environmental degradation. This objective is of overriding

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40 See Poulsen, Bollinger, Shaikh, "Kitui (Kenya) Tree Planting Programs for Ecosystem Stabilization," U.S. AID, January 1981.

importance to all the Sahelian states, since the current rate of deforestation jeopardizes the agricultural production base which provides the livelihood of over 90% of their populations.

3. Project-Efficiency Perspective

(a) Economic benefits ratio

Present value of budgetary outlays = 1,330,000 MF

Incremental economic benefit = 278,000 MF

Economic benefits ratio = 4.78

Quite clearly, the budgetary costs of this project are far in excess of the quantified economic benefits derived from it. We cannot determine if this budgetary outlay is justifiable on the grounds of non-quantified macrobenefits. However, this very high economic benefits ratio does suggest that the public sector cost/benefit ratio is not especially favorable. That is, at best, the public sector is paying cash for all or most of any "external benefits" which derive from the project.

(b) Changes in economic benefits ratio over time

The economic benefits ratio may tend to decline as tree planting information spreads through social process, and as the costs of nursery facilities is spread over a larger number of projects. However, as lower priority and less profitable projects are brought on stream, there will be a tendency for costs per project to increase. Even if we assume costs will decline, and if we make the extremely optimistic assumption of a fifty percent reduction in the budgetary burden, the economic benefits ratio would remain in the order of 2.5.

(c) Annual policy cost

The per capita budgetary cost of this project is 6,650 MF (or US $15.85). If we take the target population to be between 2.7 million and 3.6 million (approximately sixty to eighty percent of the rural population), the total policy cost would fall between $42.8 million and $57 million. Given a policy time frame of ten years, this yields an annual policy cost of US $4.3 to $5.7 million.

II. Tree Planting on Individual Lands (Mopti Region, Mali)

Project Description

To promote tree planting by individual farmers on their own lands, with a twofold objective: to provide sufficient firewood to meet at least 50% of domestic energy needs (approximately 135 kg/year per person) and to improve soil fertility through more efficient nutrient cycling, use of mulch fertilizer, soil protection and related benefits of agroforestry interventions.

This project alternative has numerous elements in common with the project already described in the preceding section, the details of which will not be repeated here.

Economic analysis of individual tree planting differs from that of the community woodlot in that there is no well defined project on which to base the analysis. We therefore make the following assumptions regarding a "typical" village household:

- family size is of ten persons.
- annual wood needs to be satisfied by this intervention are 1,350 kgs per year.
- the total number of trees required to satisfy the household's wood needs is approximately 600. These trees will be interspersed on agricultural land. Ten hectares of privately held household land will receive approximately sixty trees each.

Within this hypothetical framework, the following specific project assumptions are added:

- Wood yield per tree is 2-5 kg/year.
- The beneficial effects of tree planting lead to a five percent increase in agricultural productivity on the affected fields. This is a benefit -- appropriated by the owners of the land -- which does not arise in the case of a woodlot. The benefits in question include protection from excessive sun and from the mechanical impact of rainfall, reduction of sheet erosion from heavy rainfall, the binding effect of tree roots on upper soil layers, nutrient cycling by deep roots and the presence of decaying matter and of humus.

- In the base case, there are no non-wood by-products.
- There are no special provisions required for water supply.
- Wood output will be 40% of final levels by Year 3, and full production will be achieved in Year 6.

Table 4.3 summarizes project inputs and outputs. As the table indicates, there are several important differences between this project and the preceding one: First, per capita wood collectors and transport are lower because wood supplies are located on the same land which the household cultivates; second there are no capital costs associated with either land or with commercial fencing; third, the assumption of an around-the-clock guard is dropped for individual farm tree planting; fourth, agroforestry - as opposed to woodlot - interventions automatically imply a non-wood benefit in the form of increased agricultural yield.

