International Board for Soil Research and Management

FINANCIAL ASSESSMENT OF LAND MANAGEMENT ALTERNATIVES:

PRACTICAL GUIDELINES FOR DATA COLLECTION AND CALCULATION OF COSTS AND BENEFITS

Thomas Enters

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About the author:

Dr. Thomas Enters is a socioeconomist at IBSRAM's headquarters in Bangkok, Thailand.

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PREFACE

Social scientists have published a wealth of theories, and developed data bases, intricate models, and expert systems, as have biophysical scientists. Experts in their fields can use these to develop scenarios and to draw conclusions about particular situations and options for development. However, most of us are not experts in economics, and cannot use the complex formulas and procedures for economic analyses. And those who try, may misuse the procedures, and collect irrelevant data sets. What is lacking in many cases are simple and user-friendly, down to earth guidelines for data collection, and the 'best' method for their analysis.

Economics occupies an important position in the Framework for the Evaluation of Sustainable Land Management (FESLM). After reviewing the most appropriate ways to approach economics and the evaluation of land management practices, as documented in IBSRAM Global Tool Kit No. 1[1] and in Issues in Sustainable Management nos. 2[2] and 7[3], IBSRAM proceeded to produce an overview of data needs to apply the 'best' methods and to use the data in a particular case. The *PACIFICLAND* project offered an excellent opportunity to develop and test such practical guidelines during a training workshop held in Suva (Fiji) from 12-20 October 1999. One result of this activity is this Tool Kit. It is a valuable step towards applying economics in sustainable land management research that many national scientists can use, and that we expect to be helpful to many others in similar situations.

Frits Penning de Vries
Director of Research

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1 Baum, E., Gyiele, L.A., Drechsel, P. and Nurah, G.K. 1999. Tools for the Economic Analysis and Evaluation of On-farm Trials. IBSRAM Global Tool Kit No. 1. Bangkok: IBSRAM.

2 Enters., T. 2000. Methods for the Economic Assessment of the On- and Off-site Impacts of Soil Erosion. 2nd edition. Issues in Sustainable Land Management No. 2. Bangkok: IBSRAM.

3 Drechsel, P. and Gyiele, L.A. 1999. The Economic Assessment of Soil Nutrient Depletion *Analytical Issues for Framework Development*. Issues in Sustainable Land Management No. 7. Bangkok: IBSRAM.

BACKGROUND

During the first two phases of the IBSRAM *PACIFICLAND* adaptive research programme a range of different soil conserving technologies with a focus on vegetative barriers or contour boundaries (including annuals and perennials) has been tested and evaluated. In general, the research has shown that the technologies tested reduce soil degradation and have positive impacts on crop productivity particularly due to the water-conservation effects of the contour strips. The research has increased the knowledge of the biophysical effects of soil degradation and conservation considerably. However, the focus on biophysical parameters has resulted in a neglect of socioeconomic research that provides insights into the effectiveness of alternative treatments with regard to financial and economic indicators.

IBSRAM and its collaborators in research and extension are well aware that farmers will not adopt any of the sustainable land management (SLM) practices and/or soil conserving technologies available if they do not offer short- and long-term benefits to the farm household. As soil and water conservation practices are justified and economically viable only if the discounted net benefits exceed the discounted net benefits of the next best use of land, IBSRAM is embarking on research that concentrates on the economics of soil erosion and sustainable land management. The research builds on earlier work by Renaud (1997), Enters (1998a and b), Penning de Vries *et al.*, (1998), Francisco (1998) and Baum *et al.* (1999). It will be designed to investigate the role that economic and institutional factors at various hierarchical levels have in shaping the farmers' incentives to manage land resources in ways that lead to soil conservation. The guidelines presented in this report are one of the building blocks of IBSRAM's *PACIFICLAND* research programme. They are designed to assist IBSRAM and its collaborators in on-farm research activities in Fiji. The proposed technique for IBSRAM's economic research is cost-benefit analysis (CBA). It is a technique that is ideally suited for comparing the stream of net benefits produced over time by competing (i.e. mutually exclusive) investment opportunities such as investments in agriculture.

CBA is a coherent method for collecting data and organizing, comparing, and presenting information from the perspective of the trade-offs in decision making. It is a common tool for project appraisals and farm investment analysis and is designed to assist decision-makers in choosing alternative courses of action and allocating scarce resources. The choice is usually between two or more alternative courses of action. As such, CBA is a decision-aiding framework and a good quality CBA is but one element of an overall assessment.

OBJECTIVES AND STRUCTURE OF THE REPORT

The main objective of the guidelines presented in this report is to provide the *PACIFICLAND* researchers involved with on-farm trials for sloping land management with a user-friendly tool for data collection and analysis. At the same time, extension workers in the field can use the guidelines. The guidelines discuss the need for conducting CBA, explain why the data need to be collected, how they can be obtained and what pitfalls to watch out for. In addition, the guidelines are designed to bring 'economics' closer to researchers and extension workers (i.e. to de-mystify economics), to foster interdisciplinary research and to stimulate discussion in the field.

As we will see later, 'doing' a CBA is a straightforward activity. However, as simple or straightforward as it may be, it can provide completely irrelevant results if data collection is not accompanied by an understanding of livelihood strategies in the rural areas, policies that impinge on rural development and agricultural production, the perception of the land users and, last but not least, the aspirations of the younger generation, i.e. those people for whom we intend to conserve soils.

The guidelines are divided into nine parts. Part 1 is a brief introduction of CBA – concentrating on financial analysis – for the non-economist. Part 2 discusses the 'zooming-in' approach and the importance of analyzing information that cannot be retrieved through household surveys. Part 3 presents CBA as a step-by-step process starting from the identification of relevant parameters and inputs and outputs, their quantification and finally their valuation. Part 4 deals with the actual guidelines in table format accompanied by explanations in Part 5. Part 6 explains the derivation of the discount rate and time horizon and Part 7 summarizes the most important points. Useful literature is provided in Part 8 and a glossary in Part 9.

Although the tool kit was originally designed for researchers and extension personnel in Fiji it is equally applicable in other parts of the world.

PART 1 – INTRODUCTION

To comprehend why some farmers decide to invest in land improving technologies whereas others do not, requires an economic approach. From a farmer's perspective, there are essentially two cost components in agricultural production, i.e. the direct costs composed of land, material, labour, and capital costs and the indirect costs of the productivity loss over time (these are the on-site costs or environmental costs as they affect the farm household). Investing in soil conserving technologies reduces the future productivity loss and may even raise outputs. But are the additional inputs – and most soil conservation technologies require some additional inputs and/or a reduction in area cultivated – worth the effort? This question of future benefit and cost streams and their comparison with current scenarios has plagued soil conservationists for decades, although tools have been available for some time to evaluate different agricultural practices and to point to the most profitable alternative from the farmer's point of view.

