MULTIPURPOSE TREE SPECIES RESEARCH FOR SMALL FARMS: STRATEGIES AND METHODS

Proceedings of an International Conference held November 20-23, 1989 in Jakarta, Indonesia

The Winrock International Institute for Agricultural Development is a private, nonprofit U.S. organization working in agricultural development around the world. It was established in 1985 through the merging of the Agricultural Development Council (A/D/C), the International Agricultural Development Service (IADS), and the Winrock International Livestock Research and Training Center. Winrock International's mission is to help increase the agricultural productivity, improve the nutrition, and advance the well-being of men, women, and children throughout the world. Its main areas of emphasis are human resources, renewable resources, food policy, animal agriculture and farming systems, and agricultural research and extension. Winrock International's headquarters are located in Morrilton, Arkansas, with regional offices in Arlington, Virginia and Bangkok, Thailand.

Winrock International co-sponsored this conference under the Forestry/Fuelwood Research and Development (F/FRED) Project, for which it serves as prime contractor. Funded by the U.S. Agency for International Development, F/FRED is designed to help scientists address the needs of small-scale farmers in the developing world for fuelwood and other tree products. It provides a network through which scientists exchange research plans, methods, and results. Research and development activities center on the production and use of multipurpose trees that meet the several household needs of small farmers.

The International Development Research Centre (IDRC) is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activities are concentrated in six sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; earth and engineering sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an International Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional Offices are located in Africa, Asia, Latin America, and the Middle East.

The Indonesian Agency for Forestry Research and Development (AFRD), in the Ministry of Forestry, coordinates and supervises nationwide forestry research activities. This research directly supports the Ministry in its major missions of reforestation and land rehabilitation, forest protection and nature conservation, and the rational utilization of forest resources for maximum sustained yield. The AFRD maintains cooperative research programs with international research networks, the private sector and other research institutes.

Cover Photo: Agroforestry in Central Java, Indonesia.

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Editors: **Christine Haugen**
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Co-sponsors: **Winrock International Institute for Agricultural Development**
International Development Research Centre of Canada
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Co-publishers: **Forestry/Fuelwood Research and Development Project (F/FRED)**
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Preface

While a great deal of interest has been expressed in multipurpose tree species (MPTS) in recent years, little has been published on the use of MPTS on small-scale farms. Furthermore, most of what has been published has not been oriented toward the needs of small-scale farmers, or based on research methods in which the results are unique to specific conditions and which are not appropriate in other situations, are therefore unavailable to small-scale farmers for implementation. Yet the need to develop research results oriented toward the needs of small-scale farmers, extending this research information to the farmers, and obtaining research results that are comparable are critical to the future usefulness of MPTS research.

The conference was designed to improve the methods currently used in MPTS research on the needs of small-scale farmers, to orient research efforts toward these needs, to enhance the delivery system needed to make this research available to farmers, and to identify means of standardizing research methods among researchers.

In the spirit of developing a regional network of scientists actively involved in MPTS research, the conference provided a mechanism for the exchange of research plans, methods and results. The emphasis of the conference, however, was on research plans, methods and results that are important and useful in an international context. The conference therefore focused on research methods that could be used to help make research results more comparable between studies and sites.

The conference was divided into four general topic areas: determining end uses, demand and market potentials; evaluating the supply of products; determining extension, implementation, and training needs; and orienting research efforts to small-scale farm needs.

Forty scientists representing ten countries presented papers and poster sessions with their thoughts and ideas. More than eighty scientists and invited observers participated in the discussions.

The intent of the conference sponsors, in addition to providing an open forum for discussion, was to publish and distribute the following proceedings worldwide with the hope that the thoughts and ideas generated will advance the frontiers of MPTS research. The conference outputs are the proceedings plus the opportunity for more than eighty scientists to discuss and debate MPTS research in Asia for four uninterrupted days.

We hope this publication serves as a productive step in the development of strategies and methods for orienting MPTS research to small-scale farm use.

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Acknowledgements

Any undertaking on the scale of organizing and conducting a major international conference requires the generous contribution of time and effort of numerous dedicated professionals. We would like to extend a special thanks to the Agency for Forestry Research and Development for organizing and conducting the conference field trip, and to Forestry Minister Hasjrul Harahap for the opening and closing addresses. We would like to recognize and thank the members of the Conference Planning and Organizing Committees and their respective Chairmen Wartono Kadri and Ombo Satjapradja for their outstanding work in planning and staging this important international event. We gratefully acknowledge the efforts of the three co-sponsoring organizations and their staffs: the Ministry of Forestry of Indonesia, the International Development Research Centre of Canada, and the Forestry/Fuelwood Research and Development Project funded by the United States Agency for International Development and administered by Winrock International Institute for Agricultural Development. Finally, we would also like to thank each participant for preparing an abstract for review by the Planning Committee and for preparing and presenting papers or posters at this conference.

Opening Ceremony

Address by the Honorable Hasjrul Harahap
Minister of Forestry, Republic of Indonesia

Participants of the conference, ladies and gentlemen, scientists and researchers from many countries -- it is a privilege for me to be here with you today. This conference has an important role to play in the search for appropriate strategies and methods for orienting multipurpose tree species research for small-scale farmers. The ideas generated as a result of this conference will contribute a great deal to the development of social forestry in Indonesia, as well as in other developing countries.

One of the fundamental goals of Indonesian forestry development is to improve the socioeconomic conditions of the people of Indonesia. Many farmers live in the vicinity of forests in countless watershed regions. Programs to improve the standards of living for rural communities in these areas include various economic opportunities in agroforestry, forest resource industries, and community forestry.

In many areas of Indonesia reforestation campaigns have had an encouraging impact on local economic growth, and have led to a notable increase in the tree stand volume of various species. These gains have contributed significantly to the rehabilitation of degraded land, and in turn to the preservation of a viable environmental balance in the region. Common products of these multipurpose trees include wood for handicrafts, construction and energy.

A survey on fuelwood for household energy in East Java indicates that the per capita consumption is $0.5m^3$ per annum. If 50% of the East Javan rural households depend on fuelwood for their daily energy needs, the aggregate demand will consume between 6-7 million m^3 of wood every year. The majority of the survey's respondents indicated that the fuelwood for their energy supplies came directly from the multipurpose tree species planted on their farms. Farmers also plant multipurpose trees for soil and water conservation, thus contributing to the preservation of the environmental balance.

We are pleased to note that a field trip to Sukabumi in West Java is one of the highlights of this conference. Sukabumi is one of Indonesia's success stories where local farmers have grown stands of *Paraserianthes falcataria* through their own initiative. This is one of the most popular indigenous multipurpose tree species in Indonesia.

In reference to the agenda of this important conference, to improve the economic welfare of small-scale farmers while protecting the environment, I wish to stress a few important points:

- first, closely study the farmers' economic characteristics and sociocultural background in terms of their existence at both the macro and micro levels;

- second, it is necessary to keep in mind the various constraints confronting the farmers as well as governmental institutions. In this respect, it is of the utmost importance to gain an adequate understanding of the Indonesian Government's programs and policies, especially as they relate to strategy and operational planning. Inadequate insight into these aspects could lead to difficulties in the implementation of the conference's conclusions and recommendations; and

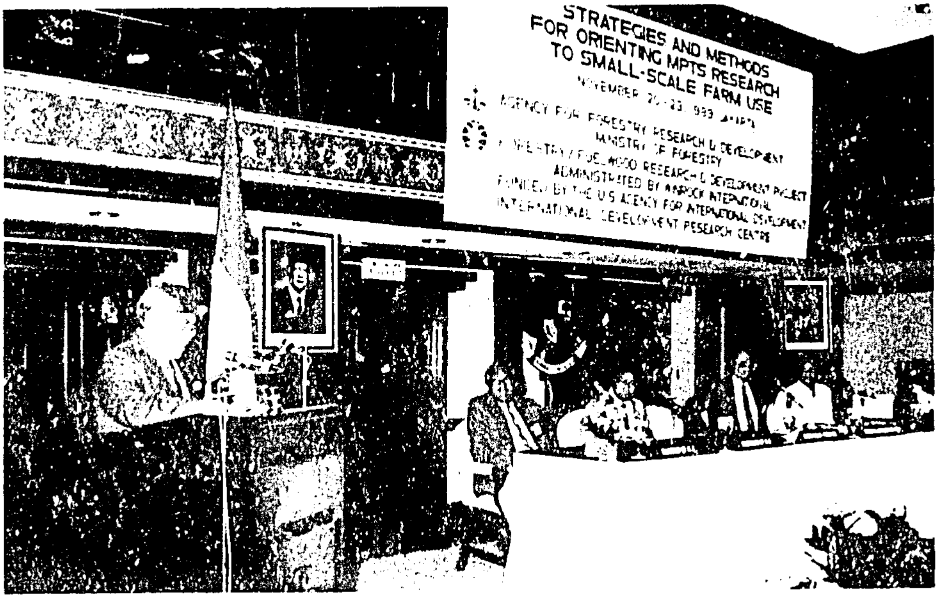
- third, the recommendations can only be carried out effectively if they are accompanied by pragmatic considerations. By necessity they should be well within the reach of all the relevant parties, from the farmer beneficiaries to the various governmental institutions and the private sector.

Before I conclude this speech, I would like to say that the Indonesian Ministry of Forestry greatly appreciates the sponsorship of this conference by Winrock International Institute for Agricultural Development, the U.S. Agency for International Development, and the International Development Research Centre of Canada.

This conference will be of immense benefit to the participants and observers representing various regional institutions. Valuable ideas and information will be freely exchanged among all participants and interested parties for the mutual benefit of us all.

I also extend my appreciation to the organizing committee for the realization of this important conference.

Finally, I declare this conference open.



Address by Thomas Niblock
Winrock International

The establishment and continued growth of the Multipurpose Tree Species (MPTS) Research Network has periodically brought scientists together to encourage research and information exchange on topics of importance to Asia and the rest of the world.

Theme conferences such as this have provided the opportunity for scientists to focus on specific issues of MPTS research and thereby strengthen professional ties while developing regional approaches to specific research problems.

In a special sense, this particular conference represents a culmination of the Network's efforts to promote greater awareness among scientists about small-scale farmers -- the clients of their research. Directing MPTS research toward the needs of these farmers is essential for the future. If, in their enthusiasm for research and intellectual challenge, scientists lose sight of the recipients of their work, they have failed in their mission. Steps leading up to this important conference have included:

- developing a regional social science study of existing tree planting methods practiced by small-scale farmers in Asia;

- conducting a related multidisciplinary study to identify farmers' preferences for tree characteristics to establish guidelines for tree improvement programs;

- exploring alternative methods for on-farm research; and

- conducting economic and marketing research.

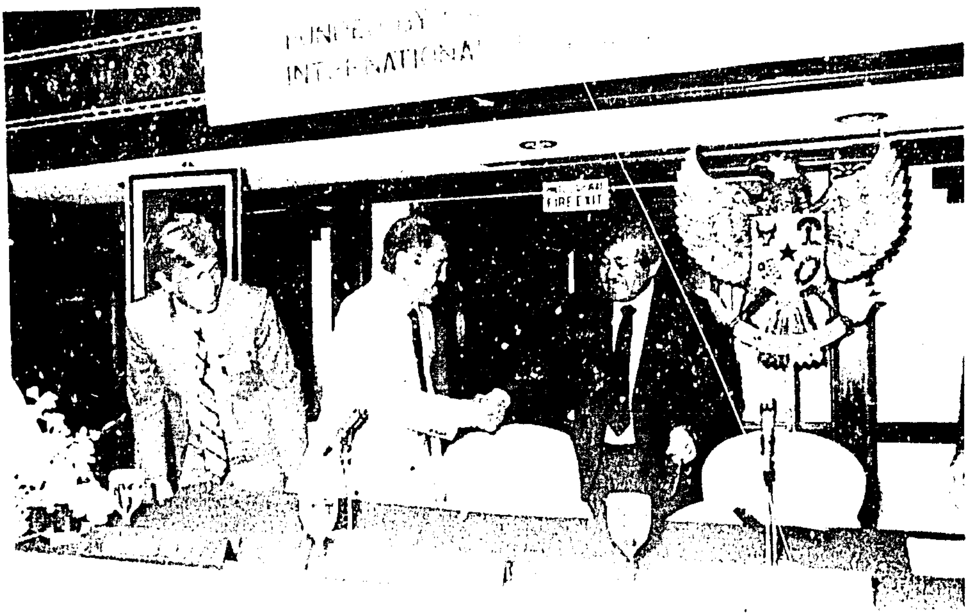
Plans for economic analyses of existing Network trials were made in early 1989, and a training course has been designed to familiarize foresters with strategies and research methods for marketing tree products from small farms.

Both the Network's Steering and Research Committees have stressed the need for making research responsive to farmers' needs. At their last meeting in July at Los Banos, Philippines, the Research Committee recommended that the second five-year phase of the Forestry/Fuelwood Research and Development (F/FRED) Project include regional studies to examine the demand side of MPTS, the effects of introduced species on the rural poor, new markets for MPTS products, and new MPTS-based industries. It was emphasized that generating additional income with MPTS is sometimes more important to farmers than growing them to meet their basic household needs.

This conference moves the Network one step closer to raising the standard of living of the rural poor by helping scientists understand the end uses and markets for MPTS products from small farms, production and supply relationships, extension and training techniques that can bridge gaps between research results and their implementation on-farm, and directing research to the problems and issues of small-scale farmers.

This conference represents a milestone of efforts to bring scientists together to share research findings, and more importantly, poses a new challenge for them to use the benefits of their collaborative research to understand and address the needs of their clients -- the small-scale farmers.

Left to right: Hasjrul Harahap, Thomas Niblock and Cherla Sastry.



Left to right: Ombo Satjapradja, Wartono Kadri and Hasjrul Harahap.

Session 1: Determining End Uses, Demand and Market Potentials

Chairman: Charles B. Mehl

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Session Chairman: Charles B. Mehl

Winrock International
Bangkok, Thailand

The existing and potential end uses of trees and forest products, the demand for existing multipurpose tree species (MPTS) products, and the existing and potential markets for those products need to be assessed in order for MPTS research and extension programs to be effective tools for rural development. Papers in this session center on research methods and strategies to assess use and production of trees by small-scale farm households, both for their own use and for sale.

Sadeque and Mehl review the rationale and methods for a regional study on existing small farm tree and forest use practices. They maintain that a basic understanding of the social and economic factors affecting small farm use and production of trees can best be gained through a combination of comparative studies looking at general socioeconomic trends, and case studies looking at specific issues in depth. They discuss the major design problems of combining flexibility and rigor in defining and reporting social and economic factors across societies in a regional study, and the ways in which these issues were resolved.

Kartasubrata discusses the experiences of a researcher participating in this regional study. He describes field methods and the preliminary results of small farm tree and forest use in two villages in West Java. He provides several suggestions to improve the methodology for regional studies and how to make the study more relevant to the research needs of Indonesia.

Lim compares surveys and participant observation, the two most common types of social science field research. He stresses the importance of building trust between the villagers and the researcher, an important aspect of the participant observation method, to obtain reliable information. He recommends a combination of the two methods, with participant observation used to gain sensitive information, and surveys to collect data quickly over an extensive area.

In contrast, Priasukmana and Dwiprabowo review research methods to determine demand for MPTS products in commercial markets. They provide a method for comparing products through a hierarchy of product groups, classes, lines and product types.

Wickramasinghe describes the methodology used to analyze existing conditions in the dry zone of Sri Lanka and recommends improvements that can contribute to sustainable agricultural systems. She suggests how this approach can be used elsewhere to analyze the potential for introducing agroforestry systems with MPTS.

The final paper returns to marketing. Pabuayon analyzes the role of markets in small farm MPTS production in the Philippines. She stresses the need for an efficient market to move MPTS products from the farm to the consumer, and demonstrates how the concept of efficient marketing can be integrated into MPTS research.

The recommendations of these papers are many and varied, yet several general issues emerge:

- research on social and economic aspects of farmers' use and production of trees and forest products is relatively new, yet it is a rapidly expanding area of study;

- while traditional social and economic research methods can cover some of the important issues adequately, new applied research methods are needed to address most social and economic aspects of MPTS production; and

- most of the new methods and strategies discussed point out the need to break out of traditional disciplinary boundaries.

In conclusion, we should begin to explore the applications of the new methods presented in this session, refine them and conduct preliminary studies. Cross-cultural and site-specific research should continue to be combined. The ideal combination would be a series of comparative studies that provide information on general trends, and specific case studies that explore social and economic applications and conditions.

The results of this research on end uses, demand and markets of MPTS need to be directed to the work of forestry researchers and extension workers, to focus research efforts on existing small farm practices and needs, and potential markets for small farm MPTS products. Several issues should be given priority for research:

- how social and economic conditions common to small farms (small holdings, marginal soils, insufficient capital, insecure tenure, and poorly developed markets) affect their production and use of trees;

- how MPTS can be improved to correspond to those conditions and meet the needs of small-scale farm households; and

- how markets can be developed or made more efficient for small farm MPTS products.

Regional Study on Farm and Village Land/Forest Use Practices: Conceptual and Background Considerations

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The authors describe basic theoretical and methodological issues faced by a group of researchers in the design of a cross-national, cross-cultural socioeconomic study. The regional study on *Farm and Village Forest Use Practices in Asia* emerged from discussions at a workshop on Standardized Methods for Farm and Village Forestry held in Kathmandu. Prior to this study, most regional social science research on natural resource utilization tended to consist of distinct, independently conceived, conducted and analyzed case studies tied together loosely by common themes. An understanding of general trends could only be drawn from the conclusions of the individual studies. Such comparisons are highly subjective and difficult to verify.

Participants in the regional network study are attempting to determine common characteristics and factors affecting villagers' land and forest use practices through a comparative, statistical analysis of standardized information gathered at all the study sites. Lists were assembled of the minimal social, economic, cultural and environmental information required to understand local forest use practices and to implement social forestry programs. It is expected that this process will provide a rigorous and objective regional analysis facilitated by common objectives, established definitions of the phenomena under study, and the reporting of data in a standardized format agreed upon by all the researchers.

Structure of the Study

Researchers

Most of the participants are located in two countries: five in the Philippines (including a national level coordinator) and four in Thailand. Another two are in Nepal and one each in Bangladesh, Indonesia and Sri Lanka. The F/FRED Land and Forest Management Network Specialist serves as the regional coordinator.

All of the researchers except the coordinators are studying two villages each, for a total of 26 villages throughout the region. In addition to a regional analysis of all 26 sites, comparative analyses at the national level will be made in the Philippines and Thailand.

Study Components

The objective of the study is to determine whether selected social and economic relations, processes and institutions affect how people use and manage trees and forests, and whether variations in these social and economic factors contribute to differences in farm and village forestry systems. A major assumption is that two sets of parameters set limits and help to define the type of land use system and tree and forest use practices in a given area. Agroecological conditions such as soil, topography, rainfall, and temperature place limits on the species of trees and their potential growth. The other set of parameters that need to be considered are the social, cultural and economic contexts of tree and forest management and use.

Sites selected for analysis are classified into broad agroecological zones. Basic characteristics of the farm and village forestry systems are studied in two distinct seasons of the year, so that seasonal variations in tree and land use can be observed.

Selected social and economic factors are studied using a variety of field research methods, including observation, discussions with key informants, informal interviews, and formal survey interviews. The researchers write detailed descriptions about the villages and farm and village forestry practices to provide a context for understanding variations in the social and economic factors being compared across the region.

The initial study design consisted of seven categories of data for comparative statistical analysis: background information to include demographic data and information on available infrastructure, agroecological conditions, land tenure and property relations, village leadership and institutions, government development intervention, social stratification, and tree/forest use practices. Two of the categories were later eliminated from the statistical comparative study, although they are still included as part of the descriptive background reports. Social stratification was removed because the major concepts could not be defined in a manner acceptable to most researchers. Local leadership and institutions was taken out because this information tends to be intuitive and descriptive, almost always unique to specific locations, and virtually impossible to report in a form that would allow meaningful comparisons.

The social and economic factors will be compared from the data collected at all the study sites within each agroecological zone. This will determine how differences in social and economic factors influence farm and village forestry systems under similar agroecological conditions. The data will also be analyzed across the agroecological zones, to determine how similarities in social and economic conditions can lead to comparable farm and village forestry systems under differing agroecological conditions.

Levels of Data Collection and Reporting

Data are being collected at the national, regional (district or subdistrict), village and household levels. The national and district/subdistrict level data, collected from secondary sources, are to provide a context for understanding the village and aggregate household data, insofar as national or district level variations in land and forest laws, religious or ethnic composition, or other general social or cultural conditions can help to explain differences among the countries in village level forest use practices. Only one set of national level data is required for each country. Similarly, only one set of district level data is needed, regardless of the number of communities in the district included in the study.

The core of the study consists of village and household level data. A major component of the village level data is climatic, topographic and edaphic information collected by observation and discussions with key informants to provide the basis for dividing the communities into agroecological zones. Other essential village data include general information on infrastructure (ie. markets and transportation), community level institutions, and government interventions such as credit, extension, and development programs in the villages.

The researchers select a sample of 50 households in each of their study villages representing all farm categories, especially poor households. After completing a household enumeration and establishing necessary rapport with the villagers, the researchers administer formal questionnaires to collect the comparative data on background information, government development intervention, and land and property issues.

After the general interviews are completed, researchers select 25 households from among the 50 respondents for in-depth interviews on tree and forest use practices. These households are visited at least twice in the year, in most cases once during the wet season and again during the dry season, to ascertain general seasonality of tree and forest use.

The Need for Standard Definitions

It may seem axiomatic to state that a comparison of social and economic phenomena among several societies requires standard definitions of terms. Yet definitions of social, economic and cultural phenomena are rarely standardized to allow for comparative analysis. Items can be compared only if observed, measured and reported in a manner that makes their comparison meaningful. Rigor in definitions is needed, to allow comparisons of similar phenomena or conditions. Poverty, for example, can be defined in innumerable ways, and indeed almost every government and opposition group, every academic discipline and subdiscipline seems to define it differently. If the concept of poverty or poor rural households is to be included in a region-wide study, it is clear that the study participants must agree upon and abide to a single definition of the concept. If different levels or types of poverty are to be differentiated, then boundaries must be defined clearly to leave little ambiguity between the categories.

Yet even what seem to be commonly understood terms, such as village, household, farm size, and land rental, require considerable flexibility in definition, to allow for a great variety of forms among and even within societies. The following examples are illustrative of how concepts were defined and agreed upon by the study participants, how terms were standardized to allow for adequate flexibility to describe a variety of phenomena in several clearly defined comparable categories, and how the data are recorded using a standardized format that allows comparative analysis.

Agreeing to Common Definitions

Who are Small-scale Farmers?

One of the major objectives of the regional study is to determine whether tree and forest use practices of small-scale farm households differ from the practices of households operating medium or large-scale farms. Defining small-scale farmers may be as complex as characterizing the relative level of poverty and affluence in rural societies.

The participants agreed that rigid, universal cutoff points of specific numbers of hectares for categorizing farm households would be arbitrary and meaningless. It is understood that inter-country and even intra-country variations in the structure of farm households are significant. If a single measure is used to divide farm size throughout the region, then relatively large and prosperous farms in one area will be combined with relatively small and poor farms in another. A farm of 0.5ha of land may be among the largest and richest in much of Bangladesh or in Java, Indonesia. Yet the same 0.5ha in the non-irrigated dry lands of Rajasthan, India or in most of northeast Thailand would be among the smallest farms in those areas, where 4-6 hectares are commonly needed to produce enough to sustain the household. If, for example, a range from 0.5-2.0ha is selected as a cutoff for small-scale farms, the measurement itself becomes so inconstant to the point of being meaningless.

The researchers decided instead to use the FAO definition, which classifies small-scale farmers as low income producers (below the national poverty line or below the national average farm income) with small holdings. Farming, fishing and/or agricultural labor is the major occupation of the household and its major source of income. Their holdings (whether owned, rented or used without payment) are either inadequate to meet their minimum needs or just sufficient to meet those needs. Absolute size of holdings, then, is not as important as the low income and poverty associated with the farm. Researchers use their own judgement in determining the land size categories that help to define the small-scale farmers in their specific study location. Each researcher records the dividing line for small farms, and provides a rationale for using that measure. Other measures of household wealth and occupation help eliminate those small holders who are not poor or who earn substantial income from non-agricultural sources. Farm size, then, becomes a proxy measure for rural poverty rather than a measure in and of itself. Small-scale farmers, whether working less than 0.2ha in Java or less than 4.0ha in northeast Thailand can be compared if clearly and rigorously categorized as sharing the common characteristics of the FAO definition.

Household

Standard definitions of households were discussed at length. The participants concluded that households in the context of the network study would include all individuals residing in the dwelling unit. Members may or may not be from the same family, but they do partake meals from the same kitchen. Domestic servants, house tutors and seasonal laborers who reside in the same dwelling and take meals from the same kitchen during the study period would be considered members of the household. Family members living away from the household during the study period (a son studying in the capital city, a daughter working in another district, a father working overseas) would not be included as household members. Therefore, the definition of households would differ from the family unit, representing the actual consumption and production unit.

Village

Defining a village is usually based upon social delimitation rather than official boundaries. This means that a village boundary is best defined by the villagers themselves, who identify the area and households that constitute the boundaries of a village. Although religious and ethnic characteristics can often decide the size and boundaries of a community, a village community may also incorporate more than one group.

A village in Thailand or Nepal, for example, is the term given to the smallest administrative unit, but it is defined by the number of houses and frequently differs from the way the villagers themselves define their community. A large village community can be divided into several administrative villages, or several small village communities can be included into a single administrative village. To avoid the complexity of deciding what constitutes a village, it was agreed that participating researchers, after discussions with the inhabitants, would be the best judge of defining the area and size of the village community. It was also agreed that the village community should be, to the extent possible, a clearly defined social and spatial unit, and not a unit defined arbitrarily by the government for administrative purposes.

The Need for Flexible Terms

Forms of Land Tenure

Asian agriculture is characterized by many diverse forms of land tenure relations typical of subsistence peasant economies. These forms of tenure arrangements continue to exist even as the rural economy becomes commercialized. While often there are forms of tenure unique to specific locations, there tend to be several broad categories that apply across cultures and countries. General land tenure forms such as cash rental, sharecropping, mortgage arrangements, legal and illegal use of state land, and various forms of common property are broadly defined. To the extent possible, the researchers attempt to categorize the land tenure arrangements found in their study locations according to these broad definitions.

For purposes of comparative analysis, the specific tenure arrangements are not as important as the common, general forms. The number of farmers under sharecropping arrangements and their tree and forest use practices, for example, can be compared among villages and societies, even if those in each country have different obligations and different levels of payment. It is important to note the actual forms of tenure relations, but these are to be included in the descriptive community reports. If deemed important enough for more in-depth analysis, the variations in sharecropping can be the subject of either a later comparative study or a case study.

Defining a District

Due to the considerable variation in social, economic and cultural conditions within most countries in the region, the study participants agreed there was a need to collect background information at a level between the village and the nation, to provide an adequate context for understanding the social and economic phenomena described at the village and aggregate household levels. The topography or ethnic composition of a study community may not be common to the country in general, but may be more typical of the section of the country where it is located. Agreeing to the need for an intermediate level of data collection proved easy, agreeing to the unit of data collection and the generic name for the unit turned out to be quite difficult.

The researchers eventually agreed that the smallest local level administrative unit would be selected that incorporates a number of villages and yet is large enough to house offices of most government agencies. Hence it should be an administrative unit with enough government offices with adequate secondary data, but smaller than a provincial or regional administrative unit that would cover too large an area.

Such a unit in Thailand is an *amphoe*, generally translated as a district. Yet a "district" in Bangladesh covers a much larger area, equivalent to a province in Thailand or a state in the United States. The more appropriate intermediate unit for data collection in Bangladesh is known as the *upazila*, or subdistrict. Administrative units above the upazila are the district (comprised of several upazila) and the division (comprised of several districts). In the Philippines the lowest administrative unit is the *barangay*, often a village in rural areas A municipality or township is composed of several barangay. Several townships and municipalities make up a province, and several provinces in turn make up the largest administrative unit, the region. Researchers from the Philippines, then, agreed that the Philippine province seemed more the equivalent of the Thai district or the Bangladesh upazila. For purposes of the comparative study, the term "district" was defined with enough flexibility to refer to the Thai district, the Bangladesh subdistrict and the Philippine province.

Defining the Categories of Study

As with units of analysis, rigor is required in defining the categories to be studied. In a study on forest and tree product use patterns, high priority was given to defining tree and forest products and the sources of those products. Again, the different categories had to be clearly defined, yet had to be broad and flexible enough to allow a variety of similar products to be included in each category for comparison.

Sources of Tree Products

The different types of forest and tree products used by villagers are obtained from various sources. By method of collection, they may be free public goods, purchased goods or collected from the villagers' own sources. Twelve sources were identified, to account for a range of methods and locations of collection. These include government forests, various types of private agroforestry systems, community forests and other common property, purchased products, and non-tree or non-forest products collected or purchased for the same use as tree or forest products (such as natural gas for fuel).

These are ranked for each household in order of priority by relative volume of collection. The most important source, for example, state forests for fuelwood, is recorded as "1", with all secondary sources ranked as "2" and all minor sources of the product ranked as "3".

Types of Tree Products

Taking an inventory of forest and tree products commonly used by villagers can be an overwhelming task. Tree products commonly used can be quite varied, depending upon access to resources, occupational pattern, variety of productive activities, and diversity in farming systems. To account for these variations across the network study, 10 different uses of tree products and 10 different tree parts were identified. The categories of tree use are fodder; fuelwood; charcoal; fruit and food tree crops; timber and construction materials (used or produced regularly); industrial uses; handicrafts; other regular uses; house construction (occasional use); and other occasional uses. The tree parts identified are leaves; buds; flowers; fruit; green branches; woody branches; bark; wood; roots; and exudates. In addition to ranking the source of each product and the preferred species from each source, the three most prevalent tree parts used for each product are ranked from greatest to least use.

Standardizing Scales of Measurement

Comparing Land Size and Distribution

In many agrarian societies, land is the most critical variable in determining one's socioeconomic status and power, access to productive resources, income, nutrition and other areas of household life. However, it is important to note that per capita land availability, land holding distribution, land productivity, land use patterns and cropping intensity varies among the countries where the network study is undertaken. Therefore, it is only reasonable to expect that no common definition of farm size and nature of land holding distribution can be decided upon to fit all countries and locations.

Land size is determined according to land ownership and operational control of other than owned land, ie. mortgaged and rented land. By taking into account all the different categories of land owning and holding, and deducting the leased and mortgaged land, the household's effective land size may be derived. The household's particular position in the community can be determined by comparing it to the hierarchy of land holding distribution in that particular community and region. It has already been discussed above that the researchers agreed to accept the FAO definition of small-scale farmers. The researchers also agreed that medium-scale farmers would be those farm households with enough land to meet their household needs and to produce or earn an occasional surplus. Large-scale farmers were those with more than enough land to meet their household needs and to produce a regular surplus. The agricultural production can be either subsistence or commercial. If farmers produce most of their goods for sale, medium-scale farmers are defined as those farm households who sell enough of their farm product to meet their household needs.

Each researcher sets his or her own dividing lines between small, medium and large-scale farm households. The important comparisons among societies are the tree and forest use practices of various social and economic groups including the poor, the well-to-do, the small, medium and large-scale farmers, and how they fit within the structure of each of the societies.

Comparing Wealth and Income

As in the case of land, wealth and income comparisons are also highly country and site specific. Unlike land, income is extremely difficult to measure. Obviously, one has to measure or quantify income first, before comparisons or rankings can be made. After lengthy and detailed discussions, the study participants decided that due to the notorious complexity of income measurements, wealth indicators would be utilized as proxies for income in determining the economic status of households. Accordingly, at least three indicators of wealth, ie. mode of transportation, communication (media), household construction, and their relative rank were to be listed for each household. These would lead towards the ranking of the household's economic status as reflected by their wealth.

This methodology may not be the most accurate means of describing the economic status of households as consumerism may not have developed evenly throughout the Asian region. A household in rural Thailand with a television set would rank higher than one with only a radio. Such a comparison would be meaningless in Nepal where there are no televisions. Furthermore, discretion about wealth is also considered a virtue in much of the south Asian region, so an accurate picture of a household's wealth may not be fully evident from observation alone. However, despite these limitations, the indicators of wealth were thought to be the most approximate proxies for evaluating household economic status in the local context. Once again, the ranking would be done according to local judgement based on subjective and objective criteria, observation by the researcher, and discussion with key informants.

Income determination was sub-divided by farm, non-farm, off-farm and other income (remittance, rental, and profit/dividend) sources. They were to be recorded by proportion, cash equivalence, subsistence needs and traded amount. It is expected that through these various possible breakdowns, actual income would be translated into monetary units as closely as possible. Although the respondents may well conceal some of their income, the researchers expect this measure to show the relative incomes of the survey households. The measures of wealth and income are compared with land size, so the analysis of small-scale farm households will not include those with small holdings but with substantial incomes from non-agricultural sources.

Expected Analytic Output

Forest and Tree Use Practices of the Rural Poor

Although there is increasing information available about the nature and patterns of forest and tree product use by the rural poor in Asia, this network study is expected to provide more concrete information about these patterns. Many rural poor households depend upon access to forest and tree products for food, fuel, fibers, domestic use needs and cash income. The researchers expect to ascertain the tree and forest products used and sold by rural households, the seasonality of tree and forest product use from different sources, sources of the products, and the age and gender of those producing or collecting the products. Additional information is obtained on the species used for specific purposes, preference of species and their preferred planting location.

There is growing evidence to support the realization that various socio-cultural and economic factors through societal processes govern the natural resource (forest product) use pattern of rural communities. This study will identify and investigate those issues with the help of the standardized data sets, researchers' own observations, rapid rural appraisal techniques and available secondary sources.

Interventions in Tree and Forest Management and Utilization

Policy implications are expected to be derived from the information gathered on tree use practices and the socioeconomic variables affecting these practices. Policy implications can be translated into interventions aimed at better and more efficient utilization of tree and forest resources. Effective interventions can increase forest and tree product production. This may facilitate access to these resources by the rural poor. Interventions designed on the basis of this evidence would have greater chances for success as they would be responding to actual utilization and needs of rural poor households and socioeconomic factors and processes that govern forest and tree use practices.

If these factors are shown to affect the nature and organization of farm and village forestry throughout the region, it will be possible to predict forestry and land use systems in areas with similar social and economic conditions. It will then be possible to recommend, with some certainty, interventions in farm and village forestry and land use systems to improve forest management and the production and use of trees for the benefit of the rural poor.

Data on species preference, preferred planting location, tree part utilization patterns and product utilization by species can enable forestry planners to design and implement reforestation programs catering to the actual needs of poor rural households. Additional information on land use patterns, use of credit, labor and other inputs, agricultural and forestry service delivery systems, and agroforestry practices is obtained through the study. Data on these issues can help in agricultural and forestry policy planning and redirect attention to the needs of small-scale farmers.

Implications for MPTS Research

The network study will show the multiple uses of trees and other woody perennial species. The exhaustive listing of tree products and tree part utilization by the sample respondents will clearly demonstrate the complex human-plant interactions in the daily lives of rural people. This will further emphasize the multiple uses of the tree species and provide a vast pool of new knowledge to MPTS researchers. These researchers can utilize this knowledge in selecting MPTS species for a variety of agroecological sites and countries in the Asian region. The data can also be used to help tree breeders in varietal improvement and to disseminate new knowledge about relatively unknown MPTS species and their uses. This information could be vital for regional information exchanges resulting in the diffusion of new species to ecologically suitable locations.

Implications for Social Forestry Programs

The network comparative study can benefit social forestry programs in Asian countries in many ways. Species and their planting niches may be better identified with the assistance of the network data. Social foresters in each country will be better informed about agroforestry systems in the study locations. Future planning and forestry project development can benefit from the knowledge about indigenous practices.

Finally, social forestry planners will receive new knowledge about the critical influence of social, economic and cultural factors on forestry and tree use patterns, planting preferences, and the management of forest and tree resources of the rural people. Knowledge about these issues will serve as guiding principles in planning, designing and implementing new social and agroforestry projects.

End Uses of Trees In Village Forests: Two Case Studies from Java

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There is a growing literature on village forests and social forestry programs concerned with tree planting on forest and village land in Indonesia (Bratamihardja 1987; Kartasubrata 1988; Wiradinata and Husaeni 1987; Sukartiko 1986; Sumadi 1987). Even so, there is a noticeable lack of information concerning the end uses of trees by villagers.

Basic demographic, socioeconomic, agroecological and other background information provide a context for understanding preferences for specific tree species and the end uses of trees or tree products. Major socioeconomic categories in village communities are expected to use tree resources in different ways depending on the species and types of tree products available. Small-scale, marginal and landless farmers are expected to meet their fodder and fuelwood needs from different sources than more affluent villagers.

The primary objective of this study was to identify preferred multipurpose tree species (MPTS) and use of the end products by differing socioeconomic groups in the villages.

Methodology

The methodology for the study generally follows the guidelines outlined in the MPTS regional study. To adjust for local conditions several additional approaches were applied including agroecosystem analysis, informal and structured interviews, and participant observation.

Location

The study was carried out in two selected villages in the Citanduy River basin in the eastern part of West Java, 250km east of Jakarta. Payungagung, in the subdistrict of Panumbangan is located from 600-800m above sea level. The household study concentrated on the hamlet of Cimaja of Payungagung at an altitude of 800m. The second village, Karangsari, in the subdistrict of Padaherang, is about 80km southeast of Payungagung at 50-200m elevation. The hamlet of Cipicung in the lower area of the village was surveyed.

Sampling Method

In each hamlet a random sample of 25 households were interviewed and observed on forest and tree use practices. Male and female respondents were questioned separately about various characteristics of the preferred species to define a more relevant set of ideotypes for MPTS breeding programs.

In addition to the structured interviews conducted with the survey sample, unstructured interviews were carried out with formal and informal leaders and informants. Community activities which could not be adequately covered by interviews were observed.

Secondary data was collected from reports and documents available from agencies at the national, provincial, district, subdistrict and village levels.

Payungagung

Physical Characteristics

Desa Payungagung (Payungagung Village) is located in the northern hill range of East Priangan. Located at an altitude of 600-800m, the climate is relatively cool. The average annual rainfall is 2,896mm.

A small river, the Cikianger, dissects the village and flows into the Citanduy River, finally emptying into the Indian Ocean. The Cikianger supplies water to a limited area of wet rice fields and fish ponds in the village through ditches and bamboo pipes.

The soil is clayey to loamy. The prevailing soil type is andosol with patches of grumusol, 30-60cm deep with a medium infiltration capacity. The acidity ranges from pH 4.5-5.8.

Village Composition

Total households	1,010
Total residents	3,850
Male	1,874
Female	1,976
Children (0-14)	1,269
School children (7-12)	562
Work force (15-64)	2,431
Elderly (over 65)	150

All inhabitants are Moslem.

Infrastructure

Desa Payungagung has 17km of paved and 3km of unpaved roads. There are five motorized vehicles for transporting both cargo and people. The nearest daily market is located in Panjalu, about 5km from Payungagung.

Electric service provided by the government has not reached Payungagung yet, but plans are being made for the future. However, thanks to the self-help activities of the community using available water resources, a number of electric generating units have been established. Seventy-one households in the hamlet of Cimaja have electricity provided by a hydro-generator powered by a checkdam built by the Department of Forestry.

Land Use

Sixty-five to 95% of the land around the Cimaja hamlet is used for dryland agriculture, and 5-15% for *sawah* (wet rice fields). Wet rice is cultivated once or twice a year, using local varieties. Productivity ranges from 2-2.8 t/ha.

Most of the dryland agriculture consists of clove gardens, locally known as cengkeh (*Eugenia aromatica*). It is usually planted as a monoculture, forming village forests, and to a lesser extent in mixed tree associations with other perennials. Seasonal crops are usually not cultivated in most of these gardens because of the heavy shade cover. The dominant tree species observed in Payungagung include *E. aromatica*, *Paraserianthes falcataria*, *Maesopsis eminii*, *Toona sinensis*, *Artocarpus heterophylla*, *Persea americana*, *Swietenia macrophylla*, and *Parkia speciosa*. Species recommended by the model farm include *Leucaena leucocephala*, *A. heterophylla*, *Citrus* spp. and *P. falcataria*.

Use of Trees

The preferred species in Cimaja are *E. aromatica*, *P. falcataria*, *A. heterophylla*, and *M. eminii*.

Eugenia aromatica. About ten years ago "Eugenia fever" struck the Cimaja villagers. The price of dried clove flowers, mixed with tobacco in the *kretek* cigarette industry and for kitchen use, reached a peak of Rp 14,000/kg (US$1 = Rp1,000 at that time). Understandably, most of the field crops were cleared and converted to *E. aromatica* plantations. In the last five years the price has dropped to Rp 3,000-4,000/kg. Even so, the role of cloves is still important in the household economy in Cimaja. Because of the diminishing returns from the clove gardens the maintenance of the trees, particularly fertilizing, has also declined. Only if the gardens become too shady for *E. aromatica* are the other trees cut and then provide fuelwood and timber as a bonus.

In addition to dried flower production, *E. aromatica* serves as a source of energy for the community. The use of wood from the trees (felled because of disease or decay) is for fuelwood rather than for construction. The desired tree form has many branches and thick foliage with a short stem to facilitate easy harvesting of the flowers.

Paraserianthes falcataria. Cimaja villagers like this tree because it grows fast and the timber can be used for light construction. Additionally, the branches can be pruned regularly for fuelwood and the leaves can be fed to the livestock. The tree is generally planted in mixed tree gardens, and occasionally in homegardens. The desired tree form has a large stem diameter and a straight, long, clear bole. Dense canopies with many branches and leaves are preferred. Natural seedlings found around the trees are used for regeneration.

Artocarpus heterophylla. Villagers like *A. heterophylla* because it bears fruit every year. The fruit is tasty and relatively expensive. One mature fruit may cost between Rp 2,000-2,500 (US$1 = Rp1,700). Immature fruits are used in various Indonesian dishes which may cost from Rp 150-200/kg. The leaves are used as fodder for livestock and the stem provides good lumber for construction.

A. heterophylla is planted in homegardens as well as in mixed tree gardens. Villagers raise their own seedlings and transplant them to the fields in the rainy season.

The desired tree shape has a thick stem, many branches and a dense canopy. To stimulate fruiting, small branches and twigs on the main stem are pruned. Flower buds sprout on the stem where it was pruned.

Maesopsis eminii. This tree species is desirable because it grows very fast practically anywhere. The timber is used for construction, the branches for fuelwood and the leaves for fodder. The preferred tree form includes a large diameter stem, a long, clear bole and a dense canopy. Regeneration takes place naturally, or the natural seedlings are transplanted to suitable sites.

Karangsari

Physical Characteristics

Desa Karangsari (Karangsari Village) is located in the lower part of the Citanduy River basin, 60km south of the city of Ciamis and about 30km from the tourist resort town of Pangandaran on the coast of the Indian Ocean. At an altitude of 50-200m it has a hot climate compared to Payungagung. The average rainfall is 1,743 mm/year, with temperatures between 26-33°C.

The village covers an area of 869 hectares, 50% of which is lowland, 15% is hilly and 35% is mountainous. Seventy-five percent can be categorized as fertile, 10% of intermediate fertility, and 15% is less fertile.

Village Composition

Total residents	3,645
Male	1,803
Female	1,842
Children (0-14)	1,039
Work Force (15-64)	2,501
Elderly (over 65)	105
Graduated from:	
Grade school	3,103
Dropouts	115
Middle school	67
High school	25
University	1

Most of the villagers are farmers, 34% of the households are landowners, 12% are sharecroppers and 32% agricultural laborers. The remainder of the population is engaged in industry, trade, government services, handicraft production and seasonal labor.

Two local languages, Sundanese and Banyumas Javanese, are spoken in addition to Bahasa Indonesia. The entire population of Karangsari is Moslem.

Infrastructure

The road system consists of 4km of paved and 5km of unpaved roads. The provincial road runs from Banjar to Pangandaran and facilitates transportation between the villages. The most common transportation is by bicycle, used for both people and goods.

The closest market is in Padaherang, about 3km from Karangsari. For more extensive purchases, of either food or raw materials for production, the market at Banjarsari 15km away is preferred. The Banjarsari market is bigger, transportation on the provincial road is relatively easy and the difference in transportation cost is small, at Rp 100 per person.

The government electric service has not yet reached Karangsari. In other villages, closer to the cities, electric poles are being installed. Many residents in Karangsari own a radio, but few people own a television set.

Land Use

At the time of the study a reclassification of land use patterns was being carried out to revise the data from the 1930s. Tentative results indicate that the wet rice fields had expanded at the cost of dryland and swamps.

Agriculture

The prevailing agricultural practices are wet and dry land cultivation of seasonal and perennial crops. Production in 1987 included 609 tons of rice, 222 tons of cassava, one ton each of corn, groundnuts, soybeans and jengkol (*Pithecellobium lobatum*) and lesser quantities of various fruits and vegetables.

Wet rice production is less than optimal because of poor irrigation conditions. Complaints are being expressed about floods in the rainy season and drought in the dry season.

As a result, crop failures are common. Rat infestations occur frequently because synchronized planting cannot be carried out due to the erratic water conditions.

Use of Trees

Tree crops are planted in homegardens and on other agricultural dry land. The predominant species are *Cocos nucifera*, *Paraserianthes falcataria*, *Albizia procera*, *Achras zapota*, *Maesopsis eminii*, *Toona sinensis*, *Artocarpus heterophylla*, *Nephelium lappaceum* and *Parkia speciosa*. Multipurpose tree species recommended by the Karangsari model farm include *C. nucifera*, *A. zapota*, *L. leucocephala*, *A. heterophylla* and *P. falcataria*.

The four preferred species in Karangsari are *C. nucifera*, *P. falcataria*, *A. procera* and *A. zapota*.

Cocos nucifera. Karangsari villagers like this tree because it grows well in the village and has many uses. According to one estimate there are about 2,000 coconut trees in Karangsari, most of which are in Cipicung.

The stem can be used in house construction or for furniture. The young leaves are used for decoration, the flower stalk can be tapped to produce palm juice and palm sugar, the fibrous husk is used for household utensils or fuel, immature coconut meat can be mixed in fresh drinks, and the mature meat is used in various soups or for oil production.

Coconut trees are generally planted in homegardens and to a limited extent in mixed tree gardens and rice fields. Planting in homegardens enables villagers to care for the trees and harvest the coconuts easily and efficiently. The prolific growth in the homegardens is due to the nutrients available from kitchen waste and the absence of coconut beetles, which avoid the traffic around the houses.

Villagers prepare their own coconut seedlings by drying selected coconut fruits and keeping them in shady places, or planting them in nurseries. After about a year the seedlings are planted in the field.

A good coconut tree has a straight stem and abundant horizontal leaves. Most coconut trees begin to fruit after 10 years, whereas hybrids fruit at five years. A mature tree produces from 5-20 coconuts per month. After removing the fibrous husk, the coconuts are sold for Rp100-150 each to middlemen. They are then sold in the markets in big cities, such as Jakarta and Bandung for household consumption. The fibrous husks are sold as fuel to tile and brick factories in Central Java.

Paraserianthes falcataria. Earlier this century *P. falcataria* was abundant in Karangsari, however, after this tree began to be used in a variety of industries and for house construction many of the trees were felled. Replanting rates lag behind harvesting so the standing stock is decreasing.

Villagers like this tree because of its rapid growth and reasonably good construction timber. The branches are pruned regularly for fuelwood and the leaves are used for fodder. *P. falcataria* trees are generally planted in mixed tree gardens and to a limited extent in homegardens.

A well shaped tree has a long, straight, clear bole with a large stem. The canopy should be dense with many branches. Natural seedlings are usually abundant around the trees. The seedlings are used as plant material for new stands.

A sawmill processing *P. falcataria* in the nearby town of Banjar exports processed lumber to Japan. The logs are supplied from an area within a radius of 50km, including Karangsari. The timber is bought by middlemen. For a medium sized tree with a dbh of 40cm the current market price is Rp 80,000.

Albizia procera. Villagers like *A. procera* because of its fast growth, and use the wood for construction and fuelwood. The leaves are used for supplementary fodder. These trees are planted in homegardens and in mixed tree gardens. Regeneration takes place after coppicing, and seedlings around the trees are transplanted to new areas. A well shaped tree has a large, straight stem with many branches and a thick canopy.

Achras zapota. *A. zapota* produces good tasting, high priced fruits annually. Wood from unproductive trees is sold as a raw material for kitchen utensils. *A. zapota* is planted in homegardens and in mixed tree gardens. Seedling production is carried out by planting seeds in nurseries, in plastic bags, or by marcotting. A well shaped Achras tree has a large stem with many branches and a thick canopy.

Data Analysis

The results of an exercise in data analysis on the relationships between end uses of tree products and economic status of the villagers are presented in Table 1 for Payungagung and in Table 2 for Karangsari. The villagers' economic status is categorized as high, medium, and low based on three groups of wealth indicators:

- house, homeplot, and/or the materials used to build the house such as brick, wood, mud, mats, straw, type of roofing materials, and/or shingles;

- access to mass media/information in the household, ie. television or radio; and

- transportation used by the household - private car/truck, public transportation, or bicycle.

The null hypothesis tested is that income level and species preferences for various products are independent. The method of analysis applied was the Chi-Square (X^2) Test. At the 95% confidence level, no dependency relationship exists between household economic status and preferred MPTS for fodder, fuelwood, fruit/flower/food, timber/construction material, or all uses of wood. A statistical difficulty encountered in applying the chi-square test to this study is the small size of the sample.

Highlights of the Study and Suggestions on Methodology

From the outset, F/FRED requested that more attention be paid to the methodology than to the results. This case study is considered a test of the research instruments for the regional study.

At the same time, the author tried to quantify the conditions under which villagers obtain needed tree products from preferred MPTS. Agroecological and social conditions under which a variety of tree products are obtained were assessed.

Villagers' Perception of MPTS

The villagers' criteria in evaluating preferred MPTS include the potential of the trees to meet short-term (daily) and long-term needs of the village.

Short-term needs such as fodder for livestock, fuelwood for cooking, and vegetables and fruit have to be met continuously. To meet these needs villagers plant *A. heterophylla* (leaves for fodder, young fruits for vegetables, mature fruits as a cash crop), *E. aromatica* (dried flowers for sale to the cigarette industry or for kitchen use), *C. nucifera* (leaf butts for fuel, fruit for cooking or for sale), and *P. falcataria* (leaves for fodder, small branches and twigs for fuelwood).

Long-term needs are incidental or occasional. In some cases the farmers plan ahead and plant trees to meet these needs. An example of a long-term need is building a house. Species planted for house construction include *P. falcataria* for light construction material, *A. procera* for door and window frames or beams, *A. heterophylla* for door and window frames when fruit production ends, *M. eminii* for planks or roofing, and *S. macrophylla* for window frames, beams and roofing.

Fuelwood and cash are needed for ceremonies. Fuelwood can be obtained by cutting old, unproductive trees of *A. heterophylla*, *E. aromatica*, *Mangifera indica* and *Arenga pinata*. The need for cash can be partially met by selling large marketable trees or tree products such as *P. falcataria*, *S. macrophylla*, or *C. nucifera*.

Preferred MPTS

The MPTS network should pay special attention to *P. falcataria* which grows well in two different agroecosystems. It was indicated as a top priority tree by the villagers after *E. aromatica* and *C. nucifera*. The latter two species are considered agricultural tree crops and are the focus of attention by other institutions and networks.

The positive attributes of *P. falcataria* make it a popular species. As a legume it also restores soil fertility. The Indonesian government has started a *sengonization* campaign (sengon is a local name) in regreening and reforestation programs. Care must be taken to prevent the fatal infestation of the insect *Xystrocera festiva* and a new viral disease affecting young buds, which could be disastrous on plantations.

Research Methodology

Several suggestions can be made about regional research methodology. Criteria used to select a study site could include high population pressure on resources, low level of employment opportunities outside the agricultural sector, with the majority of the population living in poverty. These three problems call for the urgent attention of development activities and supporting research.

The eastern part of Indonesia should be declared a priority zone, particularly in the semi-arid areas of Nusa Tenggara Barat and Nusa Tenggara Timur provinces. Results of studies in these areas can be compared with findings in similar ecosystems of Asia. Studies should also be carried out in the humid areas of Indonesia.

