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A Framework for Analyzing the Socio-Economic Impacts of Agroforestry Projects

By

D. Evan Mercer

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About the Author

Evan Mercer is a Research Economist with the USDA Forest Service, Southeastern Forest Experiment Station, P.O. Box 12254, Research Triangle Park, North Carolina 27709, U.S.A.

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D. Evan Mercer

USDA Forest Service
Southeastern Forest Experiment Station

September 1993

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ABSTRACT

A Framework for Analyzing the Socio-economic Impacts of Agroforestry Projects

Despite the proliferation of agroforestry extension and development projects and the substantial progress which has been made in agroforestry economics since its inception in the early 1980's and, rigorous assessments of actual socio-economic impacts have been almost non-existent.To address this gap in agroforestry analysis, the USDA/USAID Forestry Support Program and the Southeastern Forest Experiment Station are cooperating to develop and test data collection and analytical techniques for assessing the socio-economic impacts of agroforestry projects. This paper represents the first step in this process by presenting a preliminary framework for rigorous, agroforestry, socio-economic impact assessment. The framework emphasizes assessment of impacts on farmer income and productivity in general and the distribution of those impacts within and between households and communities. It addresses the problems cited above of applying conventional agricultural and forestry project analysis to agroforestry systems by combining a variety of standard data collection and statistical and econometric analytical techniques in an innovative manner.

The framework will be field tested in three case studies during 1993-94, one each in Southeast Asia, Central America, and Africa. The results of the field tests will be used to refine the framework, produce specific guidelines for socio-economic impact analysis of agroforestry projects, and to make recommendations for improving project design, implementation, and extension methods. They will also allow determination of the likelihood of success for socio-economic impact assessment given financial and human resource constraints of the assessment team and the characteristics of the agroforestry project such as levels of previous monitoring and evaluation and the geographic, cultural, and socio-economic characteristics of the project site.

A FRAMEWORK FOR ANALYZING THE SOCIO-ECONOMIC IMPACTS OF AGROFORESTRY PROJECTS

I. BACKGROUND

During the 1980's, agroforestry became an established focus of international rural development efforts. For example, the International Council for Research in Agroforestry (ICRAF) identified 166 agroforestry projects supported by development and research organizations, universities, and government agencies worldwide in 1988-89 (Müller and Scherr 1990). By the early 1990s, the U.S. Agency for International Development (USAID) supported 28 agroforestry research and extension projects in 16 countries in Asia, Latin America, and Africa.

Conventional wisdom suggests that agroforestry projects are capable of providing both ecological and economic advantages to target communities and households. The majority of efforts to evaluate agroforestry projects, however, have failed to adequately assess the socio-economic impacts. For example, after reviewing 108 agroforestry project impact evaluations, Scherr and Müller (1991) report that only 8% assessed economic costs or benefits, 5% examined adoption or distribution of benefits by type of participant, 10% assessed changes in product supply, and less than a third assessed impacts on yields.

Agroforestry socio-economic impact assessment has been hampered by a number of factors including the lack of farm-level input and output data, the lack of standardized methods for basic tree and crop yield assessments, and the lack of guidelines and consistent methods for data collection and analysis (Scherr and Müller 1991). Although economic theory and methods of conventional project analysis developed for pure agricultural and pure forestry systems generally apply to agroforestry systems and projects, agroforestry presents some unique data collection and analytical challenges. These challenges arise from several factors. First, agroforestry systems tend to be much more spatially and temporally complex than the agriculture and forestry systems for which conventional socio-economic impact analysis was designed. Furthermore, the typically high variability found within and between farmers' agroforestry fields during the current year and over time and the multiple input and output that characterize (indeed define) agroforestry create additional problems for performing rigorous, statistically significant impact analyses.

Given this background, the USDA/USAID Forestry Support Program and the Southeastern Forest Experiment Station are cooperating to develop and test data collection and analysis methods for assessing the socio-economic impacts of agroforestry projects. The primary objectives of this effort are:

- to develop a flexible framework for socio-economic impact assessment of USAID agroforestry projects,

- to develop guidelines for collecting and analyzing socio-economic data for agroforestry projects and activities, and

- to further knowledge of the socio-economic factors associated with success and failure of agroforestry projects.

This document presents a preliminary framework for ex-post assessment of the socio-economic impacts of agroforestry projects. Successful socio-economic impact assessment requires a solid understanding of the key problems, issues and solutions, and the specific social, economic, and ecological conditions associated with each project. These vary within and between projects and sites. Therefore, the socio-economic impact assessment framework has been designed with intended flexibility in order to accommodate differences in project design, implementation strategies, and local conditions.

In only rare cases would all of the methods described in this document be appropriate for the specific local circumstances and the expertise and experience of the evaluators.[1] Following an initial rapid appraisal of the situation, the evaluators need to use professional judgement to determine the appropriate subset of methods to be utilized. As such, this paper describes a general approach to socio-economic impact assessment which proceeds in three stages (rapid appraisal, formal data collection, and data analysis). Specific methodologies for accomplishing each stage are described without dictating specific step by step procedures.

The framework will be field tested in two or three case studies during 1993-94. Results from the field tests will be used to refine the framework, produce specific guidelines for socio-economic impact analysis of USAID agroforestry projects, and make recommendations for improving project design, implementation, and extension methods. Section II of this document presents an overview of the preliminary impact assessment framework. Analytical methods are discussed in Section III, and the data requirements and suggested collection methods for implementing the assessment are presented in Section IV.

II. OVERVIEW

The framework is based on a household level analysis because it has become increasingly obvious that farmer adoption of agroforestry and project success depend critically on the level of financial and economic benefits produced at the household level (Gregersen et al. 1989; Mercer 1992; Scherr 1992). In the absence of significant household-level economic impacts, farmer adoption will be low and production of other impacts will be unlikely.

The economic benefits of agroforestry, however, often extend well beyond the household. For example, any positive environmental externalities associated with agroforestry (e.g.

[1]Implementing this method, requires at a minimum the following personnel: an experienced, senior economist and sociologist and two to four local consultants trained in rural data collection methods and agricultural economics or sociology.

watershed protection, reduced soil erosion, reduced deforestation, etc.) may provide additional benefits to local communities and the nation in addition to increasing the income and living standards of individual farmers. Therefore, the framework extends the household level impact analysis to broader social strata.

Objectives. The specific objectives of agroforestry projects typically fall into the following five categories: increasing the number of trees grown, increasing the role of agroforestry in land use, increasing production of specific products or services, improving the well-being of specific target groups, and increasing farmer knowledge of agroforestry (Scherr and Müller 1991). All of these specific objectives serve to fulfill the following two, fundamental objectives of agroforestry projects:

1. to improve the use of rural resources (especially land, water, forest, and human resources) in order to enhance the sustainable development of target communities, and
2. to improve the living standards and quality of life of specific target groups such as the rural poor.

The first fundametal objective relates to economic efficiency (Mercer 1992). Agroforestry projects are promoted to increase the efficiency of the use of rural resources by reducing or eliminating ecologically destructive land-use practices and introducing new or improved agroforestry enterprises in order to produce sustainable increases in incomes and living standards. The second fundamental objective is a social equity or distributive efficiency objective (Ward and Deren 1991). Most agroforestry projects also seek to improve the incomes and living standards of poorer households and communities relative to wealthier households and communities.