CBA has emerged as a comprehensive yet user-friendly tool producing succinct results relevant to decision making. It allows for evaluations at various hierarchical levels and from different perspectives. It is important to shape one's analysis into a form that is recognizable by the target audience and addresses their interests. From the onset of any study or assessment the vantagepoint of the analysis needs to be clear. So we have to ask ourselves whether we are interested in the farmer's or the society's perspective. In other words, it has to be made explicit whether the focus is a private CBA (financial analysis) or social CBA (economic analysis).
The economic analysis in which the allocation of productive factors is assessed from the society's perspective differs from the financial analysis in three ways:

1. Distortions induced by regulations, imperfections in the market and over-valued currencies give rise to deficiencies in the use of existing price data (market prices) as the basis for evaluating inputs and outputs. These deficiencies require a re-evaluation of market prices and the adjustment for direct transfer payments.
2. Discount rates have to be adjusted, as farmers' private rates of discount are higher than the social rate of discount.
3. Negative (off-site costs) and positive (off-site benefits) externalities are incorporated in the analysis.

As a financial analysis – and this is what this tool kit is concerned with – CBA is conducted from the perspective of the individual firm, in our case the farm household. In general, it involves the comparison of alternatives against a base scenario over time. The value of any alternative can be estimated relative to the base case. Very broadly, alternative can mean any activity. This means that agricultural practices as well as changes in crop productivity can also be – and probably should be more often – compared with non-farm and off-farm employment opportunities[1]. Even when this is not explicitly a research objective it is necessary to look into the issue of alternative employment opportunities as they affect labour availability – now and in the future – and labour cost – an issue that will receive more attention in parts 2 and 5.

CBA provides relevant information on the economic aspects of alternative agricultural practices – including soil conservation technologies – at the farm level. In order to capture the time dimension CBA discounts the future benefits and costs of any alternative course of action to take account of the preference individuals express for present over future consumption. This

[1] This applies also to market imperfections and policies whose impacts can also be assessed within the framework of CBA.

is extremely important as the stream of costs and benefits changes over time. This is particularly the case for tree crop enterprises where no benefits can be realized until the first fruits are harvested and sold, the first fuelwood has been taken to the charcoal maker or the first poles to the construction companies. With regard to SLM the long-term perspective is crucial, because we expect changes in productivity to be different for alternative treatments.

If the present value of the benefits exceeds the present value of the costs, i.e. the net present value (NPV) is positive, then it is worthwhile for the farmer to switch from one activity to another. The basic technique is then to discount costs and benefits occurring in different periods and express them all in a common value at any point in time. While there are other economic assessment criteria such as the benefit-cost ratio (BCR) or the internal rate of return (IRR) the NPV is considered to be the best all-round selection criterion.

The NPV from a certain activity over n years is computed as:

$$NPV = \sum_{t=0}^{n} \frac{(Bt - Ct)}{(1+r)^1}$$

where *Bt* and *Ct* are the total benefits and total costs in year *t*, and *r* is the discount rate. As the proposed research is designed to investigate alternatives in particular to compare soil (and water) conservation (*sc*) with conventional farming (*cf*) the equation form changes to:

$$\Delta NPV_t = \sum_{t=0}^{n} \frac{[(Bt^{sc} - Ct^{sc}) - (Bt^{cf} - Ct^{cf})]}{(1+r)^1}$$

where ΔNPV_t denotes the change in NPV.

If the change is negative it is obviously not in the interest of the farmer to adopt the soil conservation technology assessed. If the change is positive then it is likely that the farmer considers adoption, although we should not forget that farmers are not profit-maximizers who base their decisions solely on the economic criterion or indicator. Likewise, between two alternative conservation technologies, a farmer is likely to shift if the change is positive. A good example here is the superiority of contour strips with pineapples over contour strips without pineapples.

The approach is straightforward. All that needs to be done is to identify the relevant parameters that make up *Bt* and *Ct*, quantify all the inputs and outputs, and finally value them. Part 3 takes us through this step-by-step process. The valuation part is explained in parts 5 and 6.

What have we learned?

The introduction has three basic messages. First, to assess the value of soil conservation requires a comparison of agricultural activities. CBA is a comprehensive yet user-friendly tool, which allows us to evaluate alternatives from different perspectives. This tool kit focuses on the private perspective and CBA can help us to determine which of the two options – soil conservation or conventional technologies – is more profitable, i.e. superior in financial terms.

Second, in order to capture the time dimension CBA discounts the future benefits and costs of any alternative course of action. This is important as the analysis allows us to account for anticipated changes in productivity.

Finally, CBA is an interactive, participatory step-by-step process whereby those people affected by decisions assist in the definition of options and their likely impacts. It is thus ideal for participatory on-farm research.

PART 2 – ZOOMING IN

Participatory on-farm research is much more than collaboration between scientists and farmers in experiments. It exceeds the efforts to understand farming systems, cropping patterns and preferences farmers may have for particular land management practices or crops. If we really want to gain insights into the decision making of farm households and calculate NPVs, or any other sustainability indicator our evaluation has to start with the landscape (i.e. the biophysical and socioeconomic characteristics) and not with the farm. Although farming systems and livelihood strategies in rural areas are highly diverse, most CBAs assume a homogeneous rural community. Much time is spent on describing differences in farming systems and cropping patterns. Far less time is devoted to an analysis of the socioeconomic, institutional, and policy environments, which tremendously influence what the members of a farm household can do, do and/or want to do[2]. Understanding the rural setting and economy is crucial in determining correct values for the CBA. This includes in particular the costs of labour, the time horizon, and the discount rate.

The rural landscape is composed of not only diverse communities. People living in any particular community or setting are also not a homogeneous mass that can be defined easily. The 'representative farm household' unfortunately does not exist. Farm households within one community (village or settlement) are characterized by differences in human capital and other resources, which have considerable effects on their livelihood strategies as well as willingness and ability to change. Take for example differences in income generation, wealth, and age. An older farmer who lives on remittances from children living and working in urban areas has a very different perspective compared to a young woman farmer who has to stay on the land to take care of her children. Both may be involved in exactly the same farming activities, but may look at alternatives in very different ways as they have different labour costs, time horizons, and discount rates. It is thus erroneous to use (for all farmers) the minimum wage rate as the labour cost; some predetermined time horizon, which is perhaps based on the time it takes for changes in productivity to become pronounced; and a fixed discount rate.

Nagatalevu *et al.* (1996) have analyzed the differences among communities in the ginger growing areas of Fiji. Within the four areas examined they describe differences not only in farming systems and cropping patterns but also in access and control of resources, income generation, goals and objectives, and general production constraints. Add to these variables accessibility, land tenure arrangements, and market development and it is obvious that farmers are not only faced with different prices, but that they have also different opportunities and perceptions. The issue of perceptions is crucial, as an ex-ante analysis cannot rely on existing data and values. Perceptions of the future vary not only across the landscape but also within any given community. They differ between men and women, among wealth and age classes, and probably between newcomers and longtime residents.

Accessibility can mean many different things. For the purposes of CBA two issues are important. First, accessibility determines output and input prices. As a rule, farmers in a remote village receive less for the same product (due to higher transport costs) than farmers living close to the main road or the nearby market. Likewise, living in a remote area means that most

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2 This does not mean that biophysical determinants are irrelevant. They are very important particularly in Fiji where rainfall patterns explain to quite an extent differences between the dry and wet zones. However, since most of us are more familiar and aware of the biophysical issues they are not stressed in this guide.

agricultural inputs are more expensive. While this affects the valuation step of the CBA, some inputs may not be available at all, which restricts the number of alternatives.