Table 4.4 shows the costs and benefits for the agroforestry intervention project, calculated for each of the twenty years of project life. The table uses the same assumptions regarding input valuation, project life and discount rate as were used in the analysis of the village woodlot project. It should be noted that the average value of agricultural yield per hectare (used to quantify the value of increased agricultural productivity) is assumed to be 650 kilograms. At 65 MF per kilo, this yields a per-hectare output value of 42,250 MF. This figure is based on average yield and 1980 price data for sorghum. Obviously, each different crop will be valued differently. Therefore, the economics of an agroforestry program on sorghum growing lands may be quite different than on lands were higher value crops - such as groundnuts - are cultivated. This issue is one of the sensitivity factors addressed below.

(a) Financial Analysis

The Net Present Value of the Agroforestry Project is 80,190 MF. That is, the project is extremely profitable in that it generates income streams whose present value is roughly one-and-a-half times as large as the initial investment.

TABLE 4.3

Inputs and Outputs of Agroforestry Project

INPUTS

Investment Inputs

1. Land: None set aside exclusively
2. Labor:

   non-peak season:
   - 90 days adult labor for site preparation, laying out and digging holes and weeding
   - 5 days adult labor in training

   peak season:
   - 13 days adult labor in planting
3. Fencing: none
4. Seeds: provided at no cost to the village
5. Other Capital Inputs: none

Recurrent Inputs

1. Labor:

   non-peak season:
   - 6 days/year (adult labor) for "management"
   - 18 days/year incremental* labor time for wood collection and transport. Of this, fifty percent is assumed to be child labor
   - 20 days adult labor in pruning, spreading mulch, etc.

   peak season:
   - 4 days/year incremental peak season labor (fifty percent child labor; fifty percent adult)

* over and above normal movement to and from the agricultural fields on which trees are planted

TABLE 4.3
(cont'd)

OUTPUTS

1. Firewood: 2,736 kgs/yr (valued in terms of labor saved in collection)

2. Labor saved from wood collection:

   non-peak season: 70 days adult labor

   peak season: 17 days adult labor

TABLE 4.4

Costs and Benefits of Agroforestry Project
(Financial Analysis)
(10^3 Malian Francs)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
REVENUES	0	0	32.4	48.7	64.9	81.1														
Labor Saved	0	0	24.0	36.0	48.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Increased Yields	0	0	8.4	12.7	16.9	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1
CAPITAL COSTS	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
Land	-																			
Labor	55.4				9.4					9.4					9.4					
Other	-																			
RECURRENT COSTS																				
Peak Labor	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Off-Peak Labor	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8
NET REVENUES	(76.5)	(21.1)	11.3	27.6	34.4	60	60	60	60	50.6	60	60	60	60	50.6	60	60	60	60	87.7

NVP @ 20% = 106.8

(b) Sensitivity Analysis

The following sensitivity factors have been analyzed:

- A change in the discount rate from 20% to 10% (Case 2).
- The assumption that tree planting on agricultural land yields none of the anticipated benefits regarding increased agricultural yield (Case 3).
- A twenty percent increase in wood production, with the increment being sold commercially at approximately 40 MF/kg (Case 4).
- The assumption that a proportion of the wood producing trees planted will also bear fruit, yielding an average output of 90 kgs of fruit per hectare per year (1.5 kgs per tree, on average, valued at 100 MF/kg) (Case 5).
- The assumption that a higher value crop (groundnuts) is planted in the fields (assumes 50% higher crop value).

RESULTS

The results of Cases 1-5 are presented below:

CASE	NET PRESENT VALUE 10^3MF
Case 1 (Base Case)	80.82
Case 2 (10% discount rate)	268.56
Case 3 (no increase in agricultural yield)	11.91
Case 4 (20% commercial wood)	150.35
Case 5 (commercial by-product: fruit)	374.32
Case 6 (higher value crop)	115.28

In all cases, except Case 3, the project remains very profitable. Case 3 suggests the very important conclusion that even if there is no secondary benefit in terms of increased yield, the project is, nevertheless, marginally viable.

(c) Scarce Resources Analysis

The same comments regarding water availability and peak season labor needs for the village woodlot are applicable here.

As regards cash scarcity, the project assumes little or no cash outlay at any stage. Therefore, investor cash constraints are not likely to inhibit implementation. Furthermore, the very attractive cash cost/benefit picture of Cases 4 and 5 may provide an important incentive to farmer participation.