Although a wide array of potential socio-economic impacts may arise from agroforestry development projects (Falconer 1990; Falconer and Arnold 1989; Gregersen et al. 1989; Rao et al. 1985; Schwartz and Eckhardt 1985; Tabora 1991), a socio-economic impact assessment operating under budget and time constraints must focus on the most important subset of the potential impacts. Therefore, this study emphasizes the impacts of agroforestry projects on the two fundamental objectives discussed above. Changes in overall income and productivity at the household and community level provide a measure of whether the project has met the fundamental economic efficiency objective. Unless positive income impacts are realized it is unlikely that the project activities will be sustained, and any non-economic impacts will be short lived. Income is interpreted broadly to include both non-market and non-monetary benefits and costs in addition to market inputs and outputs. The impact on target households and communities provides a measure of success in meeting the social equity/distributive efficiency objective. Estimating the socio-economic impact of an agroforestry project in terms of these two objectives requires answering the questions in Box 1.

Production function analysis, non-market valuation techniques, financial and economic benefit-cost analyses, and a Policy Analysis Matrix (PAM) are employed in a spreadsheet

BOX 1. Questions for Socio-Economic Impact Assessment.*

1. Which (if any) agroforestry systems or technologies are being adopted?

2. What is the rate and scale of adoption of agroforestry systems or technologies?

3. How much adoption would have taken place in the absence of the project?

4. How does the net income of project impacted households and communities compare to the non project impacted households?

5. What are the net economic benefits resulting from the project at the household, community, and regional or national levels?

6. What are the relative benefits received by different household members, households, and communities from the project activities?

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* Adapted from Scherr and Müller (1991)

environment to analyze the economic efficiency impacts at the household, community, and national levels. Discrete choice econometric analysis of household survey data is combined with results from the benefit-cost analyses to estimate the social equity/distributive efficiency impacts. As illustrated in Figure 1, the proposed impact assessment process proceeds in three stages: 1) an initial three to four week rapid appraisal, 2) a 10-12 month intensive data collection effort, and 3) data analysis and report preparation. An overview of the objectives and procedures for each of these stages follows.

Stage One: Rapid Rural Appraisal (3-4 weeks). The objective of this stage is to identify a first rough approximation of the negative and positive impacts of the project; the characteristics of target populations, farming systems, and agroforestry system adopters and non-adopters; and the availability and quality of secondary data. The information from the rapid appraisal is used to determine primary data collection requirements and improve the planning, design, and execution of the Stage Two, in-depth, formal surveys and data collection efforts. A variety of rapid appraisal tools are utilized in a triangulation framework (Bruce 1989; Burch 1987; Chambers 1985; ICRAF 1983; Kumar 1987; Molnar 1989; Raintree 1987; Shaner et al. 1982). These include key informant interviews, focus group interviews, community meetings, direct observation, community and resource mapping, informal surveys, and review of project documents and secondary data sources.

Stage Two: In-depth data collection (10-12 months). Based on the results from the rapid appraisal assessment, two in-depth data collection activities are implemented simultaneously over a 10-12 month period. A formal survey of a random sample of households of the total population in the project area serves to collect adoption, production, non-market valuation,

social, economic, and demographic data suitable for statistical analysis. These data are used to answer questions 1, 2, and 3 in Box 1. In addition, based on results from the RRA, a subsample of households are chosen for an in-depth farm budget/production survey to collect weekly crop calendar, land-use calendar, household time allocation, and farm input and output data. The specific process for collecting this information will depend on local conditions and the resources available. More details are provided in Section IV DATA COLLECTION. The farm budget/production data is combined with the household survey data for use in whole or partial farm budgeting, production function analysis, and benefit-cost analysis in order to answer questions 4, 5, and 6 in Box One.

Stage Three: Data analysis. Economic efficiency impacts can be analyzed at three levels: household, community, and national. Household level financial and economic analyses are performed for the representative agroforestry and non-agroforestry farming systems. Production function analysis is used to estimate yields for annual and woody crop components of the farming systems. These are combined with market prices (and/or non-market valuations) of inputs and outputs in a spreadsheet format to calculate net present values of the agroforestry (with project) and non-agroforestry (without project) systems.[2] The difference between these two values represents the financial (and economic impacts) at the household level. These analyses are referred to as *household financial and economic benefit-cost analyses.* The *household financial analyses* calculate the monetary profitability of the farming system and provide insight into the cash income impacts of the project. Adding non-market inputs and outputs to calculate the total net economic benefits to the household provides the *household economic analyses.*

Community level impacts are estimated by aggregating the household level analyses and using shadow pricing to estimate social values for inputs and outputs, including any externalities. Given a project implemented on a national scale and sufficient adoption rates, the regional/national impacts can be estimated by aggregating the community level analyses in a Policy Analysis Matrix (PAM) framework (Pearson and Monke 1987). These analyses are referred to as *social benefit-cost analyses.*

The social equity/distributive efficiency impacts are also evaluated at three levels: intra-household, inter-household, and inter-community. The intra-household analysis emphasizes the distribution of benefits and costs between sexes and generations within households.[3] The inter-household analysis estimates the distribution between households at different socio-economic levels, while the inter-community level examines the distribution of benefits and costs between communities. Data for analyzing intra-household distributive impacts are drawn from the farm budget/production surveys. For the inter-household comparisons, discrete choice, econometric analysis is applied to data from the household surveys to determine the differences between

[2]The number of different systems to compare will depend on local circumstances.

[3]In certain situations (e.g. polygamous cultures or multi-family households) other sub-household groupings may require analysis (personal communication, N. Diamond, USAID/R&D/EID).

agroforestry adopters and non-adopters and to predict the probability of adoption by different types of households. Combining this with the results from the benefit-cost analyses allows estimation of the levels of benefits received by different types of households. Aggregating the household level analysis to the community provides a means of comparing distributive efficiency impacts across communities.

III. ANALYTICAL METHODS

Part A, below, discusses the analytical methodologies for estimating the economic efficiency impacts on households, communities and the nation. A brief description of the overall approach is followed by more detailed discussions of specific techniques such as agroforestry production function analysis, non-market valuation techniques, shadow pricing, choice of discount rates, and the Policy Analysis Matrix. Section B describes the analytical approach for assessing the income distribution or equity impacts of agroforestry projects.

A. Economic Efficiency Impacts

The objective of this part of the assessment is to evaluate the impact of the project on individual, household, community, and ,perhaps, regional or national incomes and productivity. The first question to answer is, "What are the impacts on net cash, farm income from adopting the agroforestry project?" Answering this requires comparing net cash incomes of households participating in the agroforestry project versus non-participating households. The analytical approach to this question is based on conventional, ex-post, benefit-cost analysis (e.g. Gittinger 1982; Gregersen and Contreras 1979; Mishan 1988) in a multiple input and output environment.

In general, biological and farm management data are combined with market input costs and output prices to estimate production functions for multiple input-output agroforestry systems and to calculate the financial (cash) returns to target farmers in terms of discounted net present values (NPV). Production function analysis (described below) allows comparison of the technical or production efficiency of agroforestry versus non-agroforestry systems. Comparing the NPV's of agroforestry and non-agroforestry households with financial cash-flow, benefit-cost analysis provides a measure of the financial impact.

In situations where household level non-market inputs and outputs are significant, a broader analysis is required. In these cases, non-market valuation techniques are combined with the financial analysis to estimate the net present value of total economic benefits (cash + non-cash) received by households. This allows evaluation of the impacts of the production of cash versus non-cash benefits on adoption behavior and project success. Aggregating over all farmers and incorporating shadow prices and social values extends the analysis to evaluate the economic impacts at the community, regional and national levels.