Accessibility, however, also means access to natural resources. Of prime importance here is access to fertile farmland and/or forests that can be converted for agricultural production purposes. The length of fallow period and abundance of soil resources has to be reflected in the choice of study sites and selection of alternatives. In other words, where permanent cultivation does not reflect current agricultural practices, it should not be compared with soil conserving practices. Instead soil conservation needs to be compared with long-fallow and short-cultivation practices.

The diversity that we encounter in the rural landscape and economy has an historic dimension, and needs to be considered during four stages of the research, i.e. ❶ site selection, ❷ participant selection, ❸ treatment alternative and ❹ valuation[3]. This requires that we zoom in from the smaller to the larger scale to familiarize ourselves with the conditions before choosing the location of the on-farm research and to ensure that we have sound mega-data in order to understand the research results.

❶ To be policy relevant, site selection should be driven first by socioeconomic and second by biophysical characteristics. Key determinants in choosing sites are:

- market integration (cash cropping or subsistence orientation);
- accessibility (including infrastructure development and resource-use restrictions);
- land tenure arrangements and land security;
- land use and settlement history;
- interactions and dynamics between forest and agriculture;
- population composition and growth (demographic pressure, migration flows etc.); and
- share of agricultural income of GDP.

❷ Just as important as the selection of sites is the selection of appropriate participants (about 30 is suggested). First of all, they should be willing to participate and interested in the research. Second, villagers within one community need to be stratified according to wealth, agricultural income share of total income, age and – if applicable – gender. While it is not necessary to consider any possible combination of the three of four variables in the sample, it is crucial to understand which type of participant is involved in the research and how well he or she represents the community.

❸ Treatment alternatives should be determined in close collaboration with participating farmers. It makes no sense to test alternatives that nobody wants or are so complicated that they endanger the research process. Only such inputs and outputs should be considered that can be bought and sold with relative ease in the local market. The conventional or base treatment should be a realistic reflection of current agricultural practices. Inventing 'traditional' practices that do not have a tradition defeats the purpose of the research.

❹ Valuation is the third step in the CBA. In particular, aspects ❶ and ❷ have a bearing on valuing inputs and outputs. Here we should also consider whether subsidies or regulations influence prices. In some cases, incentives for land degradation can be so perverse that no incentive is powerful enough to make conservation profitable. If we encounter extremely low or high prices in comparison to world market prices we have to ask what the likelihood is of sustaining

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[3] They are all just as important for extension purposes.

such price levels. We should also give initial thought to risk factors and collect data on such issues as crop theft, damage by wildlife and livestock, and natural occurrences such as storms, floods, droughts, and other disasters. They may affect alternative treatments in different ways. For example, if an annual crop is destroyed the damage valued in financial terms is much lower than the damage to an orchard of several years. Risk aversion will affect ❸, the possible treatment alternatives.

What have we learned?

To be policy relevant, the historical dimension of land use and the diversity of the rural landscape and its economy are factors determining the selection of study sites and treatment alternatives. Factors such as accessibility, land tenure arrangements and demographic pressures influence the CBA. Within a community villagers need to be stratified according to wealth, share of agricultural income, age and – if applicable – gender, as these characteristics affect the valuation of inputs and outputs as well as the time horizon and discount rates to be applied.

PART 3 - CBA AS A STEP-BY-STEP PROCESS

So far, we have not entered the CBA process. What we have done is collected information that will assist us in selecting appropriate study sites, research partners in the villages, and realistic treatment alternatives. We should have a good understanding of the villages where the participating farmers reside, the local economy, policies and regulations as they affect agricultural production and the tenure regimes under which the farmers operate. Furthermore, we should by now be familiar with the general farming systems and the importance of farming to the households. Some of these issues seem self-explanatory or so evident that time spent on them appears to be wasted. However, this is not so, as experience tells us. How often have farmers been told about the value of fodder, when in fact they do not own any livestock? How often has the potential of fuelwood-producing trees been praised when in fact farmers collect deadwood with far less labour input in the nearby forests? How often have traditional farming practices been described or prescribed for experiments, which in fact exist only in the scientists' minds? How often have labour intensive alternatives been proposed that require additional inputs during times of labour shortages? The list of questions could be extended *ad infinitum* to stress the significance of slowly zooming into the study villages and on-farm research sites as well as the importance of inter-disciplinarity. To capture the complexity of the rural landscape and economy and to understand how farmers conduct a CBA from their own personal perspectives requires zooming in, to provide a solid basis for decisions made during the step-by-step process of CBA.

A step-by-step process means that we start with ❶ the identification of constraints and all components – inputs and outputs – that need to be measured, then move over to their ❷ quantification, and conclude the analysis of the treatment alternatives with ❸ the valuation, i.e. the calculation of the assessment criterion. All of this is obvious enough but at times it is difficult. I will briefly discuss the three steps in Part 3 and provide in table format the exact requirements in Part 4.

❶ The objective of the analysis is to compare costs with benefits to determine which among alternative treatments have acceptable returns. More specifically we want to assess the differences between conventional and soil conserving technologies in financial terms to find out which of the two is more profitable in the long term. The identification of inputs and outputs, constraints and opportunities as well as relevant elements for the calculations is not an area where economists have a comparative advantage. It is a truly inter-disciplinary exercise, which requires close collaboration with the participating farmers. According to a cropping cycle, inputs and outputs for treatment alternatives need to be noted and their availability discussed.

The result of problem identification is a checklist of variables that needs to be quantified in the next step. In our particular case we are only interested in partial budgets and investments in only one activity. Nevertheless, it is helpful to identify all aspects relevant to a farming enterprise even if it turns out in the end that one or the other is irrelevant for our purposes. The list should cover:

- materials or physical goods such as seeds, fertilizer, pesticides, tools and equipment (e.g., hoes, sprayers and tractors), storage facilities;
- input supply and product marketing;
- labour by operation and distribution by season (by months is often impractical or unnecessary);

- land (maybe irrelevant if alternatives require the same land area and if there is no difference in land values between comparable plots with different production potentials);
- relative changes in yields due to soil degradation;
- risks and constraints;
- credit sources; and
- farm-gate prices and costs in different seasons (and their trends).

❷ Before any valuation can be done, we have to know what it is that we want to put a value on. In the quantification we measure physical inputs and outputs, such as:

- seeds or planting material;
- fertilizer (organic and inorganic);
- pesticides;
- fuels and other energy;
- tools and equipment;
- labour inputs (in person-days or animal units) for each activity including transport and marketing; and
- changes in yields over time.

Listing for each treatment in table format allows for comparisons between cells. If there are no differences between the cells of two alternative treatments, items can be excluded from the analysis. For example, the use of a sprayer for the application of pesticides is probably treatment-independent. However, the amount of pesticide used may differ and must therefore be quantified. Also, some equipment may depreciate faster in one than another treatment. This needs to be considered.

It is currently not known sufficiently how labour input is adjusted as productivity declines over time. Therefore it is crucial to continue measuring labour inputs under different productivity scenarios.

Finally, we have to agree on the measurement units to be used. They should be local as this facilitates the participation of farmers and communication amongst farmers and researchers. Units also need to be defined. This is particularly important with regard to labour units. Person-days are probably the most appropriate unit although it should be clarified what this means in terms of hours spent in the field. Agreements should also be reached whether measurements are according to volume or weight. Each has its advantages and disadvantages. For comparative purposes this is very important when we measure yields.