Sampling Method

The stratified random sampling method is recommended in the selection of respondents. Stratification can be applied on the basis of the extent of land ownership, because land is still the principal source of income for villagers.

The number of respondents should be determined based on a preliminary sample, to predetermine the level of the allowable sampling error. To achieve uniformity, the level of the predetermined sampling error should be the same at all study locations, and for cross-cultural studies.

Length of Research

Research in the field should be carried out for at least three months. This should be distributed during the transition of seasons from wet to dry and vice versa, to record the activities and conditions in the study village and for comparison with the previous season. This plan allows enough time to become familiar with the locale and the people, to study the households in general, and observe the level of end uses of tree products by villagers.

Quantification of Data

To study the level and end uses of MPTS, quantitative measurements may be necessary. Research instruments need to be designed so that quantitative data on the level of tree product use can be collected. Conclusions can then be drawn about the level of dependency of households on the available trees, and correlated to the number of trees that should be planted in the homegarden to meet household needs sustainably.

Inventory of Tree Potential

Data on tree potential in the village is necessary to crosscheck the outcome of the interviews. The data can also be used to evaluate whether the level of tree potential can supply the needs of all the villagers, and whether the existing trees can reach the level of the theoretical potential.

Herbarium

For dominant or preferred species in the study villages, herbarium material should be prepared and kept for the sake of accuracy in recognizing the species.

References

Bratamihardja, M. 1987. Social Forestry on State Forest Land. Paper presented at a workshop, December 1-3. Yogyakarta, Indonesia: GMU Faculty of Forestry with FONC and FAO/RWED.

Kartasubrata, J. 1988. Social and Economic Research on Farm and Village Forestry in Indonesia: Some Case Studies. In *Collaborative Research on Farm and Village Forestry*, eds. D. Taylor and C. Mehl. Bangkok: Winrock International.

Sukartiko, B. 1986. Agroforestry Practices Outside Forests in Relation to Reforestation and Regreening Programs. In *Comparative Study on the Utilization and Conservation of the Natural Environment by Agroforestry Systems*. Kyoto, Japan: MAART Kyoto University and Toyota Foundation.

Sumadi, G. 1987. Implementation of Social Forestry on Private Land. Paper presented at a workshop, December 1-3. Yogyakarta, Indonesia: Gadjah Mada University, Faculty of Forestry with FONC and FAO/RWED.

Winrock International. *Handbook on Data Collection and Research Methods for the Regional Study on Farm and Village Forest and Land Use Practices*. Bangkok: Winrock International-F/FRED Project (forthcoming).

Wiradinata, S. and E. Husaeni. 1987. Land Rehabilitation with Agroforestry Systems in Java, Indonesia. In *Agroforestry in the Humid Tropics*. Los Banos: EAPI, East-West Center, SEARCA.

Table 1. Dependency test between household economic status and MPTS products - Payungagung Village.

	Chi-Square	Degrees of Freedom	Critical Chi-Square at $\alpha = 0.05$	Test Results Dependency
A. Fodder				
High	2.1249	2		
Medium	1.0680	2		
Low	0.0476	2		
Total	3.2505	4	9.49	no
B. Fuelwood				
High	0.7949	3		
Medium	1.4808	3		
Low	3.9615	3		
Total	6.2372	6	12.59	no
C. Fruit/Flower/Food				
High	0.4286	2		
Medium	[illegible]	2		
Low	[illegible]	2		
Total	2.7704	4	9.49	no
D. Timber				
High	0.3823	2		
Medium	0.0023	2		
Low	0.3571	2		
Total	0.7417	4	9.49	no
E. All Uses				
High	2.5069	1		
Medium	0.5833	1		
Low	0.2083	1		
Total	3.2986	2	5.99	no

Table 2. Dependency test between household economic status and MPTS products - Karangsari Village.

	Chi-Square	Degrees of Freedom	Critical Chi-Square at α = 0.05	Test Results Dependency
A. Fodder				
High	-	-		
Medium	0.4402	1		
Low	0.7826	1		
Total	1.2228	1	3.84	no
B. Fuelwood				
High	-	-		
Medium	0.2326	2		
Low	0.4136	2		
Total	0.6462	2	5.99	no
C. Fruit/Flower/Food				
High	-	-		
Medium	0.9345	2		
Low	1.6614	2		
Total	2.5959	2	5.99	no
D. Timber				
High	-	-		
Medium	1.9688	2		
Low	3.5000	2		
Total	5.4688	2	5.99	no
E. All Uses				
High	-	-		
Medium	0.7067	1		
Low	1.2564	1		
Total	1.9631	1	3.84	no

Survey and Participant Observation Research Methods on Problems and Issues of Small-Scale Farmers

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The importance of combining survey and participant observation research methods in understanding the problems and issues faced by small-scale farmers in rural areas is demonstrated in this paper.

Personal experience, field observations and data analysis have shown that the data collected by survey research alone are misleading or unreliable because rural farmers often respond with information that does not accurately portray the situation being studied. On the other hand, through participant observation, the researcher establishes a closer rapport with the farmers and is thus able to collect more reliable data.

The participant observation method also has its limitations. Its use is normally restricted to a small segment of the population and is time consuming. If the objective is to study rural farmers over an extensive area within a short period of time, a better understanding of the situation can be achieved through a combination of small surveys and participant observation methods. This is particularly appropriate when manpower and other constraints exist. Participant observation is important in leading the way before any effective survey is undertaken. A combination of these two research methods would enhance the successful introduction and implementation of suitable projects using multipurpose tree species (MPTS)

Background

Before implementing any MPTS project, a sound research methodology to understand the socioeconomic conditions of the target group should be formulated. The research methods used in data collection affect not only the development programs but also their degree of success. Effective implementation of development programs for the rural poor depends on understanding the problems and issues they face. Studies have shown that some programs failed simply because local needs, constraints and practices were not taken into account (Evans 1988). Thus, a key factor contributing to the success of development programs in rural agricultural communities is an understanding of their fundamental problems.

The survey method is often used in developing countries for socioeconomic studies to examine the conditions and problems of rural residents. In this method of data collection, questions are asked of a sample of respondents, using either a questionnaire or an interview (Theodorson and Theodorson 1969). It is generally used as a means of systematically describing individuals' opinions, attitudes and behaviors (Freeman and Sherwood 1970). The researchers or their assistants visit the villagers for a few hours, ask questions and record the answers. Such data are often analyzed to recommend programs to overcome the problems of the poor.

Undoubtedly, this survey method provides some understanding about conditions of the rural poor. However, very often it does not present an in-depth picture. Moreover, some villagers may even give false or misleading information to the government officials. This phenomenon was observed while carrying out anthropological field research in Pelawan, a rural Chinese New Village[1] in Peninsular Malaysia. Of the 117 households in Pelawan at the time of the study in 1984-5, 115 households were Chinese, one was Malay and one was Indian. Most were engaged in agricultural activities such as rubber tapping, oil palm cultivation and vegetable farming. There was a mine concession area in the region east of the village and a forest reserve to the northeast.

The Surveys

During the author's fieldwork in the village (November 1984-February 1985), two surveys were conducted on the socioeconomic conditions of the villagers. The first was undertaken by three Malay undergraduates of a local university. In this survey, after meeting with the local headman, the students were introduced to several heads of households who provided information on income and other household characteristics. The degree of accuracy of the information provided to the students, particularly on income and land ownership, can be concluded from the following typical reaction of three villagers:

> We don't know who they actually are, how can we tell them the truth? They claimed to be students but who knows, they may be government agents coming to investigate us. Anyway, we simply said something so they would leave as soon as possible. We don't want any trouble from them.

The second survey was conducted by the Division of New Villages Development of the Ministry of Housing and Local Government, Malaysia. A date was set for the District New Village Development Officer to gather socioeconomic data from the villagers. Since most villagers do not read or write Bahasa Malaysia, the national language, questions were asked in local Chinese dialects (ie. Cantonese, Teochiew and Hakka) and questionnaires were filled in by the District New Village Development Officer, who was Chinese. The local headman was available to provide whatever assistance was needed. When questions were asked about land ownership, income, and household composition, many villagers did not reveal the truth. The following situations are typical.

Understatement of Income Levels

This woman is not certain about declaring her monthly household income. She asked the headman:

> Brother, how much should I reveal about my household's income? Is it all right to tell my husband's income and exclude my earnings? My husband told me to state a low income level.

The headman replied:

> Don't worry. This is just a common survey taken by the government from time to time. Simply give an amount. What about $300 a month? I know you earn more than that. Mr. Lee, write down $300 as her household income.

Underdeclaration of Land Ownership

A typical comment from the headman to a farmer who said he didn't own any land:

> How can you claim to be landless? Everyone knows you own a few acres of oil palms. What about the other land (ie. illegal land) you cultivate? Anyway, Mr. Lee, you can write down what he said. I don't want to create any unnecessary problems.

Understatement of Employment and Housing

A head of household told the New Village Development Officer there were 12 members in his household, none of whom owned land, and that they faced problems of unemployment and underemployment. He also claimed that their house of two rooms was too small for them. The officer recorded exactly what the man said. The headman pointed out that the information was incorrect. There were, in fact, only five family members in the village, while the rest were migrant laborers working elsewhere. None of the family was unemployed.

General Answers to General Questions

In response to questions about the main problems facing households, the normal answers were "no land", "no work" and "poverty".

By observing these two surveys of a rural community, it is obvious that whatever information was gathered revealed only limited understanding of the actual situation. In fact, because of the understatement of income, land ownership, employment and so on, the real issues and problems facing the community were not highlighted. The following important information is not clear: the condition of land ownership; the extent of illegal land cultivation; the pattern of employment and division of labor by gender; the unemployment situation; and reliable levels and sources of household income.

Observation of the same phenomena by researchers doing fieldwork in other communities supports the doubt about the validity of statistics obtained by survey questionnaires in the developing world (Alers 1983; Malla and Fisher 1987). The author's observations confirmed that the major factor leading to unreliable data in survey questionnaires is suspicion about the real motives of the survey. This is not surprising at all as "many people are apt to treat local researchers as government agents" (Lee 1982).

The Participant Observation Method

Aware that rural Chinese are suspicious of outsiders and of the limitations of the survey method in collecting reliable data, the author used the participant observation method. This method involves an in-depth study of the village. It relied on a variety of methods to gather data including participation and observation of events when they occur, the use of knowledgeable local informants, discussion and informal interviewing (Bulmer 1983).

Using this method, suspicion about the motives of the researcher was minimized as the fieldwork in Pelawan lasted three and a half months, long enough to establish good rapport with the villagers. During the fieldwork, the author participated in the daily activities of the villagers, ranging from farm work, preparing for religious ceremonies, writing letters for illiterate villagers to tutoring students. After gaining their general acceptance, the participant observation method worked out well. In addition to data collected by informal discussion interviews and recording of important events, an informal survey was conducted on the socioeconomic profile of 41 households. All the data were cross-checked with knowledgeable local informants.

By this method, insights into the villagers' socioeconomic profile, their problems and needs were revealed. The following is a summary of the problems and issues of the rural farmers in the New Village:

- two-thirds of the total households own agricultural land under oil palm or rubber cultivation. The total land area is small. Among land owning households, 90% own three acres or less;

- 94% of the economically active labor force is engaged in agricultural activities;

- of the total labor force, only 4% are unemployed (the unemployment rate is lower than the national level of 7.6% in 1985);

- of the total labor force, 37% are self-employed, 39% are unpaid family workers, and 20% work for others;

- 71% of the total unpaid family workers are women engaging in agricultural activities (the role of women is thus very important in generating income in the agricultural sector);

- of the total households, 20% farmed on rented land under a maximum lease period of two years;[2]

- 54% and 22% of the total households practiced illegal farming on mine-concession land and state forest reserves,[3] respectively (this source of employment is not secure in the long run);

- of the total household income, about 40% is derived from cultivation of rented land, mine-concession land and state forest reserves (these sources of income are insecure in the long run);

- the average monthly gross household income is R$746 or US$298. This is lower than R$1,095 (US$438) per month for all households in Peninsular Malaysia in 1984;[4] and

- the incidence of poverty was 5% (this is lower than the 18% for Peninsular Malaysia in 1984).

From the above findings, it is obvious that data collected using the participant observation method are more reliable than the previous two surveys conducted in the same village. In the participant observation method, information was gathered only after the villagers had accepted the researcher and were willing to reveal their actual socioeconomic situation. With close rapport between the researcher and the rural farmers, important information on illegal farming on the mine concessions and forest reserves was obtained. This had not been disclosed to the interviewers in the two previous surveys.

Implications for MPTS Projects

Although the author's study did not directly relate to MPTS planting in the rural community, findings from the participant observation method provide some pointers. The situation found in this village can be extrapolated to other agricultural rural villages which are similar in terms of land use.

The planting of trees for multiple uses is not new to the villagers. Rubber trees and oil palms are planted on farmer-owned land. The products are sold as a cash crop while the branches or leaves are used as fuelwood and fencing materials.

For rural farmers in Malaysia and other countries, the term MPTS may be new but planting trees for multiple uses is not (Sastrapradja 1989). Rural residents have been planting fruit trees such as banana (*Musa* spp.), cempedak (*Artocarpus* spp.), duku and langsat (*Lansium* spp.), durian (*Durio zibethinus*), mangosteen (*Garcinia mangostana*), rambutan (*Nephelium lappaceum*), and coconut (*Cocos nucifera*) in their *dusun* (or orchard) for many years, to meet daily needs and supplement household income. The Malaysian government has actively encouraged farmers to systematically plant fruit trees to increase household income in rural areas since the 1960s.

Tree planting is labor intensive and women play an important role in the planting process. They participate in land clearing, planting, weeding, fertilizing, and harvesting.

Scarcity of land and lack of land ownership prevent Chinese new villagers from planting MPTS. Villagers are willing to plant trees if given rights to use mine-concession land or forest reserves for a reasonably long period.

Villagers are ready to plant MPTS if they can be assured of high returns. They need to be made aware of trees that are worth planting, and which products are in demand and can be readily marketed.

Due to low incomes, farmers have little or no savings. Lack of capital makes it difficult to be involved in long term ventures such as tree planting without financial assistance from the government.

The implication is that MPTS projects are feasible in this farming community where land is generally available. The forest land and former mine spoils in the vicinity can be used to plant suitable MPTS. Since tenancy is a major problem, efforts to give the farmers some form of right to use the land is essential. No farmers would plant trees illegally in this village. Temporary cultivation under land use systems such as *taungya* in Burma (Blanford 1952) or *tumpang sari* in Indonesia (Jabil 1969; Atmosoedaryo 1978a; 1978b) can be arranged for these farmers. This form of temporary right to cultivate is not new as taungya was practiced in the forest reserves of Peninsular Malaysia (Cheah 1971). Once initial problems related to land use are resolved, steps can be taken to introduce trees to meet their needs. As in many agricultural communities, farmers will plant trees only if they own the land.

Since rural farmers generally earn low incomes and have little savings, credit assistance is needed to encourage them to plant trees. It is difficult for landless farmers to borrow from financial institutions where interest rates are high and collateral is required. In this respect, the government's help in the form of credit without interest, or at low rates for inputs such as fertilizer and insecticides is essential. In the tumpang sari system in Indonesia, such credit proved to be efficient and productive as all the farmers repaid their debts (Atmosoedaryo 1978a). Another recommendation is that a plentiful supply of MPTS seedlings be subsidized by government agencies (Soetrisno 1989).

Tree planting programs will only be successful if the products are marketable. This is particularly important where tree planting is regarded as an important source of supplementary income for rural households. It has been pointed out that farmers who were encouraged to plant turi (*Sesbania sesban*) as a raw material for pulp and paper, abandoned the projects due to a lack of markets for their yields (Sastrapradja 1989).

This means that farmers would not plant just any MPTS claimed by development agents to be marketable or in demand. Not all MPTS are appropriate in all ecosystems. The farmers know to a certain extent which trees are suitable for their farms, a point which may not be fully appreciated by researchers. Farmers may not plant certain trees because of social taboos. Therefore, before determining the end uses, demand and markets, it is important to study the actual needs and present practices of the farmers.

Conclusion

The aim of this paper is not to argue that the participant observation method is superior to the survey method in social science research. There is no single research approach appropriate in every case. If the research goal is to canvass a large segment of the population, or to measure public opinions and attitudes, the survey is an appropriate research tool. However, in the case of researching problems and issues of rural farmers, the survey method alone is inadequate. A lack of close rapport between the researcher and the farmers often results in the collection of false or misleading information.

On the other hand, the participant observation method is well suited for the study of sensitive issues which are not readily revealed to others. However, there are two major limitations in the use of this method. It is generally used to study a small group where the researcher interacts with all of the members in the community. Its application to a large population is limited. It is also extremely time consuming. The researcher needs to stay in the village for an extended length of time to interact with the people and collect data.

If the objective is to study rural farmers over an extensive area within a short period of time, a better understanding of the situation can be achieved through a combination of small surveys and participant observation. This is particularly appropriate when manpower, time, financial and other constraints exist.

The researchers can begin the study by adapting the participant observation method in a variety of ways. Instead of staying in the village for a consecutive period of time, the researchers can visit rural farmers from time to time, participate in their activities (particularly those related to the village community as a whole), and find ways to solve the problems they face. This way, the researchers can establish a close rapport with the farmers. Their acceptance of the researchers is important. After gaining their confidence, the questionnaires can be tested and modified. At this stage, the researchers can confidently conduct small surveys based on an appropriate sample. The participant observation method reduces the problem of rapport and enables the collection of more reliable data in follow-up surveys.

In short, mixing both participant observation and surveys are encouraged to better answer research questions. Each method complements the other, generating more confidence in the results. Results such as patterns of land ownership and use would ensure the appropriate introduction of MPTS projects to meet the needs of the villagers. The combination of these two methods offers exciting challenges to social scientists involved in rural studies and promising rewards for rural development.

Notes

[1] During the Japanese Occupation (1942-45), the Malayan Communist Party (MCP) gained assistance from Chinese rural villagers to fight the Japanese. After the war, rural Chinese continued to assist the MCP in their armed struggle against the British colonialists. Attempting to win "the hearts and minds" of the people, 572,917 people were resettled in 480 new villages between 1949 and 1952. Eighty-six percent of the new villagers were Chinese in 1954.

[2] The land is rented from other smallholders whose rubber trees were cleared for oil palm cultivation. During the first two years of oil palm establishment, intercropping is possible as the trees are still young.

[3] Illegal cultivation on mine-concession land is an unstable source of income for rural households. The land that has been leased to mining companies can be put into mining production at any moment. Generally, short notice is given to the illegal farmers. As a result, only short term crops are grown.

Cultivation on state forest reserve land is relatively new. Before 1970, this illegal farming was not necessary as there was more mine-concession land available. However, toward the end of the 1970s, when more of the concessions were put into production, some villagers had little choice but to take the risk of using forest reserve land nearby.

[4] R$ refers to the Malaysian ringgit. US$1 was approximately R$2.5 in 1984-5.

[5] In Peninsular Malaysia, tin mining activities have left large tracts of land barren, amounting to 202,700ha or 2% of the total land surface.

References

Alers, J.O. 1983. Reliability of survey techniques in highland Peru. In *Social Research in Developing Countries*, eds. M. Bulmer and D.P. Warwick, pp. 183-192. Chichester: John Wiley & Sons Limited.

Atmosoedaryo, S. 1978a. The importance of forests for rural communities. Paper presented at the Eighth World Forestry Congress, Indonesia.

____. 1978b. The prosperity approach to forest community development in Java. *Commonwealth Forestry Review* 57(2):89-96.

Blanford, H.R. 1952. Regeneration with the assistance of taungya in Burma. *Indian Forest Records*, Vol. XI(III):81-121.

Bulmer, M. 1983. General introduction. In *Social Research in Developing Countries*, eds. M. Bulmer and D.P. Warwick, pp. 3-24. Chichester: John Wiley & Sons Limited.

Cheah, L.C. 1971. A note on taungya in Negeri Sembilan with particular reference to the incidence of damage by oviposition of insects in plantations in Kenaboi forest reserve. *The Malayan Forester* 14(2):133-153.

Evans, J. 1988. Overview of Tree Planting on Small Farms in the Tropics. In *Multipurpose Tree Species For Small-Farm Use*, eds. D. Withington, K.G. MacDicken, C.B. Sastry and N. Adams, pp. 26-30. Arlington, Virginia: Winrock International and the International Development Research Centre of Canada (IDRC).

F/FRED. 1988. *Asia Interim Progress Report.* Bangkok: Winrock International.

Freeman, H.E. and C.C. Sherwood. 1970. *Social Research and Social Policy.* New Jersey: Prentice-Hall, Inc.

Jabil, A.K. 1969. A two week visit to the Islands of Java and Bali. *Rimba Muda* 5(1):10-18.

Lee, R.L.M. 1982. Anthropological and Sociological Fieldwork in Malaysia: problems and prospects. *Manusia dan Masyarakat*, New Series 3:1-5.

Malla, Y.B. and R.J. Fisher. 1987. Planting Trees on Private Farmland in Nepal: the Equity Aspect. In *Multipurpose Tree Species For Small-Farm Use*, eds. D. Withington, K.G. MacDicken, C.B. Sastry and N. Adams, pp. 166-174. Arlington, Virginia: Winrock International and IDRC.

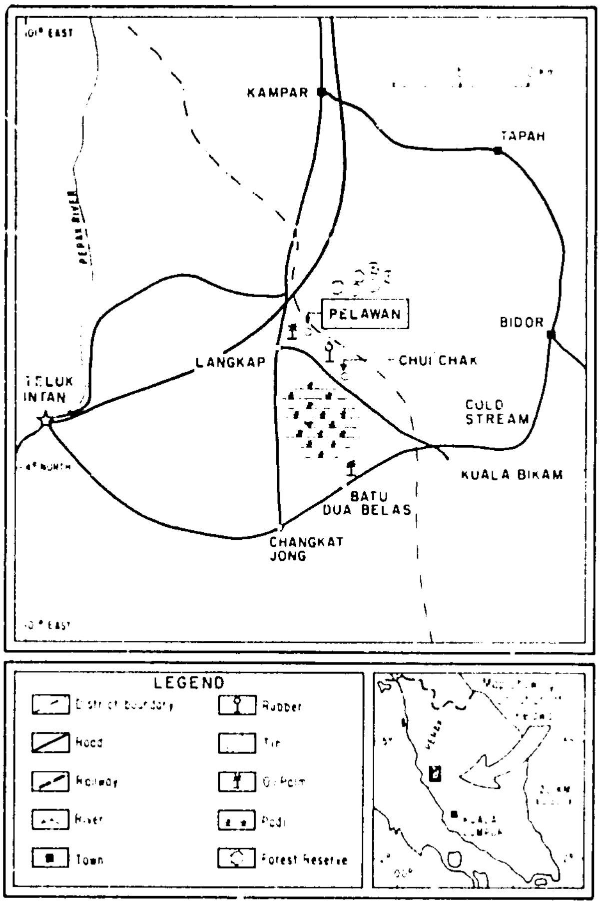
Sastrapradja, S. 1989. The use of multipurpose tree species for rural communities. Paper presented at Pertemuan Koordinasi, Penelitian dan Pengembangan Jenis Pohon Serbaguna (MPTS), Bogor: Pusat Litbang.

Soetrisno, L. 1989. Socioeconomic aspects of multipurpose tree species for rural communities. Paper presented at Pertemuan Koordinasi, Penelitian dan Pengembangan Jenis Pohon Serbaguna (MPTS), Bogor: Pusat Litbang.

Theodorson, G.A. and A.G. Theodorson. 1969. *Modern Dictionary of Sociology.* New York: Thomas Y. Crowell.

Appendix

Location Of Pelawan And Its Environs



A Descriptive Research Method to Estimate Demand and Market Potential of Multipurpose Tree Species Products

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Three commonly used research methods include exploratory research, descriptive research and causal research. The major emphasis in exploratory research is the discovery of ideas and insights. Descriptive research determines the frequency of an event or the relationship between two variables. It is guided by an initial hypothesis, such as the trend in consumption of a product with respect to a variety of variables. The causal research method determines the cause and effects of relationships. It is typically an experimental approach, since experiments are designed to determine cause and effect. These three methods can be considered as stages in a continuous process. Exploratory research is often the initial step in this process.

Demand and market potential of multipurpose tree species (MPTS) can be determined through a marketing research approach, which is considered descriptive research. The descriptive research method is applied when the purpose is either to describe the characteristics of a group of consumers with respect to their consumption of products, or to estimate the percent of the population behaving in a specified manner. As humans, consumers are unpredictable to a certain degree. Their needs and aspirations are constantly changing. Psychology, anthropology, sociology, economics and statistics have all helped to improve market research.

The application of market research to MPTS products is quite important. The results can be used for planning, problem solving or as a control. Market size, location, acceptability of the product, consumer preferences and reactions, packaging, product alternatives and competitiveness can be identified. Information obtained through market research includes (Lazo 1977):

- the competitive advantage of MPTS products;
- acceptance of a product in the market;
- available supply of products;
- economic factors affecting sales;
- specific characteristics of a market by region;
- potential market by territory;
- market trends;
- evaluation of present sales methods and policies;
- determining relative market profitability;
- distribution costs;
- price studies;
- determining the source of customers' dissatisfaction; and
- forecast of market potential and estimated demand.

The Basic Concept of Demand, Market and Product

In estimating demand, according to Stanton (1984), three aspects that need to be considered are products, which include product variant, product class, product line, company sales, industrial sales, and national sales; geographic level, whether at the village, sub-regional, regional, national, or international level; and time scale, whether short-term (1-5 years), medium range (5-10 years), or long range (10 years or more).

To identify the market of a particular product, five types should be considered: total market, potential market, available market, served market and accessed market. In calculating the potential market of a particular product the interest of the buyer, income level and purchasing power are important considerations.

In product development, three factors should be known in order to access the market: the principal use of the product; features related to quality, brand, packaging, and size; and after sales services, guarantees, transportation, and credit.

Descriptive Research Process

The research process is a sequence of iterative steps. Five steps used in market research are defining the problem in precise terms; determining the design; collecting data; data analysis and interpretation; and research report writing (Churchill 1979).

Problem Formulation

The research process can only be properly designed when the problem is clearly defined and the objective of the study has been precisely determined. One of the most difficult tasks facing the researcher in defining problems is understanding the consumer's decision-making process as well as the factors that influence those decisions.

It is important to note that a general statement about the problem is not sufficient. The product should be defined by hierarchies such as product variant, brand, type, and product line. The geographic scale of the study should be defined in terms of level, whether at the national, regional, sub-regional, or village level. A time frame should indicate whether it is short, medium, or long range. Information about the consumers should indicate whether the products are consumed at the household, industry, government, wholesale, retail, or international levels.

The objective of the study is also defined at this stage. This determines the subsequent design of the questionnaire.

Research Design

The research design stage prepares a framework to guide the data collection and analysis. The descriptive research method presupposes prior knowledge about the subject under study and is designed to test specific hypotheses.

Two types of studies are possible under this method -- longitudinal and cross-sectional. The cross-sectional design is the most common and familiar. It involves a representative sample of the population. Several characteristics of the sample are measured once. Longitudinal design includes a series of sample elements such as industries, stores, dealers, individuals, households, government institutions, or other entities.

The cross-sectional study provides a snapshot of the variable under study at a particular point in time. In contrast, the longitudinal design demonstrates change over time.

Field studies and surveys are two tools used in cross-sectional studies. A survey attempts to represent a known universe, both in terms of the number of cases and in their selection. The field study is less concerned about generating large representative samples and deals with the in-depth study of a few typical cases. The emphasis in the field study is on the interrelationship of several factors.

Market segmentation is important to consider in designing research on MPTS products. There are two types of consumers in the market: ultimate end users, and industrial users. Ultimate end users buy products to satisfy their needs. Industrial users buy products as raw materials or for processing in the manufacture of other products.

This market segmentation affects advertising and distribution. The two groups purchase products in different ways relative to quantity, quality, size, distribution, price, and specifications. Ultimate consumers can be differentiated further by demographic characteristics that can include region, rural vs. urban areas, age, gender, education, occupation, and levels of disposable income. Industrial users can be divided into manufacturing, transportation, trade, and government sectors.

Data Collection

Secondary Data

Once the research problem has been defined, the next step is to collect the data. The first attempt should focus on secondary data. Advantages of using secondary data include improving the problem definition, as a source of ideas to improve the problem solving process, and serving as a source of comparative data to better interpret the primary data. A disadvantage is that because the data was collected for other reasons, the results may not serve the purposes of the new research problem as defined.

Secondary data on MPTS products and sales can be classified by source -- internal and external. Internal data is found within the organization where the research is being undertaken, while external data is obtained from outside sources.

Important external data sources for MPTS products include publications of annual statistics by region, and censuses of agriculture, manufacturers, population, etc. Internal data can be obtained from MPTS research reports, MPTS seminar proceedings, proceedings of agroforestry seminars, and regional agriculture and forest service reports and statistics.

Primary Data

Primary data is generated by the researcher to answer the questions posed by a specific problem. One type of data collected is demographic and socioeconomic which includes information on age, education, occupation, marital status, gender, income, or social class.

Another type of primary data is the attitude or opinion of the respondent to a certain product. Attitude is claimed to be the forerunner of behavior. Attitudes and opinions are used interchangeably in market research (Myers and Reynolds 1967).

Awareness or knowledge of products is also of great interest. Primary data related to awareness include general knowledge about the product, where it can be purchased, product price, who produces the product, how it is used and for what purposes, and its specific distinctive features.

Motivation is important in market research. It refers to a need, drive, wish, desire, or impulse that energizes, activates, moves, directs, or channels behavior toward goals. Typically, behavior in marketing refers to purchasing.

There are several means for collecting primary data. The most common are communication and observation. Communication involves questioning respondents through the use of questionnaires. The question may be either verbal or written, and the answer may be given in either form.

Questionnaires

Questionnaire design can include such types as structured-undisguised, unstructured, structured-disguised, and questionnaires classified by method of data collection.

The questions on the structured-undisguised questionnaires as well as the answers are standardized. Few alternatives are used. The following example considers the subject's attitude toward MPTS product consumption, "How important is fuelwood to you?"

- very important
- important
- not important
- no opinion

The advantages of this type of questionnaire are the simplicity of its delivery and its facility in tabulation and analysis of the data. This method is most productive when the possible replies are well known, limited in number, and clear cut.

Unstructured questionnaires are often considered the cornerstone of motivational research. The basic assumption is that the individual's thoughts and behavior are relatively unstructured. Examples of this method are word association, sentence completion, and storytelling.

Structured-disguised questionnaires were developed in an attempt to reveal subconscious motives and attitudes while maintaining the advantages in coding and tabulation common to the structured approach. This is the least used in market research.

Questionnaire Design

Designing questionnaires is a skill and not a science. The following seven steps are presented as a guide or checklist for reference (Churchill 1979):

- determine information needs;
- determine the appropriate type of questionnaire and method of administration;
- determine the individual questions;
- determine the type of response to each question;
- determine the number and sequence of question;
- re-examine steps 1-5, and revise if necessary; and
- pretest the questionnaire and revise.

The hypotheses guiding the descriptive study are used to develop the questionnaires. They determine the information needs because they specify the relationship under investigation.

Sample Design

The next step in the process is to select a sample. Probability and non-probability samples are two common types.

Probability samples are divided into simple random samples, stratified random samples, and clusters. Simple random samples are those in which each population element has an equal chance of being included, and every combination of the sample is just as likely as any other combination to be chosen.

A stratified sample is where the parent population is divided into mutually exclusive subsets, and a sample of elements is drawn from each subset. Stratified samples are the most statistically efficient. They have the smallest standard error for a given size, and allow the investigation of variables for particular subgroups within the population.

Stratified samples are further divided into proportionate and disproportionate samples. In proportionate stratified sampling, the size of the sample taken from each stratum depends on the relative size of the stratum in the population, whereas in disproportionate stratified sampling, the sample size depends on the variability within the stratum as well.

A cluster sample is where the parent population is divided into mutually exclusive and exhaustive subsets and then a random sample is selected. If each of the elements within the selected subsets is studied, it is called one stage cluster sampling. If the selected subsets are also sampled, the procedure is two-stage cluster sampling. A systematic sample is a form of cluster sample in which every element is selected after a randomly determined start.

An area sample is one of the most important types of cluster samples in applied, large-scale studies. By defining areas as clusters, then randomly selecting areas, the investigator develops lists of population elements for the selected areas.

An illustration of stratified random sampling is the 1972 fuelwood survey conducted by the Forest Products Research Institute (FPRI) (Sumarna and Sudiono 1973). The levels and territories of the government at the province, district, subdistrict, and village levels dictated the application of multi-stage sampling. Random sampling was carried out from the district level through the household level as consecutive elementary units. A distinction was made between urban and rural areas based on the assumption that levels of fuelwood consumption would differ. This was further subdivided into household, industry, and railway enterprise sectors. The industrial sector was divided into food and chemical industries.

In a later FPRI survey (Dwiprobowo *et al.* 1980), household and industrial samples were taken using a similar technique. The sample at the district level was non-random, whereas subdistrict, village and household samples were taken at random. The earlier sample was designed to estimate fuelwood consumption in the entire province. The later survey emphasized the pattern of fuelwood consumption relative to other factors.

Analysis and Interpretation of Data

The purpose of data analysis is to interpret the collected information. It consists of preliminary steps and statistical analysis.

Preliminary Steps

The preliminary analytical steps after obtaining field data are editing, coding and tabulation. Editing involves a careful scrutiny and correction of the completed data collection forms. Particular attention is paid to unanswered questions, inconsistent answers and "do not know" responses.

At the coding stage, raw data is transformed into numbers that can be tabulated and counted. Coding involves a two step process of specifying the categories into which the responses are placed, and assigning code numbers to the categories.

Tabulation consists of counting the number of cases that fall into various categories. Simple, or one way tabulation involves counting a single variable. In cross-tabulation two or more variables are treated simultaneously. An example would be counting the number of cases with characteristics in common. It studies the relationship among and between variables so the results can be easily understood. It can also provide an insight into the nature of a relationship since the addition of one or more variables to a two way cross-tabulation analysis is equivalent to holding each of the variables constant.

Statistical Analysis

Some studies stop after tabulation and cross-tabulation. Others involve additional analyses in a search for statistical significance. A recurring problem is the selection of the statistical testing procedure. The choice of an appropriate technique depends on the type of data, the research design, the assumption underlying the statistical test, and the power of the test.

Although a discussion of statistical techniques is beyond the scope of this paper, it can be noted that several questions in the research design affect the choice of method, including the independence of the sample observations, the number of groups, the number of variables and the control exercised over those variables likely to affect the results.

The Research Report

The final step in market research is summarizing the results and writing a report. The findings and recommendations of the researcher must be clearly understood to be used effectively by the reader.

Four general types of reports include the executive report, the technical report, the data report, and the popular or persuasive report (Lazo 1977).

An executive report presents a summary of the findings and recommendations, followed by the details of the findings, a statement about the methodology employed in the study, and additional information in tables and charts to help the reader visualize the contents of the report. The aim is to give the busy executive a quick, factual report on which to base a decision.

The technical report submits evidence, conclusions and data in sufficient quantity to provide a clear understanding of the research. It contains a statement of the problem, the methodology utilized, research results and findings, a reference list of the sources of information consulted, tables and charts to clarify the findings, and the conclusions and recommendations of the researcher. The sole purpose of the technical report is to obtain, collect and present necessary technical information.

The data report merely presents the findings in tables and charts but does not interpret the data.

The popular (or persuasive) report is a non-technical report, written in a popular style, with a broad, non-technical audience in mind. Its intended use is to provide general information to the public at large. The report must be factual, but interesting, with enough emotional appeal to attract a large number of readers. Other criteria to keep in mind while preparing the report include completeness, providing all the information the reader needs at an easily comprehended language level; accuracy; clarity, with precise phrasing; and conciseness, keeping the writing crisp and direct. Presentations of the findings in graphs should be included to visually enhance understanding of the results.

References

Churchill, G.A. Jr. 1979. *Marketing Research. Methodological Foundations*. Second Edition. Hinsdale, Illinois: The Dryden Press.

Dwiprabowo, H., H. Roliadi and Buharman. 1980. *Pattern of fuelwood and other fuel consumption in household and industries in D.I. Aceh*. Report No. 155. Bogor: Forest Products Research Institute.

Lazo, H. 1977. *Marketing, Modern Business*. New York: Alexander Hamilton Institute.

Myers, J.H., and W.H. Reynolds. 1967. *Consumer Behavior and Marketing Management*. Chicago: Houghton Mifflin.

Stanton, W.J. 1984. *Fundamentals of Marketing*. Seventh Edition. New York: McGraw Hill.

Sumarna, K., and Y. Sudiono. 1973. *Fuelwood consumption for households, industries, and the State railway enterprise in East Java*. Report No. 8. Bogor: Forest Products Research Institute.

Marketing Tree Products from Small Farms: Case Studies from the Philippines and Implications for Research

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The transformation of small agroforestry farms from subsistence to a semi-subsistence economy is taking place in many less developed countries (LDCs). The rate and impact of transformation differ across countries. However, it is a common observation that although farmers are able to participate in marketing activities, they do not receive fair and adequate returns from their efforts. Therefore, sufficient incentives for raising productivity are lacking and marketable surplus and incomes remain small.

Market development should be an essential component of social/community forestry, integrated into development plans to promote ecological stability and raise the socioeconomic welfare of small-scale farmers. The underlying premise is that efficient markets allow for greater productivity and income which, in turn, enhance conservation efforts.

This paper is divided into three parts. The first discusses why market development should be integrated into a comprehensive plan of social/community forestry. The second part presents empirical evidence on the marketing of agroforestry products in the Philippines, identifies marketing-related problems of small-scale farmers, and makes suggestions for a market development program. The last part identifies subject areas for a marketing research agenda and considerations for research methods.

Market Development - An Essential Component of Agroforestry

The social forestry program of the Philippines aims to promote ecological stability and improve the socioeconomic welfare of the forest occupants. This is being undertaken through upland development efforts by the government under its Integrated Social Forestry Program (ISFP) and the private sector with increasing support from non-governmental organizations (NGOs).

As a social equity program, the ISFP aims to provide direct improvements in agroforestry productivity and income for the 17.8 million Filipinos occupying the upland forest areas. This is to be achieved through an incentive structure that includes land tenure security, technical assistance, credit support, and viable marketing schemes. Tangible benefits in terms of higher productivity and incomes must be realized by the forest dwellers to enable them to participate in soil and water conservation measures for the protection of the Philippines' forest resources.

The potential of marketing to improve farm productivity and income, and its effect on conservation has been overlooked. Productivity, income, and conservation may be reinforced or constrained by market-related factors. As small-scale farmers become part of the marketing system, price increasingly becomes an important variable in their decision-making process. A suitable price for their products should contribute to the achievement of conservation and improved standards of living for upland farmers.

Improved levels of income may be achieved through higher productivity and a favorable price structure. The latter is required to sustain productivity and is a function of efficient input and output markets. The availability of low-cost production inputs (seeds/seedlings, fertilizer and other farm chemicals) as well as better output prices should have positive impacts on agroforestry production.

An efficient marketing system is one which moves goods from producers to consumers at the lowest cost consistent with the provision of services that consumers desire and are willing and able to pay. This implies the formation of prices corresponding to the cost of bringing the products at the right time, place, and form demanded by consumers and the payment of a normal return to those who perform the marketing services, that is, without excessive profits.

The need to integrate the concept of efficient marketing in social/community forestry is important because of the unique environment of the forest dwellers. They comprise the most underprivileged and impoverished sector with limited opportunities for participation in the Philippine economy. The uplands are characterized by marginal farm productivity due to low adoption of technology and soil conservation measures, lack of access to yield-increasing inputs, and disincentives arising from land tenure insecurity.

The inefficient marketing system is manifested in terms of low farm prices, high marketing costs, and the dependence of forest dwellers on enterprising middlemen for the marketing of their agroforestry produce. These problems generally result from inadequate farm-to-market roads, storage, grading and processing facilities, market information, and market facilities where buyers and sellers can interact and transact business in a relatively competitive manner. These conditions lead to market imperfections that allow buyers to exercise exploitative control on prices at the expense of small-scale farmers. Thus, market power is wielded by the buyers and the farmers do not receive sufficient incentives to participate in marketing activities or to adopt appropriate technologies for increasing production. Their output and income remain low and they barely rise beyond subsistence.

Production and marketing are interrelated activities. There can be no sustained output to meet the expanding demands for food, fodder, fuelwood, and timber in the absence of efficient markets. Efforts in market development must be pursued in the context of a broad-based, integrated and comprehensive approach to address the problems of the forest dwellers. Presently, the Department of Environment and Natural Resources (DENR) of the Philippines is preparing a twenty-five year Master Plan for Forestry Development (MPFD). A major component of the plan is the development of markets for the efficient delivery of inputs to farmers, and agroforestry produce from production to consumption points.

The Upland Environment

The growing human population in forest areas results in land use conflicts between agriculture and forestry. Upland dwellers now comprise one-third of the Philippines' population. At an annual growth rate of 2.59%, the upland population will reach 24.7 million by the year 2000 (Cruz *et al.* 1988). Unless employment opportunities become available on a sustained basis, this trend will mean intensified human activities in the uplands in search of food, resulting in further degradation of forest resources. The current rate of deforestation, or the conversion of forested areas to alternative uses, is estimated at 119,000ha per year (Donovan 1989). Environmental protection and upland development should aim to stabilize land use practices, eventually eliminating shifting cultivation, and enhance the productivity and profitability of land already occupied. An efficient marketing system can potentially improve farm prices and provide incentives for greater productivity.

The low income of upland dwellers, estimated at P10,000-P15,000 per year (US$1 = P22), is attributed to low farm output of agroforestry products due to marginal productivity (Calanog 1989). Rosegrant (1987) reported that crop yields of upland farms are much lower than those of lowland irrigated farms. A summary of average yields and a comparison between upland and lowland yields are presented in Table 1. The estimate for rice yield is for the Buhi-Rinconada area of Bicol (FORI 1980) and corn yield data is from the uplands of Cebu (Cruz *et al.* 1988).

With farms ranging from 1-3ha and family size averaging six members, the marketable surplus is very small, with 70%-80% of the farm output earmarked for home consumption. In general, the farmers do not get proper prices for the remaining 20%-30%.

Potentials of Agroforestry and Better Markets

Scientists and planners refer to agroforestry as a rational land use for social/community forestry with considerable potential for meeting environmental and equity goals for the upland dwellers. Tropical agroforestry systems have been identified including crop rotation and intercropping. Generally, it integrates the planting of agricultural crops and raising a few head of livestock and poultry with perennials

Table 1. Average annual yields (t/ha).

Commodity	Upland	Lowland	National Average
Rice	1.41	2.68-4.06	
Soybeans	1.10	1.56	
Mungbean	2.43	3.35	
Rice (Bicol)	0.73		2.40
Corn (Cebu)	0.08		1.13

such as fruit and forest tree species for multiple purposes including food, fodder, fuelwood, green manure, and fencing.

In the Philippines, annual crops such as rice, corn, and vegetables are combined with trees such as banana (*Musa sapientum*), jackfruit (*Artocarpus heterophylla*), mango (*Mangifera indica*), coffee (*Coffea arabica*), cashew (*Anacardium occidentale*), coconut (*Cocos nucifera*), raintree (*Samanea saman*), bamboo (*Bambusa* spp.), giant ipil-ipil (*Leucaena leucocephala*), and moluccan sau (*Paraserianthes falcataria*). The last two species are grown by farmers participating in the smallholder tree farming project in the timber concession areas of Surigao and Agusan Provinces in eastern Mindanao. Leucaena is commonly planted in homegardens and along roadsides for shade, fuelwood and fodder.

The potential benefits from intensive farm cultivation are enormous. Selected farmers in the upland areas of Cebu, Benguet, Laguna, and Cavite Provinces have reported gross incomes ranging from P50,000-P80,000 on plots of 1-2ha. An important feature of these areas is their proximity to urban markets, enabling them to sell almost everything they grow.

Marketing Systems/Methods

Marketing is a process encompassing all the steps involved in the flow of products from the producers to the consumers. It is a system undertaken within a network of channels, middlemen, and institutions which facilitate the production, distribution, and exchange of products. Kohls and Uhl (1980) define a marketing system as being composed of alternative product flows called marketing channels, a variety of firms (middlemen -- private or public agencies), and numerous business activities (marketing functions).

Table 2 illustrates the components of the marketing system. The goals of each sector/subsystem are identified. The concept applies generally to the agricultural and tree products of forest dwellers but empirical marketing research must be modified to consider the unique characteristics of upland systems, such as the diversity of products, the small size of farms, and the subsistence means of production.

The marketing of agroforestry products is largely through private trade. Unlike lowland agricultural systems where staple crops, such as rice and corn, benefit from the government's procurement and marketing program, agroforestry products are sold to consumers through a system composed almost entirely by private middlemen. Although the government's marketing program for rice and corn does not discriminate between lowland and upland farmers, the lack of infrastructure and the remoteness of production areas in the uplands deprive the farmers of the support prices provided through the program, currently at P5.00 and P2.90/kg for rice and corn, respectively.

For other cash crops such as fruits, the forest dwellers are also dependent on private traders except where direct sales to nearby consumers is possible, but this is usually limited. Consolacion and Francisco (1988) reported that vegetable traders in Benguet Province act as a market outlet, input supplier, and credit source. This implies a credit-marketing relationship which is usually disadvantageous to the individual farmers.

Table 2. Components and goals of the marketing system.

Components (sub-systems)	Intermediate Goals	Ultimate Goals
Producers	Minimize marketing obstacles	Equalize supply and demand
	Fair prices for products	Promote stable price, income
Flow	Facilitate product, financial, and information flows	Maximize long-term profit
Functional	Increase income	Reasonable return on investment
Market channel	Minimize short-term risk	Stablize supply Maximize long-term profit
Consumers	Reasonable price	Satisfaction at least cost
Market environment	Improve market performance	Minimize market imperfection

The system is the same for the marketing of fuelwood, charcoal, and minor forest products such as ornamentals, bamboo, nipa (*Nypa fruticans*) and rattan (*Calamus* spp.). Fuelwood collected by farmers from the forest, their own woodlots or backyard tree gardens is split and bundled at 10-15 kg/bundle. These are carried to the roadside or hauled by animals (carabao). Sale to consumers may take place along the road or the wood may be taken to town. Fuelwood is transported by jeepney or other light vehicles for distribution to retail outlets and to the final consumers, ie. households or bakeries.

Bamboo marketing follows almost the same pattern to its ultimate end users -- households for construction, fish pen owners and small-scale furniture and handicraft manufacturers. For rattan, the forest occupants are the cutters/harvesters who are paid a minimal fee for their services by contractors, the authorized agents of rattan concessionaires.

A marketing program in eastern Mindanao provides a market outlet for the participants of the smallholder tree planting project. Given credit and technical assistance, smallholders engage in the planting of fast-growing trees such as Leucaena and *P. falcataria* for fuelwood, charcoal, leaf meal, or poles to prop bananas. Props are sold to nearby banana plantation owners. *P. falcataria* is channeled to the Paper Industries Corporation of the Philippines (PICOP) for its pulp and paper mill. Arrangements specify the schedule of harvesting, hauling to the roadside, and transport to the mill. As in most marketing contracts, a predetermined price is set.

To produce electricity, the National Electrification Administration (NEA) has embarked on a program of leucaena planting for its dendrothermal plants. So far, there has been no in-depth assessment of the marketing system under this program or its impact on the farmers' welfare.

Marketing Channels

Calderon and Diaz (1986) identified various market channels for agroforestry products, such as annuals and fruit, produced in selected areas of northeastern Leyte, Iloilo and Nueva Ecija. The most common patterns are presented in Table 3.

Table 3. Common market channels for agroforestry products.

Producer →				Consumer
Producer →			Retailer →	Consumer
Producer →	Wholesaler →		Retailer →	Consumer
Producer →	Contract buyer →		Retailer →	Consumer
Producer →	Financier/Wholesaler →		Retailer →	Consumer
Producer →	Wholesaler →	Processor →	Retailer →	Consumer

Source: Calderon and Diaz (1986).

The simplest system involves direct sale from the producer to the consumer. Marketing tends to become more complex as the numbers of intermediaries and services provided increase. Some products require minimal services, ie. fresh vegetables sold to nearby households, while others necessitate services of time, storage space, and energy inputs. Harvested coffee and pili (*Canarium ovatum*), for example, must be dried, stored, transported, processed, and packed for distribution to consumers.

In most cases, farmers perform very limited marketing services. The value added by these services is captured by the middlemen who often have the capital and the necessary facilities. An example would be a contract buyer who enters into an agreement with a mango farmer to harvest and buy the latter's produce even before the flowering stage. The buyer assumes pre and post-harvest expenses including flower inducers for the mangoes, labor, packaging materials, and transportation services. The financier-wholesaler provides capital and other facilities to farmers and other buyers to obtain sizable volumes for distribution to retailers. Unlike retailers who operate in small volumes, large trade volumes enable wholesalers to realize big returns, and where they control the bulk of the trade, to influence and set prices.

Marketing Problems, Issues and Strategy

In rural areas of LDCs, the marketing system is considered inefficient and is associated with exploitation by middlemen. The overall impact is low producer prices, high consumer prices, and large marketing margins[1] resulting from high marketing costs or above-normal profits of middlemen, or both. High marketing costs are due to operational inefficiencies, ie. poor packaging materials and traditional post-harvest losses. The above-normal profits of middlemen result from inefficient price formation due to poor communication and transportation facilities, highly segmented markets, lack of access to market outlets, and highly unequal bargaining power between buyers and sellers (Pabuayon 1987).

The lack of market information on the part of the small-scale farmers and the inability of many buyers to penetrate remote producing areas due to poor roads increases the opportunity for the buyer/trader to exercise monopsony power at the expense of the farmer. The poor road conditions directly raise transfer costs to the consumers' disadvantage. Capital constraints for bulk procurement and purchase of facilities, and lack of infrastructure serve as barriers for potential market entrants leading to a less competitive market environment.

Upland farmers are constrained by problems such as the inability to find alternative market outlets, and low prices (Calderon and Diaz 1986; Calanog 1989). Such disincentives limit farm output and commercialization. This was the case where farmers in Camarines Norte (Bicol) refused to plant Leucaena because there was no feed mill in the area and fuelwood was readily available. Taking these products to markets outside the province would result in high transportation costs (Capistrano and Fujisaka 1984). The participants of an upland development project in Balatan, Camarines Sur preferred planting fruit trees to hardwood species because the latter could be difficult to sell (Duldulao 1979). The farmers in the tree planting project in Mindanao felt that PICOP exercised monopsonistic price control as it was the sole buyer of *P. falcataria* in the area (Chua and Diaz 1985). Similarly, Aguilar (1982) noted the oligopsony control of lowland merchants in the Ikalahan reservation who dictated prices through a form of informal collusive agreement.

The above suggests the need for government intervention to lower the real costs of marketing and improve the competitiveness of the marketing system. A conceptual framework for designing a plan to improve the marketing system for small-scale tree farmers should include the following components:

- provision of market information for all market participants regarding supply, demand, prices, grades, standards, and alternative outlets to allow sound decision-making;

- market infrastructure development focusing on farm-to-market roads, storage and processing facilities and public markets/ buying stations;

- promoting the adoption of post-harvest technologies and village-level processing, ie. cottage industries and small-scale furniture and handicraft manufacturing for greater value added and employment, through extension on technical and market information, training for entrepreneurial skills and small-scale financing;

- strengthening farmers' associations for better bargaining power with input sources and market outlets;

- direct marketing assistance by helping farmers find markets, in the conduct of negotiations, and in formalizing marketing agreements/linkages;

- development of a marketing extension system for effective delivery of required support services; and

- policy advocacy for favorable input-output price structures and marketing subsidies for small-scale farmers.

Implications for Research

A development strategy that focuses on improving markets for small-scale agroforestry farmers requires adding to the knowledge of marketing systems through research. Most studies in the Philippines have centered on lowland agricultural systems. Research assessing the effects of marketing systems on small-scale farmers in the uplands is indequate. Such research is necessary so that appropriate programs may be developed for the farmers. While it is recognized that commonalities exist in many LDCs, the marketing system of each country is unique in view of the physical, technological, social, cultural, political, and external factors affecting the system. The dynamic nature of the marketing system and the growing complexity of rural markets as they become exposed to outside forces implies the need for sustained market research efforts.