Production function analysis. Production functions are mathematical formulations of input-output relationships which describe the rate at which resources (inputs) are transformed into final products (outputs) (see Doll and Orazem 1978; Färe et al. 1985, Lovell and Schmidt

1988). Production functions depict either the maximum level of output that can be produced while holding inputs constant, or conversely, the minimum amount of inputs to produce a specified output level. Dual cost, revenue, and profit functions can also be estimated by including prices in the production function analysis. Optimizing these functions allows one to generate *production possibilities frontiers (PPF)* which consists of all the possible optimal combinations of inputs and outputs for a given technology and set of prices.[4]

Two types of efficiency can be analyzed via production function analysis. *Production (or technical) efficiency* of an agroforestry system relates to the degree that the production process maximizes physical outputs while minimizing or holding inputs constant. It is measured by the degree to which the system operates on the *PPF*. In contrast, an agroforestry system is considered *profit efficient* if it produces the maximum amount of outputs (i.e. it is production efficient) using the combination of inputs that maximizes profits for a given set of prices (i.e. it is allocatively efficient) (Lovell and Schmidt 1988). Comparing the production and profit efficiencies of agroforestry and non-agroforestry households provides a measure of the productivity and income impacts of the project. The technique also allows measurement of the impacts of human, capital, and land and water resources on productivity.

Unfortunately, production functions cannot be explicitly observed in the real world. Rather, only the different combinations of outputs and inputs of existing production systems are observable. Statistical analysis of these combinations allows derivation of an approximation of the actual production function and estimation of the technical efficiency of the individual agroforestry and non-agroforestry production systems. This is typically accomplished by using least-squares regression techniques to draw a line of best fit through the empirical input/output data points (Bauer 1990). Then, regression coefficients are calculated to determine the magnitude and sign of the effect of an additional unit of each of the inputs on the overall output of the system.

Very few production function analyses of agroforestry systems have been performed. For example, in Swinkels and Scherr's (1991) annotated bibliography of agroforestry economics, only 8 of the 230 entries (3.4%) even mention production functions. Most of those 8 citations are qualitative descriptions of or recommendations for conducting production function analyses. Only 1 of the papers actually attempts estimation (Abu 1989).

Few agroforestry production function analyses have been conducted for two main reasons. First, production function analysis requires many observations of input-output relationships at different levels of inputs, data which must either be collected in household surveys or from research station experiments (Swinkels and Scherr 1991). Unfortunately high-quality input-output data over an entire agroforestry rotation has rarely been available (Sullivan

[4]See Mercer (1992) for examples of agroforestry production possibilities frontiers.

et al. 1992).[5] The approach outlined in this paper suggests techniques for collecting the required data or using bio-economic modelling to simulate the data.[6]

Second, production function analysis has historically been undertaken for single output, several input, agricultural production systems (Capalbo and Vo 1988). Most attempts at applying econometric production function analysis to multiple-output, multiple-input systems have met with only partial successful (for example: Just et al. 1983; Muller 1980; Shumway 1983; Weaver 1983). Recently, however, new approaches have been suggested for overcoming the problems of multiple input and output production systems. These include Huffman's (1988) *endogenous switching econometric models* and the non-parametric, mathematical programming approach referred to as *data envelopment analysis* (Seiford and Thrall 1990; Färe et al. 1985). Both of these techniques will be tested during the case study field tests of the impact assessment framework.

The second step in the analysis is estimating the profit efficiency of agroforestry and non-agroforestry systems with respect to the estimated production functions and the objective function of the farm household. Two approaches exist for tackling this problem. In traditional production analysis, firms (households) are assumed to maximize profits. In the more recent *household production models* (the prevailing conceptual paradigm for examining the economics of small farm households), households are assumed to maximize overall household utility rather than strictly profits (Mercer 1991; Singh et al. 1986). Estimating household production models, however, is extremely data and time intensive, and recent work suggests that economic cash-flow, benefit-cost models are theoretically comparable and empirically easier to implement than household production models (Jenkins and Harberger 1988).

Economic cash-flow models have additional advantages. First, by structuring the analysis on an incremental basis, economic opportunity costs and inter-party transfers are explicitly considered. Second, by constructing separate cash-flows for households, communities, the nation, and involved agencies, one can examine the project impacts at different levels. Finally, sensitivity analysis is facilitated through the use of micro-computer spreadsheets. This allows the analyst to explore how the total net benefits respond to changes in the system parameters. Thus, economic cash-flow models in a whole or partial farm budgeting context are used in this analysis. Cash-flow models and farm budgeting are briefly described below.

Economic benefit-cost cash-flow models. The basic economic cash-flow technique involves estimating the quantities and values of all inputs and outputs over at least one complete

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[5]Most agroforestry analyses have used adjusted monocrop yield functions, research station results, or the best guesses of experts (for example, Ehui 1992; Karch 1992; Thomas et al . 1992; Wojtkowski et al. 1991; Wojtkowski and Cubbage 1991).

[6]Bio-economic modelling is not discussed explicitly in this document. Clark (1976), Thomas et al. (1992), Wojtkowski (1989), Wojtkowski et al. (1991), and Wojtkowski and Cubbage (1991) provide detailed discussions and agroforestry examples.

production cycle and incorporating them into a computerized spreadsheet (Jenkins and Harberger 1988). The production systems can be modeled from the viewpoints of all levels of analysis including individual households, communities, the national government and development agencies. Since the costs and benefits are typically incurred at different times in the production cycle, an interest rate is used to discount all costs and benefits to the same year (usually year one). The discounted costs are subtracted from the discounted benefits to estimate the *net present value* (NPV) for each system. The relative size of these NPV's is a measure of the relative economic efficiencies of the systems.[7] The system with the larger NPV produces greater amounts of wealth. In most cases, it is also desireable to assess the returns to different factors of production, such as land, labor, capital, and cash inputs. This will be especially important for analyzing adoption behavior. For example, although an agroforestry system may product a larger overall NPV, the NPV per unit of labor may be larger for non-agroforestry systems. Labor scarce and land abundant households then may choose the non-agroforestry system over the agroforestry system in order to maximize returns to the scarcest resource(s). The reason for this choice may be overlooked without examining returns to scarce resources.

The impact assessment framework proposed here performs this analysis at various levels. First, a financial analysis from the household's perspective allows comparison of the household level, cash income impacts. Next, adding household level, non-market benefits and costs provides a comparison of the total wealth impacts for the household. Aggregating households and using shadow pricing to estimate social values for inputs allows calculation of the economic impacts at the community level. Finally a Policy Analysis Matrix can be used to examine the economic efficiency impacts of agroforestry projects and policies at the national level.

The cash-flow analyses can be performed in the context of either partial or whole-farm budgeting (Gittinger 1982; Swinkels and Scherr 1991). Whole farm budgets include budgets for the complete farm household production system and, hence, provide an assessment of the overall impact of the agroforestry technology on the farm household. The impacts of agroforestry are examined in terms of its resource requirements and how it affects other farm household enterprises. Partial budgeting, in contrast, only looks at that part of the farm budget associated with the additional costs and benefits of the agroforestry technology. Partial budgeting, therefore, is used when the agroforestry technology only affects a particular enterprise or sub-system within the entire farm household system.

The choice of partial versus whole farm budgeting depends on the particular project, agroforestry and farming systems involved, and analytical time and resources available.[8] Partial budgeting saves time and resources and may be appropriate when only a single crop or technology is added to existing farms. However, since partial budgets are set up incrementally and often ignore a with-and-without project analysis, the opportunity costs of land and family

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[7]Although other criteria (e.g. internal rate of return, benefit-cost ratio, net pay-back period) are often used, NPV has become the prime criterion in recent years (Hoekstra 1983, 1985).

[8]This choice would be made during the rapid appraisal assessment in Stage One.

labor must be estimated directly. Whole farm budgeting, in contrast, automatically includes these opportunity costs. It also allows estimation of project impacts on total farm income and activities and, therefore, provides a better basis for analyzing the effects of incentives, subsidies, and other government policies on project success.