❸ Once all of the inputs and outputs have been quantified they need to be multiplied by their prices or costs, i.e. we put a price tag on each of the identified and quantified elements. Here we have to make numerous decisions. We have to decide whether we can use the same values across the board, i.e. throughout the year and for all farmers, or whether prices need to be adjusted because of changing opportunity costs or fluctuations of farm-gate and market prices. Also, we have to find out whether all people receive the same wages as hired labourers. In some cases, women and children may receive less than men. Another aspect is the use of indirect prices where items are not traded in the market. This will be covered in Part 5.

If we are only interested in comparing annual cropping for one year all we have to do is subtract all the costs from all the benefits. This will give us the net value of production (net income) of a given year from a particular field. Discounting is irrelevant. As soon as the valuation period is extended, i.e. the time horizon is more than one year, discounting is necessary. It thus becomes important to choose an appropriate time horizon (how far do we intend to look into the future) and to estimate a realistic discount rate, as the NPV is very sensitive to both parameters. These issues will be addressed in Part 6.

What have we learned?

A properly conducted CBA can provide a wealth of information. Vice versa, a sloppy one can provide very misleading results. The literature is full of examples with studies indicating attractive rates of returns for soil conservation technologies, although adoption rates remained low. One reason is that the step-by-step process was not followed properly. Some elements remained unidentified, others were not quantified properly, while some were valued incorrectly. It is important to move slowly from problem and component identification via quantification to valuation. Many of the necessary tasks do not require an economist at all. Agreements must be reached on units to be used. Finally in the valuation we have to choose an appropriate discount rate and time horizon for the analysis.

PART 4 – GUIDELINES FOR COMPLETING THE EMPTY CELLS

This part of the tool kit provides the nuts and bolts, where we translate the discussion of Part 3 into real numbers and values. The NPV is calculated easily using a spreadsheet programme. The results will only be as good as the programme input and the assumptions that we use for the calculations. We will start with material and labour inputs, continue with outputs and then with the valuation. The first table consists of two main parts. In the upper part we deal with labour inputs, in the lower parts with material inputs. The numbers used in the final column are a guide to the explanations in Part 5.

❶ Material and labour input (example ginger).

Name of farmer						
Operation	**Description and form**	**Labour input in person-days**	**Dates by month**	**Cost per unit**	**Total cost**	**1**
Land preparation	Manual Mechanical	Family Hired				2
Constructing drains		Family Hired				
Establishing barriers		Family Hired				3
Constructing mounds		Family Hired				
Seeding or planting		Family Hired				4
Pruning of barriers at planting		Family Hired				5
Mulching		Family Hired				6
Fertilizer application		Family Hired				7
1. Weeding		Family Hired				8
Pesticide application		Family Hired				7
2. Weeding		Family Hired				8
Pruning of barriers at weeding		Family Hired				5

Operation	**Description and form**	**Labour input in person-days**	**Dates by month**	**Cost per unit**	**Total cost**	**1**
Mulching		Family Hired				6
3. Weeding		Family Hired				8
Harvesting		Family Hired				9
Transport to the village		Family Hired				10
Postharvest field work		Family Hired				11
Marketing		Family Hired				12
Others, such as credit payments						13
Material inputs						**14**
Seeds						15
Seedlings						16
1. Inorganic fertilizer						17
2. Inorganic fertilizer						17
Organic fertilizer						18
Pesticide 1						19
Pesticide 2						19
Fuels						20
Other material inputs						21
Hiring of equipment						22

❷ Outputs

Name of farmer						
Outputs	**Quantity produced**	**Quantity sold**	**Dates**	**Unit price**	**Gross income**	**23**
Primary crop						24
1. Secondary crop						25
2. Secondary crop						25
Minor agricultural products						26
a)						
b)						
c)						
d)						
Wood products						27
a)						
b)						
Other products						28

❸ Valuation

Valuation is the practice of placing monetary values on costs and benefits. In fact, we have already translated inputs and outputs into monetary values above, although we have omitted land as an input. This is justified because we have chosen the comparative evaluation approach and assume that land price under each treatment will remain the same over time. If we assume otherwise we can incorporate residual values into the calculation, which will be higher at the end of the assessment period for the soil conservation alternative.

A closer look at the equation below indicates that we have collected all the information that we need to calculate Bt^{sc}, Bt^{cf}, Ct^{sc} and Ct^{cf}.

$$\Delta NPV_t = \sum_{t=0}^{n} \frac{[(Bt^{sc} - Ct^{sc}) - (Bt^{cf} - Ct^{cf})]}{(1+r)^t}$$

If we are only interested in comparing the production in any given year but not over time, then we have completed the assessment (see appendix for examples). However, in our case we are interested in long-term investments, the NPVs of future costs and benefits, and want to know whether farmers can expect higher returns in the long term and not only in the first year. This means that we have to consider and select appropriate values for the lifetime of the investment n and the discount rate r, because the NPV is very sensitive to both values. Once agreement has been reached, which will be addressed in Part 6, they serve as input in the equation above.

What have we learned?

The real challenge in any CBA is that of obtaining complete records of all costs and benefits. Filling in the blanks is a methodical procedure. Developing the tables properly is crucial. So identifying all the inputs and outputs is just as important as filling in the blanks. If we are only interested in comparing investments of one year we are finished once all the cells are completed and we have deducted the total costs from the total benefits. More difficult is the assessment of long-term investments, which is exactly what soil conservation is all about.

PART 5 – EXPLAINING THE VALUES

The list of data to be collected can be extremely long. In designing the final data sheets it is important to go with the farmers through a scoping exercise to determine which inputs and outputs need to be considered. This has to be done with great care as farmers sometimes do not explicitly view a by-product as important to the enterprise although it is important to the household and may affect the growth of primary and secondary crops or determine the length of fallow period. For example, mushrooms can grow in great numbers on fallow land. If they fetch a high price farmers may opt to extend a fallow period by one or two years.

When determining prices it is important to take into account the seasonal variations that lead to fluctuations due to a changing supply/demand balance. For example, producing off-season vegetables is far more lucrative than producing them during the main season. Also, as we will see below, direct prices are not available for all products. Where we cannot resort to market or farm-gate prices we have to apply indirect market price techniques, i.e. the value is inferred from other market prices. This may be the case for organic fertilizers and firewood where we will use the value of production increases and surrogate prices, respectively (see below for details).

In the following we explain for each farming operation, input and output the crucial steps and the pitfalls to watch out for. The numbers on the left refer to the numbers in the right-hand column of the tables in Part 4.

1 Table headings:

Operation denotes the activity. Not all activities in the table are important (note that the example is for ginger production). It is best to subdivide activities as much as possible. If more than one crop is grown then activities need to be added for secondary and minor crops. The table is designed for both conventional and soil conserving technologies. The rows dealing with the barriers can either be deleted for the conventional technologies or a zero can be filled in.

Description and form provide information on the actual activity and notes the main form, i.e. manual, animal, mechanized. Of particular importance is whether the whole field – and whole fields are the units of investigation – was treated (e.g., at times pesticide applications may not be necessary on the whole field) and whether the farmer was able to complete the task satisfactorily (e.g., good burn, planting at the right time, weeding completed properly and on time, etc.). The last aspect is a quality statement by the farmer, which will help in explaining the variation in yields.