Some of the issues and research methods relevant for small-scale producers of agroforestry products are listed below to provide topics for developing a research agenda. It is divided into subject matter areas and methods in marketing research. The list is not exhaustive and actual research proposals must be based on priority considerations. The approach depends on the research objectives, availability of data, and background and expertise of the researcher.

Subject Areas

Suggested topics include:

- supply and demand studies for agricultural and tree products to identify demand requirements, supply potentials, surpluses and shortages at the national, regional, provincial and district levels;

- price analyses -- location/geographic price differences; price differentials by grades, quality, types of products; and temporal price variations such as trends, seasonal, cyclical and random movements;

- general marketing studies covering types of products produced and marketed, product disposal, product flows and market channels, market intermediaries at various levels, marketing functions, costs and margins, volume traded, prices received and paid, method of sale, method of payment, problems and constraints;

- analysis of market structure, conduct and performance using specific criteria and indicators;

- feasibility analysis of business ventures under various marketing conditions such as cooperative marketing, contract arrangement, and small-scale processing;

- assessment of market infrastructure needs of rural communities; and the

- role of government and NGOs in marketing.

Approaches and Methods of Analysis

- commodity, institutional, or functional approach in analyzing marketing systems;

- case studies versus sample survey;

- types of data by source of information (primary vs. secondary data) and time dimension (time series vs. cross-sectional data);

- data presentation (tabular, graphs, or text; and

- data analysis -- qualitative or descriptive vs. quantitative (statistical techniques such as hypothesis tests, regression and correlation analysis; and linear or quadratic programming techniques used in spatial or intertemporal equilibrium analysis).

Note

[1]Marketing margin is defined as the difference between prices at two market levels, ie. between farm and wholesale, wholesale and retail, or farm and retail. For the latter, it is the difference between the producer price and the consumer price and represents payment for the marketing services provided.

References

Aguilar, F.V. Jr. 1982. *Social Forestry for Upland Development: Lessons from Four Case Studies*. Project Report. Quezon City: Institute of Philippine Culture, Ateneo de Manila University.

Calanog, L.A. 1989. *Development of Marketing Assistance Programs for Agroforestry Farmers in the Philippines: A Preliminary Analysis.* Project Report: ERDB-DENR.

Calderon, A.G. and C.P. Diaz. 1986. *An Economic Analysis of Agroforestry Products Marketing System in Selected Upland Areas in the Philippines.* Project Report: Forest Research Institute (FORI)/PCARRD.

Capistrano, A. and S. Fujisaka. 1984. Tenure, Technology and Productivity of Agroforestry Schemes. Paper presented at the Workshop on Economic Policies for Forest Resources Management. Manila: Philippine Institute of Development Studies (PIDS).

Chua, S.R. and C.P. Diaz. 1985. *Economic Significance of* Albizia falcataria *Tree Farming to Small Farmholders*. Part I. Project Report: FORI-PCARRD.

Consolacion, C.C. and H.A. Francisco. 1988. *Rural Poverty in Ethno-Community: An Analysis*. Project Report: UPLB-Winrock International.

Cruz, Ma.C.J., I.Z. Ferranil and C.L. Goce. 1988. Population Pressure and Migration: Implications for Upland Development in the Philippines. *Journal of Philippine Development* 26(1):15-46. Manila: PIDS.

Diaz, C.P. and S.R. Chua. 1985. *Economic Significance of Ipil-ipil* (Leucaena leucocephala) *Tree Farming to Small Farmholders.* Part II. Project Report: FORI.

Donovan, D. 1989. *Environmental Management for Conservation of Watershed Resources.* A Draft Report for the Master Plan for Forestry Development of the Philippines. Quezon City: DENR.

Duldulao, A. 1979. *An Integrated Project for Kaingin Control in the Philippines: A New Approach to Forest Conservation*. Project Report: UPLB/DNR/PCARRD.

Kohls, R.L. and J.N. Uhl. 1980. *Marketing of Agricultural Products*. 5th ed. New York: MacMillan Publishing Co., Inc.

Pabuayon, I.M. 1987. Market Development Strategies and Assistance for Small Farmers. *Journal of Agricultural Economics and Development* 16/17:60-68.

Rosegrant, M.W. 1987. *Price and Investment Policies for Food Crops Sector Growth in the Philippines*. Project Report: IFRI-ADB.

A Methodological Approach for Sustainable Agriculture in Dry Areas: A Case Study from Sri Lanka

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Information about the current environmental and socioeconomic conditions of the dry zone areas of Sri Lanka are presented. The need to rehabilitate the dry zone using sustainable crop production methods is underscored. A methodology and an approach designed to raise the standard of living in rural areas and strengthen the national economy are outlined. It is hoped that this feasibility study will contribute to the debate on methods of promoting sustainable agriculture in dry areas.

Background

Sri Lanka's biological resources have been exploited for centuries. At first it was on a small scale, with primitive shifting agriculture which allowed the system to rejuvenate through fallowing, and later, on a larger scale, with the establishment of plantation agriculture in the southwest during the last century. The result of this pattern of land use is the predominance of commercial plantation agriculture based on tea, rubber and coconut in the wet zone, while the rest of the country remains relatively undeveloped.

Recent development efforts in agriculture have aimed at achieving self-sufficiency in food production and improving the quality of life for the 70 percent of the population dependent on agriculture for employment and income. Three strategies to improve crop production have been designed. The first is the provision of large-scale irrigation systems to increase the number of crops per year in the dry zone. The second is agricultural diversification and intensification in the wet zone. The third is the introduction of advanced technologies, particularly high-yielding, short-rotation crop varieties to increase the yield per hectare.

Of the total 6.5 million hectares of land in Sri Lanka, only 36 percent is located in the wet zone, which has a well distributed annual rainfall of 200-600cm. The dry zone, extending over 4.2 million hectares, is noted for its seasonal and extremely low rainfall, in most years ranging between 80-200cm. Two-thirds of the rain falls during the northeast monsoon between September and February, with a small amount falling during the southwest monsoon of April to June. The rest of the year is a prolonged dry season. Following this cycle, farmers cultivate two crops. The most important *Maha* Crop is cultivated during the northeast monsoon rains and a second, less reliable *Yala* Crop is cultivated with the southwest monsoon.

The response of the dry zone peasants to the seasonality of rainfall is apparent not only in their cropping and farming patterns but also in household food availability, employment and income. The consequences of this climatically determined lifestyle was demonstrated to the author in a study on the role of women in domestic crop production in the dry zone (1989a; 1989b).

The ancient communities coped with their environment through shifting cultivation in the uplands, with lowland paddy cultivated by accumulating surface runoff into reservoirs. The traditional practice of shifting cultivation diminished under population pressure, resulting in an expansion of settlements and a scarcity of arable land. The change from shifting cultivation to commercial crop production and permanent cropping of plots has led to a variety of environmental and socioeconomic problems, including diminishing productivity and environmental quality, and increasingly costly inputs.

Today in Sri Lanka, the improvement of crop production in the dry zone areas is of particular concern to policy makers because of its vast expanse, inadequate rainfall, lack of employment opportunities other than agriculture for a majority of peasants, and the scarcity of available arable land in the wet zone. Recent development efforts have promoted rice production, the staple food of Sri Lanka, and the diversification of agriculture through alternative crops.

Supplementary crops such as coracana (*Eleusine coracana*), sesame (*Sesamum indicum*) and manioc (*Manihot esculenta*) have been grown in the dry zone for centuries. Emphasis on promoting alternative crops such as cowpea (*Vigna unguiculata*), greengram (*Phaseolus radiatus*) and blackgram (*P. mungo*) began in the 1960s and has become widespread in commercial agriculture. At the present time, high rates of soil erosion, poor soil conditions, increasing salinity and decreasing productivity are major problems. However, whether the deteriorating condition of the environment is due to environmental limitations, to poor farming practices, or a combination of both is a key question.

The Need to Rehabilitate the Dry Zone

Exploiting natural resources and the environment to achieve urgently needed economic growth took place at an extremely high rate during the last century. The need to maintain a sustainable, renewable resource base for future food production and the peasantry was of little concern. Under the current economic pressure and the commercial interests of agriculture, sustainability and ecological benefits are disregarded by the farmers, planners and policy makers. Neglecting to restore degraded land and adopting environmentally unsound farming practices in place of traditional ones have caused irreversible damage. Ensuring long-term crop production now depends on costly artificial inputs, jeopardizing both income and employment. Although rehabilitating deteriorating and degraded croplands is an environmental necessity, it can be justified on a socioeconomic basis as well.

Assessing Environmental Needs

Justifying the need for rehabilitating the most degraded areas requires an analysis of entire agroecosystems. Research conducted at the field level is limited because most of the observations are made under managed conditions at an experimental level. On the other hand, quantifying environmental repercussions is very complex and difficult in practice. Most of the damage to the environment has taken place over the long-term in association with trends in the pattern of resource utilization. Site specific studies and research on specific agroecosystems are scarce.

Research conducted by the author in the dry zone of Sri Lanka (1987) and in the hill-country (1988; 1989c) established a baseline which emphasized the need to rehabilitate degraded areas in a number of agroecosystems. The impact of prevailing farming systems on the soil was examined by measuring water retention capacity, organic matter content, soil erosion and the impact on water resources. This study graphically demonstrated the depletion of resources in the area, and underscored the need to monitor and control increasing runoff and soil erosion which is leading to high levels of salinity and sedimentation in the water supply.

Under these circumstances, rehabilitation of the dry zone is an urgent necessity. A management system is needed which will improve the soil. The poor soil structure, low rate of percolation and low moisture retention capacity in association with cleared soil surface increases runoff and evaporation instead of storing the water for intermediate and prolonged dry spells. In most of the dry zone, the vegetative cover and land use practices encourage further deterioration. Measures taken to prevent adverse effects are minimal.

Socioeconomic Needs

Adoption of conservation techniques is a prerequisite to ensure the continuity of a functioning society. At the national level, the sustainability of crop production is important to the domestic food supply. Almost 73 percent of the cultivated land in the dry zone is under the management of small-scale farmers. The average extent of land holding varies, with comparatively larger holdings in the areas of lowest productivity.

Despite the importance of dry zone crop production for the nation's food supply, underlying socioeconomic factors need to be addressed as well. There is an urgent need to reorganize the current farming systems to reduce the extreme seasonality of food production, thereby increasing food availability, employment opportunities and income. The seasonal differences in agriculture adversely impact the rural population because of a lack of available work and income during the dry season. The long-term stability and sustainability of agriculture are of prime importance to Sri Lankan society as a whole.

The Study Site

The site selected for this feasibility study covers an area of 1,000 hectares in northwest Sri Lanka. It includes 80ha of lowland paddy, 720ha of upland and 12ha of forest. The rest is under homesteads, shrubs, buildings and reservoirs. Of the 240 families living in the area, 231 are directly dependent on the land while the rest are partially engaged in non-agricultural wage labor.

Two cropping systems, the upland system of dryland crops and the lowland system of paddy predominate. Both systems are seasonal and unreliable due to the fluctuation in rainfall. Although the upland farming system, locally known as *chena,* is often described as a traditional system of shifting cultivation, it no longer involves a periodic shift to new areas, consisting of slash and burn on permanent plots. The availability, amount, duration and timing of rainfall determine when to plant and the number of possible crops each year.

Over the last three decades, traditionally grown subsistence crops such as *E. coracana*, *P. mungo*, tubers and varieties of drought resistant dry rice have gradually been replaced by cash crops including *P. radiatus*, *S. indicum*, *V. unguiculata* and *Arachis hypogaea*. Eighty-four percent of the uplands is cropped under just three cash crops -- *P. radiatus*, *V. unguiculata* and *S. indicum* with an emphasis on maximizing yields. Even so, the maximum growing season is often limited to seven months.

The introduction of high-yielding varieties has led to changes in farming practices and the application of inorganic fertilizers, pesticides and herbicides. The peasants feel that these improved crop varieties have significantly decreased their profits. Therefore, an alternate system is needed which would minimize the environmental hazards of farming and generate a reliable, stable income for a secure standard of living. The feasibility study was designed to formulate a strategy applicable throughout the dry zone.

The Importance of Ecological Sustainability

Meeting socioeconomic needs and rehabilitating the environment simultaneously is difficult to achieve. Often, when the economic climate is favorable, environmental concerns are ignored. The establishment of ecologically sustainable crop production systems is a long process. This is complicated further when the peasants want to achieve results quickly. The seasonal upland farming system is unsustainable but is preferred by the farmers for the immediate economic returns and because there are no other available alternatives. Perennial systems, such as mixed Kandyan homegardens, ensure the long-term continuity of crop production with minimum inputs and are not subject to climatically determined employment cycles. However, if agricultural systems aim to fulfill multiple objectives then both of these methods need to be integrated to maximize crop production and minimize environmental impacts.

Under the increasing pressures of landlessness and scarcity of arable land to meet the needs of the peasants, croplands can not be diverted for conservation or converted into ecological reserves. Long-term sustainability of the land and biological productivity must be maintained while meeting the needs of society.

Methodology

The primary objective of the project was to modify the present land use into a sustainable perennial system. It was a great challenge to find ways of increasing productivity by cultivating seasonally fallow lands with drought resistant perennials. The proposed reform was to be brought about through an intense process of surveys, observations, investigation, discussions, community work and willing acceptance by the local community. The resources of several disciplines in the natural sciences as well as the social sciences were mobilized to bring about a radical change in the selected area.

The strong mutual relationship between nature and the rural population is a complex phenomena. To be effective, reclamation of physical land resources must be accompanied by social research. Several baseline studies were needed, concerning the social interaction with the natural system. Both natural and social scientists collaborated with the peasants in the cluster of villages around the ancient water collecting reservoirs known as *cascades*.

Effective coordination of all three groups was extremely important. The villagers were considered not only as beneficiaries, but as key informants, advisors and implementors. The confidence of the scientists in the villagers encouraged them to use their skills and experience as inputs to the project. It was a challenging opportunity for the villagers to incorporate their ideas into a development project. As highlighted in Table 1, the primary objective of the study was to examine the human response to the environment and to analyze the consequences of this response on the environment. Introducing practical rehabilitation measures incorporating advanced technologies and genetic improvements was also important. The project was designed to motivate farmers to take the initiative, while basic training, material assistance and guidance were provided through the coordinating unit.

Baseline Studies

Field research, a household questionnaire survey, and participatory observations were carried out over an entire year. This made it possible to gather information on spatial and seasonal trends. In conducting these sectoral studies an attempt was made to have the assistance of the villagers in locating sites, inventorying plants, collecting soil samples, measuring soil moisture conditions and fluctuations of the water table. Village meetings were held to disseminate the research results, to get feedback, and to promote self-reliance among the farmers.

At this stage, it was an exciting experience for the villagers to use the regional aerial photographs at a scale of 1:10,000. This was an effective media as the villagers were able to pinpoint specific locations and discuss their experiences at those sites. By comparing the aerial photos taken in 1956 and 1986 the change in land utilization was immediately apparent. The scientific observations indicating the adverse consequences of human induced changes, coupled with the farmers' observations of the environmental deterioration on their farms, were helpful in convincing the villagers of the need to rehabilitate the environment.

Once the farmers were convinced of the need to rehabilitate their land, it was necessary to take steps to solve the problems. The environmental studies provided information on the climate, hydrology, soil, vegetation and landforms. Aerial photographs were utilized to visually locate and explain spatial characteristics as well as graphically demonstrating human induced changes on the environment.

Both the environmental and socioeconomic findings were viewed with interest to understand the present situation and to explore alternatives and prospects for the future. An attempt was made to highlight how these social and environmental conditions influence each other. It was concluded that rainfall is the major factor influencing social behavior and economic activities.

The field data revealed that 72 percent of the annual crop production takes place during the prominent rainy season, when two-thirds of the rain falls. Almost all arable lowland and uplands are cultivated with seasonal crops. Excluding the near-landless, 52 percent of the families in the area produce an adequate amount of food for annual family consumption during this season.

Results of Field Studies

The cyclical nature of rainfall is the limiting factor, resulting in a great variation in crop production, food availability, labor requirements and income. The arable land under cultivation only during the rainy season should be cultivated with drought resistant perennials. Low cost soil and water conservation strategies should be introduced.

If irrigation is provided, social and economic problems will be alleviated by a system of year-round crop production and agricultural employment. An alternative solution could utilize biological strategies to enhance the production of a range of food and raw materials for agro-based industries.

The application of fertilizer, pesticides and herbicides for better crop production is difficult for about 42 percent of the families. Purchasing such inputs is possible only for a few wealthy landowners. For the rest it is possible only if a surplus is produced or if cash is earned through wage labor. For profitable farming and sustainable crop production, costly inputs should be reduced with organic farming techniques. As pointed out by Hauck (1978), FAO (1975), and Parr and Papendick (1983), the application of chemical fertilizers has raised the cost of operation and is not practical for small-scale farmers.

Crop failures are quite common during the Yala season of southwest monsoons, resulting in food scarcity and low income. Meeting family food needs is difficult during the prolonged dry seasons because of the lack of off-farm

Table 1. Major aspects considered in the sectoral studies.

Environmental Conditions	Socioeconomic Conditions
Climate: Rainfall as the limiting factor.	Activities and Livelihood: Employment, income, production, farm operation and management, labor input and seasonal or annual trends.
Hydrology: Rainfall distribution and intensity, irrigation and ground water quality.	Traditions, Habits and Skills: Social behavior and economic activities, traditional methods of resource conservation, utilization, crop processing, vegetation/crop management and marketing.
Soil: Both physical and chemical condition.	Social Organization: Social structure, economic structure, flow of services, and system of resource management and organization.
Vegetation/Crop Cover: Type, composition and spatial distribution.	Technology: Methods of crop production, application of inputs, technology related to food processing, agro-based industries.
Landforms: Morphological differences, hydrological patterns.	

employment. Such problems are most acute among the poor because the harvest from their land is not adequate to save for the off-season.

Since erosion is continuous, farming practices such as complete clearing of the land before the rainy season either should be abolished, or soil erosion should be controlled through alley cropping with MPTS.

Human induced desertification should be controlled to the greatest extent possible. Establishing trees on such land promotes the infiltration and storage of moisture as well as stabilizes the soil. The need for better water conservation methods for sustainable agriculture is underscored by the National Academy of Sciences (1974) and the Congress of the United States (1983).

Appropriate Measures

As revealed by the sectoral studies and discussed at the village meetings, appropriate conservation measures should be put into immediate practice. One question that sparked a lively debate centered around the most appropriate measures to meet both social and environmental needs. Another question is whether rural villagers will accept the proposals and work together to reach the goals of a sustainable system. Another topic discussed was if the farmers are willing to undertake the proposed system, whether rehabilitation can be carried out with minimal interference to the cash crop production.

The villagers unanimously agreed to adopt appropriate rehabilitation measures and formulated the following implementation strategies -- integrating drought resistant food producing perennials in their small-scale farm operations; diversifying and intensifying cropping by adopting genetically improved tree species; and producing surplus raw materials for agro-based industries.

A group of scientists and villagers went through a list of species to identify drought resistant perennials to help the farmers select specific species and consider possible planting sites.

The Farmers' Choices of Perennials

The traditional use of trees in this area is limited to the collection of forest products and timber. The villagers are not used to propagating indigenous species and their existence is limited to the upland chenas in isolated cases. The products of indigenous species, such as bassia (*Maduca longifolia*), tamarind (*Tamarindus indica*), wood apple (*Limonia acidissima*) and margosa (*Azadirachta indica*), are collected by women and children, and either sold immediately or processed and stored to fetch a higher price during the off-season. The naturally germinated plants are often destroyed when the upland farms are burned in preparation for planting. As a result of felling mature trees, the supply is diminishing rapidly. Growing trees for shade, food and timber is usually restricted to homegardens and no attempt has been made to grow trees in the uplands.

The farmers' knowledge of drought resistant species is limited to those which have traditionally been used in the area. Their knowledge of genetically improved varieties is minimal. Perennial species common to the area are presented in Table 2. Thorny shrubs and forest species are not listed. Only a few species are noted in the fields and these have usually germinated naturally. Because of this, most of the upland farms are characterized by high rates of evaporation and exposed soil surface. *Gliricidia sepium* and *Leucaena leucocephala* are two exotic species mentioned by the farmers, but they are grown only for hedges. Planted species commonly seen in homegardens include *Artocarpus heterophylla*, *Cocos nucifera*, *Musa acuminata colla*, and *Mangifera indica*.

The farmers' preferences for tree species, ranked by priority, are for food, timber, and medicine. Although the villagers are aware of the multiple uses of trees, most of them mentioned only food and timber values. Fodder value, fuelwood production and the use of organic residues as fertilizer were mentioned by only eight percent of the households. These additional values are unimportant to the villagers as they let their animals roam freely to feed, collect fuelwood while clearing the fields for planting, and burn plant debris rather than applying it to enrich the soil.

The major factors determining the utilization of perennial species are traditional tree use, awareness of methodologies, and the need for tree products. Most of the farmers prefer to have at least a few trees in their upland farm plots and a dense cover in their homegardens for both shade and food.

Farmers also prefer high-yielding, genetically improved, drought resistant varieties such as *C. aurantium* grafted to *L. acidissima*. This combination is advantageous because it tolerates both droughts and saline soil conditions, takes up little space and provides high yields, particularly during the dry seasons. Farmers feel such species can be interplanted with the seasonal crops without shading out the crops or taking up much space. The number of plants that can be grown along a row is greater than with other perennials. Other species that flourish in the dry zone without inputs or specific management practices are *M. acuminata colla*, *Punica granatum*, *Carica papaya*, *Moringa oleifera*, and *M. indica*. About 42 percent of the families want to grow *C. nucifera*, *A. heterophylla* and breadfruit (*A. altillis*) on their upland farms, while the rest of the villagers prefer to grow them only in their homegardens. The households planning to grow these trees on their upland farms are wealthier than the rest, owning between 8-10ha of uplands.

The decision of the villagers to grow trees was largely determined by the extent of their land holdings. Most of the near-landless preferred to grow trees only in their homegardens. The preferred locations of trees for specific purposes are presented in Table 3.

The farmers were given training in nursery management techniques in order to produce enough seedlings. The most popular species were given top priority and during the first phase, 40,000 seedlings of *M. indica*, *C. aurantium*, *Anona squamosa*, *A. heterophylla* and *C. nucifera* were raised in 20 nurseries. Production was then continued on a smaller scale.

Off-farm employment was promoted by the project. Animal husbandry was expanded by introducing crossbred animals, particularly in the dairy program. Training programs on food processing and preserving were available for women. The most promising cottage industries are the extraction of oil from bassia kernels,

Table 2. Common perennial species.

Botanical Name	Local Name	Present Uses	Location
Madhuca longifolia	Bassia	Timber, shade, oil extracted from seed used for medicinal purposes and on unused land	Along the boundaries of the paddy fields
Tamarindus indica	Tamarind	Timber, seed and leaves used for medicinal purposes. Ripe pod used as a spice	Homegardens, unused land, upland farm plots
Carica papaya	Papaya	Fruit	Homegarden
Aegle marmelos	Bael fruit	Shade, fruit, timber and medicine	Upland farms, unused land, common land
Musa acuminata colla	Banana	Fruit	Homegarden
Moringa oleifera	Drumstick	Vegetable	Homegarden, Upland farms
Punica granatum	Pomegranate	Fruit, medicinal leaves	Homegarden
Artocarpus heterophylla	Jak	Food and timber	Homegarden
Cocos nucifera	Coconut	Food and timber	Homegarden
Mangifera indica	Mango	Fruit and timber	Homegarden
Cassia auriculata	Ranawara	Medicinal plant, leaves cooked as greens	Common land
Azadirachta indica/Melia azedarach	Margosa	Oil extracted from seeds is used for medicinal purposes and timber	Upland farms, common land
Limonia acidissima	Wood-apple	Fruit	Upland farms, common land
Psidium guajava	Guava	Fruit	Homegarden, common land
Murraya koenigii	Curry leaves	Leaves used for medicinal purposes and as a spice	Upland farm, common land, homegarden
Citrus aurantium	Orange	Fruit	Homegarden,Upland farms

Table 3. Preferred locations for growing perennials and ideotype.

Purpose	Location	Ideotype
Timber and Food	Homegarden	Broad canopy, bushes
Food	Upland farm plot	Thin, straight poles
Food	Common land	Broad canopy
Timber	Along hedges	Straight poles or narrow canopy bushes
Fuel	Along hedges, homegardens and common land	Broad canopy, dense branching, short stems
Medicinal	Homegarden, along hedges and common land	No preference
Mulch	Along hedges of the farm plots	Bushy
Fodder	Common land	Short stemmed bushes

preparation of cordials, jams, pickles, curd and yogurt, and preparing and packaging medicinal herbs. As the raw materials for these industries are available locally, the endeavors are quite satisfactory. Nearly 18 percent of the families in the area extract oil from *M. longifolia* for sale, earning on average about $30 (US). Farmers do not grow the trees, but collect the seeds and sell the kernels for medicinal purposes.

The training on conservation methods had a direct impact on the farmers as they were able to apply these low cost soil and water saving measures immediately on their farms. The provision of an agricultural extension officer by the project was appreciated and on-farm discussions of conservation issues were helpful in implementing the project.

Problems

The expected progress of the project in promoting community participation, awareness and self-reliance was found to be satisfactory while the coordinating unit was in operation. The long-term continuity of the project is in doubt, however, because of the decisions made on the short time horizons of the farmers.

As a result of the financial difficulties in the villages, outsiders can easily exploit the area for short-term economic gains. While the project was in progress, some of the farmers showed interest in cultivating tobacco as a cash crop instead of alternative food crops. Comparatively wealthier farmers, with larger land holdings, were eager to accept such alternatives by limiting the perennials to their homegardens. This threat is not unique to the study area but is a result of economic and political interests in farming. Under the present constraints, reforming the system for sustainable production is extremely difficult due to hardships caused in the establishment phase of planting unproductive perennials on croplands.

Another problem relates to the household financial situation. When the project was initiated and infrastructural services were provided it was expected that most of the farmers would participate in the project. However, only 68 percent of the families were able to purchase basic inputs. During the cultivation phase the participation rate decreased to 52 percent.

The lack of rainfall over much of the year slowed the satisfactory establishment of nurseries and planting of alternative crop varieties. Most of the planting of these new crops took place during the traditional cultivation seasons.

One of the greatest difficulties relates to management. Seedlings were destroyed by unrestricted grazing during the off-seasons because the fields were not well protected. Nobody took responsibility for the trees planted in the reserves or along hedgerows. Therefore, the coordinating unit had to take on the additional responsibility of protecting them to enhance the survival rates.

The project planned to produce seedlings for both planting and grafting in the village nurseries. However, most of the farmers preferred to receive free seedlings instead of nursery training, which would have provided continuity of the work to achieve the proposed rehabilitation.

Convincing farmers of the utility of the newly introduced tree species was very difficult as the experimental sites were outside the area. Their knowledge about new varieties was limited to *G. sepium* and *L. leucocephala*, but these species are not grown for multiple uses.

Conclusion

Achieving the optimal use of land resources and inculcating values of careful stewardship of the land for long-term sustainability were the primary goals of this project. The interest in planting cash crops is well established among farmers. After decades of ecologically destructive farming, it is difficult to rehabilitate the environment without investing several decades of experimentation prior to implemention over a wide area. Therefore, a national policy is needed to help the farmers establish a sustainable system gradually. The agriculture, extension, and forestry sectors must work together in collaboration with the farmers to help them develop farm forestry as an integral part of their farming system.

The farmers' preference for growing perennials is determined by their immediate needs. When the daily problems are not acute and available resources meet many of their needs, the villagers tend to ignore the future. Perennial tree crops are preferred for food production because fuelwood, fodder and mulch needs are not yet acute and have been traditionally met from sources other than farm forestry systems. Therefore, in order to achieve the successful participation of the peasants, the planners should focus on food producing species. The multiple uses of these species can then be disseminated among farmers through training and experience.

Guaranteeing the long-term continuity of a project is very difficult after the coordination is terminated. Expecting full community interest and participation may be unrealistic, because the individual interests of the farmers are greater than their community spirit.

The importance of the participation of the villagers in reorganizing their farming systems was emphasized in this project. The integration of social scientists and natural scientists proved to be useful in designing the project to meet the needs of the local communities. The importance of understanding the human interaction with the environment has been stressed by Rambo (1981). This exercise can also be understood as an attempt to stress biophysical factors while enhancing the socioeconomic system in a selected area.

References

Congress of the United States. 1983. *Water-Related Technologies for Sustainable Agriculture in Arid/Semiarid Lands.* Washington, D.C.: Office of Technological Assessment.

Food and Agriculture Organization of the United Nations. 1975. *Organic Materials as Fertilizers.* Soil Bulletin No. 27. Rome: FAO.

Hauck, F.W. 1978. Organic Recycling to Improve Soil Productivity. Paper presented at the FAO/SIDA Workshop on Organic Materials and Soil Productivity in the Near East. Rome.

National Academy of Sciences. 1974. *More Water for Arid Lands: Promising Technologies and Research Opportunities.* Washington, D.C.: National Academy Press.

Parr, J.F. and R.I. Papendick. 1983. Strategies for Improving Soil Productivity in Developing Countries with Organic Waste. In *Environmentally Sound Agriculture*, ed. Lockeretz, pp. 131-143.

Rambo, A.T. 1981. *Environment and Development: The Place of Human Ecology in Southeast Asian Studies Programmes.* Reprint No. 32. Honolulu: Environment and Policy Institute, East-West Center.

Wickramasinghe, A. 1987. Ecological impacts of the Dry Zone Farming Systems in Sri Lanka. *Malaysian Journal of Tropical Geography* 15:49-57.

_____. 1988. *Ecological Impact of the Farming Systems in the Hill-Country of Sri Lanka.* Research Report. Colombo: Natural Resources, Energy and Science Authority of Sri Lanka.

_____. 1989a. The Participation of Women in the Labor Force in Crop Production in the Dry Zone of Sri Lanka. Paper presented at the First National Convention on Women's Studies, March 1-3. Colombo: Centre for Women's Research.

_____. 1989b. The Women's Role in the Rural Household and Agriculture in Sri Lanka. Paper presented at the Workshop on Gender and Development, April 16-21. England: Commonwealth Geographical Bureau, the University of Newcastle Upon Tyne.

_____. 1989c. The Environmental Deterioration in the Hill-Country of Sri Lanka. *Malaysian Journal of Tropical Geography*.

Session 2: Evaluating the Supply of Products

Chairman: Lee Medema

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Evaluating the supply of products from Multipurpose Tree Species (MPTS) is the focus of this session. Although much of the research on production and supply in forestry has concentrated on large-scale plantations, the papers presented in this session were to focus on the integration of MPTS on small-scale farms.

Songkram Thammincha's paper on the *Economic Feasibility of Fuelwood Production: A Financial Approach* describes the status of fuelwood utilization and supply in the lime and pottery/ceramic industries in western Thailand. An economic analysis is presented on fuelwood plantations concluding that such plantations are financially feasible. The paper recommends future strategies for research and development of fuelwood production.

Sathi Chaiyapechara's *Comparative Analysis of Appraisal Methods for Funding Forestry Projects* analyzes the appraisal reports of financial institutions to determine the major criteria utilized to approve funding for forestry investment projects. The most important criterion is the financial internal rate of return for projects funded by banking institutions, whereas for bilaterally funded projects the financial return is not the sole deciding factor.

Rattan and Bamboo as a Major Industrial Resource for Rural People in Peninsular Malaysia by Razak Wahab, Hamdan Husain and Abd. Latif Mohmod includes a descriptive overview of the rattan and bamboo industries in Peninsular Malaysia. Discussions cover the current status of these industries, some of the major industrial problems and the role the Malaysian government has taken to resolve these problems. The paper suggests future growth for the industry including sustainable raw material supplies, expansion of manufacturing technology and the expansion of product diversity.

The Chairman's perception of research needs regarding topics suggested by the papers presented in Session 2 include:

- time series analyses of growth and yields of MPTS;

- analysis of the decision making criteria of donor agencies that fund small-scale MPTS projects;

- *ex-post* analysis of the realization of expected costs and benefits of MPTS projects; and

- identifying products and product outlets for MPTS, rattan and bamboo.

Topics for further consideration suggested by the Chairman include an assessment of existing MPTS inventories and an analysis of the factors that influence supply; an analysis of MPTS production/yield trade-offs for MPTS products, and for trade-offs between agricultural and tree crops in an agroforestry context; and methods for analyzing existing and potential markets.

Economic Feasibility of Fuelwood Production: A Financial Approach

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The status of fuelwood utilization in lime and pottery/ceramic industries in Ratchaburi Province, western Thailand is presented. These industries use about 500,000 cubic meters of fuelwood annually. Pottery/ceramic factories use "chopstick fuelwood", 1-3cm in diameter and 1.30m in length, and "large fuelwood", 10-20cm in diameter and 2m in length, while lime factories use only large fuelwood. The rapid depletion of forest areas has caused serious problems of fuelwood shortage while the ban on logging has exacerbated the problem even further.

The analysis compared large-scale Eucalyptus plantations on forest land under private lease and small-scale plantations on farmland under different spacings and felling cycles, ie. 1x1, 1x2, 2x2, 2x4 and 4x4m with three and five year felling cycles. Results conclude that chopstick fuelwood production is economically preferred on both forest and farmland under 1x1m spacing with a three year felling cycle, whereas 4x4m spacing and five year felling cycles are most productive for large fuelwood.

All data in the analysis were cross-sectional data. It has been suggested that time-series data be collected from fuelwood cutters, middlemen, and end-users in order to validate the cross-sectional data.

Background

The use of fuelwood in rural households and industries in Thailand is very important, and in many cases is considered indispensable. Natural forests are the major sources of this fuelwood. Other sources include fruit orchards, homegardens, and farm woodlots. With easy access to fuelwood sources, particularly state forests, rural people harvest and use fuelwood without any conservation measures. Although wood has been replaced in many areas by conventional commercial energy, it is still regarded as a necessity by certain rural industries.

Ratchaburi Province provides a good example of fuelwood utilization by rural industries. The province is located 120km southwest of Bangkok. Two typical industries that rely on wood-based energy are lime and ceramic production.

Lime production in Ratchaburi dates back to the beginning of the 1930s. Currently, there are 32 producers with a total of 65 kilns, accounting for 20% of the national lime output (Chomcharn 1985). The size of fuelwood used ranges from 10-20cm in diameter and is 2m long. The total volume of fuelwood required for lime production is 150,000 - 200,000m^3 per year, 90 percent of which is from natural forests.

Ratchaburi province has established itself as a leader in ceramic production, particularly in utilitarian glazed water storage jars and fish sauce jars which are sold throughout the country. The glazed water jars can be found in nearly all Thai houses to store drinking water (Panyachan and Magsabsri 1986). Other products include floor and roof tiles, blue and white and multicolor porcelains, and fired clay bucket cookstoves. There are a total of 47 producers and 49 kilns. Two types of fuelwood are used in the ceramic industry -- large fuelwood 10-15cm in diameter and 1.5m long to start the firing process, and chopstick fuelwood to keep the fire burning. For each operation (or ceramic firing) 6-12m^3 of starting fuelwood and 25-35m^3 of chopstick fuel are used, bringing the annual fuelwood consumption of the ceramic factories to 300,000m^3.

Both industries depend on fuelwood from natural forests. The deforestation rate in Ratchaburi was estimated to be about 9,544ha per year from 1961 to 1985 (Royal Forest Department 1985). This has caused serious environmental problems and fuelwood shortages. Approximately 98,000ha, or 19% of the total land area of forest remains, but both legal and illegal cutting continues.

For environmental protection, and to produce sustainable levels of fuelwood for the lime and ceramic industries, it is important that fuelwood plantations be established to reduce the rate of forest exploitation. The study of the economic feasibility of such plantations provides important information for decision makers at all levels, ranging from individual farmers to policy makers.

The overall objective of the study is to determine the economic feasibility of alternative methods of fuelwood production and marketing for the lime and ceramic industries in Ratchaburi Province. The specific objectives are:

- to assess present and future patterns of consumption and supply of fuelwood in the lime and pottery industries;

- to determine the economic feasibility of Eucalyptus fuelwood production; and

- to develop specific recommendations for future research and development strategies for Eucalyptus fuelwood production.

Data Collection

The study began with a survey of fuelwood consumption by interviewing all lime and pottery factory owners. Systematic sampling was employed in the interviews with fuelwood entrepreneurs, fuelwood cutters and woodlot owners. The data collected included the following:

- primary data on type and volume of fuelwood utilized by lime and pottery producers;

- data on fuelwood marketing in Ratchaburi Province, such as sources of fuelwood for cutting, labor employment system, transportation distance, pricing system and price determinants;

- data on costs of Eucalyptus plantation establishment from privately-owned and state-owned plantations in Ratchaburi Province and the Banpong Regional Forestry Office;

- yield of 3-year old Eucalyptus plantations under 1x1, 2x2, 2x4 and 4x4m spacing from the Ratchaburi Species Trial Station and yield of the 5-year old plantation with 4x4m spacing at the Khao Bin Plantation of the Banpong Regional Forestry Office; and

- secondary data from studies undertaken by various agencies to be used in the cost/benefit analysis of fuelwood and lime production.

Data Analysis

Three criteria were employed in this study to determine economic feasibility -- benefit-cost ratio (B/C ratio), net present worth (NPW) and internal rate of return (IRR).

A benefit-cost ratio is the total present worth of the expected benefits divided by the total present worth of the expected costs. Only projects or technologies with a ratio greater than 1 are economically justified in terms of resource use.

Net present worth (sometimes referred to as net present value) is the difference between the present worth of expected benefits less the present worth of the expected costs. All technologies resulting in a positive net present worth are economically justified in terms of resource use.

Internal rate of return is defined as the rate of discount that makes the present worth of the expected benefits equal to the present worth of the expected costs. Only investments having an IRR higher than the exising market interest rate are resource efficient (MacCormac 1985). The preferred alternative is that which yields the largest B/C ratio, the largest NPW or the largest IRR.

Results and Discussion

Fuelwood Consumption

Of 32 lime factories in Ratchaburi, 29 factories used fuelwood while only three factories used both fuelwood and coal. The volume of fuelwood consumed by the lime factories was calculated from the fuelwood used at each firing, multiplied by the number of firings per year. Data were collected from 21 factories. The average number of firings per kiln was 20 per year. The total volume of large fuelwood consumed by the 21 factories was 121,400 m^3/yr. Calculating fuelwood demand on that basis, the lime factories in Ratchaburi consume 184,990m^3 of fuelwood per year.

The 47 pottery/ceramic factories consume 62,282m^3 of large fuelwood and 256,480m^3 of chopstick fuelwood per year. Therefore, the annual fuelwood consumption of both lime and pottery/ceramic industries in Ratchaburi is 503,752m^3 (Table 1).

It is known that part of the fuelwood consumed by these factories is from illegal poaching of trees in reserves. Cutters and fuelwood entrepreneurs are reticent about discussing their sources and the volume of fuelwood harvested. Factory owners do not want to disclose their actual figures on fuelwood consumption but express their great concern about the fuelwood shortage. For this reason, indirect calculation and time-series data are necessary.

Feasibility of Fuelwood Production

The project analysis assumed that planting would be at a rate of 1,000 rai (1 rai = 1,600m^2) annually. B/C ratio, NPV and IRR were used to determine feasibility.

The data in Table 2 indicate that the preferred alternative is to establish plantations at a spacing of 1x1m for chopstick fuelwood production. The second best alternative is at a 2x2m spacing with 3-year felling cycles. The feasible plantations for large fuelwood are at a 4x4m spacing with 5-year felling cycles.

Conclusions

An analysis of the economic feasibility of fuelwood production was conducted for the lime and pottery/ceramic industries in Ratchaburi Province.

The total fuelwood consumption of the pottery/ceramic and lime factories in 1987 was 503,752m^3. More than half of the fuelwood consumed was from forest land, the rest came from farmland, public land, roadsides, and homegardens.

It is economically feasible to establish Eucalyptus fuelwood plantations for industrial use. Profitable types of plantations are for chopstick fuelwood at 1x1m spacing (IRR = 25.45%) and at 2x2m spacing (IRR = 20.13%) on a three year felling cycle. Large fuelwood plantations are economically feasible only at a 4x4m spacing with a five year felling cycle (IRR = 14.52%).

Table 1. Fuelwood consumption of lime and pottery/ceramic industries in Ratchaburi in 1987.

Type of Fuelwood	Volume (m^3)		
	Pottery	Lime	Total
Chopstick fuelwood	256,480	-	256,480
Large fuelwood	62,282	184,990	247,272
Total	318,762	184,990	503,752

Table 2. Feasibility of Eucalyptus fuelwood production on forest land (1,000 rai/year) in 1988.

Spacing m^2	Discount Rate %	Present Worth Costs Baht/Rai	Present Worth Benefits Baht/Rai	B/C	NPV Baht/Rai	IRR
	8	7895.95	12534.37	1.59	4638.42	
1x1	10	7455.53	11199.35	1.50	3743.82	
3-yr felling cycle	12	7062.39	10043.04	1.42	2980.65	25.45
Chopstick fuelwood	14	6709.94	9037.58	1.35	2327.64	
	8	6250.42	7098.63	1.14	848.21	
1x2	10	5855.16	6342.57	1.08	487.41	13.40
3-yr felling cycle	12	5504.15	5687.72	1.03	183.57	
Chopstick fuelwood	14	5191.12	5118.31	0.99	-72.81	
	8	5445.93	6955.01	1.28	1509.08	
2x2	10	5066.85	6214.22	1.23	1147.37	20.13
3-yr felling cycle	12	4731.54	5572.61	1.18	841.07	
Chopstick fuelwood	14	4433.69	501[illegible].71	1.13	581.02	
	8	5083.86	5439.66	1.07	355.80	
2x4	10	4710.24	4860.29	1.03	150.05	11.72
3-yr felling cycle	12	4380.46	4358.49	0.99	-21.97	
Chopstick fuelwood	14	4088.18	3922.15	0.96	-166.03	
	8	4810.62	3798.16	0.79	-1012.46	
4x4	10	4451.79	3393.63	0.76	-1058.16	-5.90
3-yr felling cycle	12	4135.14	3043.25	0.74	-1091.89	
Chopstick fuelwood	14	3854.56	2738.58	0.71	-1115.98	
	8	4810.62	3002.98	0.62	-1807.64	
4x4	10	4451.79	2683.12	0.60	-1768.67	-21.64
3-yr felling cycle	12	4135.14	2406.08	0.58	-1729.06	
Large fuelwood	14	3854.56	2165.18	0.56	-1689.38	
	8	6434.42	7940.76	1.23	1506.34	
4x4	10	5717.71	6619.70	1.16	901.99	14.52
5-yr felling cycle	12	5123.60	5561.29	1.09	437.69	
Large fuelwood	14	4627.02	4706.60	1.02	79.58	

Note: US$1 = 25 Baht

References

Boonyavechewin, S. and B. Puriyakorn. 1980. Growth, above-ground biomass and fuelwood production of *Eucalyptus camaldulensis*. Paper presented at a seminar on *Eucalyptus camaldulensis*. Bangkok: Royal Forest Department (RFD).

Chomcharn, A. 1985. *Wood-based energy system for rural industries and village activities: A case study on Thailand's lime production of Ratchaburi Province.* Bangkok: RFD.

Gittinger, J.P. 1982. *Economic Analysis of Agricultural Projects.* EDI Series in Economic Development. Baltimore: The Johns Hopkins University.

MacCormac, C. 1985. Economics of bamboo forestry research: some suggested approaches. *Proceedings of the International Bamboo Workshop*, China, October 6-14. Ottawa: IDRC.

Panyachan, P. and V. Magsabsri. 1986. *Glazed water jars of Ratchaburi*. Bangkok: Bongkot Production Co. Ltd.

Provincial Industrial Authority. 1988. Seminar on Problems of Pottery/Ceramic Factories in Ratchaburi. Bangkok: Ministry of Industry.

Puriyakorn, B. and S. Chaijarus. 1980. *Establishment and utilization of plantations in community forest projects under the rural development plan of 1980-82.* Bangkok: RFD and the Land Development Department.

Royal Forest Department. 1985. *Forestry Statistics of Thailand 1985.* Bangkok: Planning Division RFD.

Comparative Analysis of Appraisal Methods for Funding Forestry Projects

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A number of appraisal reports of financial institutions have been studied to determine the major criteria affecting the selection of projects for funding. All but one were tree production projects, including social forestry. The basis for funding decisions seems to be the financial and economic internal rates of return, regardless of whether the ultimate objective of the project is social or commercial. In many cases, the project has been designed to protect the investment/loan, often at the expense of potential benefits for the villagers. When the primary objective of a social forestry project is to benefit people, the author believes there should be some criteria representing this objective in the funding process.

Background

The process leading up to the decision to fund a project has always been an intriguing subject to outsiders. If the decision making process of the donor agencies were known, it would facilitate the project design process.

Each donor agency has its own criteria for such decision making. In some cases, the decision to fund a project may be on humanitarian grounds alone. In others, however, the financial return is more important.

It is difficult to understand the funding process completely as only approved project documents are available for analysis. In spite of this limitation it was useful to study the rating and funding systems. The main objective was to determine the common denominators of the projects, if possible. The scope of the study was limited to projects dealing with tree production with available project documents or appraisal reports. The twelve documents, chosen at random, include two projects funded by the Asian Development Bank (ADB), nine projects funded by the International Bank for Reconstruction and Development (IBRD), and one project jointly funded by the IBRD and the United Nations Development Programme (UNDP). Components and expected outputs for each of the projects are summarized in Table 1 with a brief description included at the end of this paper. The reports are listed in the Appendix.

Types of Tree Production

Tree production can be divided into two broad categories -- social forestry and commercial production. They differ in their basic concepts, non-profit versus profit-oriented production of trees. Even among the social forestry models, the approaches and goals of the project design team often cause the project to be more profit-driven than humanitarian. They recover the costs of social forestry by stressing the profit component of the project in order to repay the loan, regardless of the intended beneficiaries. Several of the projects, however, demonstrated a humanitarian spirit by providing free seedlings, land and other inputs to help marginalized sectors of the population improve their standards of living. The size of the loan was often similar between these two types of projects. The projects from Bangladesh and Uttar Pradesh are examples of projects designed to safeguard the investment.

Examples of benefit sharing arrangements in social forestry projects include providing bamboo to tribal people in the hills in the Karnataka project in India, or distributing 25% of the forest products to the villagers after rehabilitating degraded forests in West Bengal. Although benefit sharing could be used as a criteria in project appraisal, it was not mentioned as a justification for funding.

In commercial tree production, such as the Tree Crops Project in Sri Lanka, or the Woodfuel Supply Preinvestment Study in Thailand, the appraisal was a straightforward cost and benefit analysis.

Types of Funding

The type of projected funding greatly influences the project appraisal process. For a loan, the decision is based on the ability to pay it back. In some cases, a soft loan may be granted to assist developing countries. Where this is the case, benefits for the people in the true sense of social forestry could be one of the criteria for project approval. However, none of the analyzed projects listed this among their criteria. Most of them mention helping people as a result of the project, but it is not a major focus.

A project to be funded by a financial institution is appraised using different criteria than a bilateral project between two countries. In the latter, the decision whether to fund the project has been decided far in advance, involving agreements known only between the countries. For a multilateral loan, the appraisal is as rigorous as a loan from a commercial bank.

Appraisal Method

In all cases, the projected financial and economic benefits were enumerated as well as the costs. The rate of return was calculated and compared to a standard rate varying by country. All the projects analyzed for this study had rates of return well above the cutoff, or standard level.

Analysis of sensitivity and risk are other standard appraisal tools. Although many projects did not require cost recovery from each of the components, the project as a whole still passed the rate of return tests. The prominence of this section in the project document/appraisal report leads to the conclusion that it must be a very important part of the process.

Commentary

It is evident that the internal rate of return is the major criterion used to appraise a project, financially and economically. In all cases, positive rates of return far higher than the rate established in the guidelines were projected. For commercial projects such as the Tree Crops Project in Sri Lanka and the Woodfuel Production Project in Thailand, it is logical. But in social forestry, when helping the people to raise their standard of living is the main objective, it leaves some room to be desired.

Social forestry has generally been undertaken in poor, lesser developed countries with the marginal sectors of the population, utilizing scarce national resources. Financial justification of such programs is very difficult if they are based on humanitarian or political grounds. At times, even a soft loan with a low interest rate is a burden when there are many other important programs to be undertaken.

Community development programs are often criticized as they can not justify the investment in economic terms because the return is lower than for competing programs.

In order to pass the internal rate of return test all possible outputs from social forestry projects must be valued and counted as a benefit. In addition, environmental impact, aesthetic value, and natural conservation can be counted as plus factors.

Financial criteria alone overlooks many important developmental and redistributional goals of developing countries in projects that are intended to assist the poor. Therefore, using strict guidelines of financial or economic internal rates of return may have caused many poverty stricken communities to miss out on the opportunity to participate in potentially beneficial projects.

Project Sketches

Community Forestry in the People's Republic of Bangladesh

Benefit sharing. The project provides seedlings for individual planting on private homesteads with all benefits realized by the people who plant them.

The land along the roadsides belongs to the government. The strip plantings on these lands are to be planted by the Forest Service and the people will be allowed to intercrop in the plantings and collect minor forest products such as fodder, mulch, etc. Benefits such as fuelwood and/or timber will be shared with those who provide protection services for the plantation.

The Forest Service will plant block fuelwood plantations on state land. All the timber will belong to the government and the people will be allowed to cut grass in the plantation. Demonstration agroforestry will be undertaken on state land under the supervision of the Forest Service and the produce will belong to the participants.

Cost recovery. During the project design phase the plans originally called for the people to be charged for the cost of fruit tree seedlings in the homestead rehabilitation sector. However, this was dropped in the implementation stage. Fuelwood seedlings are free of charge, but the GOB intends to charge for the cost of production later.

Economic analysis. The economic internal rate of return (EIRR) has been estimated at 16% for the project. The sensitivity test for a 20% increase in cost and a 20% reduction in benefit will lower the EIRR to 11.5%. The risk on the investment has been considered minimal as the major activity of the project is the establishment of fuelwood plantations on government land with all the proceeds from the timber output accruing to the government. The project has been designed to avoid risk.

Sagarnath Forestry Development Project, Nepal

Economic analysis. The EIRR has been estimated at 41% for the project life of 24 years. The financial internal rate of return (FIRR) has been calculated for the project as a whole to be 18%. A sensitivity test of the project has been undertaken and the result is acceptable, although under certain conditions the rate might be as low as 13%.

Uttar Pradesh Social Forestry Project, India

Cost recovery. The government of UP intended to recover all the costs of the social forestry program, including capital and operating costs, over 30 years without interest. However, it was later agreed that the GOUP would recover only labor, material costs of planting and technical supervision, with overhead costs provided as a routine government service. In order to recover the cost as planned, it was decided that a plantation mix of 70% fuel/fodder and 30% of commercial species would be feasible, with all the fuel and fodder output for the villagers and all the commercial timber production would be sold by the Forest Service.

Benefit sharing. Grass, leaf fodder, flowers and fruit are to be free for the villagers with an equitable share of fuelwood for free or at nominal cost. The Forest Service would market the entire output from the commercial plantation from timber to bark and oil seeds, which would be sufficient for the government to recover the investment costs over 30 years.

Economic analysis. The EIRR was estimated to be 13.2%. If farm forestry were excluded the rate would be 12.4%. EIRR for all components, including organization building, would be greater than the 10% cutoff rate. The social rate of return was 36.4%.

Kandi Watershed and Area Development Project, Punjab, India

Cost recovery. As the project is designed to benefit a large segment of the population, and as this area has been designated as underdeveloped, with 25% of the population living below the poverty line, there is no cost recovery planned other than the usual marketing fees and indirect taxes.

Economic analysis. Although the project is more of a social improvement type, the applicable rate of interest is the standard 12%. The EIRR for the Dholbaha watershed component has been calculated to be 16%; for rehabilitation of the upper catchment, 12%.