Valuing Non-Market Inputs and Outputs. Market prices are used for inputs and outputs for which markets exist. However, for most agroforestry project situations (especially those emphasizing subsistence farmers) markets will be non-existent for many inputs and outputs. Three general approaches exist for estimating the value of non-market goods and services and converting them into monetary measures: opportunity cost, surrogate market, and direct elicitation or survey based approaches (Hufschmidt et al. 1983; Kramer et al. 1992; Vincent et al. 1991). Determining which methods to use depends on the local circumstances and should be decided on during the rapid appraisal stage of the assessment project.

The *opportunity cost* approach is based on the principle that almost every economic resource has several potential uses. Since using the resource for one activity requires foregoing its use in other activities, one can estimate the resource's value as the return it would produce in the most profitable, foregone activity. For example, in the absence of fuelwood markets, the value of fuelwood produced in an agroforestry system could be estimated as the value of the opportunity cost of the labor saved in wood collection.

Surrogate market approaches utilize market prices of substitute or complementary goods or services to value the unpriced good. For the fuelwood example, the value of fuelwood could also be estimated in terms of an equivalent expenditure required to produce the same amount of heat from kerosene.

Survey-based techniques rely on directly eliciting the valuations of non-market goods and services. Surveys and games (such as bidding games, budget allocation, and tradeoff games) are used to help elicit people's preferences and willingness-to-pay (wtp) for the good or service. Another survey-based approach, *contingent valuation*, directly asks respondents their opinions on the worth of different goods and services. Statistical analysis is applied to the responses to estimate an average value or wtp for the good (Mitchell and Carson 1989).

Social Valuation (Shadow Pricing). Moving from the household level, financial and economic cash-flow analysis to estimating the economic impacts of the project to the community or nation, requires adjusting prices households face to reflect the social rather than private value of both inputs and outputs. Changing the price or value of a good or service to more closely reflect its *social* opportunity cost, produces a new value called the *shadow price.*[9] Computing shadow prices proceeds in three successive steps: 1. adjusting prices to reflect direct transfer payments from and between governments, 2. adjusting for price distortions in traded goods, and 3. adjusting for price distortions in non-traded goods. Gittinger (1982, chapter 4) provides an

[9]The term shadow price can refer to any price that is not a market price, but the term usually connotes an estimation of the value of the good or service to society rather than to an individual or firm.

in-depth discussion of this process.

Discount Rates. Due to the multi-period nature of agroforestry, costs and benefits are incurred at different times over numerous years. The standard method for accounting for the time differences of cost and benefit flows between systems, is to use a discounting procedure which takes into account the different preferences people have for paying bills or receiving benefits now as opposed to later (Gittinger 1982; Mishan 1988). The basic discounting formula is:

$$V_0 = V_n(1+r)^{-n}$$

where V_0 = value in year 0 of the cost or benefit received in year *n*
V_n = value of the cost or benefit in year *n*
r = discount rate

The choice of the discount rate, *r*, is a crucial (and often controversial) aspect of this procedure (Hoekstra 1985; Hueting 1991; Gittinger 1982; Markandya and Pearce 1988). Hoekstra (1985) recommends using the marginal cost of money to the farmer for the private, household level analysis. He suggests that the discount rate should account for the methods that farmers use to finance investments, i.e. through borrowed capital, equity capital, or foregone consumption. For social benefit-cost analysis, Hoekstra recommends using the opportunity cost of capital, the return on the marginal investment that would just use up available capital. Gittinger (1982) reports that the real rate of the opportunity cost of capital is usually between 8 and 15% with a common choice being 12% for developing countries.

In contrast, Hueting (1991) argues that since the intensity of preferences for future environmental functions of tropical forests cannot be established, one cannot estimate the appropriate discount rate. Markandya and Pearce (1988) state that too much emphasis has been assigned to the discount rate rather than to the proper calculation of costs and benefits. This framework follows Markandya and Pearce. The emphasis of the analysis should be getting accurate estimates of costs and benefits. Then, a range of discount rates can be applied via sensitivity analysis to determine their importance to the final assessment. Finally, suggestions are made to decision-makers as to the evaluators' professional judgement of the most appropriate discount rate(s) used in the analysis.

Policy Analysis Matrix (PAM). The PAM approach provides a logical framework for analyzing the impacts of agroforestry projects and policies at a regional or national level. Therefore, it requires a project covering a substantial portion of the country and with a large number of adopters. In the PAM approach, the results of the private and social benefit-cost analyses are placed in a matrix framework to facilitate policy analysis that is both comprehensible to decision makers and theoretically consistent (Pearson and Monke 1987).

A prototype of a PAM is presented in Figure 2. The PAM consists primarily of two accounting identities. The first measures the profitability from the farmer's perspective, and the second measures the effects of divergences (e.g. market and policy distortions) between observed

Figure 2. Prototype of Policy Analysis Matrix

	Revenues	Costs		Profits
		Tradable Inputs	Domestic Factors	
Private prices/values	A	B	C	D
Social price/values	E	F	G	H
Market + Policy Failure Impacts	I	J	K	L
Market Failure Impacts	M	N	O	P
Policy Failure Impacts	Q	R	S	T
Efficient Policy Impacts	U	V	W	X

Private Profits, D = A - (B + C)
Social Profits, H = E - (F + G)
Output Transfers, I = A - E = M + Q + U
Input Transfers, J = B - F = N + R + V
Factor Transfers, K = C - G = O + S + W
Net Transfers, L = D - H = I - (J + K) = P + T + X

parameters and parameter levels if the distortions were removed. Therefore, the PAM provides a framework for utilizing the results of the benefit-cost analyses to simultaneously measure the extent of transfers between social strata and government organizations caused by the agroforestry project as well as the level of economic efficiency of the agroforestry systems promoted by the project.

The first row of the PAM represents private profitability of the agroforestry system measured across the columns. The second row contains the social prices resulting from the social benefit-cost analysis, and, hence, measures social "profitability" across the columns. The distorting effects of policies, market failures, and projects are represented as any divergence, measured down the columns, between private prices and values and the social (efficiency) prices and values. This follows directly from the process of obtaining the social values. Social values (shadow prices) are obtained by correcting for the effects of distorting policies.

B. Income Distribution/Equity Impacts

The income distribution/equity impacts of the project should be evaluated on at least three levels: intra-household, inter-household, and inter-community.[10] Analysis at the inter-household level provides an estimate of the relative size of benefits received by different types of households within a community, region, or nation. The inter-community level of analysis

[10]Few studies have examined the equity impacts of agroforestry, for examples see Chowdry (1985), Diamond (1992), Hoskins (1987), and Michie (1986).

complements this by comparing the benefits received by different types of communities. However, any analysis of distributive efficiency should recognize that a household is rarely a single homogeneous unit that earns and spends income or produces and consumes goods and services equally (Kumar 1989b). Rather, age and gender differences typically determine which household members incur the costs and which household members receive the benefits from development projects.[11] Hence, assuming that income increases are invariably translated into greater welfare for all household members is often incorrect. In order to address these differences an intra-household analysis is required. The evaluators should examine and document the income sources of all household members, determine which household members make decisions and control household income creation and distribution, and examine the changes in all household members' access to cash, consumption goods, and services resulting from development project interventions.

The framework presented here is based on the assumption that the two most important ways that agroforestry projects can help the poorest communities and the poorest households within communities are: 1. facilitating increased productivity (and profits) of poor, small farmers and 2. providing increased employment opportunities for the rural poor. Although certain types of taungya systems may create significant employment opportunities, in most cases the most important factors determining the distribution of agroforestry project benefits among small farmers are the system's relative profitability and farmer adoption behavior, i.e. which groups adopt the agroforestry technology and when (Mercer 1992; Raintree 1983). This provides the primary focus of this part of the impact assessment framework.