Labour input should be expressed in person-days. People are usually hired on a daily basis and will be able to record how many days they have spent rather than how many hours. Percentages of days are also possible if activities require less than a day. If fields are located at a considerable distance from the village, labour input includes (most likely) walking to the field. It therefore needs to be subtracted from the actual field activity. Ideally for research purposes, all experimental fields are located in proximity to the farmer's house. Finally, we have to note whether men, women or children performed the operations, as they may be paid different wages.

Dates are important for two reasons. First we may be able to explain variations in yield by the timing of activities. Untimely labour input can have dramatic effects on yields. Second, for the valuation of labour it is important to know whether the activity is affected by labour shortages or not.

The **costs per unit** should be expressed in local currency units. Costs can fluctuate over the seasons and can vary among households within the same village. The cost of labour depends on its opportunity cost, age, and gender. It is characterized by seasonal fluctuations when temporary out-migration reduces labour availability. Labour cost is never zero even during times of high unemployment, as people prefer leisure to unpaid labour. Rarely is the labour cost identical with the minimum wage or the government rate. The latter is more than twice as high as what villagers are willing (or able) to pay each other. During abundance of labour, villagers work for less, during labour shortages only for more than the minimum wage. Hired labour can be more expensive than family labour. For animal and mechanized inputs the local rates apply. They may also fluctuate according to season. For all the other inputs we apply the farm-gate price, i.e. the market price plus transport cost. This is important as some farmers may buy and sell in the villages, whereas others prefer the market in the next town for transactions.

Total cost provides the cost calculation for each activity and input. Farmers and researchers should discuss the price and costs of each item and ensure comparability within and amongst villages. If costs and/or benefits appear to be out of line with the ordinary then questions may have to be repeated. It is not possible to avoid misunderstandings. Once they occur original questions have to be reworded and asked a second if not a third time.

2 **Land preparation** does not necessarily consist of only one activity. Labour input has to include all the activities that take place before seeding or planting, such as slashing, burning, cleaning the field, re-burning, hoeing and ploughing. For ginger it also includes the construction of drains and mounds. Both are listed separately in the table.

3 **Establishing barriers** will probably be only necessary in the first year. However, it may be necessary to replant and fill in certain spots. Therefore it is best to use an unmodified table for the following years.

4 **Seeding and/or planting** should include the activities related to all the crops in any given year, i.e. primary, secondary, and minor crops. It also needs to include any failed first seeding and the establishment of seedlings even though they may have died without yielding any crops.

5 **The pruning of barriers,** at planting or later during the cultivation cycle, denotes the time spent to trim the hedges or barriers back. Applying the prunings (mulch) to the field is covered in the next activity. Removing material as fodder, bedding, or firewood needs to be considered here. It includes the time for bundling and transport if the farmer has to make trips in addition to the normal trip back to the house.

6 **Mulching** denotes the time spent to apply cuttings to the field. It should also describe how widespread the mulch was applied, i.e. whether it covered the inter-row areas completely. Usually pruning and mulching are performed at the same time. They are here listed as separate activities to ensure that they are covered.

7 **Fertilizer and pesticide applications** denote all the activities related to preparing fertilizers and pesticides, transporting them to the field (important if fields are distant) and actual field application. The method of application should be described.

8 Weeding is one of the most labour-intensive activities and is often affected by labour shortages. This not only increases labour costs but may, if resources are unavailable, lead to less effective and delayed weeding. Three weedings are usually the maximum. Very important here is the qualitative assessment by the farmer including, if applicable, an explanation why weeding was below standard. Weeding may also include crop protection activities if diseased crops are removed during weeding operations. If such activities can be separated from weeding the table needs to be extended by an additional row for crop protection.

9 Harvesting denotes all the activities that have to be performed before the crops (primary, secondary, and minor) can be transported to the villages including such operations as stacking, drying, and threshing. Once again timing is the essence and farmers should note down whether timing was delayed because of labour shortages or whether harvesting was affected by bad weather. Also, keep in mind that ginger can be harvested and sold as green or mature ginger.

10 Transport denotes the time spent moving the harvested crops to the place of sale or further processing. It may be done manually or with the help of vehicles or animals. It is not fixed but increases with an increase in yields. Thus, a better harvest increases transport costs. This is particularly important in ex-ante evaluations and with regard to distant fields.

11 Postharvest field work denotes all activities such as pruning hedgerows and applying mulch. It may be irrelevant for ginger when taro is planted right after the ginger harvest. The postharvest activity then becomes land preparation for taro.

12 Marketing denotes the processing activities and the actual sale of the products. If products are sold in the market it also includes the cost of transport to the market.

13 Others include activities such as the construction and maintenance of a fence and the upkeep of other equipment.

14 Material inputs include the variable inputs in any given year. If they are bought in the market, farm-gate prices apply. The market price can be identical with the farm-gate price if quantities are low. However, if farmers have to pay for transport then these costs have to be added to the market price. Material inputs include also the hiring of animals for such activities as ploughing or transport, of vehicles for farm operations, and other equipment such as knapsack sprayers.

15 Seeds are either bought or taken from a previous crop. If bought, the farm-gate price applies. Otherwise the price is a reduction in returns of the previous crop plus the labour involved in collecting, sorting, curing, and otherwise treating the seeds before seeding.

16 Seedlings are either bought in the market or from a neighbour, or produced in a farm-owned nursery. If bought, the farm-gate price applies. If produced on farm, then the production costs apply.

17 Inorganic fertilizers are bought in the market. So the market price plus transport costs apply. Not all of the fertilizer purchased may be used in a given year. Only the fertilizer used is costed.

18 Organic fertilizer costs are based on market rates if they are available for sale. Otherwise the estimation of their costs becomes very tricky. They should not be compared directly with inorganic fertilizers as they also improve physical soil structure. The costs of procuring the organic fertilizer can be used. Ensure that all the cost items are included.

19 Herbicides, insecticides, and fungicides are bought in the market. So the market price plus transport costs apply. Not all of the pesticides purchased may be used in a given year. Only the quantities used are costed.

20 Fuels are bought in the market. So the market price plus transport costs apply. Not all of the fuels purchased may be used in a given year. Only the quantities used are costed.

21 Other material inputs include any material used in one year. If it can be used for more than one year and/or for operations on other fields we have to insert at this point a depreciation rate and/or include only a certain percentage of total costs. In partial budgeting, where we compare treatment alternatives fixed assets do not have to be considered. However, it could be that one alternative requires new equipment or has higher depreciation rates for certain equipment. For example, if hedgerows produce firewood or even poles then farmers need a saw or an axe to cut the wood. This is not necessary in the conventional scenario.

22 Hiring of equipment is common and the actual rates apply. Note that rates may fluctuate and that some farmers may not have to pay at all because they are able to borrow from relatives or friends. In this case the lowest local rate applies.