West Bengal Social Forestry Project, India

Benefit sharing. Although the project appears similar to the project in Bangladesh, it differs in certain details. In the village woodlot component, state land would be leased to the village organization (panchayat). The government would cover the cost of establishment, recoverable after harvesting of the plantation output. In the rehabilitation and reforestation component of the government's degraded forest, although the government incurred all the costs, the people would be entitled to free fodder and fuelwood. Moreover, 25% of the output would be collected free by villagers in the area. The most striking feature was in farm forestry. The landless poor would be given land for tree planting. Both the landless and the poor with land holdings would be given free seedlings with a cash incentive for planting them. All the produce would belong to the planter. The government would recover nothing directly. The people would thus benefit more from this project than from the project in Bangladesh.

Cost recovery. For the project life of 30 years the government would receive a FIRR of 3% at constant prices.

Economic analysis. The EIRR was estimated at 27.9%.

Himalayan Watershed Management Project, Uttar Pradesh, India

Cost recovery. Normally, the government subsidizes poor farmers. The government would not add additional subsidies to this project except for the animal exchange program. No cost recovery was planned. The only requirement was that the beneficiaries would undertake the maintenance of the irrigation works. Loans for horticulture development and soil conservation would be through the normal government channels.

Economic analysis. The overall project EIRR has been estimated at 23%, with forestry at 24%, extension at 100+ %, horticulture at 35%, and irrigation at 64%. The EIRR would be equal to 12%, the opportunity cost of capital, if the benefit were reduced by 47% or the cost increased by 87%.

Karnataka Social Forestry Project, India

Benefit sharing. Fifty percent of the products from the government land would go to the panchayat and the rest to the State; production from the rehabilitated government land would be shared at the rate of 30% to the small-scale, landless and poor farmers with 70% to the State; 20% of the production from strip plantings would be given to the people who maintain and protect the trees free of cost, and the remaining 80% would go to the State; the entire bamboo crop would be given to the tribal cooperative; and all the prunings, fruits, and residues from all the plantings would be available free for the poor.

Cost recovery. The costs of establishing the plantations would be recovered from the sale of the products after the people received their respective share. Seedling costs would be charged only if people wanted more than the 750 seedling ceiling per household. The rest of the costs would be recovered from indirect project benefits.

Financial and economic analysis. The FIRR was estimated at 20% while the EIRR is 22%. Planting bamboo, and along reservoir shores and roadsides would have negative rates of return as these have been designed to benefit the poor with little expected direct return, as the bamboo would be exclusively for the tribal population, and the reservoir and roadside plantings would be for soil protection and aesthetic values. These components only constitute 3% of the project cost and involve less than 5% of the total project area. The project would not be sensitive to normal cost and benefit changes.

National Social Forestry Project, India

Cost recovery. The return to the forest departments is low financially but the project is oriented towards meeting daily forest needs for the villagers and rehabilitating degraded land. The FIRR for the forest departments were either zero or negative in about half of the components. Forest departments in Rajasthan and Himachal Pradesh do not intend to recover the costs. In the remaining models, forest departments recoup from 100-200% of their initial cost in nominal terms. The net present values at a 12% discount rate are generally negative, implying a subsidy by the government over time.

With the lower return from the investment the model mix has been designed to reduce loss, ie. more lower investment cost components (farm forestry), more higher return components (fewer strip, more waste land plantations), more direct distribution of benefits, and components where forest departments would recover the direct costs of investment in nominal terms.

Economic analysis. EIRR for the project is estimated at 27% (Uttar Pradesh 25%, Gujarat 26%, Rajasthan 17% and Himachal Pradesh 34%). The rate is not sensitive to changes in costs or benefits. At 12% the switching value would be a 67% reduction in benefits and a 201% increase in costs.

The FIRR is estimated to be from 11% to 35% for most components except for strip plantings on government waste lands in Gujarat and Rajasthan (4-8%). This is the result of the high cost of establishment incurred by the government and the exemption of part of the plantation from harvesting for environmental reasons.

Community Forestry Development and Training Project, Nepal

Cost recovery is not proposed as the people in the project area are very poor.

Economic analysis. The EIRR is estimated at 16% at a 12% interest rate, the switching value for yield is -33% and for costs, 116 to 301%.

Second Forestry Project, Nepal

Cost recovery is not proposed for this project.

Economic analysis. Over the 40 year life of the project and at an interest rate of 10%, the EIRR is 27%, the switching value, also at 10%, for benefits of -65% and costs of 190%.

Fourth Tree Crops Project, Sri Lanka

Economic analysis. The financial return for tea and rubber has been rated as acceptable while for coconuts it is marginal. FIRR for the corporations is estimated to be 18-19%. The economic analysis studied the economic benefits from increased production of tea, rubber, coconuts, and the costs. The EIRR for the project as a whole is 26%, and for fuelwood it is 50+%. The switching value at the 10% cutoff rate for Sri Lanka for incremental benefits is -86% with investment costs at 613%.

Northeast Region Woodfuels Supply Preinvestment Study, Thailand

Cost recovery. A portion of the project seedling production and other plantation establishment costs would be recovered through seedling sales and collection of timber harvests. This would represent about 44% of the total cost of the seedling supply. Plantation establishment costs incurred by the government would be about 22%. The rest would be paid by the private sector or participating institutions and community groups. The government could recover about 50% of the establishment costs for the rehabilitation and reforestation of encroached forest reserve land through intermediate and final timber harvest proceeds under one option, and up to 97% under another.

Economic analysis. The FIRR is estimated from 23-44% depending on the activity, ie. farm forestry under agroforestry yields a return of 44%, while a village woodlot is only 23%. The EIRR for planting is estimated from 24% for commercial woodfuel plantations to 38% for rehabilitation of encroached forest reserve land. For the entire project, the EIRR would be 18%, without research and development activities the rate would be 19%. The switching value would be a 36% increase in cost and a 26% decrease in benefits at an interest rate of 12%.

Appendix. List of projects.

ADB. 1977. Nepal: Sagarnath Forestry Development Project. NEP:AP-18.

ADB. 1981. Bangladesh: Community Forestry Project. BAN:AP-36.

UNDP/IBRD. 1987. Thailand: Northeast Regional Woodfuels Supply Pre-investment Study. (Draft).

IBRD Staff appraisal reports:

1979. India: Uttar Pradesh Social Forestry Project. No. 2386a-IN.
1980. India: Kandi Watershed and Area Development Project, Punjab. No. 2174a-IN.
1981. India: West Bengal Social Forestry Project. No. 3434-IN.
1983. India: Karnataka Social Forestry Project. No. 4590a-IN.
1983. India: Himalayan Watershed Management Project, Uttar Pradesh. No. 4317-IN.
1985. India: National Social Forestry Project. No. 5591b-IN.
1980. Nepal: Community Forestry Development and Training Project. No. 2663a-NEP.
1983. Nepal: Second Forestry Project. No. 4353-NEP.
1985. Sri Lanka: Fourth Tree Crops Project. No. 5265-CE.

Table 1. Components and expected outputs by project.

	1*	2*	3*	4*	5*	6*	7*	8*	9*	10*	11*	12*
COMPONENTS												
Research			x	x	x	x	x			x		x
Nurseries	x		x		x						x	x
Farm forestry			x	x	x		x	x	x	x		x
Community woodlots	x		x		x			x	x	x		x
Strip planting along roads, canals, railroads	x		x		x		x	x		x		
Government or commercial plantations	x	x					x	x			x	x
Technical assistance		x		x		x				x		
Training	x	x	x	x	x				x	x	x	
Watershed management				x		x	x					
OUTPUTS												
Increase supply of fuelwood	x		x	x	x	x	x	x	x	x		x
Increase output of timber		x	x			x				x		
Increase supply of forest products (fodder, small timber, fruit)			x	x	x	x	x		x			x
Increase employment	x	x	x		x	x	x	x	x	x		x
Reduce soil erosion, improve environment		x	x	x	x	x	x	x	x	x	x	x
Rehabilitate degraded land				x	x	x		x				x
Raise income or standards of living				x			x			x	x	x
Provide infra-structure	x						x				x	
Institution strengthening							x	x	x		x	x

* 1. Community Forestry Project, Bangladesh
2. Sagarnath Forestry Development Project, Nepal
3. Uttar Pradesh Social Forestry Project, India
4. Kandi Watershed and Area Development, Punjab, India
5. West Bengal Social Forestry Project, India
6. Himalayan Watershed Management Project, Uttar Pradesh, India
7. Karnataka Social Forestry Project, India
8. National Social Forestry Project, India
9. Community Forestry Development and Training Project, Nepal
10. Second Forestry Project, Nepal
11. Fourth Tree Crops Project, Sri Lanka
12. Northeast Region Woodfuels Supply Preinvestment Study, Thailand

Rattan and Bamboo as a Major Industrial Resource for Rural People in Peninsular Malaysia

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Rattan and bamboo are two of the most important and highly sought after minor forest products in Peninsular Malaysia. Over 1,500 companies are engaged in industries using these resources, employing more than 10,000 people (Mohmod *et al.* 1989). However, the involvement of rural people is confined to handicraft production with little interest in venturing into manufacturing furniture or larger bamboo products. Their products are usually sold locally and in neighboring areas. Many problems prevent the development of local, rural-based rattan and bamboo industries, among which are a lack of technical knowledge, quality control, good designs and product diversification. As a result, their existing volume-to-cost ratio leads to disproportionately high production costs and selling prices.

To promote rattan and bamboo enterprises among rural people, coordinated research and development activities need to be strengthened. In addition, intercropping and plantations of rattan and bamboo should be introduced to complement the extraction of raw materials to ensure a sustainable future supply.

Current Status

Rattan and bamboo are important minor forest products in Peninsular Malaysia providing a source of revenue and a means of sustainable employment in rural areas. This is due to the technology used in the industries as well as the readily available natural resources. These remarkable resources have many uses where their special features can be fully exploited.

Rattan and bamboo have been used for a long time in large, medium, small and cottage industries in Peninsular Malaysia. Eighty percent of the existing mills fall in the small and cottage industry category with an average capital investment of less than US$5,000, employing from 1 to 15 people (Shahwahid and Bajau 1987).

The scale of forest-based factories is defined by the amount of capital invested and number of workers. Cottage industries involve less than US$ 2,500 and employ five or less workers. Small-scale factories involve less than US$ 100,000 and employ up to 50 workers. Medium-scale factories invest up to US$ 200,000 and hire up to 75 workers. Large-scale factories are those involving more than US$ 200,000 with over 75 employees.

Of 600 rattan mills in Peninsular Malaysia, 46% are classified as cottage enterprises, 34% as small-scale, and the remainder as medium and large-scale factories. Of the 600 mills, 15.5% (87) are involved in rattan processing, 12.6% (71) operate in both processing and manufacturing, while the remaining 71.9% (405) mills are involved only in manufacturing (Mohmod *et al.* 1989). The rattan processing industry contributed US$3.5 million FOB in export revenues in 1988 while the rattan manufacturing industry exported US$6.5 million FOB worth of commodities (Statistics Department 1989).

In the bamboo industry over 800 mills are classified as cottage and small-scale enterprises while another 100 are categorized as medium and large-scale. The medium and large-scale factories are mostly involved in machine - intensive product manufacturing. Although the bamboo industry in Peninsular Malaysia began in the 1950s, their activities were confined to traditional handicrafts, while the machine-intensive industry was introduced in the last four to five years (Mohmod *et al.* 1989).

Most of the mills are located on the west coast where the infrastructure is good and the markets are available and easily accessible.

Cottage and small-scale are synonymous for the type of industry operating in rural areas. These rural industries are usually one person enterprises, managed by the entrepreneur who oversees the marketing, production, finance, personnel and overall aspects of business without the help of specialized staff (IDRC 1985). The technology of production is traditional and simple with few exceptions. Consequently, this one person management system creates many problems inhibiting further development of these industries.

Peninsular Malaysia has an abundant supply of rattan and bamboo. However, in terms of the industries related to these resources, Malaysian achievements trail far behind the accomplishments of other countries that went into the business much later. This is due to Malaysia's tendency to sell raw materials instead of producing value-added products. In 1988, export revenues for the rattan and bamboo industries amounted to only US$10 million and US$1.2 million FOB, respectively (Statistics Department 1989).

Trade data from various government agencies such as the Malaysian Export Trade Centre (MEXPO) and the Malaysian Handicraft Development Corporation (PKKM) confirm that both rattan and bamboo products show potential. The current trend indicates that there is a continuous demand for these products. The Federation of Malaysian Manufacturers (FMM 1988) projected that revenues for the export of rattan furniture would reach US$30 million in the 1990s and the increasing demand for cheap disposable bamboo products should indicate a bright future for the bamboo industry.

Problems

From site visits and feedback on questionnaire surveys, both industries cited similar problems. Major problems mentioned include the following categories.

Raw material supply

The industries face problems in securing a continuous supply of suitable bamboo and high grade rattan. The factories are forced to accept inferior quality rattan because the price for better grade materials is prohibitively expensive. Consequently, they experience problems in meeting buyers/clients' specifications.

Logging and the conversion of forests to agriculture and settlements contributes to a rapidly dwindling supply of raw materials, particularly in the more accessible forests as there are no mandatory measures to replace these natural resources.

Poor management

Most cottage and small-scale businesses are either individually or family operated by people with minimal educational backgrounds. As such, they have poor accounting practices, inappropriate factory layouts and antiquated production techniques which result in low productivity levels and poor workmanship. Their activities are usually limited due to a lack of capital and difficulty in obtaining credit and bank loans. These difficulties prevent them from expanding and acquiring a permanent business site.

Technical problems

The industry is labor intensive but entrepreneurs have difficulty in attracting and recruiting permanent workers and experienced labor. Experienced artisans either already work for established mills or operate their own mills. Apprentices usually take time to master their craft and many prefer to pursue other less arduous careers. There are not enough graduates from the Malaysian Handicraft Development Corporation to fill the expanding demand.

The technical level of the industries is very low. They rely on traditional skills, resulting in a low production volume. The village industry assistance program which provides basic machinery can not be fully utilized as the mills are scattered in rural areas lacking infrastructure such as electricity and telephone service.

Entrepreneurs often produce inferior quality products due to a variety of technical problems. Services provided by various agencies to identify and solve problems often involve no follow up. This leaves the entrepreneurs with their problems unsolved.

Product development

Originality in design is important. However, in Peninsular Malaysia, product design fails to receive adequate attention. Very few written materials are available and institutions are only indirectly involved in actual design work. Entrepreneurs have to rely on existing ethnic designs or copying ideas from other sources.

Marketing

Most entrepreneurs are unable to compete in the open market due to high production costs. They market their products by selling directly to wholesalers and retailers, and through government contracts and sub-contracting.

Many do not conduct market surveys to keep abreast of the current popular demand. They rely on the local market which often fluctuates. Not many products qualify for export, which normally requires high standards of quality.

The Role of Government

The government promotes the industries in various ways. It recognized that sufficient technical and financial support is necessary for significant growth. The Ministry of Trade and Industry (MTI) and the Ministry of National Rural Development (MNRD), together with various technical agencies, are directly involved in the development of small-scale enterprises in Peninsular Malaysia.

Financial assistance is extended in the form of loans. Under the program, certain banks provide interest-free loans of between US$800-20,000 to qualified operators. In addition, government supported institutions such as the Ministry of Youth and Sports (MYS), the Agricultural Bank (BP), the Development Bank of Malaysia Limited (BPMB), the Trustee Council for Indigenous People (MARA), and the Malaysian Industry Development Bank also provide financing for small-scale entrepreneurs at below market interest rates. An owner with assets of less than US$100,000 and fewer than 50 full-time employees is eligible to apply.

Technical aid is extended by providing machinery, technical services and training. Under the village industry assistance program since 1986, the MNRD has provided machinery to set up factories and sometimes even the building itself. Various technical agencies such as the Forest Research Institute of Malaysia (FRIM), the Malaysian Timber Industry Board (MTIB), and the Standards and Industrial Research Institute of Malaysia (SIRIM), provide technical assistance in production and basic design, organize seminars and training courses (management and production), organize national product design contests, and conduct relevant research and development programs. FRIM has a core of experienced researchers able to train the entrepreneurs in the uses of rattan and bamboo as well as studying the potential of lesser known species and byproducts.

To assist in marketing the products, MTIB, MARA, PKKM and MEXPO were commissioned to collect and disseminate information on local and export markets for Malaysian products. The MNRD organizes trade exhibitions to create market opportunities for the entrepreneurs.

Recommendations

The status and problems faced by the rattan and bamboo cottage and small-scale enterprises have been studied. Although typical of any emerging industry, the problems encountered should not be neglected as immediate solutions and suggestions are needed to improve production in both quality and quantity. Stimulating production through a rural village industry development program is worthwhile. Advocating self-help for entrepreneurs with government support is very important.

Policy changes are needed, such as granting pioneer status to the new factories to provide financial incentives, ie. reducing the sales tax on rattan and bamboo products.

A government agency could be responsible for overseeing and monitoring the marketing of raw materials to ensure an adequate supply to local manufacturers.

The establishment of village industries or service centers should focus on the economic support of complementary activities which could benefit many traditional entrepreneurs. Government and technical agencies could then provide a variety of services other than credit and help in locating market outlets. These could also serve as training centers for new entrepreneurs to learn basic production and maintenance techniques.

A product development center for systematic and coordinated research and development is urgently needed. Greater emphasis should be placed on identifying alternative products and their potential markets. Collaboration with various agencies and higher institutions is essential so that trade and technical information can be collected and centralized for dissemination to the industry. Awards for innovative products could encourage the development of improved product design and foster competition in the industry.

Extension of technology to the rural industry should periodically upgrade and improve the traditional skills already in use without sacrificing the quality and originality of the products. Emphasis should also focus on developing a local capability to manufacture machines. These machines should be designed for local materials to maximize production levels.

Education curricula should be modified to include handicrafts and furniture-making at an early age to foster interest in the industry in the younger generations.

Cultivation of rattan and bamboo through proper management is essential to ensure a continuous supply of high quality raw materials. The government should restrict the export of raw materials to promote rattan and bamboo enterprises in Malaysia.

Concerted efforts should be undertaken by all concerned as these enterprises demonstrate good prospects for development. The time has come for the full-scale involvement of the rural people. With government support to foster development of the industries, there is no reason why it should not succeed. With careful planning and cooperation among the factories and government agencies, rattan and bamboo-based enterprises should continue to develop and will eventually become competitive with the rest of the ASEAN countries.

References

International Development Research Centre of Canada. 1985. *Industrial Extension Manual for Small and Medium Industries in Developing Countries.* Volume Two. Singapore: Technonet Asia.

Mohmod, L. 1989. *Status, problems and prospects of the Rattan Industry in Peninsular Malaysia.* Occasional Paper No. 6. Kuala Lumpur: Rattan Information Center/IDRC.

Mohmod, L., R. Wahab and R. Ali. 1989. Current status of the machine intensive bamboo processing industry in Peninsular Malaysia. Paper presented at the International Bamboo Symposium, July 24-27, Nanjing, China.

Shahwahid, M. and F.E. Bajau. 1987. *A profile of the Bumiputra Rattan Furniture in Peninsular Malaysia.* Occasional Paper No. 4. Kuala Lumpur: Rattan Information Center.

Session 3: Determining Extension, Implementation and Training Needs

Chairman: Suree Bhumibhamon

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The Chairman concludes that the region faces problems of population pressure, fuelwood shortages and inefficient land use. The development of small-scale farm forestry requires proper extension services. The failure of forestry extension projects has been caused by inadequate institutional support, inappropriate extension methods and messages, poor planning, incorrect choice of target beneficiaries and poor cooperation among related agencies.

Pearmsak Makarabhirom presents a case study of the Klong Mark Nut forest village in Prachinburi, Thailand. He mentions that growing MPTS on the land improves soil quality, provides edible crops, fuelwood, or wood for household use. A multidisciplinary approach should be implemented, and researchers should spend significant time on-farm. MPTS program design should be simple, with farmer participation in designing and planning the research as well as in data collection, with a multidisciplinary team of experts from related fields analyzing the data.

Eric Brennan presents a case study of an alley-cropping and agroforestry project in Khao Kho, Thailand. Success in this work indicates a need to select target farmers, starting with a small project, and using appropriate tools to solve problems. Extension workers should be patient, flexible, dedicated and work closely with the farmers.

Narayan Hegde discusses extension and training needs to motivate small-scale farmers in Pune, India. He recommends using multiple media for mass communication and providing appropriate messages to a large, diverse target population. He notes that an NGO can play an effective role in promoting MPTS. Demonstration and training are also required.

Charit Tingsabadh regards MPTS as a land and labor-saving innovation. Since MPTS provide both benefits and costs in the farming systems of small-scale farmers, adoption of an innovation depends on a cost/benefit analysis. A demonstration of the logit model is presented with information on tree planting from northeast Thailand. The model could serve as a useful tool in designing an appropriate MPTS project to meet the needs of villagers.

Rabindra Kumar Shrestha discusses a case study of MPTS extension in a multidisciplinary context, at the Lumle Agricultural Centre in Nepal. A major constraint to reforestation in Nepal is a lack of information on MPTS research results. The Lumle extension approach selects and trains field staff, provides a supply of seedlings of the farmers' choice, and develops training programs on seedling production, planting techniques and maintenance.

The Chairman suggests a follow-up program to include an NGO forum on MPTS, and a program to develop information packages for training.

Solutions in Search of Problems: Research/Extension Constraints in Small-Scale Farm Forestry

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One of the notable ironies of demographics is that the least economically-developed countries which can ill afford high population densities and high population expansion rates are the very ones beset with such problems. As a consequence, the demand for food often exceeds agricultural output, especially since agrotechnology is usually at a very low level. The deficit situation then triggers feverish efforts to increase outputs of grain, fruits, nuts and vegetables to bridge the food gap. Farm activities aimed at achieving food sufficiency, or at least narrowing the food deficiency, fall under either of two categories (Brookfield 1972):

- farming on the intensive margin through intercropping, relay cropping or multiple cropping, particularly in fertile irrigable lowlands; or

- cultivation on the extensive margin, ie. expanding the area under tillage with little or no increase in yield per hectare per year. This generally occurs in marginal rainfed areas.

Either approach may lead to an expansion of aggregate food production per year, at least initially. However, three important phenomena contribute to the eventual decline in per hectare as well as aggregate yields:

- frequent harvests of annual crops remove substantial amounts of nutrients from the site and reduce productivity;

- intensive soil tillage disturbs the soil surface and accelerates erosion and nutrient loss, particularly on sloping farms; and

- frequent application of chemicals (fertilizers, insecticides and herbicides) alters the chemical and physical characteristics of the soil and often reduces the productive capacity of the farms.

Clearly, urgent measures need to be adopted to ensure sustainability of food production to maintain or improve human welfare.

The Search for Appropriate Land Use Systems

To achieve the important objectives of sufficiency and sustainability in food supply, researchers and development planners are searching for, evaluating, and selecting farming systems that meet national as well as individual farmers' goals. These production systems are considered desirable if they are either of two types:

- land use systems that minimize the loss of soil and nutrients and reduce the decline in productivity. These are normally soil conservation-oriented land uses, such as plowing and planting along the contours, establishing contour hedges with trees as in alley-cropping, terracing, etc. (Huxley 1986, 1988); or

- production systems that maintain or improve the fertility and productive capacity of farms at little or no cost to the farmers. These include the use of nitrogen fixing crops to maintain the nitrogen budget on-site, recycling crop and animal residues to replace lost nutrients, and mulching and green manuring with nitrogen rich biomass from the tree components of agroforestry (Escalada 1980; Getahun *et al.* 1982; Guevara 1976).

To be feasible, production systems under either of the above categories must be ecologically sound, economically viable and socially acceptable. They must also involve inputs that are affordable and readily available to small-scale farmers, using relatively simple technologies that are easy to implement in light of small-scale farmers' limited financial, labor and material resources.

Many of the farming systems in the Third World can be classified under either of the above categories, and may therefore be regarded as desirable. Some are available as off the shelf technologies derived from careful documentation of traditional land use systems or from scientific analysis of such systems (Huxley 1984). One system that stands above the rest in terms of its potential capacity for productivity and sustainability is agroforestry, which integrates annual with perennial crops. However, it is absolutely necessary to validate agroforestry systems in various unique local social, economic and ecological conditions prior to technology dissemination and local application. This is where research and extension in agroforestry will play very important roles.

Why Forestry Research Often Yields "Solutions in Search of Problems"

Research is a beneficial endeavor which requires investment of scarce resources such as scientific talent, funds, facilities and materials, before it yields usable results. For many small and less developed countries, research is a luxury that they would rather leave to their more wealthy counterparts.

Poor countries which somehow manage to engage in research justify their expenditures with the fact that their problems are sufficiently unique to make research results from other countries inapplicable to them. However, they often fail to derive maximum benefits from their research investments because of poorly designed studies which are directed at problems of low priority and which produce results that have no immediate application in solving current development concerns. In short, the outputs of inappropriate research usually become "solutions in search of problems." Several reasons can be cited as causes of this unfortunate situation.

Scientists' Preference for Basic Rather Than Applied Research

Many talented scientists connected with academic institutions in Third World countries are products of Western universities with well-established traditions of concentrating on fundamental, or basic studies that "push back the frontiers of knowledge." This tradition has produced a bias against what they often view with disdain as pedestrian problem-solving studies. As a consequence, many of the research outputs of academic institutions in poor countries have no immediate applicability to the large number of local problems that affect rural development. It is principally for this reason that the private sector dismisses researchers as a "bunch of theoreticians who do not have their feet on the ground."

This is not to imply that fundamental research is useless and totally unneeded. This form of scientific investigation is necessary because it serves as the basis for technological innovation and development that less developed nations desperately need. However, such fundamental research is more appropriately regarded as the domain of resource-rich developed countries.

In the field of forestry, the tendency towards basic studies can be illustrated by an example where sophisticated chemical analysis was used to differentiate between two very similar tree species which botanists can hardly tell apart through visual inspection. Such research efforts could have yielded more practical and useful results if, for example, they were used to determine which of the two species responds more positively to intercropping with food crops that farmers prefer. Farmers could not care less about differentiating species which are naturally similar anyway, but they would be greatly interested in knowing which of the two species yields more tree products, and which one causes the food intercrops to yield more grain through symbiotic relationships (Huxley 1984).

Propensity of Plant Scientists to Undertake Short-Term Rather Than Long-Term Studies

The payoff from studies of short-term crops, such as annuals, is more immediate than from research into perennials. Consequently, there are many more studies on agricultural crops than on tree crops. The resulting imbalance in the availability of information on these two components of agroforestry systems makes it difficult to find sufficient data on which to base a prediction, with reasonable reliability, of the behavior of intercrops in agroforestry.

Tendency of Researchers to Focus Within Their Narrow Disciplines

Agroforestry, by definition, is a multidisciplinary endeavor which brings the forester in contact with the agriculturalist and the social scientist. Fear of the unknown affects the capacity of professionals to venture outside their narrow disciplines, thereby reinforcing the tendency to remain in their cocoons. Foresters are often uncomfortable in delving into uncharted agricultural domains. When they undertake growth and yield studies for tree species that are potentially suitable for agroforestry, they often lay out the trials in classic forest block plantation patterns instead of line planting which farmers often employ. As a result of this inappropriate model for testing, individual tree and aggregate stand growth rates from such trials are usually grossly underestimated since the higher growth in open plantations with minimal inter-tree competition and maximum benefit from constant tending of the neighboring agricultural crops are not properly taken into account. It is not surprising that farmers often spurn proffered agroforestry technologies whose predicted yields, derived from block plantation trials, are regarded as unattractively low.

Weak Links Between Researchers and End Users

The forward and backward linkages between researchers who generate new information, and the public which uses the information, are often very weak in developing countries. Researchers usually have no clear idea of who their target clients are and therefore can not tailor their efforts to the needs of their clientele. Information users, in turn, do not transmit clear feedback about the usefulness or inappropriateness of the results of certain studies. Thus, scientists are often unaware that their outputs may be of no immediate use to target farmers.

Making Research More Responsive to High Priority Needs

It is accepted that most developing countries can ill afford research, let alone research activities that yield outputs not immediately useful in alleviating socioeconomic difficulties and ecological degeneration. To make research benefit/cost ratios greater than unity, ie. make benefits exceed costs, it is necessary to remedy the current situation of having solutions chasing problems. Three broad guidelines are suggested.

Training in Research Methodology

Developing skills through training to improve the manner in which problem-solving research can be carried out is very important. However, it should be emphasized that training in research methods must include sharpening skills for identifying, prioritizing and selecting the most appropriate development problems to be addressed by research, and for defining the "shape and size" of the selected problem. Correctly identifying and defining the problem is half of the battle. Suitable hypotheses can then be formulated on which trials and tests can be based.

The Forestry/Fuelwood Research and Development (F/FRED) Project, for example, is currently engaged in a series of regional skills-development training for researchers involved in the MPTS Research Network. This is a move in the right direction and should be maintained or accelerated.

Focusing on Specific Target Beneficiaries

The "shotgun" approach of developing research strategy in an attempt to distribute the benefits widely does not seem to work very well. While the positive effects may be spread over a greater number of people, those effects may be too shallow and superficial to make a difference. The "rifle" technique may be better since it focuses research towards a smaller target beneficiary, and its impact can be of greater depth and of longer overall effect. More importantly, if the target beneficiaries are firmly identified and clearly delineated, high priority problems affecting them can also be sharply defined, and research efforts can focus directly on them. This ensures the relevance of research efforts to the desires and needs of a given target group of beneficiaries.

Studies on how to make forest plantations in general become more productive will only produce bland conclusions that may not be as useful to the target population as envisaged. On the other hand, research into better species selection, farm level plantation establishment and small-scale plantation management to increase the pulpwood yield of fast-growing species on agroforestry farms will produce results that are highly relevant to a specific economic activity (pulpwood production) and extremely useful to a certain group of information users (small-scale pulpwood growers engaged in agroforestry farming.)

Aiming Research at Specific Development Problems

Problem-solving research may lack the sophistication and allure of knowledge generating fundamental research. Its redeeming characteristic is that it directly addresses pressing socioeconomic problems confronting a country, a region within a country, a community or a household of limited-resource farmers. As such, it scores high in the eyes of development planners and their beneficiaries.

When the problem-orientation of research is overlooked, results can be of little value. For example, an investigation of how to raise MPTS for fuelwood in a certain region proved to be an exercise in futility as there was no shortage of fuelwood in that region. The findings were of no economic value to the local farmers.

Similarly, in another country, trial planting of fast-growing species suitable for pulpwood were useless as there are no pulp and paper plants in the area to generate demand and provide cash incomes, and there appeared to be no prospects of a plant being sited there in the foreseeable future.

Certain developing countries ensure that development problems are given the highest research priority by setting up national research coordinating agencies to focus attention on them. While they are not endowed with coercive authority to force scientists towards desired directions, they have a certain degree of control over research funds which they can use as incentives for studies in high priority subject areas. The Indian Council for Agricultural Research (ICAR) of India, and the Philippine Council for Agricultural Resources Research and Development (PCARRD) are examples of such research coordinating agencies. Their relative success in funneling research energies towards key development problems seems to indicate the desirability of setting up similar institutions in other Third World countries.

Extension Needs in Small-Scale Farm Forestry

Agroforestry extension is necessary to enable materials and information to flow rapidly from the source -- the researchers, to the end users -- the farmers. The extensionists hasten the flow by making sure that the technology being transferred is in the right form, at the right time, and in the right place (Raintree 1983). These tactical moves serve to enhance adoption by practitioners and help stimulate social, economic and ecological development in the rural sector. To be effective, an agroforestry extension effort would need to include the following elements.

Sustainable Sources of Relevant Information

Sources of information are usually agricultural and/or forestry research institutions, including academic units. Extension can initially thrive on anecdotal information derived from empirical observations, especially during the early "awareness creation" stage. However, as extension shifts into high gear, hard data is required, and these can only be supplied through research, or from thorough documentation of the long-term experience of other agroforestry farmers. Agroforestry research needs to shift from the "descriptive" to the "prescriptive" phase at this time.

Information Processing Capability

As a rule, scientific information from research studies is too complex and filled with jargon to be directly useful as extension material. The results need to be simplified to the level of understanding of the farmers. A corps of competent information processors is needed to collect, collate, synthesize, simplify and package information into various forms, either audio-visual or printed, that are readily accepted and understood by the intended beneficiaries. These extension materials would be the primary tools of the trade of the field extension officers who directly interact with the farmers.

Dedicated Field Extension Staff

Target audiences can often be reached by mass media, but there is still a great need for face-to-face contact between farmers and extensionists for more thorough dissemination of information, backed up by on-site demonstration of the technologies being transferred. A group of dedicated field extension workers are needed to identify and motivate target audiences, to plan participatory activities with the farmers, and to provide materials and technical advice when required. City-bred, desk-bound, swivel-chair extensionists or car-riding, road-bound field staff who have no real feel for field work, and who have no empathy with poor farmers are not suitable.

Suitable Incentives

One of the tragically naive beliefs of many forestry extensionists is that they can motivate farmers to engage in forestry development by appealing to their sense of patriotism and civic spirit. They use extension catch phrases like "Plant trees and make your country green and great again."

All evidence indicates that economic motivation is the greatest, and sometimes the only incentive that convinces farmers to raise tree crops. If farmers can use the products domestically to replace purchased goods, or if they can sell them to generate cash, they will likely want to produce them, assuming that the income from the trees exceeds the potential income from other possible crops. There are three possible ways to "create" demand incentives for tree producers:

- induce the expansion and dispersal of existing small-scale forest-based enterprises so they can serve as markets for tree farm products. This will be successful if the enterprises are assured of additional raw materials from the tree farms, of market outlets for their own outputs, and of available credit for expansion. The woodchip plants which serve as markets for small-scale eucalyptus tree farms in eastern Thailand expanded in this manner and created, in turn, a flurry of tree planting activity in the region;

- make farmers aware that there are wood-using firms now operating in their vicinity which require given volumes of tree products and which pay certain price levels. The entrepreneurial abilities of the farmers will then be activated to make them produce goods to be sold to this existing but previously unknown and untapped market. The establishment of small-scale leucaena farms to produce fodder to be sold to a previously unknown animal feed mill in northeastern Thailand exemplifies how this form of motivation operates; and

- encourage the farmers and the enterprises to enter into a marketing agreement that provides guaranteed prices to the farmers for their products, and provides a steady supply of raw materials at steady prices to the entrepreneurs. The agreement between a large pulp and paper company and a group of small-scale tree farmers in the Philippines is a good example of this arrangement and how it stimulated the participation of vast numbers of small-scale tree producers.

Monitoring and Evaluation

Many extension projects are not properly monitored and evaluated. Most of the time, the on-schedule execution of planned activities is simplistically used as a sufficient indicator that the project is proceeding satisfactorily. Evaluation of the degree to which the objectives have been achieved is often not carried out on the grounds that the impacts of extension, particularly in forestry, will take years before they will be discernible and capable of being measured.

Project monitoring and evaluation (M&E), when undertaken, is often done by an in-house team whose objectivity is open to question, and whose outputs are naturally the objects of some degree of doubt. Nevertheless, such in-house monitoring is necessary to inform project managers about the status of the project implementation so that corrective action, if necessary, can be taken.

Social scientists have observed that the most effective way of carrying out these tasks is through participatory M & E where the target beneficiaries play a significant role in keeping track of implementation activities, and in assessing their impacts upon themselves. Not only are these results reliable, they also stimulate the participation of farmers at all stages of the project from planning through implementation of the extension at the village level.

Why Many Forestry Extension Projects Are Not Successful

Forestry authorities are often purely regulatory bodies that control the use of forests and forest lands. Extension activities are relatively new to them so their experience in this vital undertaking is severely limited. Furthermore, in the instances when they engage in extension, they simultaneously carry out police or law-enforcement activities. These two sets of activities are mutually exclusive. When undertaken in tandem, the extension activity generally suffers. Over and above these inherent drawbacks, several problems further contribute to less than successful extension accomplishments.

Inappropriate Extension Methods/Tools

Because of the widely dispersed location and difficulty of access of the target clients to forestry extension, project officers often resort to the use of mass media (radio, television, and print media) instead of face-to-face contacts. These otherwise powerful tools become relatively ineffective because many of the targets do not own radios, most do not have TV sets, and those who can read may not be willing to pay the price of newspapers, assuming that such papers are available in remote locations. Furthermore, the use of these mass media dictates dissemination of a mass of generalized information which may not be applicable in all cases. Agroforestry farms are notorious for being site-specific and widely variable in characteristics.

Incorrect Choice of Target Beneficiary

Tree growers produce different types of products for different markets and end uses, and use varying quantities of resources. Small agroforestry farmers producing charcoal for home use are very different from the corporate tree growers using large tracts of land and aiming at commercial markets. The type of extension approach used in each case will therefore also vary.

If forestry extension aims to develop forest resources and protect the environment while simultaneously improving the socioeconomic status of the most economically disadvantaged, then the most appropriate targets should be the small-scale farmers rather than the corporate tree growers. The extension project must be tailored to meet that goal. A mismatch between the target and the extension approach causes problems and failures.

Inappropriate Message

As pointed out earlier, many forestry extension projects emphasize the message of promoting national development, ie. "forests build the nation," rather than emphasizing individual farmers' benefits, such as "trees planted on your farm can increase your income." Patriotic messages are insufficient to motivate farmers to plant trees.

On another plane, inappropriate message refers to the dissemination of information taken directly from scientific research in its unprocessed form which is largely incomprehensible and useless to farmers who may be interested in tree farming.

Poor Timing

As agroforestry involves planting, and since the planting of tree seedlings has to be timed with the rainy season in order to ensure survival, forestry extension activities are sometimes intensified at the onset of the rainy season. While the timing in that sense is right, what many forestry extensionists fail to consider is that this is also the busiest time for the farmer in planting important food crops. The farmer may have no time to plant trees at that particular moment. Timing of extension activities should be determined by two factors -- the season and the availability of farm labor to undertake the tree planting.

Inadequate Institutional and Policy Support

As indicated above, forestry authorities continue to hold the belief that law enforcement rather than extension is the means for protecting and developing forests. As long as this view persists, it will be difficult for forestry extension to obtain full support in terms of budgetary, equipment and manpower allocation. Similarly, current policies that serve as disincentives to private sector participation in reforestation of public land will continue. In Thailand, for example, teak trees belong to the State, regardless of who planted them or where they are planted.

Revitalizing Forestry Extension Activities

In light of the above problems and constraints to forestry extension, remedial measures should be explored. Individual measures are actually self-identifying as they correspond on a one-to-one basis with the above constraints and need not be discussed in detail.

One important, all-encompassing solution that ought to be discussed is training in general. Subjecting foresters who are currently involved in extension work to training and retraining is necessary to enhance their skills in interacting with farmers in a participative and non-threatening way. This will improve their ability to select and skillfully use appropriate extension methods and techniques, and further strengthen their dedication to the important task of transferring technology for the farmers' benefit as well as for the nation.

On another level, the training of policy decision makers in forestry agencies is also necessary even if they are not directly involved in forestry extension. Such training will presumably have a positive effect on modifying their attitudes towards forestry extension and lead to greater support for the establishment and operation of a nationwide forestry extension program.

Finally, training key elements of the general public such as schoolteachers, local leaders, NGOs, and government officers is essential because skills and attitudes will predispose them towards accepting and participating in forestry development activities that are promoted through forestry extension.

Lessons Learned from Forestry Research/Extension Experience

The list of lessons learned from experience in forestry research and extension is almost infinite. However, only a few general lessons need to be discussed.

Interdependence Between Research and Extension

Extension as a developmental process is of no value if it lacks useful and relevant information to disseminate to the target beneficiaries. That information has to be generated, tested and validated through research before it can be transferred by extensionists. Research, in turn, is of little value if its outputs are not disseminated and applied to the end users. The interdependence between these two important activities must be kept in mind at all times so that both can advance in unison.

Interdisciplinary Nature of Agroforestry Research and Extension

Gone forever is the era when research and extension can be carried out by a single discipline. The multifaceted nature of rural development involving social, economic, and ecological dimensions, in which agroforestry is entrenched, dictates that all activities associated with it, including research and extension, must be carried out with the full participation of representatives of those disciplines. Unless this is faithfully observed, success will remain elusive.

References

Brookfield, H.C. 1972. Intensification and disintensification in Pacific agriculture: a theoretical approach. *Pacific View-point* 15:30-48.

Escalada, R.G. 1980. *Manipulation of cultural practices for ipil-ipil (*Leucaena leucocephala*) for maximum organic matter production and its effect on the intercropped cassava*. Baybay, Leyte, Philippines: Department of Agronomy and Soil Science, Visayas State College of Agriculture.

Getahun, A., G.F. Wilson and B.T. Kang. 1982. The role of trees in farming systems in the humid tropics. In *Agroforestry in the African Humid Tropics*, ed. L.H. MacDonald. Tokyo: United Nations University.

Guevara, A.B. 1976. Management of *Leucaena leucocephala* (lam.) de Wit for Maximum Yield and Nitrogen Contribution to Intercropped Corn. Ph.D. Dissertation. Honolulu: University of Hawaii.

Huxley, P.A. 1984. *The basis of selection, management and evaluation of multipurpose trees*. Working Paper No. 25. Nairobi: ICRAF.

_____. 1986. *Rationalizing research on hedgerow intercropping: an overview*. Working Paper No. 40. Nairobi: ICRAF.

_____. 1988. Some Considerations and Suggestions for Research on Hedgerow Intercropping. In *Proceedings of Alley Farming Workshop*, March 10-14, 1986. Ibadan: IITA.

Raintree, J.B. 1983. Strategies for enhancing the adoptability of agroforestry innovations. *Agroforestry Systems* 1(3):173-188.

Multipurpose Tree Species in Agroforestry Extension Research

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In general, most of the hillside areas in Thailand are dry and windy all year long. They are not as productive as the fertile flat areas. However, considered in light of a natural resource conservation strategy, they are very important as buffer zones between the mountain forests, populated areas, industrial areas and permanent agricultural zones.

Most of the hillside areas in which the farmers live are similar to the mountains as far as food, fuelwood resources and other forest products are concerned. The association between the villagers and the mountain forests has decreased since the government decreed those areas protected forests and wildlife sanctuaries and passed a law forbidding their utilization.

Where a forested area was declared a protected reserve the farmers moved out of the forest to live in villages. Agricultural practices were modified from subsistence to methods employing monocultures over large areas. Consequently, there has been widespread deforestation and the soil has deteriorated so that the yield no longer justifies the capital invested. When the farmers get into debt, they migrate to the cities to find work, or sell their plots and invade the forest to grow a few crops. This cycle has been repeated so often that the hillsides are degraded and the previously abundant mountain forests have been destroyed. This is a constant source of conflict between the Government of Thailand and the rural people.

Background

This study took place at Klong Mark Nut Village. It is part of the Royal Hillside Area Development Project in Prachinburi Province, near Pangsida National Park. A part of the national forest was developed through the Forest Village Program as a demonstration area for five nearby villages at the foot of Bantad Mountain. Approximately 3,400 people live in these villages.

About 750 people live in the Village of Klong Mark Nut. The village is composed of people who have moved there from several provinces in northeast Thailand since 1967. It is governed by a provincial committee board of directors which oversees land distribution to the villagers. Three plots, for a total of 15 rai (1rai = 1,600m^2) are provided to each family under the program. The land distributed consists of one rai of living area, seven rai of rainfed land and seven rai of irrigated land. The three farmers described in the case studies, however, received only 0.5 rai for a home plot.

The living area is clustered in a flat area near a source of water. Although the cultivated area is also flat, the soil is infertile as a result of years of monocropping with cassava and maize. The problems of the villagers in this area include low yields, lack of capital to purchase inputs, low market prices for their products, and crop damage by the strong winds.

Current Forestry Activities

Forest activities undertaken in the area by the Royal Forest Department (RFD) include reforestation and maintenance of 500 rai/yr on steep slopes, and the establishment of village woodlots. The villagers earn income from working in tree nurseries and on tree plantations. However, there are no clear guidelines for administering the harvesting and distribution of benefits from the government woodlots.

Agroforestry Extension Research

Agroforestry is used to promote effective land utilization in Klong Mark Nut and nearby villages. It also aims to encourage increasing participation among farmers. Two important lessons have been learned about field extension research in this area of Thailand: the RFD does not have enough resources for a fully funded research effort. Thus, research projects are designed contingent upon the researcher's interests and may not be useful to the farmers. Second, research projects, experiments, and demonstrations by government agencies are often not appropriate for farmers' needs. Experimental designs are influenced by standard experimental patterns or the use of findings from different agroecosystems. As a result, they are often irrelevant to the farmers (Makarabhirom 1988).

Extension Research at Klong Mark Nut Village

Research undertaken in May of 1988 aimed to promote efficient land use practices emphasizing increasing production and diversification per unit area through agroforestry. It also studied techniques to transfer agroforestry technology to small-scale farmers by farmer to farmer extension strategies.

Before the field trials, researchers interviewed the farmers to analyze their problems and needs together. Field trials and testing of appropriate technology for tree planting in agroforestry systems were then conducted at the RFD field station. Species tested included Leucaena, Eucalyptus, neem (*Azadirachta indica*), kapok (*Ceiba pentandra*), mangos (*Mangifera indica*), jack fruit (*Artocarpus heterophylla*), and passion fruit (*Passiflora edulis*) in conjunction with field crops. Related activities included training in beekeeping, plant propagation techniques and silviculture. The research was designed to emphasize self-sufficient family and village production before marketing the surplus.

Case Studies

Additional information on the farmers is presented in Table 1. The number and species of trees they planted is summarized in Table 2.

Boonserm Patangkam, 36 years old, moved to the village in 1976 due to a lack of available land in his previous village. At first he cultivated 30 rai of land and then sold it. Before participating in the Royal Hillside Development Project, he worked in his mother-in-law's cassava field. When his mother-in-law gave him land of his own, he planted rice. The first year he harvested 2,900kg of rice from his seven rai. The following year, he couldn't plant anything because he had no money, so he started to work as a laborer in other villages. He used wood from his field and the forest for fuelwood. In 1988 he made charcoal and sold 30 sacks for 2,400 Baht (US$1 = 25 Baht). Boonserm then participated in the Hillside Project and was given a plot of 0.5 rai to live on, and two plots for planting -- seven rai of irrigated land for rice, and another seven rai of rainfed land for field crops.

Trees Planted

Plot 1 Boonserm planted the following trees on the 0.5 rai plot: three mango trees, 13 of jack fruit, two lemon trees, one durian tree, three of bamboo (*Dendrocalamus asper*), 20 of papaya, three Sesbania, four cassod (*Cassia siamea*) trees, and ten banana plants.

Plot 2 Two hundred Eucalyptus and 15 mango trees were planted along the ridges of the paddy fields from east to west.

Plot 3 The seven rai of rainfed land is divided into two sections of four and three rai. On the four rai section he planted 36 jack fruit trees at a spacing of 6x6m, 30 rambutan (*Nephelium*

Table 1. Background of farmers.

Item	B. Patangkam	B. Sansakorn	N. Dewa
Family	7	5	6
Income (Baht)	16,000	15,000	30,000
Crops	cassava, maize, rice	cassava, maize, rice	cassava
Animals			
buffalo	2	5	1
chickens	2	9	8
fish	2,500		

Table 2. Number of fruit trees planted.

Item	B. Patangkam	B. Sansakorn	N. Dewa
A. heterophylla	36	40	32
T. indica	30	38	74
M. indica	200	100	213
L. chinensis	36	2	15
N. lappaceum	12	-	2
C. grandis	2	38	2
C. nucifera	6	6	5
C. limon	-	10	-
G. mangostana	-	2	-
D. zibethinus	30	4	5
Eugenia siamensis	3	-	-
Manilkara achras	10	-	-
B. nana	-	25	-

lappaceum) trees at 3x3m, and 236 mango trees, also at 3x3m. On the three rai section he planted grass for fodder, 15 sweet tamarinds (*Tamarindus indica*), bananas, jack fruit, and Eucalyptus and kapok trees as a fence.

The Project promoted the use of tractors to prepare the soil before planting the trees. After that, Boonserm and his wife used a buffalo to plow the soil thoroughly. Tree seedlings of all kinds are provided through the Project.

Boonliang Sansakorn, 56, moved to the village in 1964 because his father's plot at home was too small. He bought other villager's rights to plots totaling about 50 rai in the forest. He converted 25 rai to rice fields, and 25 rai were used for field crops. Later, when the forest villages were established, he gave his children 35 rai and kept 15 rai for himself. On the 0.5 rai plot he lives on, he planted three mango trees, four coconut palms, four guava (*Psidium guajava*) trees, five star-gooseberry (*Phyllanthus acidus*), three jack fruit trees, one neem tree, and one santol (*Sandopicum koetjape*). The trees were planted at random. He collects wood from the forest and uses about one sack of charcoal each month.

Trees Planted

Plot 1 Boonliang planted three more clumps of bamboo (*Bambusa nana*) on his 0.5 rai houseplot.

Plot 2 He planted a mango tree, three guava, and 375 Eucalyptus along the ridges and around the borders of his rice field.

Plot 3 Boonliang's field crop area is also divided into two parts. On the first section of four rai, he planted 170 mango trees at 3x3m, 36 tamarind at 6x6m, 100 Eucalyptus trees, 40 Leucaena trees, 40 cassod trees, with 100 clumps of *B. nana* planted around edge of the plot. On the second three rai, he planted eight mangosteen (*Garcinia mangostana*), and five lichee (*Litchi chinensis*) trees. The project provides all necessary inputs of fertilizers and pesticides. Boonliang plowed these plots himself.

Nual Dewa, 40, used to work on an irrigation project. The project ended and he became unemployed. As he had no land in his hometown, he moved to Klong Mark Nut in 1976. At that time he worked as a guard for a forest unit. He earned additional money by helping the villagers build houses. He uses about a sack of charcoal a month from wood collected from the forest. Nual was given the standard three plots of land under the Project.

Trees Planted

Plot 1 Nual planted three clumps of *B. nana* o his 0.5 rai homeplot.

Plot 2 He planted one mango, three guava, an 375 Eucalyptus trees along the ridges and around the edges of his rice field.

Plot 3 On the rainfed plot 170 mango trees at 3x3m, 40 lemon (*Citrus limon*) trees at 6x6m, 36 tamarind at 6x6m, and 38 pomelo (*Citrus* *grandis*) trees at 6x6m were planted. He planted 100 Eucalyptus trees, 40 Leucaena, 40 cassod trees, and 100 clumps of *B. nana* around the edges of his plot. The project did the initial plowing with a tractor.

Update - One Year Later

Boonserm Patangkam had planted 1,193 more trees of 27 species. There are now approximately 75 trees/rai on his plots. He also grew plants to improve the soil, and trees for boundary markers and fences. During the growing season of 1988/89, he earned 14,180 Baht from his rice harvest. He received 5,400 Baht from the field crops grown between the trees. He raised fish in the rice paddy, kept a hive of bees, and started a small nursery. In 1990 he will earn about 7,000 Baht from the propagation of four kinds of fruit trees with a total of 350 cuttings.

Boonlieng Sansakorn planted 1,073 more trees of 26 species. There are now about 74 trees/rai. He cultivated plants to improve the soil and planted MPTS around the boundary of his plots as well as on his homeplot. During the growing season of 1988/89 he earned 8,910 Baht from rice, and 4,600 Baht from field crops and vegetables. Boonlieng expects to earn 4,000 Baht from propagating plants in 1990.

Nual Dewa planted 1,817 more trees of 27 species. There are now about 125 trees/rai on his land. He interplanted field crops with fruit trees. He also planted MPTS around the boundary of his plots and his home. In 1988/89 he earned 8,250 Baht from rice, and 4,600 Baht from field crops. Nual expects to earn about 5,000 Baht from a good variety of 250 propagated cuttings in 1990.

Constraints to Research Activities

The length of time to produce results is rather long, even with the fastest-growing trees. This dampens the enthusiasm of both researchers and farmers. The length of time before harvest in agroforestry systems can be a problem. If the trees are damaged or destroyed for any reason, the data will be skewed. It is difficult to start another trial and thus, the project runs the risk of failure.

Research activities are not continuous. The farmers have little time to observe results over a long time frame, even with fast-growing trees, as there is constant work to do in the fields. Farmers sometimes may forget to monitor growth.

·Interference from other agricultural campaigns encourages farmers to focus on activities with higher short-term profits.

The project lacks technicians in related fields such as economics, animal science, and agriculture so it is not possible to put together a multidisciplinary project.

Recommendations

Research should be undertaken only with farmers who are enthusiastic about participating. Good motivation will enable them to see the research through to the end of the project.

The farmers should have a role in designing and planning the research because they understand the problems they face in trying to maximize yields better than the researchers.