Estimating employment impacts. The primary means of estimating employment impacts of agroforestry projects is analyzing household histories of off-farm employment, particularly the place of employment, the types of activities, and levels of re-imbursement. These histories will be elicited during the rapid appraisal stage and through the household surveys in Stage Two of the impact assessment framework. The quantity of and income from agroforestry related employment will be compared to non-agroforestry related employment (including non-agricultural on-farm sources) for different socio-economic groups.

Estimating small farmer impacts. Results of the benefit-cost analyses are combined with household survey data to estimate the distributive impacts on small farmers. Discrete choice, econometric models are used to analyze the relationship between household characteristics and agroforestry adoption behavior (Ben-Akiva and Lerman 1985; Greene 1990; Hausman and Wise 1978). Discrete choice models allow rigorous, multiple regression style analysis of the probability that individuals (or households) with certain characteristics make specific choices between discrete alternatives. The alternatives, for example, might be agroforestry vs non-agroforestry farming systems or improved agroforestry systems vs traditional agroforestry systems.

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[11]In cultures (e.g. polygamous) in which several sub-household groups or families live together, other factors (e.g. the social positions of the various wives) may also play a role in determining the distribution of benefits and costs (see Diamond 1992).

Discrete choice models are based on the assumption that individuals choose the alternative that produces the greatest household utility. Since the individual's utility function is unknown to the evaluator,[12] it is viewed as a random variable with a particular parametric probability distribution and an observable mean value. The probability that an alternative is chosen is defined as the probability that it provides the greatest household utility amongst the available alternatives. In essence, discrete choice econometric analysis allows one to regress a wide variety of independent variables on the probability of choosing between discrete alternatives. These variables might include, for example, income, education, farm size, household size, soil type, risk preferences, labor availability, credit availability, extension services or methods, and land tenure.[13] Thus, in addition to estimating the distributive impacts of agroforestry projects, one may also analyze the policies that inhibit or encourage certain groups to adopt agroforestry. Finally, this type of analysis allows one to identify whether constraints to adoption can be addressed through extension, institutional, or policy reforms or if the technology is fundamentally inappropriate.

This analysis proceeds in three steps. First, the probability that households with common socio-economic characteristics will adopt the project agroforestry system is empirically estimated with discrete choice econometric models. Next, the number of households in each socio-economic group identified in the discrete choice analysis is multiplied by the probability that households in those groups adopt the agroforestry system to estimate the number of each type of household that adopted the system. Finally, the number of each class of adopters is multiplied by the increase in net economic benefits provided by the agroforestry system. This provides a quantitative estimate of the economic benefits received by different socio-economic groups.

One of the most crucial problems for this analysis is defining what constitutes "adoption", "partial adoption", and "non-adoption". These will vary between projects and, hence, need to be explicitly defined and stated for each evaluation. Scherr and Müller (1991; page 244) define agroforestry adoption as, "the continued use over time of new tree/crop/grass/livestock combinations and management practices in farming systems." They identify three levels of agroforestry adoption for project evaluation:

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[12]The underlying utility function is unknown because many of its underlying parameters are unobservable.

[13]Following an exhaustive review of empirical and theoretical studies of adoption of green revolution, agricultural innovations in developing countries, Feder et al. (1985) concluded that risk and uncertainty, farm size, human capital, labor availability, credit, and land tenure are the key explanatory variables for adoption behavior.

1. short term--establishing agroforestry components or practices on an experimental basis,[14]

2. medium term--maintaining and managing the experimental agroforestry system for an extended period of time,

3. long term--accepting the agroforestry system as part of the permanent farming system through expansion on additional lands or re-establishment at the end of the tree component production cycle.

This suggests that adoption data will need to be collected in an historical and dynamic context. The level of analysis will depend on the specific project. Evaluating projects 5-10 years after initiation should allow analysis of medium term adoption. However, analyzing long-term adoption behavior will most likely be possible only 10-20 years after project initiation.[15]

Finally, project evaluators must be careful to clearly specify what is being adopted. Only in rare cases will farmers adopt the exact agroforestry package promoted by the project. Most farmers pick and choose among the project recommendations to adapt the system to their own particular needs and production methods. For example, some argue that long-term adoption and integration into the farming system only occurs after farmers have successfully adapted the system to their particular situation (Scherr and Müller 1991).

IV. DATA REQUIREMENTS AND COLLECTION METHODS

No methodological 'blueprints' exist for developing project impact assessment data collection systems. Likewise, there are no ready-made solutions for data gathering that can easily be adapted from one project and applied to another. Rather, each system has to be developed specifically to fit the social, cultural, and institutional environment of the project (Norton and Benoliel 1987). Therefore, a general approach to data requirements and collection methods is presented in this section assuming that it will need to be adapted, refined, and adjusted for each particular assessment exercise. The data requirements and minimum data sets for the rapid appraisal, economic efficiency analysis, and social equity/distributive efficiency analysis are presented and discussed in section A. Depending on the cultural and social standards in specific areas, individuals may be sensitive about revealing details about many of the variables to be elicited (for example income, production, credit, land tenure, etc.). In these cases, one will have to rely on triangulation and indicators to develop proxy variables. For

[14]Some farmers may temporarily adopt the agroforestry system for "non-economic" reasons, for example to curry favor with important officials in the hopes of receiving future benefits (Diamond 1992). These should be investigated during the rapid appraisal stage to determine the potential importance of this type of strategic behavior.

[15]For example, Rogers (1983; cited in Scherr and Muller 1991) reports that it took 9 years to achieve widespread adoption of hybrid maize (a highly profitable, easily adoptable technology) by educated and innovative farmers in the U.S.

example, the type of housing, roof materials, or possessions such as radios, watches, or lamps can be used for income indicators.[16] In section B, the methods used for the rapid appraisal, household surveys, and farm budget/production surveys are outlined.

A. Minimum Data Sets

Rapid Appraisal. During the first stage of the socio-economic impact assessment, the team utilizes rapid rural appraisal techniques to obtain an overview of the project, households, communities, and farming systems in the project area. Table I provides an example of the minimum data set to be collected during this phase. Methodological sources and example indicators are listed for each of the minimum set of variables. The list in Table I represents an ideal. For many of the variables, secondary data will be the prime data source and will be verified through key informant interviews, focus groups, and community meetings.

Recall, that the objective of this phase of the assessment exercise is to identify a first rough approximation of the negative and positive impacts of the project and the characteristics of target populations, farming systems, and agroforestry system adopters and non-adopters. The information from the rapid appraisal exercise is used to determine primary data collection requirements and improve the planning, design, and execution of the Stage Two, in-depth, formal surveys and data collection efforts.

Table I. Rapid Appraisal Data Objectives and Example Indicators

VARIABLES	SOURCE*	EXAMPLE INDICATORS
PHYSICAL/BIOLOGICAL ENVIRONMENT		
Topography	SD	elevation, average slope, distribution of landform types
Climate	SD	average annual and monthly distribution of rainfall, temperature, solar radiation
Soils	SD	soil type(s)
Hazards and Risks	SD, KI, FG, CM, DO, IS	assessment of potential hazards and risks to farmers such as pests, rainfall, and yield variability

[16]For further details and examples see Bruce (1989), Kumar (1987, 1989a, 1989b), Molnar (1989), Norton and Benoliel (1987).