23 Outputs include all the products derived from the plot under consideration. While the scoping exercise should have helped to reduce the number of outputs to a manageable size, it is important not to discard too many minor products. Cumulatively they may be important to the farm household. Their indirect value is their impact on the growth of the primary and secondary crops. In the data sheet we have to note down the quantity produced as well as the quantity sold, the dates of harvesting and sale, unit prices and finally the gross income. The **quantity produced** will indicate the yields and is necessary for comparative purposes (over time and among treatments). The **quantity sold** is usually lower than the quantity produced, because farmers may have retained material as seeds for the next growing season, products may have been spoiled or part of the product is consumed locally. All the products consumed locally will have to be valued by the market price plus the transport cost. It will be higher than the farm-gate price that traders offer in the village. The **dates** of harvest and sale will indicate the time of storage and point out a potential problem. The **unit price** should be the price at which the farmers sold their products. It is the farm-gate price or, in case the product was sold in the market, the market price plus the transport costs. The **gross income** per product should again be calculated by the researcher and farmer in close collaboration. This again provides opportunities for comparisons over time and among households and may help to elucidate constraints and opportunities unrelated to the actual research design and the comparison between conventional and soil conserving technologies.

24 Primary crops include all of the main products, usually only one or two. They are valued according to the prices that farmers receive, i.e. the farm-gate price. Products consumed but not sold will be valued according to the market price plus the transport costs.

25 Secondary crops include all of the secondary products grown in the same season or after the main cropping season. They are valued according to the prices that farmers receive, i.e. the farm-gate price. Products consumed but not sold will be valued according to the market price plus the transport costs.

26 Minor agricultural products include all those agricultural by-products produced during the year. They are valued according to the prices that farmers receive, i.e. the farm-gate price. Products consumed but not sold will be valued according to the market price plus the transport costs. Income for subsistence crops not traded locally, is based on surrogate prices, that is prices of their nearest substitutes are considered. If quantities are sufficiently low, market prices can be used. If quantities are high transport costs have to be added.

27 Wood products include all wooden products produced during the year either in hedgerows or scattered throughout plots. They are valued according to the prices that farmers receive, i.e. the farm-gate price. This is likely for poles or firewood if there is a market. If not, we use surrogate prices. For example, the value of firewood is estimated on the basis of the value of an alternative fuel, e.g., kerosene, after adjusting for the calorific value of the two fuels. If quantities are low it is best to exclude products from the calculations, although this should be noted.

28 Other products include all those products excluded from the top categories, e.g., mushrooms and insects, that are either sold in the market or consumed locally. Once again it is not necessary to include these items if quantities are negligible, although it is of interest to note differences among treatments and changes over time.

What have we learned?

The first important step in quantifying inputs and outputs is a scoping exercise. A serious attempt has to be made to break out of the narrow description of cropping practices according to the cultivation of the main crop. Many other crops may be grown at the same time in any given year, which require inputs and outputs. In intensive farming systems a number of material inputs may be applied. It is important to consider all in the analysis. At the same time, we should not overload the whole assessment process by trying to estimate and value 100 percent of inputs and outputs. That is neither necessary nor practical, which is why the scoping exercise is so important.

The second major issue is the translation of inputs and outputs into monetary values. Prices and costs fluctuate over the seasons and years. A more detailed analysis may even provide insights into probable trends. In addition, costs can differ quite substantially among farm households. Some farmers may rely exclusively on family labour and may not be able to hire in. Better-off households with substantial off-farm income may hire people for certain activities and offer above average village wage rates. It is important to remain with the household during the analysis and not to adopt the 'using average values' attitude.

Most important is to use common sense and to examine why differences between households may be more or less pronounced than originally expected.

PART 6 – CALCULATING THE NPV

We have now reached the final step of the analysis. What we have to do cannot be done easily in the field unless we have a battery-powered notebook or discounting tables (see Gittinger 1982, p. 345). In any case, we have completed the data input and are now asked to provide two additional values, i.e. ❶ the discount rate and ❷ the time horizon. If we are unable to provide these two values, we have missed a very important step during the research. In fact, we should know the two values by now and we should be able to justify why we use 15 and not five percent as the discount rate. Also we should be able to defend our decision on the time horizon of X number of years if we think that X is the appropriate lifetime of the investment.

Part 6 explains the derivation of *r*, the discount rate, and *n*, the time horizon or lifetime of investment. It also discusses ❸ sensitivity analysis as an analytical technique to test systematically what happens to the net returns under alternative assumptions such as higher input and output prices, different yield levels or discount rates, or a delay in benefits. It is a straightforward (and usually quite sufficient) means of analyzing the effects of risk and uncertainty in CBA. Another technique of risk analysis is probability analysis, which is too elaborate for the purposes of assessing the most probable outcome in our case.

The calculation of NPVs requires the determination of ❶ an appropriate private discount rate. Economic analysis uses 'social' discount rates, which do not concern us here. A 'weak spot' in many CBAs is the rationale for the choice of discount rate. The selected interest rate obviously influences the results of the CBA and needs careful consideration (Figure 1). We should therefore spell out why we use a particular rate and explain how it was derived. Discount rates differ among farmers. They are based on several factors regarding the farmers' current status and age, their outlook and attitudes towards risk and uncertainty and the length of waiting time before consumption. For financial analyses, the discount rate is usually the marginal cost of money to the farmer. This often will be the rate at which the enterprise is able to borrow money. Rates from local moneylenders do not apply, as farmers would rarely use such loans for investing in soil conservation. Also at a rate of more than 25 percent and higher, soil conservation is unlikely to yield attractive returns and we do not even have to start the research.

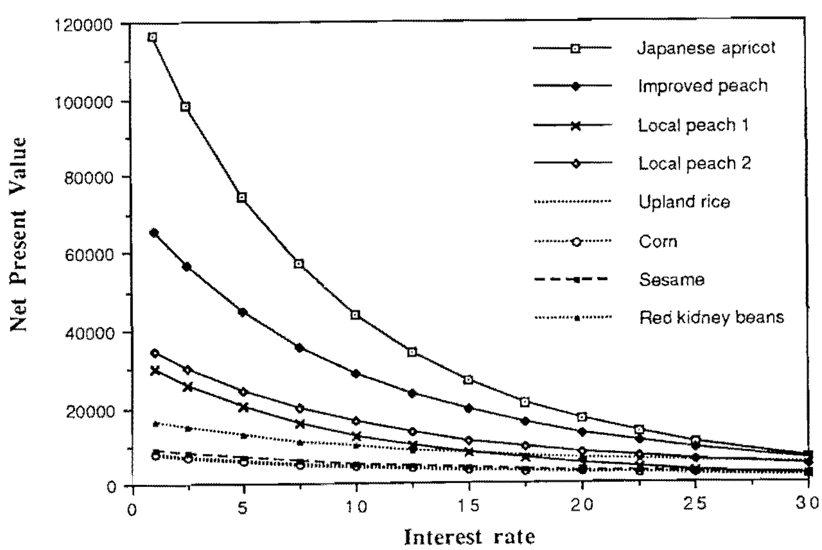

Figure 1. The effects of different discount rates on NPVs of alternative crops in northern Thailand (from Enters, 1992).