The farmers need to be trained to collect data, with frequent visits and updates from the researchers so they will monitor the trees in the trials more closely. They need to understand the progress of the experiment in order to take better care of the trees under study.

The research procedure should be simple enough for farmers to learn easily. Moreover, local resources should be utilized.

The project design should complement the on-farm activities so the researchers and farmers can work together as a team. In addition, the new techniques should fit into the system already used by the farmers with the least disruption possible, ie. the design should not drastically alter the existing infrastructure such as dikes, fences, walls, etc.

Research should not be undertaken where the farmers are put at risk. On-farm research is simultaneously used for purposes of demonstration, promotion and publicity. Research which fails means the farmers will be less willing to participate in subsequent research.

Practical, applied research should be emphasized over theoretical research which is inappropriate for local conditions. Research closely matching what the farmers are already doing will be an incentive for the farmers to use the successful results to improve their present situation.

Research should be designed to improve the standard of living on small farms. Therefore, the research should be undertaken on-farm.

Reference

Makarabhirom, P. 1988. *On-Farm Agroforestry Demonstration and Extension Study at Ban Pakdipandin and Ban Klong Mark Nut Village Royal Project, Prachinburi Province*. Technical Paper 24. Bangkok: Royal Forestry Department.

Using Farmers and Their Ideas for Effective Extension Work: A Case Study from Thailand

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Agrotechnology transfer problems are not new to the farmer, extensionist, or researcher. By focusing more clearly on what the farmers are discovering on their own, coupled with outside research results, the extension agent can help the farmers find more appropriate, effective, and acceptable solutions to agricultural problems. This means that the classical extension agent, traditionally the source of information, must now take a more flexible and unassuming approach. The Khao Kho Alley Cropping/Agroforestry Project is an example of this extension technique. Khao Kho is characteristic of much of the tropics where demographics force marginal lands to be used for agriculture, often unsustainably. With the encouragement of an extension agent, the farmers involved in this project have been the innovators and disseminators of a solution to the problems of soil erosion.

Background

The relatively new agricultural sub-district of Khao Kho is located in Petchaboon Province in the mountains of northern Thailand. Only 20 years ago this region was covered by a dense, primary dipterocarp forest. However, between 1961 and 1982, 58% of the forests in the province were destroyed as a result of legal logging concessions, illegal logging, and shifting cultivation (Bostrom 1988). In the past 10 years the government has encouraged farmers from the lowlands to homestead on 20 rai (3.2ha) of land per family to promote political stability in the region. The farmers hold title to the land and can farm it indefinitely, but they may not sell it. The 33 villages in Khao Kho are home to 1,650 families.

Unlike the flat rice paddy land familiar to most of the farmers, Khao Kho is mountainous with slopes of 25-100% in the fields. The soils in the area vary considerably, classified under the Ustic groups of Alfisols, Inceptisols, Mollisols, and Ultisols, with some Vertisols. The climate is characterized by a rainy season from April to October (with peaks in June and September) for an annual precipitation of 1,800-2,000mm. In the dry, cool season from November to January, night temperatures drop to 8°C and rise to 25°C during the day. February to April is the dry, hot season. The elevation ranges from 600-1,000m, with most of the agriculture at altitudes between 600-900m.

Current Cropping System

The current cropping system in Khao Kho is unsustainable. Annual practices of burning crop and weed residues and plowing slopes dramatically increase the rate of soil erosion. Farmers generally hire a tractor and driver to plow their land for US$8/rai (1 rai = 1,600m^2). The cost to plow 20 rai would be $160, which is 37% of the 1986 average annual farm income of $430. Tractor drivers usually plow up and down the slope, even where slopes are less than 15% and contour plowing is possible.

Although the majority of the land in Khao Kho is unsuitable for cultivating annual crops due to the steep terrain, the major crop in the area is corn (*Zea mays*), planted for animal feed, with yields of 496 kg/rai (3,100 kg/ha) (Suebsak 1986). Minor crops include mung bean (*Phaseolus aureus*), ginger (*Zingiber officinale*), cucumber (*Cucumis sativus*), passion fruit (*Passiflora edulis*), castor (*Ricinus communis*), asparagus (*Asparagus officinalis*), and mulberry (*Morus alba*). Mulberry, a perennial used in sericulture, is a promising alternative to corn due to the favorable market conditions for silk. Recently planted fruit orchards include sweet tamarind (*Tamarindus indica*), lychee (*Nephelium mutabile*), mango (*Mangifera indica*), jackfruit (*Artocarpus heterophylla*), coffee (*Coffea arabica*), and custard apple (*Annona squamosa*).

Erosion rates of 1-2cm of topsoil/year and gullies 1m deep are not uncommon (author's observation). Farmers report that corn yields have decreased by 50% in the past 10 years, and that the soil is more difficult to dig with a hoe, indicating a loss of organic matter and topsoil.

The majority of farmers can not afford to buy chemical fertilizer, and animal and green manures are seldom used for soil improvement. Farmers are aware of the problem of declining soil fertility. Some say that when they can no longer grow corn, they will plant fruit trees, believing that trees can grow in depleted soil.

In addition to declining soil fertility, there is a parallel decline in sources of on-farm fuel for cooking. The search for fuelwood results in encroachment on forest reserves and watersheds. It has been observed that the cultivation of corn helps to alleviate the fuel shortage problem, but only for families who have fuel-efficient stoves that burn corncobs.

Khao Kho Alley Cropping/Agroforestry Project

Gou Seecong, 33 years old, is typical of Khao Kho farmers in certain respects, yet atypical in others. Originally from a village in the rice plains of Petchaboon Province, he volunteered to be one of the homestead farmers in Khao Kho in 1980.

When he first moved to the village of Tanit Com Tieng in Khao Kho the topsoil had such good tilth that his feet sank into it when he walked through the fields. However, in the past 8 years, he noticed the ears of corn getting smaller and the erosion gullies becoming more obvious. Like other farmers, he recognized the problem and attempted to solve it. On his 5 rai (0.8ha) vegetable plot, Seecong experimented by planting contour rows of lemon grass (*Cymbopogon citratus*) and making contour bunds of weed and crop residues (compost contours or trash lines). Both of these innovations were effective in reducing the rate of soil erosion. With his own ideas, initiative and labor, this farmer had started "on-farm experimentation."

Gou Seecong's field was an excellent site for a demonstration plot due to its proximity to the road, allowing passersby a good view. He had no way of knowing that in a few years, farmers from villages in Khao Kho and other regions of Thailand would visit his farm to hear him talk about his experience with soil conservation. Nor could he have predicted that he would speak to university students studying forestry, or international groups such as the participants in a UN conference on Desertification Control in Asia and the Pacific in 1989.

A year after Seecong planted the lemon grass hedgerows, a new Peace Corps Volunteer extension agent began work for the Royal Thai Department of Land Development in Khao Kho. The extension agent (EA) passed Seecong's field many times and was impressed by the lemon grass hedgerows. They reminded him of hedgerows of nitrogen fixing trees (NFTs) in alley cropping systems he had studied in college.

The EA approached Seecong, and found they had similar goals in their approach to farming. Seecong was more than happy to let the EA build a small hut on his farm and live there. Over the next few months Seecong and the EA worked together on farming and experimenting with NFTs to reduce erosion.

Exchanges of information and ideas constantly occurred as the EA and Seecong worked together. Seecong was intrigued when the EA pulled up a leguminous weed with root nodules and explained the process of nitrogen fixation and how the NFTs they were planting could improve soil fertility. A week later, the EA observed Seecong explaining nitrogen fixation to a curious neighbor who asked what was being planted in contours across Seecong's field. Another time, Seecong showed the EA how they could use a 10m section of clear plastic hose filled with water to determine the contour lines for the hedgerows.

Farmer to Farmer Extension

The EA wanted to expand alley cropping to include other farmers within three months but Seecong advised against it, saying that "the others will follow on their own if what we do on my farm is successful."

Soon, nearby farmers began to wonder why Seecong was planting contour hedgerows in his vegetable plot. It now had an attractive appearance, very important in Thai culture. Seecong would answer, "I'm planting trees to protect the soil and improve it." Many farmers said he was crazy.

Four months after the EA and Seecong began working together, there was a meeting at the local temple, organized by a development worker. When the development worker failed to appear, the village leader asked Seecong to talk about what he was doing on his farm. Without preparation or materials, Seecong spoke to the other villagers about the need for soil conservation and the method he and the EA were trying. The farmers at the meeting weren't afraid to ask questions or comment honestly about what he said. What Seecong said made sense to the audience because he is a farmer and understands his neighbors in terms of culture, lifestyle, workload and available resources.

With the approach of the next planting season, the EA and Seecong wondered if some of the other farmers would be interested in trying this style of alley cropping. During the dry season, before the rains started, farmers began expressing their interest to both the EA and Seecong. The EA was very surprised with the unexpected interest in the soil conservation technique.

Each of the interested farmers was assisted by the EA for one day in marking contours using the plastic water-filled hose. The EA supplied NFT seeds to each of the farmers after they raked the crop and weed residue into compost contours. For many, this was the first time they had not burned the crop and weed residue in their fields. After the rainy season started, when each farmer had time, the EA returned and helped the farmers plant the NFT hedgerows. That year, Seecong expanded the alley cropping to cover all his land and 13 other farmers planted trial plots of varying size.

An essential tool to expand the area under alley cropping, and a further example of using farmers' ideas, was a human-powered plow that Seecong and the EA developed. The one-wheeled plow could make a furrow 80m long in 2 minutes, compared to the 30 minutes it took with a hoe. Water buffaloes are scarce in the mountains of Khao Kho, therefore human power is appropriate. Sufficient soil moisture makes it easy for a single person to pull the plow, which disturbs the soil less than a hoe and helps with soil conservation. The "human buffaloes" (both farmer and EA) were the source of much amusement in the village.

Tangible Results

Following the first rains and prior to the planting of hedgerows, 20 to 30cm of soil had built up along the compost contours in a field with a slope of 30%. Much of this soil would have otherwise collected in the reservoir at the bottom of the field, creating an additional problem of siltation.

Nine months after the NFT hedgerows were planted and the 1989 rainy season began, the positive effect of alley cropping was obvious on Seecong's farm. Where the slope was 25% and the cropping area was 5m between the hedgerows, an average of 5-10cm of soil had built up directly up-slope of the hedgerow, the beginning of a natural terrace.

The effect of the NFTs on crop yields is unknown, but data will be collected at the end of the 1989 cropping season. Seecong used pigeon pea (*Cajanus cajan*), the giant variety of *Leucaena leucocephala*, *Sesbania sesban*, and sunhemp (*Crotalaria juncea*) in his hedgerows. In terms of insect avoidance (especially the psyllid), and the establishment of a biomass productive hedgerow, the mixture of all four species was very successful. A thick hedgerow, approximately 1 plant/cm, was hand sown using a mixture of seeds.

In 1989, additional species planted included *Gliricidia sepium*, *Cassia siamea*, *Calliandra calothyrsis*, *Leucaena diversifolia* (showing some resistance to the psyllid), and *Tamarindus indica*. It is still too early to evaluate the performance of these latter species.

Conclusion

The planting of multipurpose and nitrogen fixing trees to control soil erosion has been readily accepted and adopted by the farmers of Seecong's village due to many factors. This paper emphasizes that the reason for success is due to using the farmer's ideas and supplementing them with additional extension information. In Khao Kho the farmers recognized the problem of soil erosion and took action to solve it. However simplistic that explanation may seem, when an idea is farmer-generated it will be more acceptable to other farmers. The author believes that farmers' acceptance of unfamiliar technologies has been hindered by the lack of input from the farmers themselves. This stems from the fact that the flow of information is one way, originating from outside the farmers' environment and with people who are unfamiliar with the farmers' way of life. For successful and sustainable agricultural development, a two way flow and exchange is critical. The adoption of such a system could help in solving the agricultural technology transfer problem.

In the case of Khao Kho, the demonstration plot was not on a government station, an artificial and unrealistic setting, but rather in a farmer's field, using the resources of the farmer. For neighboring farmers, such a demonstration is appropriate because it is developed within their environment under the same conditions and constraints they face.

The fact that the EA lived among the farmers and worked with them in both project related (soil conservation) and unrelated activities (harvesting crops and weeding), made him a part of the community and thus more credible. This helped the EA better understand many different aspects of the farmers' lives, leading to more effective extension work. If the EA does not live in the community or have a feeling for the work of the farmers, he will probably be less committed to seeking solutions.

Too often, extension programs are overly ambitious and push results at the expense of learning. When an EA receives orders from outside the farming environment from planners in the regional office, to complete X rai of terracing, or plant Y number of trees with Z number of farmers, problems are inevitable. Such problems might include farmers accepting a technology just to please the EA, but abandoning it shortly thereafter; lack of farmer participation in selecting and developing a technology, rendering it inappropriate; and the extension agents may acquire a reputation among farmers for being unmotivated and insensitive to the farmers' concerns and needs, hampering future extension work.

These problems block the message and prevent any progress towards lasting positive change. The experience in Khao Kho has shown that by starting small, with one farmer and one extension agent, problems in the alley cropping method could be worked out before they were magnified over an extensive area. Agricultural development workers can benefit greatly by remembering that sustainable development, like a successfully established tree, must begin as a small seed.

The primary role of the EA should be as an "encouraging" agent. In this case the EA saw something good (lemon grass contours) and used that as a door into the farmer's field. Extension agents need to be constantly on the lookout for such doors to create a positive relationship with the farmers. The EA should enter the farmer's field accepting the fact that farmers often have many of the answers to their own problems, but may simply need encouragement. When farmer to farmer extension is utilized, the information is more believable and the experience is internalized.

Using farmers and their ideas will lead to more effective and worthwhile development, as the Khao Kho Project has successfully demonstrated. For the extension agent this means being patient, flexible and unassuming, and listening and learning from the farmers.

The formula for this is simple -- pick up your hoe, get out in the field and work with the farmers!

References

Bostrom, K. 1988. *Reforestation in Khao Kho.* Participatory Forestry Development Through Extension. United Nations Development Programme (UNDP)/Food and Agriculture Organization of the United Nations (FAO).

Suebsak, J. 1986. *Agriculture in Petchaboon Province, Thailand.* Petchaboon: Provincial Agricultural Extension Office.

Extension and Training Needs To Motivate Small-Scale Farmers

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Small-scale farmers are generally faced with simultaneous, multiple problems such as a lack of resources, marginal land, an inability to make large investments in long-term projects and to take risks in new ventures. Most of them lack education and tend to be cautious in adopting new technology. These aspects should be given due consideration when developing technology packages for small-scale farmers to promote multipurpose tree species (MPTS) cultivation.

Field extension is the link between scientists and farmers to disseminate research findings to the field through specific models and messages. Based on the problems and needs of small-scale farmers, scientists carry out research trials and develop appropriate solutions. The role of the extension specialist is to develop suitable messages, based on the research findings, to encourage and motivate farmers to adopt the new technology.

Several extension and publicity media are available to disseminate the information. Each medium reaches a specific target group. Selection of the extension media for field publicity is influenced by factors such as target group coverage and media cost.

For effective program promotion it is advisable to make use of multiple media with a variety of messages. The message is more important than the media. However, even attractive messages and effective media may not influence small-scale farmers to adopt the technology unless the field application is demonstrated to be in their best interest. Thus, setting up field demonstrations, followed by a variety of training programs, may help in increasing their confidence to adopt the proposed technology.

Background

People's participation in forestry programs is a new concept which has recently been introduced to counter increasing rates of deforestation in developing countries. In many parts of Asia and Africa, forests were traditionally owned by the government and the people could collect fuelwood to meet their domestic energy needs. However, with increasing pressure on forests from both people and livestock, the natural forest resources in the tropics have rapidly been degraded, resulting in severe shortages of fodder and fuelwood. Since the governments are unable to meet the demands from the existing forests due to budgetary constraints and can not establish production plantations on degraded forest or wasteland, social forestry programs were introduced in the mid 1970s.

In India, with encouragement from the forest department, an increase in the demand for poles and fuelwood, and change in the government policy towards the supply of raw material for pulp and paper mills, many farmers started growing trees on their agricultural fields and wastelands. For the most part it was large-scale farmers who ventured into this enterprise, confined to a limited number of species such as Eucalyptus, Casuarina, and poplars, with very high economic returns. The popularity of farm forestry programs encouraged the government to expand into social forestry programs, with the major objective of encouraging small-scale farmers to take part in reforestation.

Expectations

When designing a program for small-scale farmers, it is essential to understand their basic needs and expectations from social forestry. The majority of farmers in Asia and Africa maintain a small number of livestock, either as a family tradition or as a source of supplementary income during times of economic crisis. Quite often the farmers do not cultivate fodder to feed these animals due to a lack of land, which results in a shortage of fodder and feed.

Fuelwood is another important need as 50-85% of the villagers in Asia and Africa depend on wood for cooking. A major part of this is still collected free from the government or community woodlots, leading to serious ecological problems.

Timber is needed by most of the farmers to manufacture farm implements and to build sheds and houses. While thick poles are used to build huts or houses which may last between 15-30 years, sheds for livestock and implements are built with thin poles of inferior quality to last for 5-10 years. However, most farmers do not have sufficient resources to buy fodder or fuel, nor will they spend their valuable time and limited resources on the production of these products which might adversely affect their wage earning or food production potential.

In many villages located near forests, cutting wood from the forest to sell as fuel or charcoal is the major source of employment. In the tribal areas of India, collection of minor forest products such as honey, wax, lac, gum, fruits, nuts, oil-seeds and herbs for medicines has been the major source of traditional employment for generations. With the increase in the tribal populations and the vanishing forest resources around them, creation of alternate means of employment is a priority. To meet the needs of small-scale farmers, the social forestry program should be designed to generate surplus income and gainful employment while producing fodder and fuel for domestic consumption.

To increase income and profitability, the program should be based on appropriate technology to increase production and basic infrastructure for organizing input supply and marketing. The next important step should be to motivate the farmers to participate in planting MPTS to improve their income level and quality of life.

Technology Adoption

The entire process of persuading small farmers to plant MPTS can be divided into four stages.

Creation of Awareness

Small-scale farmers are often not aware of the potential of planting trees to increase their income within a short time. It is necessary to give them information about the potential of MPTS to provide a sustainable livelihood.

Motivation

Small-scale farmers are cautious about adopting new technology and participating in new activities. It is necessary to encourage them to participate.

Training

After preparing the farmers to take part in the program, they must be trained to acquire the necessary skills to increase production and optimize their available resources.

Organizational Support

Credit, inputs, technical supervision and marketing are essential support services needed to optimize production and profits. Small-scale farmers may not be able to participate in the program unless organizational support is assured.

Extension Program

When planning an extension program, the preceding stages should be studied carefully and appropriate strategies need to be developed to achieve the objectives at each stage.

Creating awareness and motivation are essential to enhance the participation of small-scale farmers. Once the farmers are motivated to cultivate MPTS, it will be easier to provide the necessary training to upgrade their skills.

Communication is the key to create awareness. Two important components are the message and the media. Selection of both message and media depend on the target groups, which vary by country and region.

Target Group

In certain areas, it is difficult to reach illiterate farmers through the most common communication media, but a variety of effective alternate approaches can be utilized, including local leaders, village youth organizations, women's forums, schoolteachers and children. The media and messages vary in different regions depending on the education level, extent of fodder and fuelwood availability, demand for agricultural produce and other factors.

Messages for Forestry Extension

Before developing messages to create awareness and motivate the people, it is necessary to clearly identify the issues that will be communicated to the target population. These issues relate to problems of deforestation and misconceptions about the reforestation program itself. Since farmers anticipate the generation of a substantial income from new programs, higher profits, and the potential of year-round employment could be prominent themes in the message. Other messages worth considering include themes such as reforestation to improve crop production through soil and moisture conservation, tree planting to prevent wind damage, and MPTS to save on the cost of fodder, fuel, timber and to earn cash income.

The extension message should be simple to be easily understood by the farmers, so they don't have to discuss it with others to understand the idea. It is better to develop a separate message for each theme. Too many themes in one message may have a diluting effect on all the ideas.

The message should be direct, instead of vague. Quite often, posters of the social forestry departments carry slogans such as "Forestry for Survival" or "Forestry Brings Prosperity" which may not impress the farmers at all. If new messages were presented, such as "A hectare of bamboo will earn you US$10,000 in 8 years" or "Make your degraded land more productive", the messages would attract the attention of more farmers.

The message should be illustrated so that even illiterate people would become curious enough to learn more details about the message and its theme. The message should be repeated from time to time, preferably with slight modifications and additional information, so the target group does not dismiss it as the same old message. The message can be made effective and informative by appropriate selection of the media.

In a social forestry program undertaken by BAIF in Pune district, Maharashtra State, the field officers utilized this method to influence the planting of specific tree species in areas where its value was underutilized. In one of the villages, *Melia azaderach* was traditionally used as poles for building rural houses. In that area the demand for Melia poles was very high and the farmers were able to sell 3-4 year old trees with a basal diameter of 8cm for US$3 on-site. However, neither the value of Melia nor the marketability of the poles were known to farmers in other villages in the district.

Messages indicating the use of poles for building houses and the profitability of cultivating Melia were responsible for increasing the area planted by 500% in three years.

In another village of Pune district where rainfall ranges from 1,800-2,500mm, farmers have successfully grown *Thespesia populnea* on their paddy field bunds. These are pollarded every three years to harvest 20-30 poles per tree, each valued at US$2. Under this system it is possible to establish at least 30-40 trees/ha without affecting the paddy crop and earn an annual income of US$500/ha. However, the potential of planting *T. populnea* was unknown by most of the villagers even within the same area. In these places, compiling data on the income earned from the poles was extremely helpful in motivating a large number of farmers to plant Thespesia on their field bunds and in their homegardens.

In both cases income generation, marketability and profitability were the motivating forces to promote the cultivation of these species. Although these trees produce a significant quantity of fodder and fuel while the poles are being harvested, a message to grow Melia and Thespesia for fodder and fuel would not provide an adequate incentive to plant because such a message does not indicate a level of profitability. In an area where dairy farming is an important income generating activity, information about fodder yields or saving on the budget for purchased feeds would be likely to motivate farmers to cultivate fodder species.

The theme of the message may vary according to the level of participation and stage of the project. While the message in the initial stage of the project should be attractive to capture the attention of the farmers to participate in the tree planting program, subsequent messages might focus on increasing productivity, conservation of natural resources, and strengthening of infrastructure.

Media

The message intended for the target group can be transmitted through a variety of media. Some media are more effective than others. However, the most important criteria for media selection are accessibility to the target group and cost. The following media can be utilized for promoting cultivation of MPTS.

Radio

Radio programs have become very popular in developing countries, with radios available at low cost. The advantage of this media is that farmers carry their radios to the field and listen to the programs even while working. Early morning and evening are the prime times when the villagers carefully listen to the programs at home. In Maharashtra State, several farmers have purchased radios expressly to listen to agriculture and forestry programs. This medium reaches the largest target group because even illiterate farmers receive messages without any effort. Broadcasting the message before or after popular programs, particularly during prime times, would be most effective.

Television

Television can be more effective than radio because it is a visual medium. However, one drawback is that only small numbers of people in the villages have access to a television set. Quite often the villagers who own TV sets view only selected programs, and messages relayed at other times may not reach the intended audience. In India, the government has provided a television set to many village community centers and schools. These centers operate on a specified schedule. These schedules will have to be kept in mind when broadcasting messages. Television broadcasts are more expensive than radio, due to production costs and broadcasting fees.

Video and Films

These are more effective than television or radio because the viewers concentrate on the message for a longer period of time. However, two cost factors are involved -- both the production and exhibition of the film are expensive and time consuming. Late evenings or nights are ideal for organizing film presentations in villages when large crowds can be gathered. However, it is not a very convenient time for the extension workers. This media can not reach large target audiences on a wide scale.

Street Plays and Cultural Shows

Street plays, dramas and entertainment have been developed during recent years to create awareness about deforestation and to motivate farmers to plant more trees. The message utilizing these media can be very effective, but may soon be forgotten. The message can not be repeated, because people may not attend the show if they have seen it earlier. Organization of the show, and availability of actors are other limitations. This media is more expensive than a film presentation.

Village Meetings and Slide Shows

Meetings with small-scale farmers can be very effective, but tall talk may lack authenticity about the claims. Often the farmers are hesitant to attend village meetings unless special efforts are made to invite them. Meetings or talks with slide presentations are more effective because less educated people can understand the message better and believe it after seeing the pictures. The ideal time for holding village meetings is in the evening when the farmers come back from the fields. It is important to invite prominent citizens from the village and the region to present their views in the meeting to make it effective. Slide shows in movie theaters can be very effective, without involving high costs. However, such meetings can reach only a small part of the target group.

Posters and Signboards

Putting up posters and signboards in public places and along roadsides can be very attractive. These are inexpensive and reach a large audience. However, small-scale farmers may not be able to read or understand the message unless it is fairly simple with clear illustrations. There is a likely chance of the message being ignored after a few days, when the poster becomes old news.

Newspapers

Advertising in newspapers and distributing press releases to cover forestry events can be very effective to motivate educated people and school children. Readership should be taken into consideration when developing a message through such media. Newspaper articles are treated as authentic, and can create a good impression in the villages. Newspaper advertising costs a lot of money, however, and may not reach remote areas.

Handouts and Booklets

Literature can help to motivate literate people. Good illustrations can also attract the attention of the illiterate. After developing suitable literature the most important task is to reach the target group. Much of the literature available in many developing countries does not convey effective messages and rarely reaches the intended target groups. Handouts help the farmers learn about new techniques and field practices to improve production. In view of the high cost of printing and an inadequate field network, the coverage is restricted to a limited number of people.

Field Days and Tree Planting Ceremonies

Celebrations and gatherings are effective ways to attract large numbers of villagers. Organizing exhibitions, field visits and public tree planting festivals creates awareness among the villagers and motivates them to participate in tree planting. The Government of India sponsors a National Environmental Awareness campaign carried out by governmental and non-governmental organizations and schools annually during the month of November.

Organization of Extension Campaigns

For effective promotion of reforestation programs, it is best to organize a systematic campaign using multiple media, spread over a long period of time, using appropriate messages for different target groups.

In a heterogeneous village community composed of mixed income and caste groups, it is difficult for an outside extension agency to introduce a development program to reach only a particular sector such as small-scale farmers. Such programs may not attract the attention of the target groups, and they often reach only the more progressive farmers who have been successful in previous ventures. The elite farmers often misguide the small-scale farmers by telling them not to participate in the program if the wealthier group is not involved in it. Therefore, the extension campaign should cover the entire village community, while the program may be focused to benefit the small-scale farmers.

Field Demonstrations

Publicity is an effective tool to motivate farmers but its impact is short- lived, however effective it may be. Therefore, follow up activities such as field visits and demonstrations can be organized to present further evidence of the usefulness of the program to the motivated farmers. The impact of field demonstrations is fairly long lasting and it makes it easier to convince the farmers of the benefits of the new technology.

Training

Training is the next step for the farmers who decide to take part in the program. Skill- oriented training in the field, well before the initiation of the activity, can help in the adoption of appropriate technology while reducing the cost.

Training can be more effective if it is organized at various intervals and adapted to local needs. The frequency and duration of such training programs depends on the components of the program and the educational level of the farmers. A program of merely planting indigenous trees may require only short training sessions, while planting exotic trees and processing the produce would necessitate training of longer duration to teach specific skills.

In the initial stages of the program, training helps to encourage the beneficiaries to take an active role and to reduce the risk of failure. Initial success motivates the farmers to manage the program efficiently and encourages others to participate. Most of the farmers watch the early adopters before they take part themselves. Therefore, timely training to avoid failures would greatly benefit the expansion of social forestry programs among small-scale farmers in rural areas.

Farmers' Response to Multipurpose Tree Species at the Small Farm Level: Observations from Northeast Thailand

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Methodologies are reviewed for analyzing farmers' responses to innovation, drawing on the literature in the field of on-farm agricultural extension. The range of possible responses to multipurpose tree species (MPTS) at the farm level is discussed, using empirical findings from case studies in northeast Thailand. A model for analyzing the responses using logit analysis (a method for analyzing categorical dependent variables in a regression framework) is proposed for use in MPTS-related socioeconomic studies.

Innovation in Small Farm Agriculture

Typology of Innovation in Agriculture

Innovations in agriculture can be classified as either land or labor-saving (Ruthenberg 1985). For small-scale farmers, both types of innovation are relevant. They are often constrained by the availability of land, having only small plots to cultivate, or by having to rely on family labor.

Land-saving innovations raise the yield a given amount per application of additional inputs, especially labor. Examples of land-saving innovations include fertilizers, improved seeds, and pesticides. These innovations often amount to a substitution of capital (increased inputs) for land, so that the yield per unit of land increases.

Labor-saving innovations reduce the requirement for labor inputs for a given level of output. They include mechanization at various stages of cropping and the use of herbicides to replace weeding.

Other practices are not easily classified in terms of simple production functions, such as the use of irrigation, or farming system changes. Trees as an element in the farming system serve a variety of functions which are relevant to the consideration of MPTS at the small farm level (Grandstaff 1986; Evans 1988).

Adoption of Technology

In an analysis of adoption of technology, a key question concerns the conditions under which innovations are adopted. The spread of any new technology is constrained by a number of factors, such as the perceived advantage of the innovation, compatibility within the context of the farm, complexity relative to the farm, demonstrability in an on-farm context, and the observability of the innovation (Ruthenberg 1985). The essential factor in adoption is that the marginal gain from adopting the innovation must be greater than the marginal costs involved.

In practice, the adoption of agricultural innovations has a time dimension as well as being a spatial process. The farmer usually reserves some land for using the more familiar practices and introduces modifications to the innovation package proposed by the specialists.

Achieving a desired adoption level requires a complex set of related activities. Information is needed to demonstrate the advantages of the innovation, to fit the innovation to the specific conditions of each farm, to implement it on a low risk basis, and to support the technical requirements during the experimental phase.

These considerations are important in designing an extension program to introduce the innovation, as the extension service is constrained by budgetary and manpower limitations.

MPTS as an Innovation

The role of MPTS in the farming system can be considered within the framework of the classifications outlined above. Cultivating MPTS is a method of enhancing the value of the outputs from the land, similar to using improved seeds and improved farming systems. Hence, it can be considered a land-saving innovation.

On the other hand, it reduces the need to expend labor, as less land preparation and weeding are required. Therefore, it is also a labor-saving innovation.

MPTS systems may not save time, in the sense that the benefits from planting trees accrue after a longer period than from innovations involving annual crops. The adoption of MPTS can tie up more capital in the form of maturing tree crops than other types of innovations with short rotations. Because of this, the diffusion process can be expected to take longer.

Possible Responses to MPTS

Attributes of MPTS

Trees in general adversely affect the farm in that they compete for soil nutrients, they create shade which slows the growth of other crops, and they take longer to yield.

On the other hand, trees also provide benefits by meeting daily needs for charcoal and fuelwood, fodder, timber for household implements and construction, and where there is a market, trees are a source of income at the time of harvest.

Thus, integrating trees into the farming systems of small farms involves both costs and benefits. Adoption of an agroforestry innovation is therefore subject to a cost/benefit analysis in much the same way as other agricultural innovations.

The Promise of MPTS

Looking more closely at how trees improve farming, the following benefits of agroforestry are often cited. Compared to a monoculture, mixed planting provides more security in a price decline or failure of any one crop. Agroforestry systems require less labor inputs once established, and appropriate practices usually result in the control of soil erosion, pests and diseases, and optimize the use of available space.

The advantages of MPTS farming are highly variable. As there is an infinite variety of possible combinations, the problem of assessing yields and values is enormous. There is a wealth of site-specific anecdotal evidence available, but relatively few generalizations can be made about the type of MPTS systems that are appropriate over a wide area.

A danger in research is trying to find a standard package to meet all needs, which is impossible and inappropriate. A major difficulty is understanding the requirements and potentials of specific types of cropping systems involving MPTS that can serve as the starting point for extension.

Agroforestry Systems in Thailand

Reviewing typical agroforestry systems under the classification of Coombe and Budowski (Faculty of Forestry 1983), the following are typical in Thailand.

Combined agrisilvicultural systems are the most common form of agroforestry. Examples of these systems include a combination of rice and teak; rice and rubber trees; rubber trees and field crops such as rice, bananas, pineapple, groundnuts, and corn; Leucaena and hardwood trees; coffee and trees such as Hevea, Melia, Parkia, and Leucaena; oil crops such as sesame, soybeans, groundnuts, corn, kapok, coconut, sunflower, castor, etc. with hardwood tree species; and medicinal plants with hardwoods and orchids.

Combined forestry and grazing include beekeeping, and raising deer and cattle under tree plantations.

Combined forestry with crops and grazing include any combinations of the above.

Observations From Case Studies in Northeast Thailand

Farmers' Responses to Innovation

Northeast Thailand is well known as an underdeveloped, low-income agricultural region with problems of low soil fertility and high population growth. It has traditionally been the main source of labor for urban and industrial centers as well as for the seasonal agricultural labor demand. Development efforts in the region have concentrated on improving the soil and farming practices to increase rice production (the staple crop) and diversify field crops for sale (Craig 1985). It is a land of great contrasts. Some of Thailand's largest farms, cattle ranches, and industrial plantations supply raw materials for the tomato and tobacco industries. It is also an area where recently established tree plantations are meeting with active resistance from the local population (Project of Ecological Recovery 1989).

The Northeast Rainfed Agricultural

Development (NERAD) Project is an attempt to introduce improved farming practices into the traditional farming system. The following are innovations introduced by the project and lessons learned as a result (Chuangcham 1987).

A machine to sow rice directly into the paddy

The idea is to plant rice by direct sowing, as opposed to transplanting or field sowing, to avoid the problems of drought. The equipment is hand-operated and makes holes in the soil. It costs 2,500 Baht (US$1 = 25 Baht) and uses less seed in less time than the traditional method with dibble sticks.

As a result of the field trials, farmers agreed that the machine decreases the amount of time necessary for sowing. But none of the farmers bought the machines because they are too expensive. In another village, where vegetables are grown for sale, the machines were not purchased either, because planting vegetables provides a higher return than growing rice.

This result is interesting as the innovation addresses one of the problems of rice growing where rice is a major crop. The equipment can be classified as a labor-saving innovation, but it was introduced in an area where there is an abundance of available labor during the main cropping season. So the value gained, in terms of saved labor, is considered low relative to the cost of the equipment, and the effect on yield is difficult to establish. The end result is that the innovation was not adopted.

Improved shallow wells

A borehole is drilled until it reaches the underground water table (8-25 meters) and a steel pipe connecting the underground water to the shallow well is installed. The underground water continuously recharges the well. The result is increased water availability, enabling more land to be cropped, or the growing of higher valued crops such as vegetables.

The innovation was strongly appreciated by the farmers. However, there is no record of the number of farmers who have installed this type of well independently of the project.

These examples are presented to point out the lack of standard cost/benefit analyses of these innovations, which is a pity, as the information would be illuminating regarding the returns the farmers expect and are willing to risk.

Grafting fruit trees

NERAD experimented with trees as an innovation, through grafting to improve the stock of fruit trees. Selected farmers were trained in grafting techniques and were to return to their villages and teach other villagers. The project evaluation found that the trees suffered from a lack of weeding and care, and a lack of interest in general due to the perception that fruit trees take a long time to yield. The villagers were more interested in crops with short rotations and fast returns. Progress was only reported on an individual basis on certain farms.

Management of common land

In this innovation, the farmers were organized in village groups to manage the village common land for grazing. The land had been encroached to grow annual cash crops. The village council agreed to take part in the project by allotting an area for planting trees and a pasture. The pasture was sown with Hamata and Ruzy grass which was cut for sale to the villagers as fodder for cattle, the proceeds going to the village fund. The project is rated a success because of the amount of tree planting achieved and the grass collected.

This innovation is interesting in that it involves a whole community, as opposed to an individual, in the decision-making process. An interesting lesson is that the community perspective was long-term in allocating land for the project, and they successfully stopped the use of the land for annual cropping by individual villagers.

In summary, the findings from these case studies show that conditions leading to the adoption of an innovation are quite complex. At the individual level, it appears that very clear benefits need to be demonstrated with rapid returns if an innovation is to be adopted.

Innovations requiring a longer time frame for the realization of benefits might be better managed at the community level. There are many reasons for this. First, resource mobilization at the community level may produce a total resource input that is greater than that possible by an individual. Second, a common resource previously overexploited but unmanaged, according to the typical "tragedy of the commons" argument, may be brought under more productive management, thus increasing the productivity of the resource under the command of the community. In these cases, an individual would gain from having more of a resource at a lower cost than if he were to acquire it himself. Third, a community may take into account the interest of its future generations better than does an individual, by means of having a lower rate of time preference and placing equal or greater values on future rather than on present benefits, thus permitting a lower discount rate for assessing the feasibility of a project. Fourth, a strong community organization can prevent the "free rider" from benefitting from the project without making the necessary contributions, so that the costs are shared commensurately with the benefits. Finally, mobilizing common resources for community needs, such as festivals and village development projects, also reduces the necessity to demand individual contributions on each occasion, so it acts as an insurance against risks in resource availability. Some of the issues are illustrated in the examples discussed below.

Farmers' Response to MPTS

The above conclusion leads to the question of MPTS as an innovation in small-scale farming systems. On one hand, the use of tree products will benefit the farmers individually and collectively. On the other, trees displace other crops and compete for nutrients. The individual cost/benefit calculations must focus on the potential returns and the time it takes to realize them.

There seems to be little resistance to the use of common land for communal projects, including tree planting. A project involving common land creates an awareness of common interest among the villagers which is absent in projects focusing on individual farms. By taking part in the project, the villagers feel that they now control an additional resource which would be underutilized if it were left as common property. Finally, the benefits of the community-based project are subject to a process of open accountability, so there is a sense of involvement and interest in the success of the project. If a need arises in a project at the community level, the community organization can call on outside assistance more readily than an individual farmer. In this sense, the conditions for the success of the community project are more favorable and costs and benefits are shared over the entire group.

MPTS Case Studies in Direct Forestry Projects

Forest Land Occupancy Right Project

The Forest Land Occupancy Right (STK) Project is operated by the Royal Forestry Department (RFD) of Thailand to provide legitimacy to the occupants of forest land. Forest squatters are given the right to occupy 15 rai (1 rai = 1,600m^2) and the possibility of renting more land for their own use if needed, but they may not own the land outright. The recipient of the STK certificate can not sell the land, but can pass the right on to an heir. The RFD requires the STK holder to plant trees.

Feder *et al.* (1986) criticize the STK as impractical, claiming it does not promote sound agricultural practices since the STK certificate can not be used as collateral to secure a bank loan, a precondition for improving farm productivity. Another study found that the tree planting objective has not been achieved (Forestry Research Center 1985).

Forest Village Projects

Forest Village Projects are established as a means of reforestation. In an area of 1,000 rai, trees are planted by 100 households, each having the right to plant annual crops among the seedlings. The planting area is rotated every year as the trees grow. Forest plantations have been successfully established by this method up until now. Recently, opposition to such schemes has grown, with villagers and land occupants refusing to turn the land over to tree planting. New planting has been terminated due to budget constraints.

In this case, trees are not part of the small farm system. The farmer provides labor for planting and reaps limited benefits from intercropping in the first few years of the plantation when the trees are small. Clearly, this does not serve as a model for the widespread adoption of trees in the farming systems of small-scale farmers.

Phu Luang Project

The Phu Luang Project is located in Nakornratchasima Province, in an area formerly cleared for maize by farmers and currently under rehabilitation by the RFD. Farmers in the project area are organized into village communities and given STK certificates to the land. The project assists the farmers with agricultural extension and coordination services.

The project has established plantings of hardwoods and fruit trees, initiated cattle raising and beekeeping, and promoted small-scale charcoal manufacturing. Trees selected for the project include *Eucalyptus camaldulensis* and *Leucaena leucocephala*, with *Calliandra calothyrsus* and *Eucalyptus deglupta* planted for beekeeping.

According to an FAO study of the project, the farmers' response "was lukewarm at first for several reasons. As there was no critical shortage of fuelwood in the area, there was little perceived need to plant trees for this purpose. In addition, people felt it would not benefit them to plant trees, for in their experience it was illegal to fell trees in a reserved forest area. The very concept of agroforestry was alien to these maize farmers who felt that planting trees in their fields would interfere with tractor plowing."

But as the project was implemented over the years, it was found that "56 percent of the farmers had established hedgerows around their homelots and 51 percent started to plant non-fruit trees. However, only three percent had at any time participated in establishing or managing village woodlots."

Charcoal production was initiated by installing a beehive kiln to demonstrate improved charcoal production technology. It appeared to motivate few farmers to install kilns of their own.

The most productive activity of the project was the introduction of pasture grasses to provide fodder for cattle. A study showed that compared with the insignificant cattle raising at the start of the project, it had become " a rather important activity... herds of 40-50 head were not unusual if not yet very common."

Fruit trees were readily accepted and were producing income for the farmers who had received the grafting materials in the earlier phase of the project.

Beekeeping was an introduced innovation. Interested farmers were trained in basic techniques. A small-scale local industry developed, producing beekeeping boxes and frames, new bee colonies, and honey. The production was so successful that the participating farmers expressed interest in marketing the honey on a wider scale.

These instances of tree-related activities indicate that the adoption of tree-based innovations are likely to be successful when the activity generates an income. The aim should focus more on income generation, as in the example of the honeybees, than on the wood produced from woodlots.

The project also illustrates the futility of implementing community-based projects which do not attract the participation of the villagers in the area. One reason for this may be that the forest village communities are new settlements created by the project and do not have the community spirit found in older, more established villages. The villagers in the project area did not face the same fuelwood constraints as in other villages. Hence the lack of involvement in the community woodlot idea.

In conclusion, the factors that seem to be important in determining the adoption of innovations involving trees in small farm systems include:

- a clear demonstration of profitability to the adopter, particularly in terms of cash gains, relative to other income earning opportunities;

- availability of technical support to help with problems in the early stages of adoption;

- the innovation may be individually focused or community based, depending on the status of the particular resource: and

- tree-based innovations should be considered for adoption using the same criteria as for other agricultural innovations.

A Logit Framework for Analyzing Farmers' Responses to MPTS

Given the importance of individual responses in the adoption process, it is useful to be able to analyze the likely outcome of an extension program in order to tailor the program to meet the farmers' needs. A statistical model is proposed for this purpose.

The Logit Model

The logit model is an instrument for statistically analyzing choices made by individuals. The distinct advantage of this model is that it allows an analysis where the dependent variable is discrete, either yes or no, and not the relative magnitude of the response.

The use of this analytical technique is well known in bioassay, and was adopted in the late 1970s to study economic behavior in such fields as urban transportation and in the analysis of the labor market.

The utility of this technique to MPTS is the ability to analyze the adoption process in detail. In designing an appropriate extension program it is necessary to identify the target audience, and to design the program to meet their needs. This model allows the identification of individuals, using a range of criteria, who are likely to be responsive to the program.

The mathematical specification of the logit model is presented below.

Let $Y = 0$ be the outcome of the dependent variable to be explained by a number of other variables X_i, $i = 1$ to n. Otherwise $Y = 1$.

Let $P(Y=0)$ be the probability that an event Y will take the value 0. Then $P(Y=1) = 1 - P(Y=0)$.

The logit model assumes that the probability $P(Y=0)$ takes the form:

$$P(Y=0) = 1/\{1 + \exp(b_0 + b_1X_1 + b_2X_2 + ...)\}.$$

Then the value of $P(Y=1)$ is

$$P(Y=1) = \exp(b_0 + b_1X_1 + b_2X_2 + ...)/\{1 + \exp(b_0 + b_1X_1 + ...)\}.$$

The model then allows for easy estimation of the parameters b_i, since the odds, defined as the ratio of $P(Y=1)$ to $P(Y=0)$, is a linear function:

$$P(Y=1)/P(Y=0) = \exp(b_0 + b_1X_1 + b_2X_2 + ...).$$

This function can be estimated if the values of P are known for each value of X. However, in the case of individual observations, if the observed data refer to Y and not to P, the simple method of estimation cannot be used. The parameters of b can be estimated using the method of maximum likelihood instead.

The computation is made simple by using available software packages which contain routines to process the data using the model (Hall and Lilien 1986).

A Hypothetical Example

Consider the case of a village involved in a proposed woodlot project. The project design team wants to find out if the villagers are interested in taking part in planting for fuelwood. There are many factors involved, as previously described. They theorize that interest in participating will depend on factors such as land ownership, the extent of land holding, the time spent collecting fuelwood, the distance traveled, etc. To establish the importance of the various factors in assessing the response, they take a sample survey of the villagers, noting the response and the various characteristics of the respondents. The model would look like this:

INTER = f (LAND,TIME,CROPIN,DIST, FUELAQ) where

INTER	=	0 if the farmer is not interested in tree planting
	=	1 if he/she is interested
LAND	=	extent of land holding by farmer
TIME	=	time spent to collect fuelwood
CROPIN	=	income from cropping by the farmer
DIST	=	the distance traveled to collect fuelwood
FUELAQ	=	method of acquiring fuelwood, whether by self or by purchase

The results are presented in Table 1.

The result indicates that farmers are more likely to be interested in participating in the project if they have to go a long way to collect fuelwood, if they spend a lot of time on the task, or if they earn high incomes from cash crops (coefficients for DIST, TIME and CROPIN are positive). However, they are less likely to agree to the project if their land holding is large, or if they purchase fuelwood from others (the coefficients for LAND and FUELAQ are negative).

This result certainly suggests the role of cost factors in influencing the farmers' preference for the project, yet at the same time the effect of land holding might be unexpected if it were believed that farmers with large holdings would be favorably inclined to participate in the project.

In any case, the model identifies the relevant factors influencing the outcome of a proposed project and assesses the weight of each factor on the attitude of the farmer. This knowledge would greatly enhance the design process for creating projects to meet the needs and the wishes of the villagers.

Table 1. Hypothetical logit test results.

Variable	Coefficient	STD Error	T-stat
CROPIN	0.00036	0.0002	1.7778
LAND	- 0.02040	10.0331	0.6154
DIST	2.21696	0.9386	2.3619
FUELAQ	- 0.57408	0.7190	0.7984
TIME	0.26392	0.3079	0.8571

Log likelihood	-13.5138
Cases with INTER = 1	85
Cases with INTER = 0	5

References

Craig, I.A. 1985. Cropping Systems Trial Results from the Northeast Rainfed Agricultural Development (NERAD) Project. Paper presented at the International Dryland Soils/ Water Management Workshop, Feb. 24 - March 1, 1985. Thailand: Khon Kaen University.

Evans, J. 1988. Overview of Tree Planting on Small Farms in the Tropics. In *Multipurpose Tree Species for Small-Farm Use*, eds. D. Withington, K. MacDicken, C.B. Sastry and N. Adams. Arlington, Virginia: Winrock International and IDRC.

Feder, G., T. Onchan, Y. Chalamwong, C. Hongladarom. 1986. *Land Ownership Security, Farm Productivity, and Land Policies in Rural Thailand.* World Bank.

Food and Agricultural Organization of the United Nations. n.d. *Forestland For the People, A forest village project in Northeast Thailand.* Bangkok: FAO Regional Office for Asia and the Pacific.

Grandstaff, S.W., T.B. Grandstaff, P. Rathakette, D.E. Thomas, and J. Thomas. 1986. Trees in Paddy Fields in Northeast Thailand. In *Traditional Agriculture in South East Asia: A Human Ecology Perspective*, ed. G.G. Martin. Boulder, Colorado: Westview Press.

Hall, R.E. and D.M. Lilien. 1986. *Micro TSP User's Manual Version 5.0*, New York: McGraw-Hill Book Company.

Ruthenberg, H. 1985. Innovation Policy for Small Farmers in the Tropics. In *Economics of Technical Innovations for Agricultural Development*, ed. H.E. Jahnke. Clarendon Press.

Published in Thai

Chuangcham, P. 1986. *The Management of Village Public Land, the Case of Tambol Namuang, Selaphoum District, Roiet Province.* Bangkok: NERAD Project.

____.1987. *The Acceptance of Technology by Farmers in the NERAD Project.* Bangkok: NERAD Project.

Faculty of Forestry. 1983. *Agroforestry Systems in Thailand: Theory and Practice.* Seminar for Forestry Graduate Students. Bangkok: Kasetsart University.

Forestry Research Center. 1985. *The Impact of the Forest Land Occupancy (STK) Project.* Bangkok: Kasetsart University, Faculty of Forestry.

Ministry of Agriculture and Cooperatives. 1986. *Promising Technologies: NERAD Project 1982-1986.* Bangkok: MAC.

Project for Ecological Recovery. 1989. *Proceedings of a Seminar on the Forest Crisis and Village Ways of Life.* March 17-18, Cha-am, Petchaburi, Thailand.

Multipurpose Tree Species Extension in a Multidisciplinary Context: the Experience of the Lumle Agricultural Centre, Nepal

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Nepal is a small land-locked country surrounded by India on the south, west and east, and by China on the north. The country is usually divided into three geographic/ecological regions running from east to west -- the terai, the hills and the high mountains. The terai is a flat, narrow strip of land with rolling hills in the north. No wider than 50km, it runs parallel to the southern Nepal/India border. The hills are generally defined as a central belt of rugged hills, characterized by a low level of soil fertility and a high rate of natural resource degradation. This region varies from 500m to 4,000m above sea level. Lumle Agricultural Centre (LAC) is located in this middle hill region. The third region, the high mountains, rises to over 8,800m in the northernmost section of the country adjacent to the Chinese border. This region contains little cultivated land and only a small percentage of the population.

About 90 percent of the people in the hill region derive their livelihood from agriculture; the majority live at or below subsistence level. Farming systems are complex and livestock, forestry, and crop production are closely interrelated. Any change in one component may have a significant effect on the others (Mahat 1985). Forest products are important as a source of many essential commodities -- fuelwood, fodder/forage, bedding for livestock, timber, thatching material, edible fruits and vegetables, medicinal plants and a variety of products for religious ceremonies. The role of the forest in maintaining soil fertility is significant. Deforestation is reported to be causing a rapid decline in soil fertility (Wood 1979; Jordan and Herrera 1981). This fertility decline is most evident in the highly weathered soils of the hills which have a low nutrient retention capacity.

Lumle Agricultural Centre is a multidisciplinary agricultural and forestry research, training and extension project in the hills of the Western Development Region of Nepal. It is funded by the British Overseas Development Administration (ODA) and works in close coordination with His Majesty's Government of Nepal (HMGN). Since 1975 it has carried out forestry extension activities in a small Extension Command Area (ECA). The ECA contains approximately 18,000 farm households and covers 25 panchayats.[1] The major emphasis of the extension program is tree planting on both privately owned and community land.

At altitudes up to 1,500m in the ECA forest, resources are severely depleted and time spent gathering forest products is a major constraint. Very little unused communal land is left as nearly all land is cultivated wherever possible. In these areas private planting of multipurpose tree species (MPTS) has been encouraged on the farmers' own land. Communal planting is carried out on a small scale due to the relative lack of both available land and farmers' interest. Above 1,500m community planting is much more important since farmers in this area are more community spirited.

Trees in the Nepalese Farming System

The increasing demand for fodder, fuelwood and other forest products has caused severe lopping and felling of trees in the forests. This has led to severe deforestation with an adverse impact on crop production, due to the substantial decline in soil fertility on cultivated land.

Deforestation also causes the spending of increasing amounts of time to gather fuelwood, fodder and other forest products. In eastern Nepal an average of 10 trips/household/week are made to collect fodder (Abell 1981). A recent study in the hills of the western region revealed that time spent in gathering essential forest commodities has increased by 45 percent since 1960. This has caused a labor availability problem for agricultural work, resulting in a decline in crop production (Kumar and Hotchkiss 1988).

Wyatt-Smith (1982) estimated that every

hectare of cultivated land requires 2.8ha of unmanaged forest to provide sufficient fodder without damaging the forest. He further suggested the equivalent ratios for fuelwood and timber were 0.36:1 and 0.32:1, respectively. However, this amount of forest land is rarely available. Hence, the current farming systems of the hill region are not considered to be sustainable in the long-term.

To improve this situation, attention is increasingly being focused on MPTS planting on private land around the home, on unused land, and on marginal land (kharbari,[2] terrace risers, and stream banks on khet[3] and bariland[4]). The planting of MPTS on private land is seen as a method for substantially decreasing pressure on forest resources.