Table I. Rapid Appraisal Data Objectives and Example Indicators

VARIABLES	SOURCE*	EXAMPLE INDICATORS
SOCIAL/CULTURAL ENVIRONMENT		
Population Density	SD, KI	number per square kilometer
Population Demographics	SD, KI	distribution by sex, age, ethnic group, religion
Economic Demographics	SD, KI, IS, FG	distribution by income classes, occupation, off-farm employment
Forest Products	SD, KI, IS, FG, CM	type and quantity of forest products consumed and produced
Diet	SD, KI, IS, FG, CM	type and quantity of food consumed
Education	SD, KI, IS, FG, CM	distance to nearest school, literacy rate, per cent of school-age children attending school
Infrastructure	SD, KI, IS, FG, CM, DO	amount of paved roads, agricultural/forestry processing facilities, water treatment,
Migration	SD, KI, IS, FG, CM,	rate of in and out-migration
Industries	SD, KI, FG, CM, DO	number, size, profitability of industries in community
INSTITUTIONAL ENVIRONMENT		
Local Government	SD, KI, FG	organization, effectiveness, funding, responsibilities
Community Organizations	SD, KI, FG, CM	number, strength, activities
Land and Tree Tenure Systems	SD, KI, FG, CM	laws, rules, customs, degree of security
Development Assistance Institutions	SD, KI, FG, CM	number operating or planning to operate in community
Development Projects in Area	SD, KI	past, present, and planned projects, success/failure rates and reasons

* SD = Secondary Data, KI = Key Informant, FG = Focus Group, CM = Community Meeting, DO = Direct Observation, IS = Informal Survey

Table I. Rapid Appraisal Data Objectives and Example Indicators

VARIABLES	SOURCE*	EXAMPLE INDICATORS
MARKET ENVIRONMENT		
Market Locations	SD, KI, FG	numbers, distance (kms), temporal frequency, farmer access
Commodities Traded	SD, KI, FG, CM, DO, IS	major crops, livestock, forest products traded and volumes
Output Prices	SD, KI, FG, DO, IS	tree, crop, livestock prices, seasonal fluctuations,
Input Prices	SD, KI, FG, DO, IS	labor, capital, land, materials
Transport Prices	SD, KI, FG, DO, IS	price per kilometer by product
Government Interventions	SD, KI, FG, CM	price supports, subsidies, quotas, etc
LAND USE/PRODUCTION SYSTEMS		
Types	SD, KI, FG, CM, DO, IS	distribution by crops, management practices, size of parcels,
Technical Expertise of Farmers	SD, KI, FG, CM, CO, IS	% of population familiar with and/or experience using technologies
Tree Species	SD, KI, FG, DO, IS	temporal and spatial distribution and uses, census of numbers of trees grown in and around farms pre- and post project
Annual Crop Species	SD, KI, FG, DO, IS	temporal and spatial distribution and uses
Livestock Species	SD, KI, FG, DO, IS	temporal and spatial distribution and uses

* SD = Secondary Data, KI = Key Informant, FG = Focus Group, CM = Community Meeting, DO = Direct Observation, IS = Informal Survey

Economic Efficiency Analysis. Data for the economic efficiency analysis is collected in all three data collection methods, rapid appraisal, household surveys, and the farm budget/production surveys. Table II presents the minimum data requirements, the data collection sources, and example indicators for the Economic Efficiency Analysis. Acquiring good, quantitative indicators for the environmental variables will likely be difficult and in some cases impossible. Therefore, in most cases qualitative indicators or farmer perceptions will have to suffice for these variables. See Weber (1990) for a discussion of environmental and natural resource indicators.

Table II. Minimum Data Set for Economic Efficiency Analysis

VARIABLES	SOURCE*	EXAMPLE INDICATORS
INPUTS		
LAND		
Tree	RA, HS, FS	number of hectares
Crops	RA, HS, FS	number of hectares
Animals	RA, HS, FS	number of animals
LABOR--tree crops		
total labor input	RA, HS, FS	hours or days by type of labor
site prep.	RA, FS	hours or days by type of labor
planting	RA, FS	hours or days by type of labor
weeding	RA, FS	hours or days by type of labor
chemicals	RA, FS	hours or days by type of labor
thinning	RA, FS	hours or days by type of labor
pruning	RA, FS	hours or days by type of labor
felling	RA, FS	hours or days by type of labor
processing	RA, FS	hours or days by type of labor
transportation	RA, FS	hours or days by type of labor

* RA = Rapid Rural Appraisal, HS = Household Survey, FS = Farm Budget/Production Survey

Table II. Minimum Data Set for Economic Efficiency Analysis

VARIABLES	SOURCE*	EXAMPLE INDICATORS
LABOR--annual crops		
total labor input	RA, FS, HS	hours or days by type of labor
site preparation	RA, FS	hours or days by type of labor
sowing	RA, FS	hours or days by type of labor
cultural practices	RA, FS	hours or days by type of labor
fertilizer	RA, FS	hours or days by type of labor
herbicides	RA, FS	hours or days by type of labor
harvesting	RA, FS	hours or days by type of labor
transportation	RA, FS	hours or days by type of labor
LABOR--livestock		
total labor input	RA, HS, FS	hours or days by type of labor
feeding	RA, FS	hours or days by type of labor
medicating	RA, FS	hours or days by type of labor
grooming	RA, FS	hours or days by type of labor
CAPITAL & MATERIALS		
tree seedlings	RA, HS, FS	amount of seed and/or seedlings
chemicals	RA, HS, FS	weight or volume of chemical
tools	RA, HS, FS	number of each type
transportation	RA, HS, FS	number of vehicles
OUTPUTS		
TREES		
fuelwood	RA, HS, FS	quantity per hectare
poles	RA, HS, FS	quantity per hectare
timber	RA, HS, FS	quantity per hectare
fruit	RA, HS, FS	quantity per hectare

* RA = Rapid Rural Appraisal, HS = Household Survey, FS = Farm Budget/Production Survey

Table II. Minimum Data Set for Economic Efficiency Analysis

VARIABLES	SOURCE*	EXAMPLE INDICATORS
OUTPUTS---continued		
TREES--- continued		
forage	RA, HS, FS	quantity per hectare
green manure	RA, HS, FS	quantity per hectare
other	RA, HS, FS	quantity per hectare
ANNUAL CROPS		
yield	RA, HS, FS	quantity per hectare
residues	RA, HS, FS	quantity per hectare
LIVESTOCK		
food	RA, HS, FS	quantity per hectare
manure	RA, HS, FS	quantity per hectare
skin	RA, HS, FS	quantity per hectare
other	RA, HS, FS	quantity per hectare
ENVIRONMENTAL		
soil conservation	RA, HS	change in soil erosion rates, difference in topsoil thickness between agroforestry and non-agroforestry systems
watershed protection	RA, HS	hydrologic changes (volume, floods, sedimentation)
natural forest conservation	RA, HS	change in forest products harvested from natural forest, change in deforestation rates, change in area under shifting cultivation, change in forest quality
crop protection	RA, HS	change in crop damage from wind, sun, rain, etc.
other	RA, HS	

* RA = Rapid Rural Appraisal, HS = Household Survey, FS = Farm Budget/Production Survey

Equity/Distributive Efficiency Analysis. Data for the social equity/distributive efficiency analysis are also collected in all three data collection methods: rapid appraisal, household surveys, and the farm budget/production surveys. Table III presents the minimum data requirements, the data collection sources, and example indicators for the social equity/distributive efficiency analysis.