Frequently, borrowing and saving rates are not available because such facilities are not accessible to smallfarmers. Where capital is used it is possible to determine the rate of return a farmer normally expects from existing long-term farm enterprises such as livestock or orchards. Private discount rates are usually above a government-subsidized rate; i.e. private individuals employ higher discount rates, on average, than society as a whole. Since the social rate of discount is usually assumed to be 10 percent, private rates of discount would be higher, i.e. between 11 and 15 percent. Most economists recommend using a range of discount rates in financial analysis because of the difficulty in specifying appropriate rates. This can be done in a sensitivity analysis (see below), but probably private discount rates should not be lower than 10 percent and not higher than 25 percent.

The NPV is not only very sensitive to discount rates but also to the choice of · time horizons. Here again the analyst is faced with making assumptions. Some economists argue that many poor subsistence farmers have a time horizon that only goes to the next season because of pressing current needs. This 'shortsightedness' explains the presumed exploitative land-use patterns and the farmers' unwillingness, incapability or disinterest in investing in resource conservation. Poor people, it is further argued, often have no choice but to opt for immediate benefits at the expense of the long-term sustainability of their livelihoods.

It is true that many farmers make decisions to fulfill their short-term needs. However, it is wrong to assume that their decision making is generally guided by short-term thinking. If we accept the villagers' shortsightedness, a CBA of long-term investments in soil conservation becomes an academic exercise and thus meaningless. Using a time horizon of, for example, five years would result predominantly in costs and only negligible benefits.

A minimum criterion should be that the time horizon conforms with the production characteristics of the system or species under investigation, which is particularly important when perennials are integrated. Lutz *et al.* (1994) used one hundred years, while Huszar (1999) suggested that in his case 10 years was the limit, as the farmers' average age was 45 years. They expected to work the land only for another 10 years and did not expect their children to take over the farm. It is probably best to apply a time horizon of between 15 to 25 years. Once again we should be able to explain the choice of a particular time horizon for a farm household and avoid applying the same value to all households across the board. If the purpose of the financial analysis is to examine the returns to investments it is also instructive to calculate the number of years to break even. In this case the choice of time horizon is irrelevant.

We have now been able to calculate the NPV of our two alternative treatments and find that one is more profitable than the other. The values included in the CBA are the 'most likely' or 'best' estimates. The analyst has made many assumptions, and even if he or she has based them on the best information available at the time, the 'what if' questions remain. This is where we apply sensitivity analysis to assess how sensitive the results are to errors or changes in input and output values.

The first step in the sensitivity analysis is to substitute the most pessimistic estimates for each variable simultaneously, and see how that affects the NPV for the treatment alternatives. If ΔNPV_t is still greater than zero then we are able to say that even in the worst case scenario, the expected NPV exceeds the opportunity cost of capital and no further sensitivity analysis is needed. If, however, ΔNPV_t falls below zero, then we have confirmed that the investment in soil conservation technologies is risky and we need to examine further.

This we do in the second step, which is best performed in close collaboration with farmers who may want to ask what happens exactly if prices go up or down, or planners who may want to evaluate the impacts of short- or long-term subsidies. We change an important variable in the analysis and then determine the impact of the change on the outcome. We can either change r or n or make absolute or relative changes to one or a number of cells or a whole column in the input and output tables, although we should keep in mind any input-output relationships. Finally, we can assess by how much yields between treatments have to differ before it becomes worth the farmers' while to invest in soil conservation.

What have we learned?

The importance of selecting appropriate discount rates and time horizons cannot be emphasized too much, as the common assessment criteria including NPV are very sensitive to these two values. A 'weak spot' in many CBAs is the rationale for the choice of any particular value. The selection of any discount rate or time horizon should be justified and explained.

The most appropriate methods for choosing the discount rate are the marginal cost of money to the farm or the rate of return a farmer normally expects from existing long-term farm enterprises. In developing countries private rates should probably not be below 10 percent and they should certainly not be lowered only to make any alternative treatment look more attractive than it actually is.

The choice of time horizons is just as important. Much depends on the circumstances. We should not expect farmers without any land security and under threat of eviction to have a time horizon of one hundred years. At the same time, we should not assume that farmers are shortsighted and in most cases 15 to 25 years should serve the comparison of alternative treatments best.

Sensitivity analysis is a powerful tool for assessing the impacts on risks and uncertainties on outcomes and the rates of returns.

PART 7 – SUMMARY

Investing in soil conservation practices must be profitable or farmers do not have the incentive to modify their farming practices or systems. While this should be unsurprising it is surprising that usually soil conservation is not viewed as an investment and that methods for assessing the economic impacts of soil conservation have received far less attention than methods used to analyze the biophysical impacts.

Numerous methods exist for assessing investments, although not all lend themselves to assessing soil conservation technologies. In general, a 'good' method should:

- be inexpensive – compared to the utility of the results;
- be comprehensive – covering all relevant and important aspects;
- be understandable – thus open to scrutiny and criticism; and
- produce succinct results relevant to decision making.

Although not necessarily inexpensive, CBA is comprehensive, benefits from open discussions about its application, and produces relevant results. It is a coherent method for organizing and presenting information expressed in monetary values, which allows for direct comparison among alternative options such as conventional farming and soil conservation technologies. CBA provides for an interactive process whereby the participating farmers assist in the definition of potential alternatives and their likely impacts. Through their involvement in the CBA process they learn more about potential impacts of resource exploitation and conservation. When pursued with integrity, implicit judgments are made explicit, subject to further analysis and discussion. CBA is thus ideal for participatory on-farm research. Perhaps the most encouraging news is that many of the necessary tasks do not require an economist.

Doing the assessment correctly can provide much useful information for all research partners and decision-makers. Doing it incorrectly can be worse for decision making than by not doing it at all. This tool kit outlines the methodology for doing it correctly. It takes its user through the various steps of a CBA, explains how to derive the input values – most can only be found in the field – and highlights pitfalls.

We have seen that the proper assessment of soil conservation requires a comparison between agricultural activities or alternative treatments. CBA can help us to determine which of the two alternatives – soil conservation technologies or conventional technologies – is more profitable, i.e. in financial terms superior. This does not mean that they are superior in every sense. There may be sociocultural factors of greater importance than returns to labour or land. To be policy relevant, the historical dimension of land use as well as the diversity of the rural landscape and its economy are factors that help us in selecting study sites and treatment alternatives. Factors such as accessibility, land tenure arrangements, and demographic pressures influence the CBA. Within a community, villagers need to be stratified according to wealth, agricultural income share, age and – if applicable – gender. These characteristics affect in particular the valuation of inputs and outputs as well as the time horizon and discount rates to be applied. The mega-data have to be soundly based and described to understand the results of the financial analysis.

When conducting a CBA it is important to move slowly through its three steps, i.e. problem and component identification, quantification, and valuation. The result of problem identification is a checklist of variables that needs to be quantified in the next step. The first important step in quantifying inputs and outputs is a scoping exercise, in which we determine which elements to focus on, and which elements to exclude from the analysis to facilitate data handling.

In translating inputs and outputs into monetary values we have to keep in mind that prices and costs fluctuate over the seasons and years and that both can differ considerably among farm households. During the fieldwork, it is important to resist the temptation to resort to the 'representative household facing average costs', as such households do not exist.