This paper describes the MPTS extension approach in use at the Lumle Agricultural Centre. Forestry research results on production, alternative management practices, choice/selection of species and harvesting time for MPTS are scarce in Nepal. The approach therefore has taken advantage of the farmers' own considerable body of indigenous technical knowledge to produce MPTS which are in demand.

Lack of Forestry Research Results

Nepal's formal research in forestry began in the mid 1960s. At that time, emphasis was placed on the selection of exotic species with very little work on indigenous species. Priority was given to species with industrial applications, such as pines from the Americas for higher elevations, and *Tectona grandis* (exotic) and *Gmelina arborea* for lower altitudes.

Most of the research was conducted below 1,000m in the sub-tropical forest, and almost none in the mid and high hill regions. Encouragingly, over time, the research focus has shifted to priorities of Nepal on a national scale. Of 662 studies, 79 percent have begun since 1980 (Hudson 1987). A large proportion of this recent research work is on indigenous species. Research on broadleaf MPTS started in the mid 1980s with the inauguration of the Forest Research Division (previously Forest Research Project) of the Ministry of Forest and Soil Conservation.

Although research on various species at different altitudes is now being conducted, the great biological and ethnic diversity of the middle hill region makes it difficult to conduct essential biological and social research. Consequently, research on MPTS of prime importance to private planting is still at a rudimentary stage and has yet to produce results. However, if extension of MPTS is postponed due to a lack of research results, the haphazard harvest of natural resources for farmers' daily consumption needs may cause a further decline in crop production.

Therefore, in a situation where indigenous technical knowledge is considerable, an extension approach which makes use of farmers' knowledge is of greater value for short-term results than conventional MPTS research. Existing local knowledge is also the result of informal farmer research over a long period of trial and error. The LAC Forestry and Pasture extension program has benefitted greatly from the farmers' knowledge and has been able to use it successfully in the field.

LAC's Extension Approach

Selection of Field Staff

Community nurseries are established either at the request of villagers or during a field visit when it is obvious that a village or panchayat needs a nursery. A meeting is held and most of the panchayat officials, village leaders and members of the women's organizations are invited to participate. At the meeting, details and government rules for community forests are described, and the villagers are encouraged to plant trees on both community and private land. The village verbally commits to being involved in the program and selects an honest, friendly local person to run their nursery. They are then asked to furnish a site for the nursery.

The nursery foreman is given basic training at LAC on establishing and managing the nursery, along with recommendations for different planting operations. After completing this training he returns to the village to establish the nursery. The locally recruited field staff generally relate well to the villagers. Their major role is to encourage farmers to plant tree seedlings on any available land.

Seedling requirements are gathered at small meetings where farmers are asked for their choice of species and desired quantity of seedlings for the next planting season. These meetings are held before LAC's plans are drawn up for nursery production the following year. Being local farmers, the field staff know which species grow well in the area.

Seedling Production Feasibility

If production of the requested seedlings is feasible the nursery foremen gather the seeds if they are available locally. If there are no local seed sources LAC will try to acquire seeds from other sources. If the species chosen by the farmers are unsuitable to the area, the silvicultural requirements of the trees are explained in detail to the nursery foreman. After returning to the village he discusses these reasons with the farmers.

It is surprising to note that species selected by the farmers for community planting are very different from those chosen for planting on their own land. For their own land farmers generally choose MPTS, whereas species appropriate for timber, fuelwood, poles, or occasionally fodder are requested for community planting. A possible explanation is that farmers do not plant MPTS on community land due to problems of allocating products within the community. However, in some areas people have now started planting considerable numbers of MPTS on their community land.

The establishment of private nurseries has been encouraged in villages which are quite far from the LAC nurseries and where seedling demand is low. In private nurseries most seedlings grown are MPTS, since they are for planting on private land.

If the nursery owner is unable to produce the farmers' choice of species, the seedlings will not be picked up by the villagers and LAC will not pay the nursery. Thus, private nurserymen are very careful to raise seedlings chosen by the farmers. Although the private nursery program started in 1987, it is becoming popular. Eight private nurseries, producing between 2,000-2,500 saplings each, were established in the first two years of the program.

Pre-planting Preparation

Two to three months before the planting season, field staff hold meetings in the villages to discuss the quantity and species of MPTS available and to ask the farmers to select sites and dig holes to prepare for planting. Visiting individual farmers for training on planting techniques is not practical, so hands-on, one day village level training sessions are held. At these sessions the field staff discuss the advantages of digging the proper sized holes in advance. They demonstrate proper planting techniques and villagers are encouraged to try it themselves.

Most of the planting takes place during the monsoon -- the last week of May to the last week of August. When farmers live more than a half day's walk from the nursery they are paid for carrying the seedlings home (a person can carry up to 40-60 seedlings per load). This cost to LAC has been a major factor in attempts to encourage private nurseries in outlying areas. At one time it was found that farmers came to collect seedlings just to get the porterage money. At that time two way porterage was paid. Now only half way or one way porterage is given with the rate based on the distance of the village from the nursery.

In the past, some farmers received free seedlings of popular MPTS trees and then sold them to farmers of other villages for up to US$0.15 per seedling. To prevent this, field staff now check farmers' names against the list made during the pre-planting meetings. In addition, LAC has instituted a new policy of restricting the number of popular MPTS seedlings that any one farmer may take. However, it is a flexible policy and depends on the field staff and the farmers.

Planting Techniques and Sapling Care

Evidence of success of the private planting program is inconclusive at this time. In a survey of 55 farmers, Balogun and Harrison (1989) found that major causes of seedling mortality were grazing and inappropriate selection of species. The survival rate of saplings after three years was 42 percent. The planting stage was found to be the critical factor affecting seedling survival.

In order to provide saplings with a better chance of survival, LAC and the field staff are placing more emphasis on village-based training. The goal of these training sessions is to encourage farmers to plant saplings in suitable areas, to dig holes of adequate size and to add compost to the hole at planting time. In addition, farmers are reminded to remove the plastic seedling bags when planting because seedlings are occasionally left in the plastic bags when they are planted in the field. This village-based training allows small-scale farmers and women to attend, as they would generally be unable to attend training sessions at LAC due to time constraints. During the hands-on training, villagers are asked to participate in the fields so they can remember the techniques. During training they are also given information on post-planting operations and their effects on sapling growth.

The farmers' choice of species leads to the production of a wide variety of seedlings varying by location, altitude, and even ethnic group. The timely availability of the seedlings is a major concern. The nurseries try to have saplings available early in the planting season to allow good seedling establishment before the dry winter season.

Discussion and Consequences

In government run nurseries the choice of species depends on the interests of government officials and the need to meet numerical targets, rather than on the farmers' needs. This leads the government nurseries to produce seedlings that are easily and quickly raised in large numbers -- not necessarily species preferred by farmers. Government nurseries emphasize community planting and are not involved in planting on private land. This is partially due to the farmers' belief that if trees are planted on private land, the whole site will be reclassified as government controlled forest. This belief has been countered in the LAC ECA by effective promotion by the field staff and extensive publicity about government forestry laws. However, it still persists in the minds of people in other parts of the country. This problem is a major factor impeding the expansion of planting on private land.

The government field staff and the local communities do not relate well due to a lack of contact. Field visits are rarely made by senior officers due to time constraints. Another problem is that the field staff are usually posted in areas entirely different from their own, and are unaware of the different social structure and ethnic conditions of the hills. These problems mean that there is very little chance of getting proper feedback from the farmers. Furthermore, the government field staff is usually not familiar with the local MPTS. This makes it unlikely they will raise seedlings of such species, given the lack of research information on these trees.

LAC's approach in the field receives more feedback, making it easier to orient extension towards farmers' needs. A good example is that until this year, 1989, Nepalese foresters have recognized only one variety of *Ficus semicordata*. Farmers have insisted that there are two distinct varieties, locally known as Rai khanyu and Khasru khanyu. They are actually quite different in their physical appearance and in phenological characteristics. Farmers say that Rai khanyu is a good fodder tree, while Khasru khanyu is not. Khasru khanyu is usually found at lower elevations of the mid-hills (up to 1,400m) whereas Rai khanyu is found up to 1,800m or sometimes higher. LAC has always produced Rai khanyu which is what the farmers want, whereas the government nurseries have usually produced Khasru khanyu. Khasru khanyu seeds are readily available and raising its seedlings is much easier.

In the same way, farmers have also identified two varieties of *Ficus roxburghii*. One is called Nimaro and is the preferred fodder for altitudes up to 2,000m. The other is called Totne which grows at lower elevations (up to 1,400m). Farmers use different production management systems for each type found on their land. Again, this is a difference not recognized by the government nurseries.

The LAC approach has had a significant impact on the number of seedlings produced and distributed. During the 1988/89 monsoon 342,000 seedlings were produced, 80 percent of which were MPTS. Of the total seedling production, 56 percent were distributed for planting on private land and the rest went for community planting (LAC 1989). This clearly indicates that private planting in the LAC's ECA is becoming increasingly popular. This contrasts with the government's program in adjacent areas which is almost completely oriented to community planting. The government field staff is unable to produce MPTS that people want, leading to a lack of interest in planting on private land. However, this could change if budgetary problems in the government system were resolved. At the same time, the focus of the field staff would need to change towards a mixture of community and private planting rather than on community planting alone.

Conclusion

LAC has found that the farmers' own knowledge can be successfully utilized in an MPTS extension program. Furthermore, this is necessary in view of Nepal's need to combat the over-exploitation of forest resources by planting more MPTS on private land. The present Government program is not oriented towards planting MPTS on private land. However, the program potentially could be targeted towards MPTS extension by adapting their field activities, with training to modify the field staff's attitudes.

Table 1. Commonly requested MPTS.

Botanical Name	Altitude (m)	Uses
Alnus nepalensis	800-2800	Timber, fuelwood, not good fodder.
Artocarpus lakoocha	Up to 1400	Good fodder, fruit, timber.
Cinnamomum spp.	Up to 1500	Spices, fodder. (Cash crop)
Dendrocalamus strictus	Up to 2000	Fodder, poor man's timber, furniture.
Erythrina arborescens	1200-2300	Fodder, hedge, ornamental.
Ficus roxburghii	Up to 2000	Good fodder, fruit for jam/whisky.
Ficus semicordata	Up to 1700	Good fodder, fruit, soil stabilizing plant.
Litsea polyantha	300-1400	Fodder, fruit, spice and medicinal value, tool handles.
Machilus odoratissima	1000-1700	Fodder, bark used as baking powder for making bread.
Michelia champaca	800-1800	Fodder, furniture.
Saurauia nepalensis	700-2300	Fodder, leaf used as eating plate.

Aspects of LAC's extension approach could be incorporated into the government's community forestry program and help to achieve the overall objective of the nationwide community forestry campaign.

Notes:

[1] A panchayat is the smallest political and administrative body in Nepal; divided into nine wards, it normally consists of a minimum of 3,000 people in the hill region.

[2] Kharbari: Marginal land where thatch grass is grown.

[3] Khet: Irrigated land (paddy) where more than one crop can be cultivated, generally located at lower attitudes.

[4] Bariland: Unirrigated rainfed land where maize, millet and barley are grown, located around the village at higher altitudes.

References

Abell, T.M.B. 1981. Fuelwood and fodder collection within the Koshi hills. *Koshi Hill Area Rural Development Project Report* 26:12.

Balogun, P.A.K. and A.P. Harrison. 1989. *Private fodder tree planting in the LAC Extension Command Area (ECA): a long term survey of trees planted in monsoon 1986.* LAC Technical Paper No. 21. Pokhara, Nepal: Lumle Agricultural Centre (LAC).

Hudson, J.M. 1987. Forestry research in Nepal up to 1986. *Banko Jankari* 1(2):3-14.

Jordan, C.F. and R. Herrera. 1981. Tropical rain forests, are nutrients really critical? *Nature and Resources* 17(2):7-13.

Kumar, K.S. and D. Hotchkiss. 1988. Consequences of deforestation for women's time allocation, agricultural production, and nutrition in hill areas of Nepal. *International Food Policy Research Institute Report*, p. 69.

Lumle Agricultural Centre. 1989. *LAC Annual Report.* Pokhara, Nepal.

Mahat, T.B.S. 1985. Human impact on forests in the mid-hills of Nepal. Ph.D. Thesis. Canberra: Australian National University.

Wood, A.W. 1979. The effect of shifting cultivation on soil properties: An example from the Karimin and Bomai plateaus, Simbu province. *Papua New Guinea Agricultural Journal* 30(1-3):1-9.

Wyatt-Smith, J. 1982. *The agriculture systems in the hills of Nepal: The ratio of agricultural land and the problem of animal fodder.* Agriculture Project Service Centre (APROSC) Occasional Paper No. 1. Kathmandu, Nepal.

Session 4: Orienting Research Efforts

Chairman: Kamis Awang

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Session Chairman: Kamis Awang

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It has often been lamented that the research programs of many of the forestry research institutes (FRIs) in the region do not directly address the problems of small-scale farmers. To rectify this, the researchers must first understand the problems and needs of these farmers. A clear understanding of farmers' problems and their needs requires a holistic approach drawing from disciplines in agriculture and forestry, human ecology and the social sciences. Designing research for the promotion of MPTS on small farms should include information from the collaboration of researchers, development officers and extension workers. New strategies would have to be adopted to realize these objectives including:

- a change in the orientation of funding agencies with regard to research on the problems of small farms;

- increasing emphasis on training social scientists locally;

- the establishment of a social science division at FRIs;

- officially recognizing small farm research and recommending scientists for awards;

- providing linkages and channels for feedback from the field;

- conducting more on-farm trials;

- promoting a network or association of forestry scientists, social scientists, development workers and extension staff;

- adopting a systems approach, with close interaction among natural and social scientists; and

- the development of a database of the forestry problems of small-scale farmers.

Various methods are available which can be used to gather appropriate information for planning research and development programs involving MPTS and small-scale farmers. These include Agroecosystem Analysis, Farming Systems Research, Rapid Rural Appraisal, Diagnosis and Design and the principle of Farmer First and Last. However, these need to be adapted to local conditions. Research priorities will vary depending on local needs. In the case of north Vietnam, where the land use policy has been changed recently in favor of individual farmers, MPTS research needs to identify appropriate species and focus on the management of small farms. The needs in Nusa Tenggara Timur, Indonesia, are quite different, where indigenous technologies are currently in use. The logical research focus there would be on further improvement of these technologies by introducing new MPTS of greater promise.

For relevance and easy adoption, research conducted at research stations and universities must be complemented by on-farm trials. Farmers' opinions and knowledge should be incorporated in research planning and implementation. In some respects, the farmers themselves can be the principal researchers. This is illustrated by the potential of barefoot tree breeders in Thailand where the combined knowledge of scientist and farmer can accelerate the improvement of MPTS.

While the improvement in technology will need to address the issues of enhanced productivity and adaptability, the issue of sustainability is becoming increasingly important. Therefore, research must not only stress short-term results, but attention should be paid to the success of projects in the long run.

Orienting Multipurpose Tree Species Research to Small Farm Needs

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Agricultural research for small-scale farmers has long been a topic of interest and debate, but research focusing on multipurpose tree species (MPTS) on small farms has been lacking. Constraints to increased MPTS research for small-scale farmers include traditions of forestry management, lack of incentives for research personnel and the low priority given for relevant research training. Recently, several institutions in Asia have successfully placed an emphasis on MPTS research for small farms. A synthesis of existing approaches for orienting MPTS research to the needs of small-scale farmers is presented.

Background

Forestry conservation, research and development have had a long history worldwide. Research has emphasized natural forest and plantation management, harvesting and utilization of forest products. Historically, the majority of the land under forest cover in many developing countries was owned and managed by the government with certain rights and privileges granted to the people to collect fuel, fodder, and a variety of forest products. The forest service was responsible for forest conservation and the extraction of wood for a variety of end uses. However, under a growing demand for wood and increasing population pressure, forest resources were overexploited, resulting in acute shortages of forest products in recent years. Small-scale farmers dependent on free resources were often the most affected, leading to the concept of social forestry. Yet research to meet the multiple wood, fodder and other tree-related needs of small-scale farmers has lagged far behind the need for solutions to these problems.

Improving the productivity and utilization of multipurpose trees was considered a priority in 1981 at the International Union of Forestry Research Organizations (IUFRO) World Congress. In 1984, at the Asia-Pacific regional workshop, organized by IUFRO, emphasis was placed on increasing the production of MPTS plantations. Among the high priority topics were low-cost building materials, utilization of plantation grown timber, lesser-known timber species, rubber tree wood, bamboo, rattan, palm stem, wood residues, and reducing wood residues.

In 1982 at the Forest Research Directors' workshop at the East-West Center in Hawaii, the five top ranked issues for the region were silviculture, ecology, reforestation, watershed management, hydrology and agroforestry. The same priorities were adopted at a subsequent workshop at the East-West Center to develop strategies for improving the effectiveness of Asia-Pacific forest research for sustainable development (Lundgren *et al.* 1986).

Social scientists in several institutions have conducted studies on forestry problems of small-scale farmers and their expectations. For example, research has shown acute shortages of fodder for livestock in many parts of South Asia. However, in India, most of these livestock have no economic value and are allowed to roam and graze freely but are important for cultural reasons. In such areas, it may not be economical to grow MPTS exclusively for fodder.

Many of these studies often fail to suggest solutions which are technically feasible and economically viable. Agronomic and forestry research often focuses on crop and wood production and is not often linked with social science and economic research. As a result, little research is oriented to farmer-relevant MPTS research problems.

It is clear that small-scale farmers can be encouraged to plant MPTS, provided the trees augment cash income. However, it is not easy for most of these farmers to plant non-fruit trees because of their low investment capacity, their inability to take large risks or to wait for several years without any interim source of income.

Research must concentrate on these constraints in an attempt to solve them in light of local traditions and socioeconomic conditions.

Constraints to Effective MPTS Research

A number of factors limit effective MPTS research on problems relevant to the needs of small-scale farmers. Forestry traditions in most countries can be traced back to the protection, conservation and management of public forest lands. This has generally meant a strong emphasis on the production of wood products from natural forests or industrial plantations. These traditions do not generally include a focus on the problems of small-scale farmers who produce and use MPTS for a wide range of wood and non-wood products and services. Forest services in many parts of Asia have made major advances in developing social forestry programs which begin to address less traditional forest management. However, research on small farm production and use of MPTS remains a low priority for most institutions.

The concept of forest research was developed in Europe and extended from there to other parts of the world. Many of the forest research institutions (FRI) in the developing world were established with the financial and technical assistance of the institutions in Europe, North America and Australia which still maintain links for training scientists in forestry. Overseas training, particularly in well known institutions, helps scientists from developing countries to establish their credibility and rise to high level positions after they return. It also provides an opportunity to learn modern research techniques.

Policies in effect in developing countries often give priority for overseas training to scientists specializing in advanced technologies. Studies which relate directly to the needs of small-scale farmers have not been emphasized. Under these conditions, the majority of scientists receiving training in production forestry continue such research when they return to their country. This work often is not focused on the needs of small-scale farmers, but is related to the technological tools and problems studied abroad.

Nor do national research priorities help to focus much research on small farm needs. Lundgren (1986) observed that with few exceptions, priority lists have been developed neither from a systematic analysis of development problems, nor from an evaluation of capabilities and needs of forest research institutions. Lists of research priorities or priority species tend to reflect the professional background and research interests of those who develop the list, rather than an analysis of small-scale farmers' needs.

The forestry research planning process often tends to overlook small farm needs. Bengston *et al.* (1988) describe three stages in the research planning process at forest research institutions: evaluating past performance, assessing future needs and designing the program to achieve the objectives. Small-scale farmers are seldom identified as major clients of forestry research during the needs assessment of most forestry research institutions. This is to be expected given the broad mandate of these institutions.

Methods for Orienting MPTS Research to Small Farm Needs

Effective MPTS research to meet the needs of small-scale farmers requires organizations which are capable of effective research on small farm problems. Bengston *et al.* (1988) attempted to define the research capability of a research institution as the ability to generate and adopt technologies. They identified 24 factors which influence research capability of which training, the stability of funding, political support, information services and coordination among researchers were considered more important than the interaction with users and social attitudes. Several indicators used by others to estimate the research capacity of institutions include the interaction between scientists, educational institutions and users, staff evaluation and incentives, and resources and support staff made available to the scientists.

Yet omitted from this definition was a critical component of research capability -- researcher motivation. While adequate facilities, equipment and operating funds are prerequisites for effective MPTS research, the most often overlooked resources for effective research are human rather than material. There are many examples of the presence of adequate infrastructure for useful research without much effective research taking place. There are also good examples of high-quality MPTS research carried out by highly-motivated individuals with limited facilities.

A number of strategies and methods can be employed to increase professional incentives and the personal motivation of MPTS researchers to work on small-scale farm problems. Most of the approaches which follow are found in one or another research institution, but are seldom all found in any given institution.

Increase Researcher-End User Interaction

Effective interaction between researchers and the various end users of the research findings increases the capacity of research institutions to carry out research relevant to local needs (Gregersen 1984). However, many forest research institutions do not have a formal field network to interact with end users. This is particularly true when the end users are farmers who live widely dispersed in rural areas and are generally unable to express their problems to appropriate authorities. Non-governmental organizations (NGOs) and small agricultural universities or colleges with farmer-oriented research mandates are often the most effective in maintaining close links with farmers.

On-farm research has long been used in agriculture for scientists to visit the field and interact with farmers. It also helps both scientist and farmer to modify the proposed techniques to match the site conditions. Therefore, on-farm trials should be given priority for funding and should be considered an integral part of the total research program.

Use Appropriate Expertise

Understanding the problems of small-scale farmers is extremely difficult due to their complexity. The problems vary with the extent of land holding, soil productivity, family size, and non-agricultural employment opportunities. As these problems are not directly related to forestry, it is difficult for MPTS scientists to design projects without the help of economists and social scientists.

This point can be illustrated with the problem of stray grazing. Approximately 90% of the livestock in India are allowed to graze freely on public land and there is an acute shortage of fodder. However, increasing fodder production is not necessarily the best response to solve this problem. It is first necessary to understand the pattern of livestock ownership, extent of land holdings, productivity of the livestock, and the cost of fodder production, all of which require the tools and inputs of economists and social scientists. Often, it may not be economically feasible to produce fodder, unless the goal of the farmers is to improve their livestock to increase production.

Encourage Reorientation of Funding Agencies

Funding agencies often set research agendas. Such agencies can shift their priorities to motivate scientists to work in new areas. So far, few funding agencies have emphasized the need to work on MPTS-related research opportunities for small-scale farmers. Increased emphasis on MPTS research by funding agencies would be helpful in encouraging additional research oriented to this important field.

Redirect Training Priorities

Training at international institutions is of great importance in promoting scientists' career paths. Such scientists approach a problem with new ideas, and view it with a wider perspective. They also build networks with international scientists and technology centers allowing them to strengthen their department, expand their area of research and provide more job opportunities based on their capacity to generate funding.

Generally, the government decides the priority of training areas, selects the scientists and arranges for their training. When government administrators decide that scientists should study overseas only to learn advanced technology, young scientists are discouraged from studying socioeconomic issues related to small farms. Equal training opportunities for scientists specializing in forestry, economics and social science would help develop a socioeconomic branch of forestry research.

Establish a Social Science Component

The complexities of the economics of small farm management and the needs and desires of farmers require special research tools. These tools are often found in the disciplines of the social sciences and economics. Clearly, projects and programs which include a distinct social science component, office or department are likely to provide better access to methods of rapid rural appraisal, social analysis, marketing, etc. than those which do not have such institutional structures. As an independent division, the scientists would be able to develop relevant research programs and interact with the foresters.

Recognize and Encourage Farmer Research

Farmers have been experimentalists long before the advent of professional agricultural research scientists. Many crop and fruit tree varieties, management and processing practices are the results of trial and error by farmers. MPTS research can be accelerated and improved by recognizing and encouraging research by farmers themselves. While this type of research provides little material for academic journals, it can be effective in determining ways of improving the lives of small farmers.

Increase Incentives for Small Farm Research

Researchers can be encouraged to direct their efforts to small farm MPTS problems by providing additional incentives. Research incentives commonly include increased travel and publication opportunities, promotion, awards or other forms of recognition. These external incentives for research can be provided by research administrators to encourage scientists to increase the quantity and quality of research on MPTS. However, there are internal motivations which are probably even more effective in orienting research to the needs of small-scale farmers.

These internal values include a sense of obligation to society, of duty, and of social justice. To work in farmer-oriented research for these reasons often provides great satisfaction to the scientist as a result doing a worthwhile job. Positive feedback from farmers when a research finding helps improve the quality of farm life or the approval of peers who recognize well-intentioned efforts are examples of the rewards of working with such noble motives. Such feedback also helps to strengthen the self-worth of those who seek to make research contributions for the benefit of society. Non-governmental service or development organizations which conduct research often include well-motivated individuals driven by altruistic motives.

Increase Communications Between Research & Development Personnel

There should be a formal link between the forest research organizations and the development and extension agencies, to facilitate better interaction and feedback. This can be done by nominating field officers to a research, planning and review committee of the FRI. In addition, the FRI can organize an annual meeting of scientists and development officers to facilitate technology transfer and to receive feedback from the field.

The Forest Research Institute in India introduced a novel approach by appointing senior officers from the state forest departments on a rotating basis to head various divisions at the Institute. These officers, with their rich field experience, would be able to guide the scientists working with them. However, this objective is difficult to implement in practice if the transferred officers lack interest in directing research programs.

Formation of scientific associations and networks has become very popular during recent years. However, the tendency is to narrow the membership to a few special interest groups. Instead of confining it to include only the scientific community or field workers, promotion of a combined network or association of forestry scientists, social scientists, development workers and extension staff would facilitate better communication and help in finding solutions.

Another effective program to provide opportunities for forest scientists to learn about village problems is to introduce a system of sabbatical leave at regular intervals of 5-10 years. Under this system, scientists would select a group of villages where they would spend 6-12 months studying basic problems and developing a proposal to solve these problems. Such proposals could be implemented by the social forestry department or through NGOs.

Conclusion

Research which is relevant to small farm MPTS production and use is lacking, even though interest in this topic has expanded dramatically over the last 10 years. Policies for forest protection and management, training and research priorities, and lack of incentives for farmer-oriented research have limited the amount of effective research on small farm MPTS problems.

The preceding discussion demonstrates the importance in motivating forestry scientists to go out in the field and interact with farmers, field workers, and social scientists to learn about the needs of the small-scale farmers. With adequate information and encouragement, scientists can effectively orient MPTS research to help solve small farm problems.

References

Bengston, D.N., H.M. Gregersen, A.L. Lundgren, and L.S. Hamilton. 1988. *Forestry Research Capacity in the Asia-Pacific Region*. Honolulu: East-West Center.

Gregersen, H.M. 1984. Forestry Research Planning and Evaluation: An International Comparison. In *Policy Analysis of Forestry Development*, pp. 157-171. International Union of Forestry Research Organizations.

Lundgren, A.L. 1986. *A Resume of Forestry Research Priorities in the Asia-Pacific Region*. Working Paper. Honolulu: East-West Center.

Lundgren, A.L., L.S. Hamilton and N.T. Vergara. 1986. *Strategies for Improving the Effectiveness of Asia-Pacific Forestry Research for Sustainable Development*. Workshop Report. Honolulu: East-West Center.

Rambo, A.T. 1984. Human Ecology Research by Social Scientists on Tropical Agroecosystems. In *An Introduction to Human Ecology Research on Agricultural Systems in Southeast Asia*, eds. T. Rambo and P.E. Sajise, pp. 39-60. College, Laguna: University of the Philippines at Los Banos

Improving the Effectiveness of Multipurpose Tree Species Research in Nusa Tengarra Timur, Indonesia

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Research programs in Nusa Tengarra Timur (NTT), Indonesia, focus on improving the living standards of the resource poor, small-scale farmer. Multipurpose tree species (MPTS) are an important component of these programs. Researchers need to fully understand the interactions within and between components and should not isolate specific components of the system. The farmer will analyze and synthesize the options presented to ascertain whether a technology is appropriate in his or her particular situation. The research program should assist the farmer in this process. Two major elements of identifying appropriate technologies include a complete understanding of the environment in the research program area and involving the beneficiaries in the evaluation of the program. Based on this approach, projects in NTT have developed sound crop/livestock farming systems with MPTS in agroforestry associations.

Background

Tree crops play an important role in the farming systems of NTT, Indonesia. Farmers manage a range of tree species in conjunction with food crops and livestock to increase the range of options in an environment where annual crop failure is common. Farmers are able to develop sustainable and stable farming systems when tree crops are integrated in the system. Tree crops can also enhance annual crop production.

Small-scale farmers are involved in several operations simultaneously. Research programs should be oriented towards understanding where MPTS can be incorporated into the system and which options are available as alternatives. Several approaches have been used to understand agricultural farming systems. Agricultural and forestry researchers involved in agroforestry research should be fully aware of these options.

Research and development programs in NTT are currently using these techniques to identify appropriate technologies for farmers. An examination of the farming systems of NTT, and the problems and constraints faced by farmers have been instrumental in developing appropriate technologies for the province. Examples of cases where MPTS have been successfully introduced into the farming system are discussed.

Methods of Orienting MPTS Research

Research programs that have evolved around existing farming systems have been useful in identifying appropriate technologies to improve farm production. Recently, programs have focused more attention on the farmer. Comparing the validity of technologies at the farm level has ensured that MPTS can be integrated into the farming system. Four approaches need to be considered. They are Agroecosystem Analysis, Farming Systems Research and Development (FSRD), Diagnosis and Design (D & D) and the principle of farmer first and last. One system should not be used to the exclusion of the others -- each system has similar components. A combination of the four systems will ensure that sound and appropriate MPTS recommendations are identified to benefit small-scale farmers.

Agroecosystem Analysis

The agroecosystem approach is the examination of the linkages between the environment and agriculture. Conway (1985a; 1985b; 1987) discusses the major components of the concept. The concept allows the researcher to differentiate between discrete regions or zones to focus the research program and facilitate the transfer of technologies. The system has four distinct properties to describe the essential behavior of agroecosystems: productivity, stability, sustainability and equitability. The process is generally descriptive and helpful in clarifying where the research program should be directed.

The strength of the concept is that the physical environment is comprehensively described, discussing more than soils or land units. It places the researcher in a position to examine integral aspects of the environment and how they influence farmers' decisions. The researcher is able to model the interactions between the environment, the farming practice and the impact of the technology. Agroecosystems are units of broad agroecosystem zones that use soils, climate, geomorphology and topography to identify and delineate subcomponents. The agroecosystem approach allows the researcher to identify specific technologies for the subcomponents of the agroecosystem zone.

Farming Systems Research and Development

FSRD involves the detailed examination of the farm. The concept is best summarized by Shaner *et al.* (1982:13),

> ... as an approach to agricultural research and development that views the whole farm as a system; and focuses on the interdependencies between the components under the control of members of the farm household and how these components interact with the physical, biological, and socioeconomic factors not under the household's control. Farming systems are defined by their physical, biological, and socioeconomic setting and by the farm families' goals and other attributes, access to resources, choices of productive activities (enterprises) and management practices.

Comprehensive reviews on FSRD methodologies provide the foundation for understanding the technique (Shaner *et al.* 1982; Remenyi 1985; Hildebrand 1986; Collinson 1987; CIMMYT 1988). The system provides a sound basis for analyzing the economic rationale to explain why a farmer makes a particular decision. The detailed economic analyses that accompany FSRD allow researchers to identify areas where research could be directed through *ex-ante* analysis. The economic studies coupled with a familiarity of the biological components of the system can quickly allow researchers to develop practical research programs. An important aspect of FSRD is that it is multidisciplinary where scientists operate as a team. This allows the group to examine the wide range of components that make up the average farming system.

Diagnosis and Design

D & D orients the research program towards fully understanding where MPTS can be incorporated into the farming system. D & D arose out of the International Council for Research in Agroforestry's (ICRAF) need to focus on the potential of agroforestry in the farming system. Raintree (1987a; 1987b) discusses the methodology in detail as "a methodology for the diagnosis of land management problems and design of agroforestry solutions." The key features of D & D are flexibility, speed and repetition.

The main advantage is linking agroforestry to the farming system. Care is needed to avoid a bias towards tree crops in the system, compared to other options the farmer may pursue. The *ex-ante* approach is intended to ensure that researchers place all options in their proper perspective.

Farmer First and Last

The end user must be consulted throughout the whole research and development (R & D) process. Without consulting the farmer the above methodologies will lead to researcher bias. Chambers (1983) and Chambers and Ghildyal (1985) have made researchers aware of the need to involve farmers in the R & D process. Resource rich farmers may be more responsive to the researcher's program but the needs of the small-scale, resource poor farmers must be the focus of the research.

Farmers involved in the research program will provide essential feedback to the researcher about the interaction of the introduced technology with the farmer's other activities, and what unforeseen benefits the system may be providing. In the initial stages of a research program to evaluate the use of tree legumes to increase soil fertility and animal production in NTT, farmers advised the researchers that the greatest benefit they saw in the system was the reduced weed buildup. This was more important to them than the need to increase soil fertility, which was not immediately apparent. This resulted in a redirection of the research program to use the tree crops to reduce weed competition in the garden.

Case Study

Incorporating MPTS into the Farming Systems in NTT

NTT is located in the Lesser Sunda Islands of eastern Indonesia. The province consists of the islands of Flores, Sumba, Alor and the western half of Timor. It is the poorest province in Indonesia, with a per capita income of Rp 251,720 per annum (Momuat and Husni 1988; US$1 = Rp1,770). Compared to the other islands of Indonesia, very little research has been carried out in NTT. The government's focus in the last five years to improve the living standards of the poorer eastern islands has increased development activities. Agriculture contributes 53% of the province's gross domestic product (GDP) with over 90% of the population depending on agriculture for their livelihood.

The techniques outlined above have been effectively used to identify where MPTS can be incorporated into the farming system. A broad outline of the existing farming systems in the region is discussed. Poffenburger and Suryanata (1987), Fox (1977), Metzner (1982), Carson (1989) and Momuat and Malian (1988) discuss the farming systems of NTT in more detail. As Raintree (1987) recommended we must fully diagnose the problem before we can design suitable research programs. This technique is used to highlight how appropriate MPTS based research programs have been identified for NTT.

Diagnosis

Environment - Physical, Social and Economic

Farming systems are determined by the climate. NTT is the driest province of Indonesia. Due to its proximity to Australia, the area has a dry season of 6-8 months, with low rainfall (800-1,500mm), and is generally considered a semi-arid environment. The southeast monsoons bring dry winds from Australia, precluding cultivation between April and November without irrigation. Most rains fall during the northwest monsoons. Rainfall variability between years and within seasons is high. Periods of drought during the growing season, sometimes lasting 2-3 weeks, are common.

The islands of NTT consist of the inner and outer Banda arc. The inner Banda arc islands are comprised of the volcanic islands of Flores and Alor. The outer islands of Timor and Sumba have formed as a result of the collision between the Banda arc system and the Australian continental shelf (CIDA 1980). The soils of the inner islands are predominantly volcanic and vary in fertility. Soils derived from volcanic ash have poor water retention capacity, which further exacerbates the soil moisture requirements of the crop. The islands of the outer arc consist of raised sea floor materials, ranging from marine mud to coral uplifts. The soils of Timor and Sumba are either highly calcareous or sodic as a result of their marine origin. This results in several soil nutrient deficiencies.

The islands throughout NTT have a very high proportion of steep, high terrain. Timor and Sumba are still being constantly uplifted at a rate of several millimeters per year, which predisposes the land to erosion. Mountains of over 2,000m are common. The combination of active uplift, seismic activity, a severely erosive climate and geological materials susceptible to erosion have led to continuous changes to the environment. The impact of humans has accelerated land degradation in several areas.

Wet season cropping forms the basis of the farming system, with maize being the principal crop. Rice is grown where irrigation is available or in areas with high precipitation. Several other crops are grown with maize to complement the diet and to provide a harvest if the maize crop fails. In some areas, maize may fail two years in five because of adverse climatic conditions or pests. Cassava, sweet potatoes, mungbeans, pigeon peas, peanuts and squashes are common intercrops.

A farmer will generally crop two distinct parcels of land. A housegarden is continuously cropped with a range of annual and perennial crops. The second area is the *ladang*, or cultivated field, where the bulk of the annual cropping takes place. The ladang is generally cropped for 2-3 years before being abandoned. In areas where land is not readily available a farmer may have to continuously crop only one parcel of land. In NTT, very few areas can sustain continuous cropping, therefore most farmers rotate their cropping locations. The swidden system was the traditional cropping system. However, increased population pressure has intensified cropping and resulted in the conversion of forested areas into grasslands.

Most produce is grown for subsistence use and crops are rarely sold, with the exception of certain legumes. Labor and seed are the only inputs in the system. Chemicals and fertilizers are either not available, are too expensive, or too difficult to apply. Only a few of the rice farmers use fertilizer. The infrastructure to assist in the supply of inputs and marketing of cash crops is rudimentary. Marketing systems operate to the traders' advantage, resulting in poor returns to farmers for cash crops. Formal credit systems are available but are rarely designed to allow a farmer ready access to the system. Informal credit systems may operate at interest rates of 20% per month, but are readily available to farmers. It is apparent that this system is not conducive to adding costly inputs.

The average population density is 60 people/km^2. However, some districts have only 19 people/km^2 while other districts have over 150. The average family has five members, of which three may be able to assist with on-farm activities. In areas where land is not a constraint, farmers have insufficient labor to undertake multiple activities. During the wet season, farmers are fully engaged in annual cropping. The dry season is the only time in which farmers can be involved in other activities -- the lack of water restricts the number of options available to a farmer. Farmers harvest tamarind (*Tamarindus indica*), candlenut (*Aleurites moluccana*), coffee (*Coffea* spp.) and lontar palm (*Borassus flabellier*) during the dry season. In most areas livestock range free. No inputs are supplied to the livestock system and animals are harvested when necessary. In some areas chickens and pigs are given supplementary feed (maize) and cattle are provided with fodder.

Farmers are primarily concerned with producing sufficient food during the wet season for household needs. Excess production is a bonus, which allows the farmer the opportunity to purchase livestock or tree crops. Crops that compete with the main food crops are not widely accepted, even though farmers can significantly increase returns and subsequently purchase rice or maize. Self sufficiency is the key. Crops that are supplementary or complement the annual crop are readily adopted.

Problems and Constraints

Crop yields are low, with average maize and rice yields of 0.8 and 1.0 t/ha, respectively. Plants are often exposed to periods of moisture stress during the growing season. Inadequate soil moisture at establishment or flowering can significantly depress yields. Crop nutrient requirements are often not met, with cereal crops often suffering from nitrogen deficiency.

Land preparation is labor intensive in permanent cropping areas and requires over 100 man days to cultivate one hectare. Swidden cropping areas require less labor for preparation, but total inputs depend on the type of vegetation that has colonized the garden during the fallow. Grassland fallows are more labor demanding than perennial weed fallows with respect to land preparation. Weeds dictate the area a farmer can effectively crop. Field (unpublished data) found that maize yields can be depressed by over 50% if weeding is delayed more than 21 days. Farmers abandon cultivated fields after two years because of the impossible labor demands required for weeding. Fertile alluvial plains are often neglected for the same reason and *Imperata cylindrica* is a major reason for the abandonment of cropping areas. Once a crop has been planted, a farmer will spend the first sixty days of the wet season controlling weeds, leaving very little time for other farm activities.

In a 120 day growing season, the first sixty days are spent on annual cropping activities. The staple crops have very few pests and diseases. In livestock raising areas, fields need to be protected from pigs, cattle and goats. Fencing can take up to a third of the labor required for wet season cropping activities (Ormeling 1955). If fields are not adequately protected, cattle can destroy a crop in one night. Materials for fencing are becoming a scarce resource, as trees are not regenerating.

Livestock provide opportunities for farmers to generate income. Goats and cattle range on extensive grassland "commons" throughout NTT. The rangelands represent a free resource that is readily exploited. In some areas, overstocking has led to insufficient feed for animals to survive, let alone gain weight. The inadequate feed base has reduced overall animal production in some areas. In other areas, feed is freely available and animal numbers can significantly increase. Livestock are unevenly distributed with some individuals owning over 1,000 head. Farmers with only one or two animals are unable to make a sufficient return on their investment as animal production is poor.

Increased cropping pressure and livestock populations have increased land degradation. Erosion is common because of continuous farming, especially on areas where slopes exceed ten percent. Soil/water balances have been modified, with decreased infiltration of rainfall. Rivers are raging torrents during the wet season and dry up during the dry season. The infertile, non-volcanic soils are not conducive to terracing (Carson 1989). At the current rate of land degradation, existing farming systems are not sustainable over time.

Land ownership is variable. Farm size varies between 0.05-30$^+$ ha with an average area of less than 1ha. Farmers who have insufficient land are forced to continuously crop the same parcel with annual crops. Diverting land to non-food crops will result in less land being cropped to maize and other essential food. Perennial crops will displace annual crops for space and compete for critical resources. The tradeoff between producing food now and increasing income in the future is a difficult decision for a farmer, especially if sufficient land is not available. If land is available, farmers who plant tree crops may have to divert limited resources (labor and capital) away from annual crop production. The tree crop at establishment may have to be watered and protected from pests and diseases.

In areas where population densities exceed 100 people/km², energy for cooking is scarce. A considerable amount of time can be spent gathering fuelwood. When farmers have to purchase fuelwood it can become a significant household expenditure. As forests are replaced by grasslands, farmers have to resort to materials that are less combustible and use greater quantities to produce the same amount of energy.

MPTS Based Farming Systems in NTT -- Sikka, Amarasi and Roti

In NTT, several innovative farming systems have been developed by farmers to overcome the above constraints and assist in stabilizing production. Examination of these systems is necessary to identify possible approaches to resolve the many problems farmers have to confront. In some systems MPTS have played an important role in improving the farming system. Three such systems are briefly discussed -- the integrated crop and livestock system of Amarasi, the conservation farming system of Sikka, and the perennial tree crop system of Roti.

The Amarasi system involves the planting of tree legumes (originally *Leucaena leucocephala*) in the cropping areas. The system was developed in the 1930s by the Raja of Amarasi to control erosion and assist in eradicating the weed *Lantana camara*. Over time, the district was forested by *L. leucocephala*. Farmers realized that the tree legume forest mimicked the traditional swidden system. The legume improved soil fertility, reduced the fallow period, reduced weed buildup and decreased the time required to prepare a garden. Crop yields improved. Farmers required less land for annual crops and began to plant bananas to complement production. Cattle were tethered and fed *L. leucocephala* which reduced the need to fence and protect crops. Farmers fattened up to three animals per year. Farmers became less dependent on annual crops as income increased and planted perennial tree crops in the cropping areas. The increased diversity of the farming system stabilized production. Jones (1983), Metzner (1981; 1983), and Piggen and Parera (1984) discuss the system in detail.

Unfortunately, in 1986, the pest *Heteropsylla cubana* descended on Indonesia. Although *L. leucocephala* has been decimated, the system needs to be considered as an approach that integrates MPTS into the farming system. The legume did not disrupt the traditional system but acted as a catalyst to allow farmers to move out of the annual cropping cycle into a more diverse farming system. It must be stressed that the system depended on one crop, and with the loss of this major input, the system collapsed. Several tree legumes are needed to insure against the loss of an integral component.

The Sikka system is widely used throughout the tropics as a method to control soil erosion. This involves the planting of *L. leucocephala* along the contour. The tree forms a barrier, which holds back the soil and over time produces a terrace. This system stabilizes yields by reducing soil losses while the legume adds nitrogen to the system. Farmers are able to continuously crop the same area, reducing the need to shift to a new cropping site. Excess wood is sold for firewood, significantly improving farm income. Livestock are fed fodder from the tree. Less dependence on annual crops resulted in farmers planting a few perennial crops, further stabilizing production. Metzner (1976; 1982), Piggen and Parera (1984), Parera (1980; 1982a; 1982b) and Cunha (1982) discuss the system in detail. *H cubana* decimated *L. leucocephala* in 1986 and has resulted in the destruction of the terraces as the trees died out. Farmers are planting a range of alternative tree legumes to replace *L. leucocephala*.

The island of Roti is located near Timor. Rainfall is highly variable, ranging between 500-1,000mm. Annual crops are sorghum, mungbeans and pigeon peas. Lontar (*B. flabellier*), a palm, is the focal point of the farming system on the island. Farmers harvest a sugary juice during the dry season. The palm can produce up to 600 liters per year (Fox 1977). The juice is a major component of the diet and can be stored as a syrup for over a year. The juice is also fed to livestock. The palm is neither planted nor nurtured, as it easily propagates itself. Fox (1977) discusses the system in detail. The major aspect of the system is that tree crops supplied with zero inputs can significantly increase on-farm income.

Design

Based on the detailed understanding of the farming systems of NTT, research programs are identifying where improvements to the system can be made and implemented.

The Amarasi system has been used as the foundation for improving crop/livestock farming systems. Modifications are required for different areas. Several tree legumes are incorporated into the system depending on farmers' preferences and their suitability to the environment. Field (unpublished data) has discussed how legumes can be included in the farming system without suppressing wet season crop production. Legumes that are fast growing, tolerate burning and regular coppicing, are palatable to cattle and easily established by seed are recommended. Examples include *Acacia villosa*, *Calliandra calothyrsus*, *Gliricidia sepium*, *L. leucocephala* varieties resistant to *H. cubana*, and several *Albizia* and *Flemingia* spp.

Sesbania grandifolia is not suitable in large quantities because it can not tolerate pruning and at high densities may compete with the food crops. However, *S. grandifolia* is an excellent fodder and is used as a vegetable. The tree should be randomly scattered throughout the cropping area and harvested when necessary. Farmers will decide how many plants they need in their cropping area.

The legumes are planted in rows 2-4m apart, and the food crops are planted between the rows. The legumes are allowed to develop into a forest. Cropping intensity determines the length of the forest fallow. The longer the fallow, the greater the build up of soil fertility and the subsequent reduction in weed seed reserves. The legumes are planted in 2-4m alleys to allow the trees to develop a dense canopy immediately after harvesting the maize. The trees will shade out weeds and increase the amount of biomass produced for livestock fodder and as a green manure.

The tree legumes have to be regularly coppiced during the cropping phase to reduce competition with the annual crop. Oe Maten (1986) has demonstrated that by pruning the legume to ground level prior to planting and twice during the cropping phase, competition can be reduced. In some cases the pruning may increase labor inputs. Pruning to ground level before planting allows the farmer to easily cut back the regrowth at 25 and 50 days after planting during normal weeding activities.

Field (1987) found that for each kilogram of *L. leucocephala* leaf added to the soil, maize yields were increased by 0.24kg. The wood produced by the legume becomes a haven for pests (rodents and the giant African snail *Achatia fulica*) if left in the garden. Farmers either burn the wood on-site or sell the wood for fuelwood if possible. The legume selected and the recommended management system will depend on the farmer's preference, needs and capabilities. Recommendations to farmers should not be too rigid, but broad enough for the farmer to make the best decision. As long as the extension officer is supplied with adequate information he/she can assist the farmer in the decision making process.

Tree crops that require minimal inputs are recommended throughout NTT, similar to the lontar system in Roti. Care must be taken when introducing tree crops into the farming system. Farmers are concerned that the trees may compete with the annual crops, reducing potential yields. Trees that can be pruned to minimize crop competition are readily adopted.

As their dependency on annual crops diminishes, farmers may utilize their available land for other tree crops. *Cassia siamea*, *T. indica*, *Coffea canephora*, *A. moluccana* and *Cocos nucifera* are grown by farmers throughout NTT similar to the lontar palm. The trees are not supplied with any inputs and readily establish themselves in a number of environments. Farmers are able to harvest the crops when necessary and trading systems have developed to facilitate the sale of the crops.

As chemical inputs become available the farmer can improve the productivity of the crop. Most tree crops respond to fertilizer and farmers are able to make use of this opportunity as their income increases. Identification of tree crops for the range of agroecosystems throughout NTT is currently being undertaken by a number of projects. The initial program is evaluating tree crops in a zero input, negligible management system. Suitable tree crop varieties and species under this management regime will be distributed to farmers. Farmers will decide which crops they prefer to grow.

Establishment of tree crops in non-cropping areas is difficult. Livestock, fires and weeds reduce the success rate of planting trees in the grasslands. Areas that are cropped with annual crops provide the best site to establish tree crops because they can be protected during the establishment phase. The annual crop may compete with the tree crop in the first year but this will be a negligible setback in the life of the tree. As farmers abandon the fields, the trees can be protected from fires, weeds and livestock.

Conclusion

Farmers are the key to a successful research program. Ignoring the farmers will lead to the recommendation of inappropriate technologies. The end users of the research will decide whether a technology is appropriate. Small-scale farmers will adopt MPTS as existing farming systems have demonstrated. Tree crops should not be recommended based on only one aspect of the farming system. Suggesting a tree species solely for fuelwood will gain less acceptance when compared to a tree that has been demonstrated to have a multitude of uses that complement the existing farming system. MPTS that fit into the farming system and improve productivity are actively sought by farmers.

Care must be taken to avoid restricting the options available to a farmer. A range of tree crops should be recommended so that the displacement of one species by pests or diseases does not lead to the collapse of the system. The case of *L. leucocephala* in NTT is a classic example of placing too much emphasis on only one species. Tree crops add another dimension to the intercropping system. In a situation where several crops interact a variety of solutions will be appropriate. Farmers' experience will be an important factor in ascertaining the best mix. Interactions depend on a number of factors including climate, soil, crop varieties, etc. By being aware of the possible interactions, farmers' needs and capabilities, the researcher can design trials that are compatible with the farming system. Without consultation, important and essential aspects of the overall system will be overlooked.

References

Canadian International Development Agency. 1980. *Timor Island: Water Resources Development Study*. Directorate General of Water Resources. Jakarta: Crippen International Ltd.

Carson, B. 1989. *Soil Conservation Strategies for Upland Areas of Indonesia*. Occasional Paper No. 9. Honolulu: Environment and Policy Institute, East-West Center.

Chambers, R. 1983. *Rural development. Putting the last first*. Essex: Longman Group.

Chambers, R. and B.P. Ghildyal. 1985. *Agricultural research for resource poor farmers: a parsimonious paradigm*. Discussion paper. Brighton: Institute of Development Studies.

CIMMYT. 1988. *From agronomic data to farmer recommendations: an economic training manual*. Revised edition. Mexico, D.F.: Centro Internacional para el Mejoramiento de Maiz y Trigo.

Collinson, M.P. 1987. Farming systems research: procedures for technology development. *Experimental Agriculture* 23:365-386.

Conway, G.R. 1985a Agroecosystem analysis. *Agricultural Administration* 20:31-55.

_____. 1985b Agricultural ecology and farming systems research. In *Agricultural Systems Research for Developing Countries*, ACIAR Proceedings No. 11, ed. J.V. Remenyi, pp. 43-59. Canberra: Australian Center for International Agricultural Research.

_____. 1987. The properties of agroecosystems. *Agricultural Systems* 24:95-117.

Cunha, I. 1982. *The process of "leucaenaization" in Sikka District* (in Flores Island-Nusa Tenggara Timur Province). Nita, Sikka, Nusa Tengarra Timur, Indonesia: Institute of Social Research and Development.

Field, S.P. 1987. *Report on the Food Crop Experimental Program for the 1984-85 wet season*. Kupang, Indonesia: Indonesia - Australia NTT Livestock Project.

Fox, J.J. 1977. *The Harvest of the Palm: Ecological Change in Eastern Indonesia*. Cambridge, MA and London, England: Harvard Press.

Hildebrand, P. 1986. *Perspectives on farming systems research and extension*. Colorado: Lynne Riener Publishers.

Jones, P.H. 1983. Leucaena and the Amarasi model from Timur. *Bulletin of Indonesian Economic Studies* 19:106-112.

Metzner, J.K. 1976. "Leucaenaization": an experiment in soil conservation. *Bulletin of Indonesian Economic Studies* 12:103-109.

_____. 1981. Old in the New: Autochthonous Approach Towards Stabilizing an Agroecosystem - The Case from Amarasi (Timor). *Applied Geography and Development* 17:1-17.

_____. 1982 *Agriculture and population pressure in Sikka, Isle of Flores*. A.N.U. Development Series Monograph No. 28.

_____. 1983. Innovations in Agriculture Incorporating Traditional Production Methods: The Case of Amarasi. *Bulletin of Indonesian Economic Studies* 19:94-105.