(d) Incentives Analysis

As in the case of village woodlots, the principal decision-makers on land allocations in most rural Malian communities are male, while the principal beneficiaries of the increased accessibility of firewood are women. However, the Base Case builds in a direct incentive to the entire household by offering the prospect of increasing agricultural output. Moreover, as no land need be set aside exclusively for tree planting, the disincentives to act are considerably lower than for a woodlot.

Two key uncertainty issues appear to play a role in the agroforestry project. First, the perceived likelihood of getting increased yields may be quite low; second, the fear of harming crop yield may be of concern to farmers. Case 3 shows that even if secondary benefits fail to materialize, a farmer will not suffer a serious loss. In order to address the second uncertainty factor (harming crop yields) it would seem useful to design the project so as not to interfere with crop planting. This will be accomplished by keeping the number of trees per hectare relatively low - even if this is a technically sub-optimal solution.

2. Social Perspective

(a) Economic Analysis

The following additional assumptions are introduced:

- The same set of assumptions as in the village woodlot project regarding the economic valuation of peak season and off peak season labor, of adult and child labor and of the social discount rate.

- The social capital costs of providing seedlings, nursery support, extension and related infrastructure are 55 MF per surviving tree.

- The incremental recurrent social costs of infrastructure and technical support to each farmer are 7,000 MF per year in the first five years, and 3500 MF annually thereafter.[41]

Even in the absence of imputed macroeconomic benefits, the project yields a positive Net Present Value of 280,000 MF. Given the social benefits of reducing environmental deterioration, the project can be judged very profitable from society's economic standpoint.

(b) Sensitivity Analysis

The same sensitivity analyses as applied in Cases 3-6 of the financial analysis of the project are relevant to the economic analysis. In all cases, the economic rate of return is positive and greater than the financial NPV, even in the absence of imputed external benefits.

(c) Scarce Resources Analysis

No resource constraints have been analyzed at the social level.

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41 It is assumed that much of this cost is in terms of the added time spent for agricultural extension workers who already visit farmers regularly to provide a number of agricultural extension services.

(d) National Policy objectives

All tree planting should have high priority in Mali. Agroforestry interventions have the added benefit of directly combatting soil erosion and of positively affecting rural production systems.

3. Project Efficiency Perspective

(a) Economic benefits ratio

Present Value of Budgetary Outlays = 80,400 MF

Incremental Economic Benefit = 200,000 MF

Economic Benefits ratio = 0.4

The public sector costs are well below the quantified social benefits. Given the high expected value of the non-quantifiable benefits, we may conclude that society reaps a considerable "social surplus" from this project.

(b) Changes in economic benefits ratio over time

The base case assumes relatively high extension costs per household. These costs are likely to decrease over time as increased extension coverage and demonstration effects take hold.

(c) Annual policy cost

The present value of per capita budget outlays is 8,040 MF (approximately US $18.70). Assuming a target population of between 2.7 million and 3.6 million (as in the earlier analysis) this yields a total policy cost of between $50.5 million and $67.3 million. Assuming a ten year policy time frame, the estimated annual policy cost is between $5 million and $6.7 million.

III. Conclusions

The following significant conclusions emerge from the comparative economic evolution of Community Woodlots and Individual Farmer Agroforestry Projects in Mali:

- Of the two alternatives considered, village woodlots are considerably less attractive from the investor, social and project efficiency perspectives.

- For both projects, the key contributor to financial viability appears to be the size and nature of non-wood outputs. That is, the success of a rural woodfuel program in Mali may in fact depend on projects in which wood fuel is more a by-product than the primary output of specific projects.

- The cash cost/benefit balance of community woodlots is only positive when there is substantial sale of commercial output (wood, fruit, etc.).

- Agroforestry interventions appear to be either cash-neutral or to have a positive cash balance (if we assume that increments in agricultural output are sold commercially).

- Agroforestry interventions are neither wood nor energy projects per se. Rather, they are part of an integrated approach to rural production and exchange systems. To be successful, they imply changes in agricultural techniques as much as they imply adoption of tree planting activities.

- Because of the strong links between agroforestry projects and rural production systems, such projects will draw more successfully upon the strength of long-term institutional capabilities put in place than on specific woodfuel/forestry services.

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