The importance of selecting appropriate discount rates and time horizons cannot be emphasized too much as the common assessment criteria and indicators such as NPV are very sensitive to these two values. The selection of any discount rate or time horizon should be justified and explained. The most appropriate methods for choosing the discount rate are the marginal cost of money to the farm or the rate of return a farmer normally expects from existing long-term farm enterprises such as orchards or livestock. The choice of time horizons is just as important and 15 to 25 years should serve the comparison of alternative treatments best.

Finally, as the values included in the CBA are the 'most likely' or 'best' estimates, we can use sensitivity analysis to assess the impacts of risks and uncertainties on outcomes and net returns and to answer any 'what if' questions.

While it is important during the process of CBA to be methodical, perfection is less important than the use of common sense and putting things in perspective. Farmers are rational decision-makers, but even those maximizing profits may not adopt a practice that the CBA has shown to be financially very attractive.

Two reasons explain the differences between what we have calculated and what we see in the field. First, perhaps we have made a mistake and overestimated the benefits of soil conservation or the costs of soil degradation. Second, while mistakes are always a possibility we should keep in mind that institutional factors also determine opportunities and constraints. For this reason it is crucial to select the study sites carefully, in particular if we want to make comparisons among sites, regions and ultimately countries.

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PART 9 – GLOSSARY

Benefit

Any good or service produced by an activity, project or investment that furthers the objective of the entity from the perspective the analysis is undertaken. In the analytical system outlined in these guidelines, benefits are goods and services that increase the income of farm households.

Benefit stream

A series of benefit values extended over a period of time, generally several years.

Benefit-cost ratio

The ratio of the expected or estimated present value of benefits to the expected or estimated present value of project costs.

Break-even analysis

Determination of the point in time at which an investment becomes (un)profitable.

Change of productivity approach

A method in which the costs of decreased productivity is used to provide a minimum value of preventing an environmental impact such as soil degradation. In the analytical system outlined in these guidelines it considers the difference in crop yields with or without soil conservation technologies, multiplied by the unit price of the crop, less the cost of production.

Cost

Any good or service an activity, project or investment uses that reduces progress towards the objective of the entity from whose perspective the analysis is taken. In the analytical system outlined in these guidelines, costs are goods and services that reduce the income of farm households, which includes the monetary value imposed by a negative environmental impact such as soil degradation

Cost-benefit analysis (CBA)

A conceptual framework for the monetary – in financial or economic terms – valuation of activities, investments, projects or programmes.

Cropping pattern

The area devoted to, and the sequence of, crops produced by a farmer or in a region.

Discount rate

The rate at which future costs and benefits are discounted to reflect the time preference of people.

Discounting

The technique by which total costs and benefits in different years are converted by applying a rate of interest to a common unit so that they can be properly compared to one another.

Family labour

The labour of any farm household member resident on the farm.

Farm-gate price

The price a farmer receives for his or her product or pays for input at the boundary of the farm, i.e. the price without any transport to or from the market or other marketing services.

Hired labour

Labour employed by a farmer that is other than that of the farm family and that is paid a wage.

Input

A good (such as seed or fertilizer) or service (such as labour) used to produce an output (such as a crop).

Interest

A payment for use of money generally stated as a percentage of the amount (principal) borrowed. The rate of interest is also used for discounting.

Internal rate of return (IRR)

The discounted rate at which a project has a net present value of zero.

Investment

Use of resources for a productive activity from which an income is expected to flow at a future time.

Market price

The price at which a good or service is actually exchanged in any location, not necessarily in a village or wholesale market.

Net present value (NPV)

The discounted value of the expected or estimated benefits of a project, less the discounted value of the expected or estimated costs.

Opportunity cost

The value of the best alternative or other opportunity that has to be foregone in obtaining an item or achieving an objective. The opportunity cost of an action is the value of the foregone alternative action.

Output

A good or service produced by an activity.

Partial budget analysis

A budget that addresses itself only to part of an enterprise. The form of incremental analysis designed to show, not profit or loss for the farm as a whole, but the net increase in farm income resulting from small changes such as a change from conventional to soil conserving agricultural practices.

Price

The amount (usually expressed in monetary terms) that must be exchanged for a good or service.

Risk

The extent of expected variability in returns.

Sensitivity analysis

An analytical technique to test systematically what happens to the rate of return under alternative assumptions such as higher input and output prices, different yield levels or discount rates, or a delay in benefits. It is thus a means of dealing with future uncertainties and values and testing the robustness of NPV estimates.

Soil degradation

A broad term for declining soil quality encompassing the deterioration in physical, chemical, and biological attributes of the soil. Soil degradation is a long-term process. Both erosion and nutrient depletion are part of soil degradation.

Soil erosion

Soil erosion is defined as a physical process and refers to the wearing away of the land surface by water and/or wind as well as to the reduction in soil productivity due to physical loss of topsoil, reduction in rooting depth, removal of plant nutrients, and loss of water. Soil erosion is comprised of three phases, i.e. detachment, transport, and deposition.

Stream

A series or sequence of values extending over several years.

Surrogate price

Value estimate of a particular good or service based on the known values or prices of closest substitutes or comparable goods and services under comparable conditions.

Time horizon

Economic life or lifespan of a project or investment for which costs and benefits are considered.

Time preference

The concept underlying discounting. An expression referring to the concept that values received earlier are worth more than values received later.

Valuation

The practice of placing monetary values on costs and benefits.

Yield

In agriculture, the production of a crop per unit of area. In financial terms, the rate of return on an investment.

APPENDIX

Ginger production in Qiolevu, Fiji

Inputs

Name of farmer	**Iliavi Ravu**				
Operation	**Description and form**	**Labour input in person-days**	**Dates by month**	**Cost per unit (in F$)**	**Total cost**
Land preparation	Manual	3		10	30
Establishing barriers	Manual	estbl. by land-use sect.		0	0
Seeding or planting	Manual	3		10	30
Pruning of barriers at planting	Manual	1		10	10
Mulching	Manual	1		10	10
Fertilizer application	Manual	0.5		10	5
1. Weeding	Manual	1		10	10
Pesticide application		0		0	0
2. Weeding	Manual	1.5		10	15
Pruning of barriers at weeding	Manual	1		10	10
Mulching	Manual	1		10	10
3 Weeding	Manual	1		10	15
Harvesting	Manual	4		10	40
Transport to the village		0		0	0
Postharvest field work	Manual	4		8	32
Marketing		0		0	0
Others (such as credit payments)		0		0	0
Total labour cost					217
Material inputs	**Quantity purchased**	**Quantity used**	**Dates**	**Unit costs**	**Total**
Seeds	0	0		0	0
Seedlings	3 bags	3 bags		10	30
1. Inorganic fertilizer (urea)	1	1		30	30
2. Inorganic fertilizer (NPK)	1	0.5		35	17.5
Organic fertilizer	0	0		0	0
Pesticide 1	0	0		0	0
Pesticide 2	0	0		0	0
Fuels					5
Other material inputs	0	0		0	0
Hiring of equipment					5
Total input cost					87.5
Total variable cost					304.5

Outputs

Products	Quantity produced	Quantity sold	Dates	Unit price in F$	Gross income
Primary crop (green ginger)	1,500 kg	1,500 kg		0.5	750
1. Secondary crop (m. ginger)	50 cases	50 cases		10	500
2. Secondary crop	0				
Minor agricultural products	0				
Wood products					
Other products					
Total gross income					1,200
Net income					**895.5**