Momuat, E.O. and H. Malian. 1988. *Prospects and challenges of dryland farming systems in areas with a dry climate*. Lokakarya Penelitian Sistem Usahatani, December 14-15. Bogor: CRIF, Lokakarya.

Oe Maten, S.S. 1986. The effect of Leucaena pruning on maize production planted between the Leucaena. Student Thesis. Kupang, Indonesia: UNDANA.

Ormeling, F.J. 1955. *The Timor Problem: a geographical interpretation of an underdeveloped Island*. Djarkarta, Groningen: J.B. Wolters.

Parera, V. 1980. "Leucaenaization" in Sikka District. *Leucaena Newsletter* 1:13-14.

_____. 1982a. Giant lamtoro in the land of the trees. *Leucaena Newsletter* 3:44.

_____. 1982b. Leucaena for erosion control and green manure in Sikka. In *Leucaena Research in the Asian Pacific Region*, pp 169-172. IDRC Proceedings. Singapore: International Development Research Centre of Canada.

Piggen, C.M. and V. Parera. 1984. The use of Leucaena in Nusa Tengarra Timur. In *Shrub legumes in Indonesia and Australia*, ed. E.T. Craswell and B. Tangendjaja, pp. 19-27. ACIAR Proceedings No. 3. Canberra: Australian Center for International Agricultural Research.

Poffenburger, M. and K. Suryanata. 1987. Systems of Agricultural Production in Bali and Nusa Tengarra. In *The Agriculture of Indonesia*. Oxford, England: Oxford University Press.

Raintree, J.B. 1987a. The state of the art of agroforestry diagnosis and design. *Agroforestry Systems* 5:219-250.

_____. 1987b. *D & D users manual. An introduction to agroforestry diagnosis and design*. Nairobi: International Council for Research in Agroforestry.

Remenyi, J.V. 1985. *Agricultural systems research for developing countries*. ACIAR Proceedings No. 11. Canberra: Australian Center for International Agricultural Research.

Shaner, W.W., P.E. Philipp, and W.R. Schmel. 1982. *Farming systems research and development*. Boulder, Colorado: Westview Press.

Small Farm Multipurpose Tree Species Research in the Philippines: Methods, Issues and Institutions

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As in many parts of the tropics, farming in upland or mountainous areas in the Philippines presents many challenges to policy makers, development planners and scientists. In response to this, the government has embarked on a massive social forestry program emphasizing agroforestry as the key technical component.

A major obstacle to the adoption of agroforestry is a lack of site-specific, sustainable production systems. In alley cropping, the most popular agroforestry system, only one or two woody perennial species are being used for hedgerows. This severely limits the options available to farmers as well as exposing the farm to possible ecological disasters such as the recent psyllid infestation of Leucaena.

The primary purpose of this paper is to outline a research methodology to promote the adoption of multipurpose tree species (MPTS) and agroforestry systems by upland farmers, consistent with the ecological and socioeconomic realities in the Philippines. In addition, issues and institutions involved in MPTS research are discussed. Most of the discussion centers around agroforestry because of the widely held belief that the primary application of MPTS today is in agroforestry.

Any concrete research strategy must deal with the realities of the Philippines and not with idealized conceptions. Two key constraints affecting agroforestry and MPTS research are the urgency of achieving rapid results with limited available resources.

The Issue is Survival

Of a total land area of 30 million hectares, approximately 12 million hectares of the Philippines is considered forest land. Of these, more than 4 million ha are estimated to be under some form of cultivation (Celestino and Elliot 1986). About 18 million Filipinos of a total population of 60 million live in the uplands (areas with slopes greater than 18%) of which half are dependent on agriculture. By the turn of the century, the upland population is expected to double if present trends continue (Cruz and Zosa-Feranil 1987). This has caused a host of adverse on-site and off-site impacts including the loss of soil resources, declining productivity, flooding, sedimentation of water systems, poverty, and political unrest.

To address these problems, the government created a social forestry program. By the end of 1987, it encompassed more than 500,000ha with 200,000 families as beneficiaries (FMB 1987). The program involves giving farmers the right to stay on the land for 25 years, renewable for an additional 25 years. In return, the farmers are required to practice some form of agroforestry and other soil conserving measures. By law, the beneficiaries are required to plant only 5 trees per hectare. Social forestry officers are supposed to provide technical assistance to the farmers. This is where another set of problems begins.

Many social forestry technicians barely know what agroforestry really is. At best it is equated with alley cropping, known in the Philippines as SALT (Sloping Land Agricultural Technology). This was illustrated at one of the training sessions conducted by the author for social forestry officers. During the open forum one of the participants admitted to stopping a farmer from practicing something which he now learned was a form of agroforestry! On the bright side, the lack of training is currently being addressed by a nationwide training program for social forestry technicians.

The second problem is just as serious. There are actually very few site-specific, sustainable agroforestry systems available to the farmers. As a result, most government projects rely on alley cropping, which in itself is a good technology, but it has its limitations. Its ability to conserve water remains doubtful. On the basis of studies conducted in the Philippines (Cuevas and Samson 1982; Tepatiya 1984; Lasco 1987) it seems that its ability to reduce runoff is not as effective as its ability to conserve soil. This implies that large-scale adoption of alley cropping in watershed areas may not necessarily lead to improved water conservation.

Only one or two species are currently being cultivated in hedgerows, leaving them vulnerable to pest and disease epidemics. This recently occurred when hedgerows of *Leucaena leucocephala* were suddenly defoliated by the psyllids. Alley cropping is, however, preferable to shifting cultivation but it should not be the ultimate agroforestry technique. A promising strategy is to use alley cropping as a stop-gap measure to immediately arrest soil degradation. After that, work would continue slowly toward a predominantly perennial multistorey system. There are a number of existing multistorey systems in the Philippines (Lasco 1988) but these are usually practiced over a very small area and little pilot testing on a site-specific basis is being conducted.

The point the authors wish to highlight is that the social forestry program is going full blast but the technical pillar on which it is founded is wobbly at best. It is a classic example of putting the cart before the horse.

What does this imply for agroforestry and MPTS research? First, it demonstrates that a massive undertaking is necessary to generate research results to backstop the current drive of the government to promote agroforestry. The development of MPTS-based agroforestry systems is a matter of survival for the Philippines. It is a race against time. Second, any research program must be able to produce practical results in the shortest possible time. The cart is going at full speed, and the horse must catch up or there will be disastrous consequences.

MPTS Research in the Philippines

The use of multiple purpose trees is not new. However, as a distinct focus of research efforts, the study of MPTS is very recent. A search of the literature revealed that there are few publications dealing specifically with MPTS in the Philippines. The authors realize that all trees are endowed with a variety of uses. However, some trees demonstrate more potential to meet the needs of small-scale farmers. When identified, these trees should be studied for their usefulness on small farms.

Available Resources Are Very Limited

Research support in the Philippines is very meager in all fields of study. Few research projects are implemented each year. Adequate manpower trained to conduct agroforestry research is also lacking. This is understandable as agroforestry is a new discipline.

With the present economic difficulties in the Philippines, there is very little chance that the situation will improve significantly. Thus, any program designed to promote agroforestry research must also operate within the limits imposed by the resources available. In other words, it must be able to produce results that are immediately useful on a shoestring.

Small Farm MPTS Research

Studies conducted on MPTS have focused only on a few species. *L. leucocephala* is the most studied, with research ranging from its cultural practices (Mendoza and Bagalayos 1977; Racelis and Bagalayos 1977) to its socioeconomic usefulness (Diaz 1981; Esteban 1981; Moog 1981). To a much lesser extent, other species like *Gliricidia sepium* have been investigated or recognized as having a number of uses (Perino 1979; Cadiz 1979; Reyes 1979).

In terms of the usefulness of MPTS on small farms, there are fewer studies. A limited number of research projects focused on the use of these species as hedgerows in alley cropping. Again, *L. leucocephala* received the greatest attention prior to the psyllid infestation. Studies were conducted on the effect of MPTS hedgerows on soil and water conservation (Cuevas and Samson 1982; Tepatiya 1984; Lasco 1987) and yield and farm income (Pacardo and Samson 1981; Tacio *et al.* 1987; Lasco 1987). Since the psyllid outbreak, research and testing activities have focused on alternate hedgerow species. At present, the author is conducting on-farm and on-station trials of other potential MPTS hedgerows. In the field, *G. sepium* is the most commonly used substitute for Leucaena.

Research Methods

With few exceptions, a review of completed and on-going studies on MPTS and agroforestry will show that most of them employ research station resources and methodologies. This means adequate material and labor inputs are provided on ideal site conditions. Experience in the agricultural sector demonstrates that results generated on research stations are often vastly different from the actual performance on the farm (Gomez *et al.* 1985). This raises the question of research result relevance to actual farm conditions.

The usual solution is to pilot test the technology in different areas. This is seldom being done for agroforestry at the moment (Fernandez and Serrano 1988). Pilot testing is a long, slow process. The extension agents must be aware that new technologies are being tested and developed by researchers. Publication of data is another bottleneck because of a lack of journals dedicated to agroforestry research.

If the extension agents are aware of a particular technology, they must have evidence that it is applicable to their area. For example, if researchers found that coffee grows well under *Pterocarpus indicus*, the extension agents may not be interested because *P. indicus* is not grown in their region. If they believe the technology may be applicable to the area, the question is how to make use of it. Immediately disseminating it to the farmers may be unwise because it might not work. If the agents are resourceful, they will pilot test the technology, but this may take several years to complete. The result is that it takes a very long time for research results to reach the target clientele.

In addition, research commonly concentrates on a narrow focus. One study may deal with spacing, while another may focus on pests and diseases. The simplicity of this method lends itself well to statistical analysis and easy interpretation of results. However, this tends to make the research process very time and resource consuming. It takes so much time for one project to determine the proper spacing of trees, and another to determine the proper combination of agricultural crops. This is especially true if the studies are not conducted simultaneously in the same geographical area, the actual situation worldwide.

To cite an example, agroforestry research in the Philippines was formally begun in 1982 with the creation of the Agroforestry and Plantation commodity section of the Philippine Council for Agricultural Resources Research and Development (PCARRD). Since then, only six studies have been completed under PCARRD's nationwide network (Fernandez and Serrano 1988). At the moment, there are more than 30 on-going studies in the network and several others outside the network. Considering the diverse geographic and socioeconomic characteristics of the Philippines it is doubtful whether these studies could be of immediate benefit to the farmers.

Alley cropping and many other agroforestry systems employed in the Philippines were developed either by the farmers themselves or by non-governmental organization (NGOs). Many scientists are simply documenting these systems or determining the effect of these technologies on the site. This is a positive step forward if the goal is to improve the systems or determine the potential of the technology in other areas. If it is done solely for knowledge's sake then little is contributed to the development and spread of agroforestry systems.

In light of the fact that we are racing against the clock, the current research methods are not responsive enough. There is a need for a reevaluation to design a research system that will satisfy the present realities. That is, a research method to produce results in the near-term that can be implemented without straining institutional budgets.

Research and Development Institutions

Institutions involved in agroforestry in the Philippines can be classified into three types. The first group is composed of funding institutions, either national or international. Examples of these include the Department of Science and Technology (DOST) and its affiliate agencies such as PCARRD, Winrock International and the Ford Foundation. They are very influential as they determine the direction research will take by choosing projects to fund. In general, they do not conduct the actual research, but provide monitoring and evaluation of the research they support.

The second group conducts research on agroforestry. This is primarily the responsibility of the Department of Environment and Natural Resources (DENR) through the Ecosystems Research and Development Bureau (ERDB) and its regional offices.

The third group is composed of universities and colleges which perform research as well as instruction and extension work. They are scattered throughout the 13 regions of the Philippines. They receive support from the funding agencies in addition to providing their own research budgets.

Development agencies include the DENR and the Community Environment and Natural Resources Office (CENRO) which disseminate agroforestry technology to upland farmers. There are growing numbers of NGOs dedicated to improving the conditions of upland farmers as well as enhancing ecological stability. Recognizing this, the DENR is collaborating with them to promote agroforestry. Typically, the DENR awards contracts to NGOs for the development of upland areas. To a much lesser degree, the Department of Agriculture (DA) is also involved in upland development work. A close look at these institutions reveals two problems.

First, there is little interdisciplinary or inter-institutional cooperation. Most of the agroforestry and MPTS research is being conducted by forestry units/agencies. In general, other agencies such as agricultural research institutions are not involved. This is unfortunate considering that agroforestry involves not only trees but farming as well.

Second, development institutions are not involved in research planning and implementation. Research projects are often conceived and implemented by research institutions. Development institutions may cooperate by providing a suitable site but little else. Thus, the people who are in actual contact with the farmers are not part of the process that determines the direction of technology development.

Proposed Research Methodology

In view of the preceding review of existing realities in the Philippines today, a general research methodology has been designed to operate within those constraints.

Site specific

Because of the varied ecological and socioeconomic conditions in the uplands, a technology developed in one area may not necessarily apply to others. In a traditional research program, technology development is usually followed by pilot testing. However, as mentioned earlier, there are very few pilot tests actually being conducted. To accelerate the research process it is essential that numerous site-specific studies be conducted simultaneously throughout the Philippines.

Operable within the existing financial constraints and institutions

Any proposal that demands a huge financial outlay would likely remain only a proposal. Drastic institutional changes would be very difficult at this time.

Able to produce results in the shortest possible time

A "fast track" research method is essential to catch up with the large-scale implementation of the social forestry program. This will not replace the traditional "slow track" research efforts, rather it should parallel the established research efforts. The latter could generate information that would serve as inputs for the former. However, because of the very limited research results generated up to this point, it is expected that the fast track research will have to rely on technology already developed by farmers and NGOs working in the area.

In the process of producing rapid results, a certain degree of scientific accuracy may have to be sacrificed. As long as the technology developed is useful to the farmers and enhances environmental sustainability, it seems to be a small price to pay. To achieve useful results, a variety of people from several disciplines and institutions should be involved to address all key issues in the developed technology.

On-farm research is a priority and farmer's participation must be mandatory

On-farm research with farmer's participation is a recent development in agricultural research. This approach has been tested by a number of institutions in the Philippines since the early 1980s. The method arose out of the realization that research station findings can not be directly applied to actual farms owing to a different set of conditions (Gomez *et al.* 1985). The adoption of the potato for lowland cultivation is one research area where this approach has shown great promise (Rhoades *et al.* 1985). Agroforestry is a farming system, therefore on-farm research and farmers' participation in the research process will help ensure that research findings are appropriate for the site and the needs of small-scale farmers.

Simplicity

The research method should be easy to understand and must not require sophisticated instruments or a long training period. This is necessitated by the need to keep expenses to a minimum.

Description of the Proposed Research Method

To achieve the above goals in agroforestry and MPTS research in the Philippines, it is vital that research efforts be decentralized and integrated into the front line of the social forestry program. Research must be a basic component of the activities of social forestry officers.

The CENRO offices which are scattered throughout the country should take the lead for two reasons. They are the people who are actually engaged in technology dissemination to small-scale farmers. As such, they presumably have the most detailed understanding of the conditions in the area and the strongest desire for the undertaking to succeed. They have financial resources to establish demonstration farms and extension activities.

At the same time, both universities and research agencies are located throughout the country. Researchers at these institutions can often handle more studies than their budgets allow. It would be most advantageous to them if they were given a chance to do research by superimposing their studies on the CENRO demonstration farms and the farms of social forestry participants.

Sequence of Activities

To activate the proposed research method, a recommended sequence of activities is presented in Figure 1.

Characterization of the CENRO area of responsibility

This involves the ecological and socioeconomic characterization of the area by the team. To economize, secondary sources of information should be utilized. The CENRO offices will have most of this information available.

Division of area into similar ecological zones

In certain cases there may be significant differences in site conditions across the area in soils or microclimates. The team should delineate the areas with similar site conditions. Each of these areas would have the same technology recommendations.

Identification of major agricultural production systems

This could be carried out either by structured or unstructured farm surveys depending on the resources available. Some of this information may already be available in the CENRO offices.

Identification of major problems, constraints and potentials of production systems

The major problems and constraints will become the focus of the technology development. The potentials should be fully exploited to improve

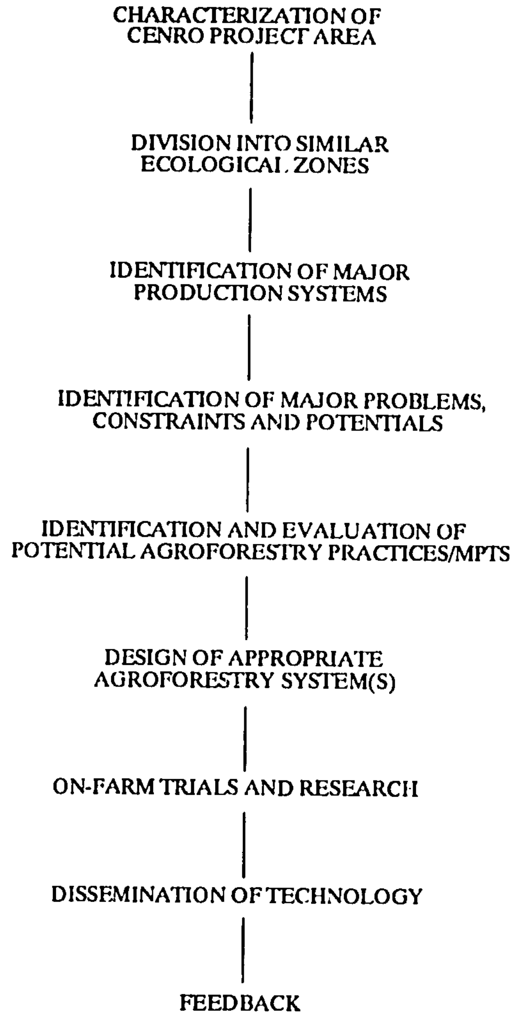

Figure 1. General sequence of activities in the proposed agroforestry and MPTS research method.

present practices.

Identification and evaluation of existing agroforestry systems and MPTS in the area

In addition to identifying major production systems, the team should pay special attention to existing agroforestry practices and MPTS. This is vital for two reasons. First, because very few agroforestry systems have been tested by specific CENRO offices. Second, most of the agroforestry systems in use were developed by the farmers themselves. The research team must therefore be on the lookout for indigenous agroforestry practices.

Design of appropriate MPTS-based agroforestry systems

Based on the primary information gathered from the area and secondary data available in research institutions, the team will design the most promising MPTS agroforestry system(s) for the area. In most parts of the Philippines, this will likely be some form of alley cropping and/or multistorey systems. The major responsibility of the group will be to determine the most appropriate combination of hedgerows and agricultural crops in the alleys. For multistorey systems, the main problem is determining the appropriate combination of upper storey and understorey plants.

On-farm trials and research

Participant farmers will be identified. The exact details of the particular agroforestry system to be implemented on each farm will be planned with the farmer. Experience in the agricultural sector reveals that farmers contribute immensely to the research process. They often suggest modifications which may lead to the improvement of the technology (Rhoades *et al.* 1985).

To ensure that the research methodology is not filled with unnecessary details, key variables and simple methods of measuring them will be identified by the team. At a minimum, these will include erosion rates, yield of agricultural crops, biomass production of hedgerows, and financial costs and returns. Most of these variables can be easily monitored by simple farm record-keeping. Erosion rates can be measured with simple techniques, such as the use of metal rods to monitor changes in soil levels. The fresh weight of biomass can be determined right on the farm. The important idea is to keep the data gathering methods simple. Scientific accuracy may not be on a par with traditional research approaches, but for comparative purposes the results generated will be good enough.

For the day to day management of the on-farm experiments, the participant farmers are expected to do the majority of the work with regular assistance from the social forestry officer. Other members of the team will visit the farm once in a while and hold regular team meetings to assess the progress of the work. They will be available for consultation as the need arises.

Dissemination of technology

Technologies that have passed the testing stage will be disseminated by CENRO extensionists. The trial farm would then become the demonstration farm. If the technology is obviously successful, nearby farmers will be likely to imitate it on their own.

Feedback mechanism

Technology generation should allow for continuous feedback and refinement as new information becomes available. The team members should be sensitive to feedback from farmers whether it is verbal or involves modifications to the technology. The work of the team could extend beyond agroforestry dissemination. Technology development is a never-ending process. Agroforestry establishment is the first step. New agricultural technologies are constantly being developed by research institutions and these should be utilized to further improve the lives of upland farmers.

Conclusion

The methodology presented in this paper contains both old and new elements. The research method draws on recent approaches such as Farming Systems Research and the International Council for Research in Agroforestry (ICRAF) Diagnosis and Design methodology. However, it is also new in that the method has been specifically designed to meet the challenges posed by upland development in the Philippines.

This paper presents a feasible alternative to meet the urgent needs of the Philippines in the short term. Much work must still be done to make this proposal a reality. The authors believe it is important to start somewhere. If this paper stimulates others to think about the problem and begin work on a soluttion, they would feel amply rewarded.

References

Cadiz, R.T. 1979. Environmental impact and uses of kakawate. *Canopy* 5(7):15.

Celestino A.F. and F.P. Elliot. 1986. *Hilly land farming systems in the Philippines: an assessment.* Los Banos: Farming Systems and Soil Resources Institute.

Cruz, C.J. and I. Zosa-Feranil. 1987. *Policy implications of population pressure in Philippine uplands.* Mimeograph. Los Banos: University of the Philippines.

Cuevas, V. and B. Samson. 1982. The effect of biological contour strips composed of ipil-ipil (*L. leucocephala*) and kakawate (*Gliricidia sepium*) in the productivity and rate of erosion of a rice-based kaingin system. In *Annual Report of the Mt. Makiling Cropping Research Team.* Mimeograph. Los Banos: Program for Environmental Science and Management.

Diaz, C.P. 1981. Socioeconomic impact of Leucaena on small farm holders. Paper presented at the National In-house Review on Leucaena Research. Los Banos: Forest Research Institute.

Esteban, I. 1981. Ipil-ipil as reforestation crop. Paper presented at the National In-house Review on Leucaena Research. Los Banos: Forest Research Institute.

Fernandez, V.A. and R.C. Serrano. 1988. Agroforestry practices, research and development. *Philippine Lumberman* 34(11):17+.

Forest Management Bureau. 1987. *Forestry Statistics.* Quezon City: Forest Management Bureau (FMB).

Gomez, A.A., E.C. Quisumbing and J.N.M. Garcia. 1985. On-farm technology testing of the Philippines Ministry of Agriculture and Food. In *Applied Agricultural Research for Small Farms in Asia.* Taiwan: FFTC.

Lasco, R.D. 1987. *A comparative study of two agroforestry farms in Pagkalinawan, Jalajala, Rizal.* Occasional Paper in Social Forestry. Los Banos: College of Forestry.

_____. 1988. Multistorey agroforestry systems in the Philippines: inventory and assessment. *Philippine Lumberman* 34(10):17+.

Mendoza, V.B. and A.P. Bagalayos. 1977. Giant ipil-ipil (*L. leucocephala*): cultural practices and growth rates in some Mindanao plantations. *Sylvatrop* 2:39-44.

Moog, F.A. 1981. Utilization of ipil-ipil as feedlots and in pastures. Paper presented in the National In-house Review on Leucaena Research. Los Banos: Forest Research Institute.

Pacardo, E.P. and B.K. Samson. 1981. Ecophysiological studies of some agroforestry species with emphasis on leucaena. Paper presented at the Workshop on Agroforestry and Fuelwood Production. Honolulu: East-West Center.

Perino, J.M. 1979. Rehabilitation of denuded watersheds through the introduction of kakawate. *Sylvatrop* 4:49-67.

Racelis, E.A. and A.P. Bagalayos. 1977. Germination of *Leucaena leucocephala* seeds under varying temperatures and length of soaking. *Sylvatrop* 2:65-66.

Reyes, M.R. 1979. Lowly kakahuate. *Canopy* 5(7):15.

Rhoades, R.E., P. Batugal and R.H. Booth. 1985. Turning conventional agricultural research and development on its head: the farmer-back-to-farmer approach. In *Applied Agricultural Research for Small Farms in Asia.* Taiwan: FFTC.

Tacio, H.D., H.R. Watson and W.A. Laquihon. 1987. Nitrogen fixing trees as multipurpose tree species for soil conservation. Paper presented at the workshop on Multipurpose Tree Species for Small Farm Use, Pattaya, Thailand.

Tepatiya, D. 1984. The effect of some cropping patterns in the upland of Buhi, Camarines Sur on soil erosion and water runoff. Unpublished PhD Thesis. Los Banos: University of the Philippines.

Orienting and Developing Multipurpose Tree Species Research In North Vietnam in Response to New Land Use Opportunities for Small-Scale Farmers

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Former research work associated with the plantation component of the Vinh Phu Pulp and Paper Mill Project in north Vietnam concentrated on a limited range of species, site conditions and planting objectives. More recently, the project has broadened its development approach and research base. In a society traditionally based on wet rice cultivation, upland areas are principally a supply zone providing a fuelwood and grazing resource, cassava for pig feeding and green manure for the rice fields. The uplands have traditionally been used on the extensive margin, and are now badly degraded. Tenure and land use was influenced by a system of rural collectivization that precluded land holding by farmers except for small, intensively managed homegardens.

Recent policy changes in Vietnam, linked to a shift away from agricultural cooperatives to the family as an economic unit, has made access to the uplands possible on a quasi-permanent basis. This suggests a transition to more sustainable methods of upland use utilizing agroforestry systems, necessitating a reorientation of project research directed towards MPTS.

Project studies of rural changes and farming systems are reviewed. Future research approaches designed to exploit new land use opportunities are discussed, drawing on existing MPTS research experience and traditional practices. Having identified the role of MPTS and the frame around which research should be developed, the paper concludes with a call for a research agenda for the project area.

Background

Since the early seventies the Swedish International Development Agency (SIDA) has supported the forestry sector of the Socialist Republic of Vietnam. This assistance has concentrated on the construction and management of an integrated pulp and paper mill in north Vietnam. With a rated annual output of 55,000 tons, the mill uses bamboo and hardwoods as raw materials from an area of 80,000 km^2, encompassing the provinces of Vinh Phu, Ha Tuyen and Hoang Lien Son.

In response to concern over future wood supplies to the mill, the Plantation and Soil Conservation Project (PSCP) was started in 1986 with the responsibility of creating a renewable source of pulpwood, increasing wood production for local needs, engaging the local population in tree growing and improving the ecological balance of the area. This theme of broadening the objectives from the original industrial base of the Mill Project continued in 1987 with the establishment of the Forest, Trees and People (FTP) Project within the working framework of the PSCP. This forms part of the worldwide FTP program funded by SIDA and FAO concerned with identifying and developing effective ways of supporting people in their efforts to grow, manage and utilize trees and forests.

Within Vietnam, FTP serves as a pilot investigative project to inform the PSCP on land use issues within the three provinces. It also breaks new ground with preliminary research and extension activities on topics such as agroforestry, soil conservation, fuelwood and fodder production. While other projects in north Vietnam involving multilateral agencies are now taking an interest in MPTS, the PSCP and FTP working through the Forest Research Centre have taken the lead in this work following a directive from the Ministry of Forestry. The significance of this work has reached a new level with the opportunities for farmers arising through recent changes in land policy.

It is clear that MPTS will play an important role in the area in meeting future demands for wood and other tree products at the household and industrial levels, as well as supporting agriculture through soil conservation and improvement. This demands a reorientation of research work directed to the needs and capabilities of farmers, and careful consideration of the methods the project can employ to meet these goals.

Rural Change

Farmers' traditions and attitudes towards land management are shaped largely by the history of the area, therefore, it is important to review the Vietnamese experience with collective agriculture and its implications for the future management of the upland[1]. Fforde (1989) recently considered the following eras.

Pre-collectivization

Before 1945 Vietnam was a semi-feudal society with over 40% of the land concentrated in the hands of landlords. Under that system farmers could cultivate land by three methods: on their own private land, from a landlord in the form of tenancy, and as a share of communal land. In all cases the family farmed land independently and represented the basic rural socioeconomic unit. Between 1953-57 a land reform program was implemented, breaking up large land holdings and returning the land to the peasantry.

Collectivization

The collectivization movement started in the north of Vietnam in 1958. The socioeconomic role of the family was downgraded and replaced by cooperatives of generally between 300-500 families organized into work brigade units of 30-40 families each. Farmers as members of the brigades were paid in points according to a scale set by the cooperative management for different types of work. Under this system the family was seen as relatively minor and unimportant.

The basic agent in the rural areas was the cooperative, reflected in the state support for both agriculture and forestry. This led to an emphasis on using upland areas for large scale monoculture, predominantly forest plantations or cassava cultivation, often preceded by clearing the natural forest. In practice, farmers concentrated their resources on areas of land over which they had more control, developing their family economies through homegarden production and the "5%" land they were allowed to keep for growing vegetables.

This collective system had a major negative effect on land management practices in upland areas. Since effective property rights were not permitted, the uplands inevitably became a "commons", liable to short-term exploitive land use practices (Fforde 1989). This was exacerbated by rising population pressure both through natural increase and migration into the area from the Delta Region. Forested areas were overcut, soil fertility was depleted through low-input cassava cultivation, and grassland was destroyed through overgrazing, leading to soil degradation and erosion.

Breakdown of the Collective System

In 1981, Party Decree No. 100 was issued introducing the Output Contract System. Although this was intended to strengthen the overall management role of the cooperatives, it started to return some economic power to the family. At the same time, the state supported a shift in access to the uplands through its land alienation policy in which state land previously held by state forestry enterprises was allocated to cooperatives. This was the precursor to more fundamental changes involving the distribution of upland plots to farmers on a secure basis associated with the passing of Party Decree No. 10 in April 1988.

Decree No. 10, titled the *Renovation of Economic Management in Agriculture*, concerned a fundamental reorientation for rural society with the return of the farming family as the basic socioeconomic unit, relegating the cooperative to a service role. A further decree in late 1988 stipulated that forest land[2] could be held in usufruct for periods of up to 50 years. Inheritance of land and transfer, concession and sale of the fruits of the user's labor on the allocated land, including perennials, is permitted.

These recent policy changes effectively set the stage for the rehabilitation and development of upland areas based on a pattern of family land holdings. The situation evolving now is complex. Not unexpectedly, many cooperatives are reluctant to give up their control over land management and have often allocated land to families through joint venture agreements to retain their dominant interest. In these arrangements the cooperative investment is repaid by the farmer, with a specified percent of the harvest going to the cooperative. In such cases the cooperative generally decides the area and form of production, as well as dictating all important harvesting decisions. Many fuelwood plantations are currently established in this way.

The policy of allocating land has been interpreted in different ways, and uncertainty exists over how the land is being divided and its conditions of use. It is only now that pilot work is being started on formalizing the process through the issue of land certificates, yet many cooperatives talk of the allocation (division) process having been completed. The author fears that in some cases tree planting supported by the project's Social Forestry Program may be indirectly helping a minority of farmers to consolidate land applications by bringing the land under cultivation -- a condition of receiving allocated land. In the long run this will tie up large areas of land in a form of monoculture that may well be sub-optimum in terms of the variety and volume of products that a family will need from the area of land they can be expected to receive under an equitable system.

The Farming System

Given a genuine opportunity to develop upland areas, farmers can be expected to extend production in accordance with a farming system traditionally based on wet-rice cultivation, involving the upland in a submissive role, directly and indirectly supplying the paddy fields with nutrients. In the mountainous districts of the project, where the area for wet rice is restricted, minority groups have developed traditions of upland agriculture based on the cultivation of upland rice, cassava and maize using a shifting cultivation or bush fallow system. The farming system can be seen as an interrelated group of subsystems: staple production, non-staple cash crop production, and animal husbandry.

Wet Rice

Valley bottom land for wet rice cultivation falls under a complicated land classification system which relates land quality to land and product sharing. Buffaloes are generally used to prepare the paddy, and together with cattle and pigs provide the essential inputs of animal manure. Only richer farmers can afford chemical fertilizer. Manure is supplemented either by mixing or direct application with green manure collected from plants growing naturally on upland areas or occasionally cultivated as boundary hedges to homegardens.

Upland Farming

Cassava is the second most important staple crop after rice. While its main use is pig feed and an inferior human staple, it can also be marketed. Cassava stems are both a good source of fuel and fencing material. In a recent survey on socioeconomic conditions, 88% of families reported growing cassava in homegardens and hill plots borrowed from cooperatives or state enterprises. Intensive cultivation involving inputs of animal manure and chemical fertilizer is becoming common where hillsides are degraded to the point where fertilizer application is seen as profitable.

Tea is a popular cash crop receiving farmer inputs of cash, labor and manure. Recently there has been renewed interest in coffee growing.

Homegardens

Farmers take advantage of the protection offered by the bounded garden area to grow a variety of products both for domestic consumption and marketing. Fruit trees are increasingly seen as a valuable asset. Over 50% of the families surveyed had fish ponds in their gardens.

Animal Husbandry

Buffaloes are essential for their role in rice cultivation and are generally well cared for, with farmers investing considerable time and cash to provide good feed. Most families will try to have at least one animal to reduce their reliance on sharing arrangements. Cattle are raised for sale as meat or draft animals. Pig rearing is the most important animal husbandry activity, providing a rapid and reasonably certain cash return based on fairly low levels of investments. There is a clear interaction between pigs and uplands with pig manure being used in intensive cassava cultivation, cassava fed to pigs, pigs sold and manure reinvested on the hill to produce more cassava.

Wood Production

Farmers traditionally grow a mixture of trees in and around their homegarden. *Melia azedarach, Artocarpus heterophylla, Eucalyptus exserta, E. camaldulensis,* and *Bambusa* spp. provide fruits, construction wood and a limited supply of fuel from small branches and leaves.

Apart from the garden, farmers until now have had little opportunity to grow or manage trees. In areas of relatively low population densities some families may have forest gardens in which they combine management of secondary forest and enrichment planting with agricultural crops. Many of these gardens illustrate how hill land can be productively and imaginatively used by farmers though tree combinations (Thanh and Binh in Littooy 1989). *Livistona saribas*, a palm, is grown in stands to produce leaves for thatching. Little is currently known about the relationship between the cooperatives and farmers in managing these tree resources.

More recently, farmers have been involved in state sponsored social forestry tree planting programs (Folkesson and Gayfer 1989) with the stated objective of regreening the bare hills and providing a source of fuelwood for the rural population. To date the major species planted has been *Eucalyptus camaldulensis,* reflecting both the project's limited experience with other species and the cooperative's (and farmer's) preference for a single stemmed tree with an established local market for sale as pulpwood to the paper mill. The actual impact of these plantations on the local fuelwood problem is likely to be marginal if the wood can be sold for other purposes or to distant fuelwood markets at a higher price. Recently, however, *Acacia mangium* and *Eucalyptus urophylla* have been introduced since research results have shown them as promising alternatives to *E. camaldulensis.*

Finally, mention must be made of *Tephrosia candida*, a leguminous shrub which farmers are increasingly using as a short term intercrop during the establishment of tea plantations, providing a source of leaf litter for the tea furrows, green manure exported to the rice fields, seed and firewood.

Research Experience

Project Activities

Since the inception of the Industrial Forestry Program in the late 70s, trials have investigated a range of species initially focused on the commercial supply of pulpwood but later broadening to include non-industrial species, specifically leguminous species for firewood and green manure production.

Research work has been plagued by protection problems, not only from free-ranging livestock but also illegal cutting, an increasing concern for all planting activities in the project area. This problem, coupled with a certain lack of continuity in research work on the non-industrial side, has limited progress on identifying MPTS suitable for the prevailing climatic, edaphic and social conditions. *A. mangium* has been adopted as a possible alternative to *Eucalyptus* spp. both for pulpwood and fuelwood production, particularly in areas where soil improvement is considered important. *Acacia holosericea* seems promising, possibly outperforming *A. mangium* on the drier, degraded sites. Results on other genera such as Albizia, Leucaena, Sesbania and Gliricidia are so far largely negative or at best inconclusive.

Research work has been hampered by other factors, including inconsistent use of inoculum, lime and fertilizers, limited and inappropriate selection of seed sources, and narrow assessment techniques concentrating on tree height and main stem diameter rather than total biomass. This may have led to an unconscious prejudice by research staff more familiar with evaluating industrial species against MPTS with multiple stems.

The range of site conditions covered by species trials has been small, concentrating on the mid to upper slopes of degraded hills. Where research work has extended to more fertile sites, towards the less densely populated parts of the project area, silvicultural care has often been of low quality. In light of the above problems, it would be premature to classify a species as unsuitable when the variety of locations (planting niches), site preparation and tending situations have not been fully investigated.

Research on MPTS in a managed system has been limited to the planting of *A. mangium* and *T. candida* as elements in a soil conservation agroforestry system involving terracing and ditching techniques combined with cassava cultivation (FTP 1989). Experience suggests that the Acacia trees are considered a negative influence on the cassava crop through the effects of shading and competition for nutrients. Tephrosia is regarded more favorably and at a site established in 1989 farmers have extended the original project design to include dense sowing of the shrub both on the contour bunds and as boundaries running down the slope between different farmer's plots. This is an interesting adaption, as traditionally farmers have dug ditches to mark such divisions rather than sow or plant woody species, as is common for fencelines in the homegardens.

These ditches are a considerable erosion hazard, often collecting and channelling runoff. This practice reflects a general lack of upland farmers' responsibility for the impact of runoff and soil deposition originating from their fields on fields down slope (Littooy 1989). Under the collective system of land management it was common for a farmer's cassava plots to be scattered throughout the area with no relation to his wet rice plots. Soil from the farmer's cassava field deposited into rice fields at the foot of the slope was not his problem, instead it became the cooperative's responsibility to repair fields and drainage ditches with their irrigation brigades. As the cooperative's resources to pay for such work is restricted under the new economic policy, the onus in the future for such repair work will inevitably fall on the farmer who has been given the right to use that area of paddy.

A. mangium has been planted in association with Tephrosia/tea plantations as discussed earlier. Since tea requires little or no shade when it reaches the production phase after 3-4 years, and the cooperatives have indicated their preference for a large, single stem as a final product on a 10 year rotation, the dense crown of the Acacia will have to be frequently and extensively pruned back so it does not reduce tea yields.

Farmers' Practices

Traditionally, silvicultural practices such as lopping and pollarding are rare. Although farmers in West Africa pollard *Azadirachta indica* to produce small poles to use as rafters, in Vietnam this construction role is served by bamboo. *M. azedarach* is managed to produce stems for cross beams while branch pruning or pollarding is held to a minimum to decrease the chances of wood rot.

Coppicing techniques are more common, particularly with established *E. exserta* stands, formerly under the control of the cooperatives or state, but now managed by families. Farmers will thin coppice shoots for fuelwood leaving one or two to grow for construction materials. A more recent management approach has evolved at one of the project's fuelwood demonstration sites where farmers contracted to manage the demonstration plot on behalf of the cooperative have been given the freedom to prune the *A. mangium* trees. One farmer pruned the lower branches every month, producing a regular volume of wood and leaf material that he estimated met up to 25% of his family's total fuel needs.

Such observations suggest that farmers' management of MPTS has the potential to adapt to new situations. Research work to date in both forestry and agriculture has concentrated on the cooperative system. Consequently, little has been learned about what farmers consider an optimum mix of products (ie. fuelwood, leaves, or wood), nor about what tradeoffs they may be prepared to accept between tree growth and crop performance. It has only been in the last few years, given a greater freedom of choice and decision making, that farmers have started to experiment with different methods and species combinations.

The Role of MPTS

Within the project area five major land use issues are considered relevant to small-scale farmers and could possibly include a role for MPTS:

- wood production -- tree growing for domestic use (fuelwood and construction) or for marketing (fuelwood, construction and pulpwood);

- improvement of grazing and fodder resources; tree fodder;

- short term intercropping -- tree/tree (shrub) combinations designed to maximize the utility of land during the establishment phase of industrial plantations;

- long-term rehabilitation of degraded soils through the industrial plantation program -- interplanting of MPTS (with industrial species) or dense planting of MPTS to conserve and improve the soil with limited off-take of tree products; and

- development of sustainable upland farming practices -- both spatial and temporal mixtures of trees and crops with support to lowland farming through green manure production on upland areas.

Under the land allocation program farmers can expect to receive rights to land varying in form (upland/lowland), quality, existing production use (cassava land, existing forest plantation, abandoned land) and locale (relative to settlements). The site-specific characteristics of the allocated land, and their home and forest gardens will strongly influence the potential role of MPTS activities regarding the choice of species, scale of planting, and tree management. A farmer with very limited land resources may need to consider MPTS that can produce fuelwood and fodder (or green manure) and improve the soil on very poor hill land in association with permanent cassava cultivation. Another farmer with more land may choose to grow fuelwood as a byproduct from a small woodlot and grow cassava using a crop rotation system involving a short rotation tree fallow. Tree fodder would only be important in areas where natural grazing areas are limited and other feeding alternatives are restricted (Froberg and Olsson 1989).

These considerations determine the environment within which MPTS research must take place, acknowledging existing variation within the project area according to physical and social parameters (population density, proportion of hill land, existing land use, ethnic groups) and variations between farmers' circumstances within each area. Fforde (1989) has classified farmers into three groups -- the poorest 10-15% are forced to adopt very short time horizons in their daily economic activities; the richest 10-20% are able to accumulate capital and benefit most from current reforms, rapidly acquiring title to those state and cooperative resources being privatized. Between these is a middle group of farmers who, although they lack starting capital, are planning to rapidly exploit new opportunities through the production of marketable surpluses from upland areas. Therefore, research will need to consider both the biological and economic performance of MPTS, focusing on direct marketing of tree products and/or tree impact on the production of crop surpluses.

Future Research Approaches

In discussing future research approaches for MPTS three basic issues must be considered: research tasks, research organization and research methods.

Research Tasks

Tasks can be subdivided into two work areas: species selection, involving a coordinated set of phased species elimination trials (SET) and provenance trials; and management trials, including spacing, intercropping and lopping or coppicing. Initially these trial programs will be run independently until a set of best species have been identified, allowing trials to be designed combining small farm management practices with species or provenance trials (MacDicken 1988).

Research tasks should be considered in each area reflecting the varying conditions facing farmers. Chambers and Fforde (1989) suggest three zones based on the principle of agroforestry practices evolving naturally in response to population increase and pressure on land resources. The upper zone in the northern, less densely populated part of the project area currently has limited potential for agroforestry development. The middle zone has reached the "take off" stage, growing land pressure already having initiated a positive response from farmers in the form of practices designed to control soil erosion (Hao and Kiem in Littooy 1989). In the lower zone, the area with the highest population and lowest proportion of hill land to paddy, cooperative and state land management policies have delayed any natural moves towards sustainable systems of upland cultivation through farmer experimentation with agroforestry. In this zone considerable outside support will be required to improve the current situation as the level of inputs required to bring hill land back into production is beyond the investment capacity of farmers or local agencies.

As Chambers and Fforde point out in their report, this zonation does not always coincide with simple physical divisions such as an upper, middle and lower split of the project area. Conditions between neighboring districts can vary considerably when considering population density and soil fertility.

This concept of agroforestry zones provides a framework around which species and management research tasks can be identified and addressed. Within each zone the form, location, intensity and utilization (tradeoffs between MPTS products and functions) of agroforestry practices will vary. Table 1 summarizes the interventions involving MPTS under consideration for the project area and on which species and management trials will initially focus.

Research Organization

The Forest Research Centre was originally developed to conduct research for the industrial plantation program. Its current operating structure and level of staffing still reflect this single interest goal. Effective MPTS research in the future will therefore demand a reorganization of the FRC in order for this program to receive the attention it deserves. Emphasis should be on the quality rather than the quantity of research.

Research should be guided through a careful assessment of available resources and consideration of exactly what MPTS research needs to be conducted both on-station and on-farm. Where possible, the Centre should interact with other government research and extension organizations in the area to develop

Table 1. Area and landscape specific planting niches for MPTS.

Area	Location	Planting Form
Lower Zone	Homegarden	Live fence/boundary trees. Dike, roadside and fishpond edge trees.
	Hill	Live fence for field protection. Field boundary trees for plot demarcation.
		Hedgerow intercropping with cassava. Hedgerow or scattered trees on terrace edges.
		Dense planting of eroded, abandoned land.
		Dense bands of trees/shrubs planted at foot of slope for production of fuel, green manure and/or fodder.
		Small commercial woodlot, producing fuelwood as a byproduct.
Middle Zone	Homegarden	Live fence/boundary trees. Hedgerow intercropping. Scattered light shade trees for tea and other crops.
	Hill/Forest garden	Field boundary trees. Contour line planting between agricultural crops. Temporary planting of closely spaced shade trees or shrubs for establishing tea plantations.
		Widely spaced permanent trees giving light shade to established tea plantations.
		Band planting of trees (spacing varying with species & objective) at certain points on the slope.
		Small commercial woodlot producing fuelwood as a byproduct.
		Widely spaced valuable timber and fruit trees in fields.
		Trees pollarded to reduce crop shading effects. Tree planting along hill paths/tracks and waterways.
Upper Zone	Hill/Forest garden	Rotational hedgerow intercropping. Improved fallow. Band cropping. Rotational taungya system.

local interest in the work on MPTS, assist in conducting and monitoring trials and avoid duplication of effort. Such organizations often have a good understanding of local farming conditions and can identify progressive, innovative farmers able to conduct certain types of MPTS research.

Research Methods

Increasing emphasis will be placed on developing a partnership between farmers and researchers using the cooperative structure in a supportive rather than a controlling role. As a link between the project and the household, the brigade may represent an appropriate medium for identifying research participants, facilitating group evaluation exercises and testing MPTS extension. Brigades can be considered as social units. They are often based on traditional settlement patterns with each brigade representing a hamlet and maintaining an elected leader.

All MPTS research should form the first step in a logical progression from the investigation stage through to adoption. Applied and adaptive research trials should lead to demonstrations, pilot extension programs and general extension programs with seedlings and extension advice being made widely available. Field activities should be carefully differentiated to avoid the pitfall of trying to do two different things on the same site, which is rarely successful.

Since MPTS research in north Vietnam is currently trying to identify both the species and management role of MPTS appropriate for the small farm environment, the general method of research must be based on an investigative approach. Farmers should be engaged in both the examination of farm-scale land use problems and conducting and evaluation of trials. Rapid rural appraisal (RRA) techniques can be usefully employed in both problem identification and in the evaluation of results. This will develop the team approach to research work that is so important if results and experiences are to be openly discussed and developed.

Research methods should be governed by the principle that "researchers must be able to provide more useful, concrete, interpretable, and predictive results than farmers and innovative extension agents" (Robinson and Thompson 1987). It is therefore suggested that MPTS research adopt a household perspective linking the design and evaluation of management trials to an awareness of the impact on the household. This can refer to either the level of demand for a particular product or tree effect on agricultural production.

Finally, all research work must be carefully and religiously documented using a standardized format that concentrates on brevity and accuracy. When dealing with the small farm situation it is easy to misinterpret trial results and farmer's comments on MPTS in the absence of a full understanding of the pertinent details.

Research Agenda

To conclude this look at the orientation of MPTS research, a time frame must be considered. For farmers to achieve the land management opportunities presented to them under Vietnam's new policies, MPTS research will need to be well planned and rigorous, carefully leading as well as learning from complementary extension activities. There is a danger of researchers and policy makers adopting a blind faith in agroforestry, utilizing MPTS in combination with agriculture as a panacea for all land use problems. The process to determine where and in what form agroforestry and MPTS are the optimum solution is inevitably time consuming. Therefore, a research agenda is required rather than a blueprint for action with its associated preference for models.

The first step in setting such an agenda must be the identification of priorities. In 1990 the project will focus on SETs, both first round and second round site-specific investigations, tests of best bet species under on-farm conditions, management trials involving *Tephrosia candida*, fuelwood production systems, and tests of agroforestry interventions. These planting activities will be supported by further investigations into indigenous species which may warrant inclusion in the MPTS research program.

Notes

[1]For the purpose of discussion the landscape of the project area can be divided into two portions, lowland -- consisting of wet rice land, and upland -- all land above the paddy. A typical landscape thereby consists of islands of hill land (upland) surrounded by rice fields.

[2]In Vietnam, land is officially classified into five categories: agricultural land, forest land, residential land, specialized land, and unused land. This classification may refer to intended land use rather than actual use, ie. areas of forest land can be borrowed temporarily for cassava cultivation.

References

Chambers, R. and A. Fforde. 1989. *Opportunities and priorities for development cooperation 1990-1995 in Vinh Phu, Hoang Lien Son and Ha Tuyen Provinces, Vietnam*. Stockholm: Swedish International Development Agency.

Fforde, A. 1989a. *Cooperatives, families and development in north Vietnam - Some experiences from the Forest, Trees and People (FTP) Project*. Bai Bang, Vinh Phu: Vinh Phu Service Union.

_____. 1989b. *Rural development in north Vietnam and the Forest, Trees and People Project*. Stockholm: Interforest AB.

Folkesson, B. and J. Gayfer. 1989. *The fuelwood problem in the RMA - Review of tree planting activities concerned with fuelwood supply and suggestions for the development of the social forestry programme*. Bai Bang, Vinh Phu: PSCP.

Forest, Trees and People (FTP) Project. 1989. *Status reports*. Stockholm: Interforest AB.

Froberg, A. and A. Olsson. 1989. *Grazing and Fodder Production Minor Field Study for FTP Vietnam*. Stockholm: Interforest AB.

Littooy, S. 1989. *Local farming technologies related to soil conservation and tree planting in selected districts of Vinh Phu, Ha Tuyen and Hoang Lien Son*. Bai Bang, Vinh Phu: Vinh Phu Service Union.

MacDicken, K.G. 1988. *Planning and implementing MPTS field trials*. Bangkok: Winrock International.

Robinson, P.J. and I.S. Thompson. 1987. Methodological issues in determining growth, yield and value of MPTS. In *Multipurpose Tree Species for Small-Farm Use*, eds. D. Withington, K.G. MacDicken, C.B. Sastry and N. Adams. Arlington, Virginia: Winrock International and IDRC.

Barefoot Tree Breeders: The Use of Farm Resources for Multipurpose Tree Species Improvement

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Tree improvement efforts by forest geneticists have largely focused on industrial use of plantation species using genetic resources from natural populations or existing plantations. At the same time, farmers are often plant breeders themselves, selecting planting materials from desirable mother plants. Multipurpose tree species (MPTS) have in some cases been intensively selected by farmers for several generations. The gene pool represented by these selections is not well represented in current breeding efforts but holds promise for rapid genetic gains for commonly used MPTS.

This paper outlines a methodology for forest geneticists to work with farmer/technicians who are enlisted as "barefoot tree breeders" to identify, collect and evaluate MPTS germplasm from on-farm seed sources.

Background

Tree improvement has largely focused on the improvement of trees for industrial purposes. Consumers and industry have demanded fast-growing, straight trees with few defects. While this has resulted in the improvement of a variety of conifers and a few tropical hardwoods, there are few cases of tree improvement of MPTS for small-scale farmers (Burley 1987). It is highly probable that the attention of most tree breeders will remain focused on the demand for improved plantation species for industrial use.

Two of the resources needed to expand tree improvement are human resources and material support (Palmberg 1989). This paper focuses on the opportunity and an approach to create a new cadre of tree improvement workers to focus on the needs of small-scale farmers for improved MPTS. There is tremendous potential for community-based barefoot tree breeders who practice simple selection and breeding of locally available or popular tree species for agroforestry in cooperation with trained forest geneticists.

The Farmer as Plant Breeder

Farmers have selected and domesticated plant and animal species for thousands of years. Many of the varieties used in the breeding programs of international agricultural research centers are varieties which have been selected and maintained by farmers (Rhoades 1989). In Thailand, most of the well-known fruit tree varieties of species such as tamarind, mango and durian are products of selection by farmers, not the improvements of agricultural scientists.

The apparent reasons for this farmer-driven selection process include the presence of adequate incentives for improvement. These incentives are often economic incentives of better market prices for higher quality fruit, or greater income from increased crop yields. In the case of Thailand, tax incentives were provided under the rule of King Chulalongkorn nearly one hundred years ago for those who produced higher quality fruit, thus encouraging a practice of improvement which continues to the present. Farmers in Nakorn Srithamarat and Trang Provinces select superior trees of *Azadirachta excelsa* in homegarden production systems for higher value furniture wood.