Table III. Minimum Data Set for Social Equity/Distributive Efficiency Analysis

VARIABLES	SOURCE*	EXAMPLE INDICATORS
HOUSEHOLDS		
Income	HS, FS	expenditures, assets, standard-of-living index, type of dwelling
Education	HS	years completed by members
Household Size	HS	number of household members
Farm Size	HS	number of hectares (productive and non-productive)
Ethnic Group	HS	ethnicity of head of household
Intra-household labor distribution	HS, FS	percentage of time employed in on- and off-farm labor
Type of Farming System (s)	HS	agroforestry vs non-agroforestry
Soil Type	RA, HS	U.S. Soil Taxonomy, FAO/UNESCO Soil Units
Risk Preferences	HS	degree of risk aversion
Credit Availability	HS	cost of credit, subjective probability of receiving credit
Labor Availability	HS	availability of off-farm employment, availability of hired labor
Land Tenure	HS	degree of land tenure security

* RA = Rapid Rural Appraisal, HS = Household Survey, FS = Farm Budget/Production Survey

Table III. Minimum Data Set for Social Equity/Distributive Efficiency Analysis

VARIABLES	SOURCE*	EXAMPLE INDICATORS
COMMUNITIES		
Income	RA	% of houses in a village with concrete/tin roofs, or with access (within 2 miles) to primary and secondary schools, quantity of farm equipment,
Education	RA	distance to nearest school, literacy rate, average number of years of education
Land Tenure	RA	degree of land tenure security
Credit Availability	RA	number of formal & informal credit organizations, cost of credit

* RA = Rapid Rural Appraisal, HS = Household Survey, FS = Farm Budget/Production Survey

B. Data Collection Methods

The data collection process outlined here relies on combining three techniques, rapid appraisal (RA), formal household surveys, and farm budget/production surveys. Combination of the three methods should economize on resources by limiting the sample sizes necessary for collecting data suitable for statistical analysis. RA is used to design the household and farm budget surveys. Combining the data and knowledge from the RA with the household surveys may allow a reduction in the required sample size for the household survey (Molnar 1989). A detailed farm budget/production survey can be extremely costly. However, the results of the household survey data can be used to reduce the number of farms in the intensive 10-12 month farm budget/production data collection effort to a limited but carefully selected number of farms.

1. Rapid Appraisal.

Rapid appraisal (RA) is not strictly a data gathering method, but rather a creative, structured use of a particular set of investigative tools in order to assess a situation, topic, problem, or sector (Molnar 1989). Although the short-term, informal nature of RA usually

does not produce data useful for rigorous statistical analysis, properly applied RA techniques can generate reliable, relatively accurate information and insights for understanding phenomena, processes, and particular problems (Kumar 1987; Molnar 1989). In our case, RA techniques are used as a heuristic device to initiate the formal data collection efforts and to generate sufficient information to reduce the required number of sample points to achieve statistical significance in the subsequent formal surveys.

RA provides an initial, critical understanding of local communities, institutions, farmers, and farming systems without which successful impact evaluation is doubtful. Data and insights from properly applied RA techniques can help to ensure survey instruments are understandable, relevant to farmers' circumstances and sensitive to local issues, improve wording of questions, to determine relevant response ranges for specific variables, determine type, sizes, and sample frames for formal surveys, and to alert local officials and community members of the upcoming formal surveys. Brief descriptions of the main techniques follow. For details on RA methods see Bruce (1989), Kumar (1987, 1989a), Molnar (1989), and Shaner et al. (1982).

Secondary Data. The first step in socio-economic impact assessment should be the gathering of as much pre-fieldwork secondary data and information as possible. Thorough secondary data retrieval and assessment will enhance the quality, uniformity, and efficiency of the evaluation. It enables advance identification of areas where data shortages exist and enables the evaluators to plan subsequent RA and formal data collection activities accordingly. As far in advance of the evaluation as possible, the implementing agency should be requested to assemble the pre-fieldwork data needs. Among the types of pre-field work secondary data and information that should be requested include:

- all project documentation to date,
- descriptive statistics and data on the target communities, to include at a minimum, socio-economics, land-holdings, land-use and production systems, environmental conditions, institutions, religious and social beliefs and customs,
- yield data for crops in both agroforestry and mono-crop production systems,
- yields of fuelwood, poles, fodder, fruit, timber, and green manure in both agroforestry and mono-crop production systems,
- number of trees planted per hectare or seedlings distributed by species,
- type and value of incentives provided to different target groups.
- markets for tree and crop products
- input and output prices

- forest resource and community maps
- history of land-use

Key Informant Interviews. This technique involves interviewing a select group of individuals with special knowledge of the topic of interest and/or who can provide information, ideas, and insights on the project or project area. Informants should be selected from a variety of sources such as project officers, farmers, community leaders, village elders, extension workers, foresters, soil scientists, agronomists, horticulturalists, economists, and government officials. Key informant interviews are most effective in eliciting information on the relationship between the project and observed changes in productivity, incomes, and farming systems and obtaining an initial understanding of the nature and extent of changes in the project area.

Community Meetings. Meetings with the entire community or a large subset of the community provide a means to introduce the project evaluation team, to prepare the community for the upcoming surveys and interviews, and to gather information and ideas for the data collection effort. Generally, these consist of public meetings open to all the members of the community or village. Rather than a discussion between community members facilitated by the evaluation team, community meetings typically involve the evaluation team asking questions and raising issues and seeking responses from the community members. Properly administered, these meetings can generate community-level statistics through the use of pre-designed forms or by quantifying the numbers of "yes" and "no" responses to verbal questions. Community meetings also provide a cross-check for correcting inaccurate information from key informants.

Focus Group Interviews. Adapted from social marketing methods, focus group interviews are being used increasingly in a variety of natural resource research and management situations. They involve discussions among small, relatively homogenous groups of local people or officials facilitated by the evaluation team members. The discussions are typically focussed on a few, key issues with the moderator introducing subjects, using probing questions to keep the discussion moving in the right direction and to insure participation of all the group participants. Focus groups are essential for designing and testing the questionnaires for the formal surveys and for gaining insights into the motivations for adopting or not adopting the agroforestry project interventions.

Direct Observation. Systematic direct observations by the impact assessment team can provide insights and knowledge of the nature of the farming systems, the physical environment, soil conditions, farm management practices, and socio-economic conditions. This process should be systematic using carefully constructed questionnaires and observation forms. Data are derived from observations of the physical environment as well as observing and recording responses in individual and group interviews. In combination with informal surveys, direct observation techniques provide a means to achieve a quick and dirty census of the numbers and types of trees grown by farmers before and after project initiation to give an indication of agroforestry adoption rates.

Informal Surveys. In contrast to large scale surveys based on probability sampling techniques, informal surveys operate on a smaller scale, emphasize collecting data on only a few variables and using non-probability sampling procedures. Questionnaires are typically limited to 10-20 questions and samples of 30-50 respondents are chosen using quota (choosing a sample from each category of community member) or convenience sampling at markets, shops, or other community gathering places.

2. Formal Household Surveys

Well-designed, medium-sized surveys ranging from 200-400 households can provide sufficient information for making valid statistical inferences on, for example, the socio-economic conditions of project area households, distribution of production systems, agroforestry adoption rates, production data, and non-market valuation of agroforestry inputs and outputs. These data are central to the impact assessment. Each household is visited one time for an interview of no more than 1-2 hours. Formal surveys work best for variables in which highly accurate measurements are not necessary but information about distribution throughout the population is required. Thus, these surveys are used to generate data for estimating such things as the proportions of the populations using different farming systems (agroforestry and non-agroforestry), rough estimates of inputs and outputs in the systems, and estimates of non-market prices of inputs and outputs. The surveys must be well planned, all instruments tested in both focus groups and field tests, and utilize well-trained, survey administrators in order to obtain quality data.

Sample Selection. Based on information collected during the RA, a statistically reliable sample frame is identified. A random sample of households are selected from this sampling frame for the survey. A number of sampling techniques are available (for examples and discussion see Schaeffer, Mendenhall and Ott 1979). In most cases *stratified* or *cluster random sampling* methods will be the techniques of choice. Both techniques ensure that certain groups in the population are included when facing constraints on the size of the sample. A stratified random sample is obtained by separating the population into nonoverlapping groups called strata from which separate random samples are drawn. Cluster sampling is a less costly form of stratified sampling in which each sampling unit is a collection (or cluster) of households. Cluster sampling lowers sampling costs when the cost of obtaining a complete listing of the population elements is very high or if the cost of adding observations increases as the distances separating the population elements increases (Schaeffer et al. 1979). Since a complete population census will only rarely be available, cluster sampling will be the most appropriate technique in most cases. Recently it has been suggested that by combining formal household surveys with the results of an RA, the required number of respondents to achieve statistical significance can be reduced (Molnar 1989). For example, Ronald Ng of the World Bank has developed a computer package for determining sample sizes when some data and information is already available from the RA. This will be field-tested in our case studies.

3. Farm Budget/Production Surveys. In order to accurately estimate the net economic benefits arising from the project, more in-depth farm input-output data than can typically be

achieved through a household survey is required. These data are essential for the cost-benefit and production function analysis. Ideally, a statistically valid random sample would be drawn from the population for detailed farm input/output data collection. In reality, given budget constraints, a small representative sample of farms (10-20) are used for intensive data collection over the 10-12 month period. The information from this effort is then combined with the results of the household survey to make inferences for the population as a whole.

Direct observation and measurement by project staff are the most accurate methods for collecting these data. However, this entails a considerable expenditure of time and resources. Given budget constraints, an alternative approach is combining the "farm record-keeping approach" described in Shaner et al. (1982) with farmers' estimations of tree and crop production (described in Murphy et al. 1982) to collect input/output data for a sample of representative agroforestry and non-agroforestry farming systems. Weekly monitoring, direct observation, and measurement by project staff ensure quality control. Basically, farmers are asked to keep regular, often daily records of specific farm activities, primarily inputs and outputs associated with specific cropping and livestock systems.[17] Data on household items such as family income and personal expenditures are generally left out to limit the farmer's record keeping burden (these data are obtained from the household survey information). Farmers will be asked to keep these records over at least one complete cropping cycle (10-12 months). At least once a month, project staff visit the sites to review the record-keeping and insure quality control. Crop calendars and farm input-output schedules will be produced from this data.[18]

V. CONCLUSIONS

Despite the proliferation of agroforestry extension and development projects and the substantial progress which has been made in agroforestry economics since its inception in the early 1980's and, rigorous assessments of actual socio-economic impacts have been almost non-existent. Although economic theory and methods of conventional project analysis developed for pure agricultural and pure forestry systems generally apply to agroforestry systems and projects, agroforestry presents some unique data collection and analytical challenges. These challenges arise from several factors. First, agroforestry systems tend to be much more spatially and temporally complex than the agriculture and forestry systems for which conventional socio-economic impact analysis was designed. Furthermore, the typically high variability found within and between farmers' agroforestry fields during the current year and over time and the multiple input and output that characterize (indeed define) agroforestry create additional problems for

[17]Although, this usually requires some degree of literacy, two successful methods for including illiterate farmers are described in Shaner et al. One approach uses forms with pictures and symbols while the other relies on using literate members of the household (such as school age children) to assist in the record keeping.

[18]See Shaner et al. for examples.

performing rigorous, statistically significant impact analyses.

To address this gap in agroforestry analysis, the USDA/USAID Forestry Support Program and the Southeastern Forest Experiment Station are cooperating to develop and test data collection and analytical techniques for assessing the socio-economic impacts of agroforestry projects. This paper represents the first step in this process by presenting a preliminary framework for rigorous, agroforestry, socio-economic impact assessment. The framework emphasizes assessment of impacts on farmer income and productivity in general and the distribution of those impacts within and between households and communities. It addresses the problems cited above of applying conventional agricultural and forestry project analysis to agroforestry systems by combining a variety of standard data collection and statistical and econometric analytical techniques in an innovative manner.

The framework will be field tested in three case studies during 1993-94, one each in Southeast Asia, Central America, and Africa. The results of the field tests will be used to refine the framework, produce specific guidelines for socio-economic impact analysis of agroforestry projects, and to make recommendations for improving project design, implementation, and extension methods. They will also allow determination of the likelihood of success for socio-economic impact assessment given financial and human resource constraints of the assessment team and the characteristics of the agroforestry project such as levels of previous monitoring and evaluation and the geographic, cultural, and socio-economic characteristics of the project site.

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AGROFORESTRY, SOCIO-ECONOMIC, IMPACT ASSESSMENT MODEL

STAGE ONE
Preliminary Data Collection

RAPID APPRAISAL

Objectives

- Characterize agroforestry and non-agroforestry farming systems
- Characterize target communities, households, and site conditions
- Determine secondary data availability and quality
- Determine rough approximation of rate of agroforestry adoption
- Identify rough approximation of project impacts
- Identify households for Stage Two farm budget/production survey

Tools

- Key informant interviews
- Community meetings
- Informal surveys
- Focus groups
- Direct observations

STAGE TWO
Final Data Collection

FARM BUDGET/PRODUCTION SURVEYS

Objectives

- Collect detailed information on time allocation of household members
- Collect detailed data on production inputs and outputs for representative agroforestry and non-agroforestry farms
- Identify crop calendars, land-use calendars, input and output calendars for agroforestry and non-agroforestry farms

Tools

- Farm record keeping surveys
- Direct observation

HOUSEHOLD SURVEYS

Objectives

- Collect adoption and farm production data
- Collect information to estimate non-market values associated with agroforestry systems
- Collect social, economic, and demographic data for a random sample of households

Tools

- Household interviews

STAGE THREE
Data Analysis

ECONOMIC EFFICIENCY IMPACTS

HOUSEHOLD

Financial Analysis

Objective

- Compare the profitability of agroforestry systems (with project) with non-agroforestry (without project) farming systems from the household's perspective

Tools

- Whole farm budgeting
- Production function analysis
- Bio-economic modeling
- Cash-flow benefit-cost analysis

Economic Analysis

Objective

- Compare the net total value (including non-market values) of agroforestry systems (with project) to non-agroforestry farming systems from the household's perspective

Tools

- Non-market valuation methodologies
- Whole farm budgeting
- Production function analysis
- Bio-economic modeling
- Benefit-cost analysis

COMMUNITY

Economic Analysis

Objective

- Estimate the total economic benefits local communities derive from the agroforestry project

Tools

- Social benefit-cost analysis
- Shadow Pricing
- Non-market valuation methodologies
- Aggregate household level analysis

REGION/ NATION

Economic Analysis

Objective

- Estimate the total regional or national net economic benefits resulting from the agroforestry project

Tools

- Social benefit-cost analysis
- Aggregate household and community level analysis
- Policy Analysis Matrix (PAM)

SOCIAL EQUITY/DISTRIBUTIVE EFFICIENCY IMPACTS

Intra-Household

Objective

- Estimate which household members receive benefits and which members pay costs of adopting agroforestry technologies systems from the household's perspective

Tools

- Time allocation analysis
- Whole farm budgeting
- Statistical analysis of household survey data

Inter-Household

Objective

- Estimate the level of project benefits received by different types of households in local communities

Tools

- Statistical analysis of household survey data
- Benefit-cost analysis

Inter-Community

Objective

- Estimate the level of project benefits received by different types of local communities

Tools

- Statistical analysis of household survey data
- Benefit-cost analysis
- Policy Analysis Matrix (PAM)

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