The ability to recognize desirable plant traits has also been demonstrated. Cereals, staple crops and fruit trees have commonly been selected by farmers who can readily recognize traits such as taste, yield, ease of management, etc. For fruit trees it is easy to identify trees which produce quantities of tasty fruits. The high quality Thai rambutan cultivar Rong Rean (school) originated from a single tree in a schoolyard in Surathani Province. The keen-eyed grower may even locate bud sports which produce unusual fruits which can be used as the vegetative basis for new varieties. The immensely successful Red Delicious apple and pink-fleshed grapefruit varieties in the United States were each developed from such grower-identified sports. It is also an easy, and common task to select seed from the largest panicle of rice or ear of maize.

These factors also apply to the selection and improvement of MPTS by farmers, although in different ways. Farmers grow MPTS on their lands for a variety of purposes (Grandstaff *et al.* 1986). There is also strong evidence that farmers select seed from superior mother trees when there are clear economic incentives to select for products of improved quality.

In the province of Lampang, Thailand, some farmers collect and use seed from select teak trees to obtain improved trees for planting on their own lands because of the anticipated economic benefits (N.T. Vergara, personal communication). In Chachoengsao Province, at least one farmer uses seed from superior *Azadirachta indica* trees for new plantings. His criteria for selection of plus trees include both stem form and the culinary quality of the flowers. In southern Thailand, *Parkia speciosa* has been selected for better taste and is grown widely as a homestead species as a cash crop and for home consumption. The incentives in each of these examples are the increased income from improved products from tree species.

While there are many examples of economic incentives for farmer-driven tree improvement, there are also many disincentives. One example is found in Mainland China where farmers who grow Paulownia in agroforestry plantings are given the same price for trees regardless of form or wood quality (Zhu 1988). This results in low prices overall as the buyer is able to use only a small proportion of the purchased wood for high value timber products. MPTS with fuelwood as a primary product are not likely to be accepted by farmers in countries such as Thailand where illegal fuelwood collection is still possible and prices of fuelwood are still low. Until such disincentives are removed, farmers are unlikely to spend limited resources improving non-fruit tree species.

Other difficulties in farmer selection of plus trees include the lack of awareness of the ability to improve trees for more than one feature. A survey of fruit tree farmers in Chantaburi Province demonstrated that while farmers grow durian with good to excellent tree form, they select only one of two commonly available varieties, even though durian wood is often sold to furniture factories or used for flooring. In some cases, farmers may have both economic incentives and the ability to recognize desirable traits in plus trees, yet lack the skills to make improvements in the way they have for other crops. This may be particularly true for the improvement of more than one characteristic at a time, such as fruit and quality of wood.

Farmers may have limited information about the added value of improved products from trees such as the higher price of knot-free wood. In many areas, state agencies offer free unimproved tree seedlings which often come from seed sources of poor or unknown quality. This encourages the mistaken idea that one tree is no different from another and that there is no advantage to selection.

Barefoot Tree Breeders

The Chinese have successfully developed the concept of community based "barefoot doctors" for centuries, resulting in the provision of basic health care to rural populations while at the same time assembling a formidable collection of information on the use of herbal medicines. Social foresters have proposed a class of "barefoot foresters" who would live in local communities and work with farmers on the propagation and management of local forestry resources.

Chuntanaparb and MacDicken (1989) have proposed a class of "barefoot tree breeders" who would extend this approach to tree improvement in rural areas. These breeders would profitably emphasize indigenous tree and shrub species which have been, and will likely always be, neglected by traditional tree improvement programs. The requisites for barefoot tree breeders would include a very basic knowledge of dendrology, genetics, seed handling, access to well-trained forest geneticists and a strong dose of common sense.

Farmers often have trees growing in their homegardens which have been brought into the farming system by previous generations. These trees may have simply come from wildlings uprooted from under nearby trees, or from seed from readily accessible mother trees. However, in some cases it is likely that farmers selected the mother trees for their homegardens. The examples of selection and propagation of trees on private lands in Thailand strongly suggest that this may be a more common practice than ordinarily recognized. Where this is the case, the barefoot tree breeder has a base population to select from which has already started through the process of selection.

Cooperation between trained tree breeders and this new class of barefoot tree breeders is essential. Table 1 provides an example of the division of responsibilities between traditional and community-based tree breeders that has been employed with forestry plantation workers and part-time farmers in eastern Thailand.

Methodology

Many different approaches might be taken to encourage and assist farmers in improving MPTS. The methodology outlined in this paper provides a detailed division of responsibilities between farmer or "barefoot tree breeder" and forest geneticist.

Asby *et al.* (1989) asked farmers to rank ten bush bean varieties in Colombia, then asked a trained plant breeder from the International Center for Tropical Agriculture (CIAT) to do the same. The final ranking of bean varieties by farmers and the plant breeder in this pre-screening were similar, yet differed primarily because farmers felt the most important criterion for selection was grain size. The plant breeder ranked the varieties in terms of anticipated acceptability to farmers.

A similar method was tested in the field with farm workers from the Thai Plywood Company on the Lad Krating Plantation. Farmers were asked to identify plus trees of *Eucalyptus camaldulensis*, then the same population of trees was screened by a trained forest geneticist.

The general steps in this process are outlined in Table 2. This procedure was tested at Lad Krating as the methodology was developed. A key to the development of enhanced tree selection skills of farmers or barefoot tree breeders is the use of appropriate resources of both farmer/breeder and forest geneticist.

Results

The results of the plus tree selection exercise by barefoot tree breeders and forest geneticists are presented in Table 3.

Case One

Plus trees were selected from MPTS network trials in Lad Krating, Chachoengsaeo Province. The trials include *Acacia auriculiformis* (genotypes 15477 and 15648), *Acacia mangium* (genotypes 15677 and 15642), *Leucaena diversifolia* (K156) and a *L. leucocephala* x *L. diversifolia* hybrid (K743) as part of a factorial treatment design. Farmers were asked to select plus trees with vigorous growth, straight stem, small size of low live branches, and no pest damage. Farmers marked the plus trees with plastic tape which were later checked and reselected by trained tree breeders.

Selection performance varied little between farmers and trained forest geneticists, with rejection of only a few trees due to the poor leader development in *A. mangium*. Table 3 shows the number of selected trees and the superiority of plus trees compared to the base population. High genetic variability in the Leucaena hybrid demonstrated high superiority of the selected plus trees. This exercise indicated the ability of barefoot tree breeders to carry out effective mass selection with little additional training.

Case Two

Barefoot tree farmers were asked to select superior clones of *E. camaldulensis*, the main tree species at the Lad Krating Plantation. Trees were planted at a spacing of 2x4 and 4x4m. In the early years (1982-1984), the seeds were from unclassified seed sources and superior local trees. Seed from Australia (Petford and Gilbert provenances) have been used since 1987. The total population is about one million trees.

Barefoot tree breeders were asked to select trees with vigorous growth, straight round stems, symmetry in crown development, which were pest free and superior to adjacent trees. The first intensive selection was carried out by six farmers over three weeks and resulted in 540 selected trees, or about 1:1,850. After the first evaluation, the barefoot tree breeders were asked to further refine the screening, being more selective. The second, more intensive selection yielded 250 trees, or about 1:4,000. The results of the second selection were very similar to those of the trained tree breeder.

Table 1. Skills required of trained tree breeders and barefoot tree breeders for agroforestry species.

Trained tree breeder	Barefoot tree breeder
* Studies of breeding systems for selected species	* Identification of suitable agroforestry tree species for improvement
* Assistance with taxonomy of selected species	* Selection and cloning of plus trees into clonal orchards
* Training in hand pollination techniques	* Farmer training in selection of ideotypes and seed collection
* Maintenance of collections from broad geographic area	* Supervision of early field testing of progeny from improvement programs

Source: Chuntanaparb and MacDicken, 1989.

Conclusions

Farmers are proven breeders of food, fruit and tree crops. This potential source of skill lies generally untapped for the improvement of MPTS. Farmers can and do select tree species for a variety of purposes. Their ability to do so is equivalent to that of trained tree breeders when given the same selection criteria. The methodology outlined in this paper demonstrates how the genetic tree breeder can work with the farmer/barefoot tree breeder to accelerate the improvement of MPTS. It is a methodology which recognizes and combines the knowledge of the scientist and the farmer/practitioner.

References

Asby, J.A., C.A. Quiros and Y.M. Rivers. 1989. Farmer participation in technology development: work with crop varieties. In *Farmer First*, eds. R. Chambers, A. Pacey and L.A. Thrupp. London: Intermediate Technology Publications.

Burley, J. 1987. Strategies for Genetic Improvement of Agroforestry Trees. In *Agroforestry for Rural Needs*, eds. P.K. Khosla and D.K. Khurana. Solan, HP, India: Indian Society of Tree Scientists.

Chuntanaparb, L. and K.G. MacDicken. 1989. Tree improvement for agroforestry. In *Applications of agroforestry research in Asia*, eds. M. Avery, C.K. Ong and M.G.R. Cannel. New Delhi: Oxford IBH Press.

Grandstaff, S.W., T.B. Grandstaff, P. Rathakette, D.E. Thomas and J.K. Thomas. 1986. Trees in paddy fields in Northeast Thailand. In *Traditional agriculture in Southeast Asia: A human ecology perspective*, ed. G.G. Martin. Boulder, Colorado: Westview Press.

Palmberg, C. 1989. Research needs in forest tree breeding and improvement in developing countries. *Agroforestry Systems* 9:29-35.

Rhoades, R. 1989. The role of farmers in the creation of agricultural technology. In *Farmer First*, eds. R. Chambers, A. Pacey and L.A. Thrupp. London: Intermediate Technology Publications.

Zhu, Z. 1988. A new farming system - Crop/Paulownia intercropping. In *Multipurpose Tree Species for Small-Farm Use*, eds. D. Withington, K.G. MacDicken, C.B. Sastry and N. Adams. Arlington, VA: Winrock International and IDRC.

Table 2. General steps required to effectively combine farmer and forest geneticist skills for MPTS improvement.

Required steps	Farmer/barefoot tree breeder resources	Forest geneticist resources
Pre-screening		
What species are appropriate targets for farm-level tree improvement?	Knowledge of species which have significant potential value for local use and for which there exist local genetic resources.	Knowledge of species or genetic resources which may meet the expressed needs of farmers, but are unknown to them.
Has any improvement or selection already been done, either by farmers or tree breeders?	Knowledge of locally available trees and "indigenous knowledge" of other farmers.	Case studies of improvement work from scientific and technical literature.
What genetic resources are available?	Knowledge of potential mother trees for improvement.	Access to germplasm collections made elsewhere plus knowledge of breeding systems and genetic resources.
On-farm selection and improvement		
Identify practical, achievable ideotypes of the priority species.	Ideas on the type of tree which would best fit local needs and markets.	Knowledge of how attainable the desired ideotype may be.
Select parent trees for first/next stage of testing.	Knowledge of and access to local base populations.	Experience in identifying plus trees based on pre-defined criteria.
Collect propagules from parent trees.	Experience in handling of plant materials. Easy access to trees in local area.	Knowledge of vegetative propagation which may not be known to local farmers.
Distribute propagules among core of tree breeders and farmers for planting and evaluation.	Access to sites for evaluation of improved materials which are likely to be representative of conditions for other farmers.	Access to experiment station sites and other trained tree breeders who can provide additional evaluations of selected materials.

Table 3. Plus tree selection in MPTS Network Trials in Lad Krating (one year old).

Genotypes	Number of plus trees	Selection intensity %	Tree characteristics: Base population Ht (m)	Base population Do[1] (cm)	Base population Dbh (cm)	Plus trees Ht	Plus trees Do	Plus trees Dbh	Superiority (%) Ht (m)	Superiority (%) Do (cm)	Superiority (%) Dbh (cm)
A. mangium											
# 15677	45	3.8	4.3	4.8	3.5	4.7	5.9	4.5	8.4	23.6	28.4
# 15642	55	4.7	4.1	4.7	3.5	4.5	5.5	4.4	10.8	17.6	22.9
A. auriculiformis											
# 15477	31	2.6	4.6	4.7	3.1	4.9	4.9	3.6	7.2	6.6	16.9
# 15648	3	0.3	4.2	4.3	2.9	4.4	4.7	3.3	4.0	8.4	10.8
Leucaena spp.											
# K743	13	1.1	4.9	3.6	2.8	6.6	5.1	4.3	35.9	40.3	52.3
# K156	22	1.9	5.3	3.9	3.1	5.7	4.5	3.7	9.3	12.7	19.3
Mean		2.39	4.57	4.33	3.15	5.13	5.10	3.97	12.6	18.2	25.1

[1] Dc = diameter at 10 cm above the ground.

Applying Farming Systems Research Concepts and Methods to the Development of Multipurpose Tree Species

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The extension to small farmers of agroforestry technology involving multipurpose tree species (MPTS) lags behind what is perceived to be technically feasible. This is similar to the situation encountered by annual-crop researchers and extensionists 15-20 years ago, which led to the growth of farming systems research (FSR) concepts and methods.

FSR concepts and methods are reviewed for relevance to research, extension, and policy making involving MPTS technology. The broad approach to FSR involves a progression from defining production problems and opportunities for better use of available production resources, through design and evaluation of improved technology, to extension of the new practices on a wider scale.

To use this approach with MPTS, more emphasis will need to be placed on refining methods for technology testing. Methods currently used in FSR have not focused on evaluating technologies providing multiple products over a period of several years, or which affect long-term sustainability through soil fertility and erosion control. In spite of the original intentions of FSR practitioners, the participation of farmers in the design and evaluation of technology also needs to be increased.

Current research plans and preliminary results of the Uplands Agriculture Conservation Project in Java are discussed. These activities include farmer meetings, surveys, and experiments managed by both researchers and farmers.

Background

In the early 1970s, there was concern that the products of agricultural research were not benefitting many resource poor farmers of the world. New technology was usually aimed at maximizing the yield of a particular commodity, and did not take into account the compromises necessary to maximize the overall productivity or economic return of the whole farm. Researchers with fertile research stations, and somebody else's money, did not take into account the aspirations, resource base and cash limitations that determine farmers' choices. Research was needed to adapt improved technology to farmers' conditions, a situation not unlike that concerning technology for MPTS today.

Farming systems research (FSR) quickly became the popular remedy for this concern. Just as quickly, FSR included an almost bewildering array of different procedures and terminologies. Most of these differences in procedure can be attributed to the production environment and problems being addressed by farmers when procedures were being developed (Harrington *et al.* 1989). Despite the differences in emphasis and particular research methods, most of the procedures share a broad similarity in underlying philosophy and overall approach. Fundamental to this approach, and to what will be referred to as FSR in this paper, are three points (adapted from Harrington *et al.*):

- a diagnostic function, to enable the selection of research priorities relevant to the farmer's circumstances;

- evaluation of the interaction between the introduced technology and other components of the farming system, to determine the overall impact; and

- the conduct of much of the research and development on-farm, where farmers can actively participate in the evaluation of the technology.

The objectives of this paper are to review the utility of FSR methods for developing MPTS technology, assess current and future trends, and give examples from an FSR project in Central Java.

Review of FSR Approach and Methods

The generalized approach to FSR is described in Figure 1. This approach is similar to many advocated for agroforestry research and development (Raintree 1987). While the approach may not have changed since the early days of FSR, there has been a considerable degree of development and refinement of individual procedures and methods.

Diagnosis

Many early FSR projects regarded site description as the first of a sequence of steps. They gathered as much information about the target area as possible, using comprehensive surveys. Only subjects that had been previously identified could be included, and attempts to cover all possible subjects and problems led to impossibly long questionnaires. This exercise was often delegated to a particular sub-group of the FSR team, usually economists, and carried out by specially hired enumerators. The technical scientists often did not contribute to, or benefit from the diagnosis, and ended up working on familiar topics such as variety and fertilizer testing.

Chambers (1983) eloquently summarized the practical results of such extensive surveys:

> ...material remains unprocessed, or if processed, unanalyzed, or if analyzed, not written up, or if written up, not read, or if read, not remembered, or if remembered, not used or acted upon.

These problems led to a greater emphasis on rapid rural appraisal (RRA) methods, where a small interdisciplinary group of researchers would talk to farmers, progressive farmers and key individuals without a predetermined questionnaire (Collinson 1981). Concepts and ideas were taken from ecology, which helped to identify and diagram relationships between farm enterprises, farms and communities (Hart 1981; Conway 1986). When broad problems were identified with a RRA approach, smaller, more directed surveys could then be designed to obtain more focused information on particular constraints.

In spite of its apparent simplicity, the informal survey can vary in terms of success or usefulness. Talking and listening to farmers is not easy. Scientists may come from a different community, speak a different language and may not be trained to interact with people. Researchers also have preferences of visiting near roads, in dry seasons, with male farmers, with the better off, and biases to their discipline or more prestigious commodities (Chambers 1983). Even agricultural researchers trained in FSR methods may not see the trees on farms they visit -- they are simply invisible to them (Raintree 1987).

Techniques of rapid rural appraisal became the subject of great interest and several specialized workshops, ie. Khon Kaen (1987). Ultimately, the only way to improve RRA skills is to practice, which means that it needs to become a routine method, rather than an occasional activity supported by external agencies or advisors.

Diagnosis does not just involve surveys, either formal or informal. Field experiments designed to explore the causes of productivity problems (exploratory trials) have been a common feature of FSR programs (Winkleman and Moscardi 1981). The first stage of experimentation or observational trials described by Huxley (1987), to explore a situation rather than confirm a hypothesis, is similar to the focus of agroforestry research. He also described a number of systematic procedures that are especially useful in agroforestry.

Diagnostic methods have therefore evolved considerably from the site descriptions of many early FSR projects. Many farming systems researchers probably started out with the idea described by Raintree (1987), believing that there was a single optimal procedure that would be perfected through experience. Instead, practitioners increasingly blend the best and most appropriate of an array of different techniques, depending on the circumstances.

The diagnosis and design procedures developed by the International Council for Research in Agroforestry (ICRAF) demonstrate an increasing portfolio of procedural variations to be used depending on the scale of the field situation (village, watershed, or region), while maintaining and simplifying the underlying concepts (Raintree 1987). Diagnosis has been increasingly recognized as an iterative process, rather than a first step in a sequential process, done once and then forgotten. Continuous diagnostic work is planned on the basis of the results of each cycle of activities and serves to constantly focus research and extension efforts (Raintree 1987; Tripp and Woolley 1987).

Planning

Diagnosis is only useful if translated into a plan of action. Reliance on subjective opinion to determine research or extension priorities does not naturally lead to such a plan. Researchers tend to accord priority to those problem areas with which they are familiar. Without an objective means of ranking, the obvious problem, such as a large insect chewing its way through maize leaves, is accorded more importance than a less noticeable but more serious problem, such as soil erosion and long term loss of fertility. It is often not clear whether problems require research or extension.

Tripp and Woolley (1987) have recently developed a more detailed planning procedure. Their method, adapted slightly, involves scoring and ranking problems on the basis of:

- the loss in productivity (%) either at present or likely in the future;

- the importance of the enterprise (crop or livestock) to individual farmers (area or number per farm, value, food security);

- frequency of occurrence; and

- number of farmers affected.

Solutions to these problems can then be prioritized on the basis of potential benefit -- productivity, stability, sustainability, equitability; and ease of adoption -- compatibility with farming system, complexity, amount of inputs/credit needed.

The confidence which researchers and extensionists have in the problems and proposed solutions should then determine the appropriate form of action (Figure 1). If the problem is not clearly defined, more diagnostic work needs to be done. If the best solution to the problem is not obvious, research needs to be carried out to evaluate a number of hypothesized options. If there is agreement about the best solution, but experience with implementation is lacking, verification of the technology is needed. If there is confidence that the technology is suitable for farmers, then time and money should not be wasted with research -- the technology should be implemented.

Searching for possible solutions is heavily dependent on experience, and can not simply be taught. As Huxley (1987) stated in relation to agroforestry, it should be clear what is already known and what is not. Unfortunately, in practice this is not always the case, and a considerable degree of repetitive research is carried out. Sources of solutions include the literature, practices in other areas, practices on progressive farms, and work at other institutes and projects. Access to literature may be difficult, and much literature may be in a different language. Newsletters in a simpler format can help, and computerized data bases and synthesizing models offer potential for the future.

Technology testing

Theory

Much of the early FSR work involved developing and testing technology for annual crops. A sequence of experiment types and designs led progressively from small plot experiments on a few farms, emphasizing the evaluation of biological productivity, to larger plots on additional farms where economic returns and farmer acceptance were evaluated (Collinson 1987).

Component technology trials determine the optimum type or level of an input (variety, fertilizer, or plant arrangement). This is the testing stage in Figure 1. Typically, component technology trials use randomized, complete block experimental designs, with plot sizes of 10-50m^2 and results evaluated by an analysis of variance of yields. Component technology trials lead to a package of recommendations.

Trials to compare the economic benefit of this new technology are often called verification trials. These trials often consist of two treatments: improved vs. farmer-planted in plots of 250-1,000m^2. Farmers are responsible for carrying out the operations after appropriate demonstrations. The number of farmers included in such trials has varied, with suggestions ranging from 6 (Zandstra *et al.* 1981) to at least 30 (FSSP 1987), probably due to the degree of uniformity of farm conditions familiar to the researchers. Analysis of the verification trial results has usually stressed a comparison of production, economic return, and variability of these across the sample (Hildebrand and Poey 1985).

The need for on-farm testing of the economic and social benefits to livestock technology, compared to further documentation of biological effects, has been increasingly stressed (Devendra 1987). Similar to crop research, the ideal approach has been stated as a progression from on-station research, through on-farm research managed by researchers, and finally to farmer managed validation (van Eys 1985). With MPTS, Atta Krah and Francis (1987) have distinguished between types of trials to collect technical, biological and economic data (what they describe as type 1 information), and farmers' own evaluation of the technology (type 2 information).

Practice

The difficulties with the above approaches to technology testing have been described by Amir *et al.* (1989). In retrospect, it can be seen that much FSR has been a losing battle to try and adapt research station experimental techniques to the on-farm situation. Often it is difficult to apply these techniques to on-farm component technology trials, and verification trials need a very different approach.

Research stations are usually situated and managed to maintain uniform and fertile conditions which can show the yield potential of different technologies. In more marginal and variable upland environments, where mixed cropping is widespread, yield or productivity per area is difficult to measure at best, and may often be an irrelevant measure of system productivity. One answer to the problem of this variation is to increase the replication of experiments across farms, or to use experimental designs with one replication per farm. Lack of land on small holdings explains why some crop researchers have preferred to use one replication per farm in their experiments.

However, the resources available to many on-farm research programs and the number of different subjects investigated in actual practice often mean that the number of replications is not sufficient to give reasonable estimates of yield. With coefficients of variation of 25%, typical of on-farm conditions, at least 10 replications are needed to detect a 30% difference in treatment effect at the 10% probability level. There is commonly an interaction between site and the treatments under test, with some treatments best at one site, and others superior at another. If this interaction exists, and only one replication per farm is used in an experimental design, the commonly used analysis of variance does not provide any useful information. In this case, more replications are needed to identify the factors correlated with the relative performances, or to study the stability across sites.

Similarly, difficulties in on-farm livestock research include the small number of animals per farm, the mobile nature of livestock, long life cycle, unsynchronized units, measurements of multiple inputs and outputs, and measurement of long-term changes in productivity (Bernsten *et al.* 1985). As farmers are often unwilling to let researchers manage their valuable animals, or manage them according to researchers' recommendations, researchers have used unit farms or sentinel herds where they manage animals under conditions that approximate the farmers' conditions as closely as possible (ICARDA 1982; Fallada and Cook 1985). Other solutions have included paying farmers incentives in cash or inputs (Calub 1985; Bunderson and Cook 1985).

Economic return is often stressed as an important criterion in evaluating new technology. However, if estimates of production per hectare are imprecise, so will estimates of return based on the production figures. Labor data needed for an accurate partial budget are very hard to obtain (Lightfoot and Barker 1986). Secondary or non-market inputs and outputs may be ignored (such as the fodder and manuring values of a grazed fallow in a crop rotation), the real costs of credit and purchased inputs are often underestimated, and the losses incurred in a bad year unaccounted.

Most economic analyses in FSR have used short-term or annual budgeting techniques. These are not appropriate where benefits and costs are spread over several years, as with livestock and trees. Efforts have been made to include a time dimension in economic models for agroforestry (Etherington and Matthews 1983), but such analyses are still rare in practice. Furthermore, one of the principal benefits of MPTS technologies is their sustainability. It is only recently that economists in general have tried to include natural resource depletion as an economic cost, and techniques for this at the field level are almost non-existent.

It is not surprising to find that many apparently productive and remunerative technologies remain unadopted. The literature shows that research procedures and methods to deal with these problems of technology evaluation can be developed. However, this sophistication requires highly trained personnel and money. Methods resulting from well endowed foreign aid projects or the international research centers are difficult to adopt by resource poor government programs on a widespread basis (Amir *et al.* 1989). The irony is that researchers have been slow to accept the conclusion concerning research approach that is already known about farm technology -- it is not the technological feasibility which is important, rather the cost effectiveness and practicability under the everyday conditions of the users.

Farmer Participatory Research

The overall failure of FSR to involve the farmer, and the practical difficulty of many FSR methods, has intensified the debate about the relative importance of technical, biological and economic evaluation versus the farmer's opinion. The literature on alley cropping provides a good example of this. There are calls to research a variety of management options, such as spatial arrangements, time and frequency of cutting, method of pruning, etc., under a variety of ecological conditions (Ssekabembe 1985). Others argue that using a classical experimental approach to determine the optimum arrangement of these variables would require many years before recommendations could be made, and would fail to take into account both the farmers and many of the secondary products of the alley farm (Sumberg and Okali 1988).

Alternative approaches, it is argued, need to incorporate farmers into the process of development and provide both farmers and researchers with an appreciation of the options presented by the technology. Well structured experimental trials to evaluate a defined technology can not provide this information, and offer little scope for farmer participation (Lightfoot *et al.* 1986).

Sumberg and Okali suggest that results can be assessed in terms of farmers' interest and adoption, which they argue is by definition validation of a technology, even if the effects of the technology are difficult to quantify. Calls to evaluate farmers' opinions and adoption rates are not new. However, systematic recording of these responses has been rare. Collinson (1987) stated that few methods have been developed for evaluating farmers' opinions, but it would seem that the use of such data is less acceptable to researchers. Fellow scientists prefer yield data and statistical rigor, and donors look for figures of production increase on which to base their cost-benefit analyses.

Interest in methods to involve farmers in the development and evaluation of technology, known as farmer participatory research, has grown rapidly in recent years (Farrington and Martin 1987; Farrington 1988). It is to be hoped that this interest in the literature will give such methods more respect. Much of the research involves establishing a dialogue between farmers through group meetings and discussions, and encouraging them to identify and modify the technology to be tested. Indeed, Bunch (1982) suggests that the real aim of development workers ought to be to train farmers how to do research, rather than conduct it themselves.

In the past, FSR methods emphasized effective evaluation before technologies could be recommended for adoption (Norman and Collinson 1985). In the future, it may be easier to develop and screen promising technologies through farmer participation using adoption as the criteria, and then evaluate them for impact on production and income. This process would represent a reversal of the original FSR procedures.

The Uplands Agriculture Conservation Project

Objective and Target Area

The Uplands Agriculture Conservation Project (UACP) represents a joint IBRD and USAID effort to support upland conservation and development in Indonesia. The goal is to increase farm production and income, while minimizing soil erosion in densely populated upland areas by improving farming systems, farm technologies and management. There are five components of the project -- research, extension, training, road construction and a project innovation fund.

The project is being implemented in four districts in Central Java, and four in East Java. These districts are located within two major watersheds, the Jratenseluna, which is the catchment of 5 major rivers, and the Brantas. The eight districts are comprised of 250 thousand hectares of rainfed land, home to 18 million people, of which 80 thousand hectares have been classified as in a critical state of erosion.

The topography in the project area is predominantly hilly, with elevations of 100-400m. Rainfall varies from 1,800-2,600mm per year, distributed in a rainy season of 7-9 months. Average farm size in these uplands is about 0.6ha. Typically, farms include plots on rainfed lowland, on rainfed upland, and a homegarden. About 50 crops are economically important, with rice, corn, cassava, peanuts and soybeans the most prominent annual food crops, and coconuts, coffee, and various tree fruits the major perennial crops. About 35% of farmers' income comes from food crops, 20% each from livestock and off-farm employment, and the rest from perennial crops and forest products.

Current Technology

The extension and research components of the project started simultaneously in 1985. The extension strategy is to form farmers into groups, demonstrate improved technology on 10ha demonstration plots (formed from several individual farmers' plots) in one year, followed by an expansion to a further 50-300ha surrounding each demonstration plot the following year. Soil conservation has placed great emphasis on terrace and waterway construction, with subsidies of fertilizer and seed for food crops. Grasses (*Setaria*), legume trees (*Leucaena leucocephala, Sesbania grandiflora*) and fruit trees are distributed for planting on terrace risers.

Farmers' adoption of grasses distributed for planting on terrace risers has been high, due to their value as fodder. The potential for livestock as a source of income is considered to be high, but a major constraint is fodder production, especially in the dry season. Increasing this fodder supply, through cut and carry systems of grasses and MPTS is likely to be very compatible with erosion control.

Terracing which has been a major part of the technology extended by the project, is less suitable for the widespread shallow soils in the area. If done well, it is expensive. Because of these problems, there is growing interest in reducing erosion through vegetative means, rather than by terrace construction. Alley cropping as a possible alternative has received much attention recently, but there is insufficient knowledge of practical technology standards for widespread implementation, and the likely impact of these on productivity and conservation.

Research Priorities

The issues faced with alley cropping in the context of the project was to decide what is known, and what needs to be known. The state of knowledge concerning the suitability of alley cropping for the UACP areas can be broadly summarized.

The principles of alley cropping as a means of soil fertility maintenance have been demonstrated as valid on other continents, notably Africa. The principles of alley cropping as a means of erosion control through the barrier effect, mulching by cuttings, and changes to soil properties are taken as accepted (Young 1988). However, the magnitude of these effects on production and the economic benefits in the project area, compared to alternative technologies, are unknown.

Farmers in other areas of SE Asia and Indonesia have adopted alley cropping as a means of soil conservation and forage production. The practice of alley cropping is said to have originated in Timor (Metzner *in* Raintree and Warner 1986).

Farmers in UACP areas plant several MPTS, including *L. leucocephala, Gliricidia sepium*, and *S. grandiflora*. These species are usually grown as scattered trees in homegardens or as hedgerows along plot boundaries. However, there are a few cases where *Flemingea congesta* and other species have been planted intensively as regularly spaced hedgerows in upland plots. Many of these represent prior introductions by government programs, such as the regreening program, during recent decades. Farmers' knowledge concerning the fodder and soil conservation potential of these MPTS is unclear.

Much of the cultivated uplands in the project area is already terraced to some degree, although the standards of this terracing for runoff and erosion control are generally poor. Terraces are usually 2-5m wide, and cassava is often grown along the terrace edge where the soil is the deepest and the cassava easy to dig. This means that it is difficult to implement hedgerows precisely along the contour, alley widths are largely determined by terrace width, and benefits of MPTS on terrace edges will have to be visible enough to displace the cassava.

Uncultivated upland areas, covered by *Imperata cylindrica* or other grasses, are common in the project area. The long-term use or rotation of this type of land, and its importance for grazing and fodder collection has not been well studied. Consequently, the potential for MPTS as a fallow improver, fodder source or means of introducing permanent cultivation is largely unknown.

L. leucocephala has been severely affected by the psyllid in recent years. In some initial observation studies by the project, *F. congesta* has shown vigorous growth. The extension component of the project has started to include *F. congesta* in demonstration plots on shallow limestone soils.

Research Plans and Methods

Based on the information outlined above, a research program was planned using the process in Figure 1 as a framework, keeping within the limits of the resources available to the project. An important factor was the pressure to demonstrate practical results quickly, which meant that the research steps outlined in Figure 1 were carried out simultaneously instead of sequentially. The research priorities resulted in the design of several activities:

- a survey in the project area to determine farmers' perception of MPTS and their use in soil conservation. Due to the type of information needed, an unstructured interview procedure (with no pre-defined questionnaire) was used. Four researchers spent 4 days contacting and conversing with extension agents and farmers in 4 districts of East Java (November 1989).

- researcher managed trials (replicated block experiments at one site) to quantify the effect of hedgerows on soil erosion and productivity:

    - an experiment in the project experimental station to compare soil erosion under alley cropping with *F. congesta*, to terraces (established 1988);

    - an experiment in the project experimental station to compare biomass production of different hedgerow species including *Calliandra calothyrsus, Tephrosia volgeti, F. congesta*, and *Desmanthus virgatus* with associated crop production and soil erosion (established 1988);

    - an experiment to evaluate long-term productivity of a shallow limestone soil, typical of many project areas, under hedgerow intercropping with *F. congesta*. Changes in soil properties and production of annual crops will be monitored, using four treatment combinations of hedgerows vs. control, with and without inorganic fertilizers. This site is currently marginal for annual crops and was last used for cassava production (established 1989);

    - an experiment to compare long-term soil changes and crop productivity under different amounts of *F. congesta* mulch (established 1988); and

- farmer managed trials in two project villages to determine farmers' acceptance and evaluation of planting hedgerows on terrace edges.

Approximately 15 farmers will be involved in each village, with the planned intervention consisting of establishing mixed hedgerows of *F. congesta* for mulch and *G. sepium* for fodder. This activity is in the initial stages, with preliminary meetings with the farmers in 1989 to describe objectives and the technology. The initial reaction of the farmers seems promising.

Preliminary Findings

Farmer survey

The survey in East Java showed that farmers use a range of MPTS for fuelwood, fodder, fertilizer and shade for perennial crops. A range of characteristics, including plant and root architecture, susceptibility to insect damage, fodder palatability in different seasons, leaf decomposition rates, and calorific value of the wood determined the overall suitability of individual species for different uses (Table 1). The species described are mainly grown as shade trees in coffee plantations, along roadsides, or as hedgerows along plot boundaries. The combined benefits mentioned above appeared insufficient to outweigh the disadvantage as perceived by farmers, of displacing food crops on land cultivated for this purpose.

Two species thought by researchers to have particular potential are Gliricidia and Flemingea. Gliricidia has been extensively distributed under the regreening program during the last 25 years, and in some villages adoption has been considerable with planting stock actively traded. The foliage of Gliricidia is used as fodder mainly in the dry season; in the wet season, farmers say the leaves are less palatable to livestock, and are used as fertilizer. In some cases, leaves were composted. Gliricidia was considered to be good fuelwood, but the root system was said to be poor for terrace stabilization.

Flemingea has been introduced into the area during the last 30 years by the plantation crops extension services (for coffee shade), and by the State Forest Company for soil conservation. A few extension workers and farmer leaders have realized the potential of Flemingea for terrace stabilization and have tried to promote its use on land cultivated for food crops. There has been little adoption to date, however. Farmers said that it competes for space with food crops -- principally cassava, which is normally planted on terrace edges. Farmers agreed that the

Table 1. Commonly used MPTS in UACP areas, East Java, Indonesia.

Scientific Name	Current Uses	Rating by Farmers
Erythrina spp.	Coffee shade	Medium
Leucaena leucocephala	Coffee shade	Good
	Fuelwood	Good
	Fodder	Good
	Fertilizer	Good
Dalbergia sissoo	Timber	Good
	Fuelwood	Good
	Fodder	Medium
	Fertilizer	Good
Sesbania grandiflora	Fuelwood	Medium
	Shade	Medium
	Fodder	Good
	Vegetable	
Gliricidia sepium	Fuelwood	Good
	Fodder	Good
	Shade	Medium
	Fertilizer	Good
Acacia villosa	Fodder	Good
	Hen feed	
	Terrace support	Medium
Flemingea congesta	Terrace support	Good
	Fodder	Poor
	Fuelwood	Poor
	Fertilizer	Medium
Calliandra calothyrsus	Fuelwood	Medium
Calliandra tetragona	Fodder	Good
Paraserianthes faicataria	Shade	Medium
	Fodder	Medium
	Fuelwood	Medium
	Timber	Good

leaves make good fertilizer, although some said that the slow decomposition was a disadvantage. There were differences of opinion concerning fodder value. In the wetter areas where other fodders are more available, it was said that livestock did not like Flemingea. In drier areas, however, farmers said they used it as fodder in the dry season, and feeding of goats was noticed on some farms. One farmer said he had experimented with Flemingea seeds as food, which he compared to mungbean.

The results of the survey indicate that the perceived benefits of MPTS are not sufficient for them to be easily adopted as a conservation measure on annual crop land. Research needs to develop management practices that can maximize these benefits and minimize competition with food crops. Extension needs to support seed distribution with information on management. Policy measures which discourage cassava cultivation will make conservation measures with MPTS more attractive.

Biomass Production of Hedgerows

Four MPTS species were planted at Ungaran research station in October 1988. Cuttings were taken every 45 days at 1m in height. Biomass production (sun dried weight) from cuttings during the first 10 months of growth per double hedgerow were:

Tephrosia volgeii	- 42.0 kg/m
Calliandra calothyrsus	- 1.1 kg/m
Flemingea congesta	- 0.9 kg/m
Desmanthus virgatus	- 0.0 (failed to establish)

There was some decrease in the associated alley crop of mungbean planted in February, with yields of 730 kg/ha in the Desmanthus (control) plots compared to 300, 540 and 430 kg/ha in the Tephrosia, Calliandra and Flemingea plots, respectively. Cowpea planted in April seemed relatively unaffected by the MPTS species, all plots yielding 200-300 kg/ha. As these crops were given inorganic fertilizer, and the MPTS were in initial stages of growth, it is unlikely that any benefits of nutrient addition from the pruning would have been evident. Future pruning in this and other MPTS experiments will be timed to coincide with critical growth stages of the associated crops, such as planting and flowering, rather than at regular intervals.

Erosion Under Alley Cropping

Alley cropping with *F. congesta* (single rows at 4m spacing, 30% slope) was one of several treatments in a long-term field trial established at Ungaran research station in October 1988. During the first year, growth of the Flemingea was generally good, but there were a number of gaps in the hedgerows which required reseeding.

Erosion in the first year, with 2,515mm of rain, was 110 t/ha in the alley crop plots, compared to 25 t/ha for bench terraced plots, and 50 t/ha in ridge terraced plots. This relatively high rate of erosion was expected, as the hedgerows were not yet sufficiently established to produce much benefit. The plots will continue to be monitored.

Effect of First Year Mulch

Mulching corn with *F. congesta* biomass on a clay soil (Typic ustorthent/Typic ustropept) in Boyolali District, showed only marginal yield benefits -- 5 t/ha corn yield with 5 t/ha fresh weight mulch applied at planting, compared to 4.2 t/ha corn yield with no mulch (Umi Haryati unpublished).

However, all the plots were fertilized at the recommended dose of 90:45:60 ($N:P_2O_5:K_2O$). Similar mulching experiments of upland rice with *L. leucocephala* in Java have shown that response curves to mulch and fertilizer are similar (Toha *et al.* 1986), with 10 t/ha fresh weight of foliage equivalent to 100 kg/ha urea. At optimum rates of fertilizer, little benefit is gained from the additional nutrients supplied by mulch.

This finding has important implications for potential adoption in the UACP area. Experience has indicated that soil conservation measures, ie. grasses on terrace risers, are more quickly adopted if there is a significant short term gain such as fodder. Farmers already use relatively high amounts of fertilizer on upland crops, so MPTS hedgerows are unlikely to have a noticeable impact on crop yields due to the nutrient effect. Alley cropping may be a useful technique for soil conservation, but in the absence of an increase in yield due to the nutrient effect, the technology will be much less attractive to farmers. This suggests that more stress should be placed on managing MPTS as a fodder source, which may offer visible benefits.

Conclusion

A combination of carefully designed surveys and experiments can be effective in answering key questions concerning the usefulness of MPTS, for orienting MPTS research, and for developing practical recommendations for extension. The design of these activities should be dependent on the type of information needed. In some cases, careful researcher managed experiments or structured surveys are needed to provide quantitative data. In other cases, a more qualitative evaluation of farmer opinion or adoption, from farmer managed experiments or informal surveys, will be sufficient to define future research and extension needs. Researchers are generally more comfortable with 'hard' quantitative data and activities under their control. In the future, active involvement of farmers, and reliance on their opinion needs to be increasingly developed to make research more effective and efficient.

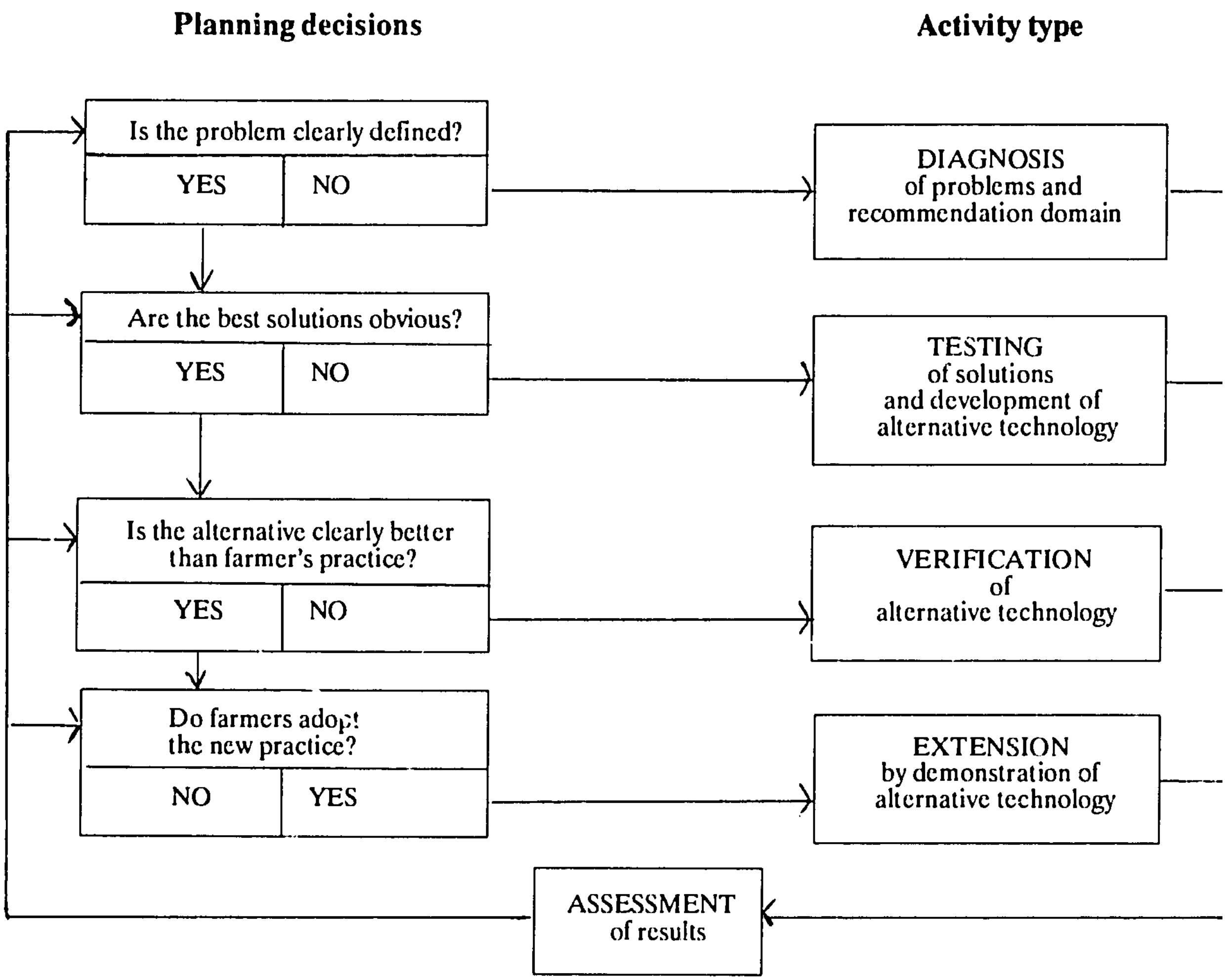

Figure 1. General approach to farming systems research.

References

Amir, P., R.C. Hawkins and D.M. Mulyadi. 1989. Methods of on-farm research. In *Development Procedures for Farming Systems Research*, eds. S. Sukmana, P. Amir and D.M. Mulyadi. Jakarta: Agency for Agricultural Development, Indonesia.

Atta-Krah, A.N. and P.A. Francis. 1987. The role of on-farm trials in the evaluation of composite technologies: the case of alley farming in southern Nigeria. *Agricultural Systems* 23:132-152.

Bernsten, R.H., H.A. Fitzhugh and H.C. Knipscheer. 1985. Livestock farming systems research. In *Animals in the Farming System*, ed. C. Butler Flora, pp. 64-109. Kansas: Kansas State University.

Bunch, R. 1982. *Two Ears of Corn*. Oklahoma: World Neighbors.

Bunderson, W.T. and R.H. Cook. 1985. Feeding conserved forages to traditional cattle in the Nuba Mountains, Sudan. In *Research Methodology for Livestock On-farm Trials*, eds. T.L. Nordblom, A.E.K.H. Ahmed, and G. Poats, pp. 41-64. Ottawa: IDRC.

Calub, A. 1985. Experimental design and procedures for on-farm livestock trials. In *Farming Systems Socio-Economic Monitoring Tour/Workshop*, pp. 131-152. Los Banos: International Rice Research Institute (IRRI).

Chambers, R. 1983. *Rural Development: Putting the Last First*. London: Longman Press.

Collinson, M.P. 1981. A low cost approach to understanding small farmers. *Agricultural Administration* 8:463-471.

______. 1987. Farming Systems Research: Procedures for technology development. *Experimental Agriculture* 23:365-386.

Conway, G.R. 1986. *Agroecosystem Analysis for Research and Development*. Bangkok: Winrock International/Agricultural Development Council.

Devendra, C. 1987. The relevance of on-farm animal research in Asia. In *On-Farm Animal Research, Extension and its Economic Analysis*, eds. P. Amir and H.C. Knipscheer, pp. 13-18. Arkansas: Winrock International.

Etherington, D.E. and P.J. Matthews. 1983. Approaches to the economic evaluation of agroforestry farming systems. *Agroforestry Systems* 1:347-360.

Fallada, B. and R.H. Cook. 1985. Design and implementation of in-herd/on-range trials: use of sentinel herds. In *Research Methodology for Livestock On-farm Trials*, eds. T.L. Nordblom, A.E.K.H. Ahmed, and G. Poats, pp. 133-152. Ottawa: IDRC

Farrington, J. 1988. Farmer participatory research: Editorial introduction. *Experimental Agriculture* 24:269-279.

Farrington, J. and A.M. Martin. 1987. *Farmer Participatory Research. A Review of Concepts and Practices*. Discussion paper 19. London: ODI Agricultural Administration Network.

FSSP. 1987. Design Techniques for On-farm Experimentation. *Farming Systems Research/Extension Training Units*, Vol. 2. University of Florida: FSSP.

Harrington, L.W., M.D. Read, D.P. Garrity, J. Woolley and R. Tripp. 1989. Approaches to on-farm client-oriented research: similarities, differences, and future directions. In *Development Procedures for Farming Systems Research*, eds. S. Sukmana, P. Amir and D.M. Mulyardi. Jakarta: Agency for Agricultural Development, Indonesia.

Hart, R.D. 1981. An ecological systems conceptual framework for agricultural research and development. In *Readings in Farming Systems Research and Development*, eds. W.W. Shaner, P.F. Philipp, and W.R. Shmehl, pp. 50-65. Tucson, Arizona: Consortium for International Development.

Hildebrand, P.E. and F. Poey. 1985. *On-farm Agronomic Trials in Farming Systems Research and Extension*. Colorado: Lynne Rienner.

Huxley, P.A. 1987. Agroforestry experimentation: Separating the wood from the trees? *Agroforestry Systems* 5:251-275.

ICARDA. 1982. *Project IV: The Role of Livestock in Farming Systems*. Aleppo, Syria: ICARDA.

Lightfoot, C. and R. Barker. 1986. *On-farm Trials: A Survey of Methods*. Eastern Visayas, Philippines: Farming Systems Development Project.

Norman, D. and M. Collinson. 1985. Farming systems research in theory and practice. In *Agricultural Systems Research for Developing Countries*, ed. J.V. Remenyi. ACIAR Proceedings No. 11. Canberra: Australian Centre for International Agricultural Research.

Raintree, J.B. and K. Warner. 1986. Agroforestry pathways for intensification of shifting cultivation. *Agroforestry Systems* 4:39-54.

Raintree, J.B. 1987. The state of the art of agroforestry diagnosis and design. *Agroforestry Systems* 5:219-250.

Shaner, W.W., P.F. Phillip and W.R. Schmehl. 1982. *Farming Systems Research and Development: Guidelines for Developing Countries*. Boulder, Colorado: Westview Press.

Ssekabembe, C.K. 1985. Perspectives on hedgerow intercropping. *Agroforestry Systems* 3:339-356.

Sumberg J. and C. Okali. 1988. Farmers, on-farm research and the development of new technology. *Experimental Agiculture* 42:333-342.

Toha, H.M., A.M. Fagi and K. Permadi. 1986. Nitrogen fertilizing and leucaena mulching of dryland rice. *Seminar Hasil Penelitian Tanaman Pangan*, Vol. 2: Padi. Bogor, Indonesia: Pusat Penelitian dan pengembangan Tanaman Pangan.

Tripp, R. and J. Woolley. 1987. *The Planning Stage of On-farm Research: Identifying Factors for Experimentation.* El Batan, Mexico: Centro Internacional para el Mejoramiento del Maiz y Trigo (CIMMYT).

van Eys, J.E. 1985. On-farm trial design. In *Research Methodology for Livestock On-farm Trials*, eds. T.L. Nordblom, A.E.K.H. Ahmed and G. Poats, pp. 283-288. Ottawa: IDRC.

Winkleman, D. and E. Moscardi. 1981. Aiming agricultural research at the needs of farmers. In *Readings in Farming Systems Research and Development,* eds. W.W. Shaner, P.F. Phillip, and W.R. Shmehl, pp. 35-49. Tucson, Arizona: Consortium for International Development.

Young, A. 1988. Agroforestry in the control of soil erosion by water. *Agroforestry Abstracts* 1(2/3).

Zandstra, H.G., E.C. Price, J.A. Litsinger and R.A. Morris. 1981. *A Methodology for On-farm Cropping Systems Research.* Los Banos: IRRI.

Small-Scale Farmer Oriented Strategy for Evaluation and Improvement of Multipurpose Trees

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The growing importance of small-scale farm woodlot development, rural forestry and agroforestry has been amply highlighted in recent literature including FAO (1978; 1981), Burley (1980), World Bank (1978), and Spears (1983) to mention just a few. These new dimensions of forestry development have the following characteristics in common: they are people-oriented both in terms of implementation and benefit; they constitute small-scale operations by individuals or communities; they have high social benefits, particularly for the rural poor; and they are often more environmentally stabilizing than industrial plantation forestry.

The potential role of multipurpose tree species (MPTS) and shrubs which can provide a range of goods and services in agroforestry and rural forestry development has been discussed by Burley and von Carlowitz (1984), Steppler and Lundgren (1988), Nair (1984), and Owino (1989) among others. For effective evaluation and improvement of MPTS for small farm use, issues worth special consideration include: the large number of potential uses of MPTS on farms; rationalizing the specific roles of MPTS on farms; ecological and farming system specific adaptations; improvement of MPTS yields through better husbandry and breeding; agroforestry technology-specific experimentation (ie. hedgerow intercropping, contour bunds/strips, scattered trees on cropland, etc.); MPTS germplasm supply and exchange; and experimental design implications.

This paper discusses these issues as they relate to research to maximize MPTS adaptation and yield under the management of small-scale farmers.

Overall Goals of Research on MPTS for Small Farm Use

In most situations, the dominant goals of research will be to adapt MPTS to specific sites and farming systems taking into account the farmers' needs for MPTS products, the compatibility with companion crops, the enhancement and sustainability of the land productive capacity, and to produce quality wood, mulch, fodder and other tree products in great quantities as fast as possible, to ensure maximum economic returns.

The goal of high-yield production has always been recognized in traditional agricultural and forestry research with relatively little attention paid to adapting MPTS to the site or the farming system. The significant roles which MPTS can play in enhancing and sustaining land productive capacity have been discussed by Bene *et al.* (1977), King and Chandler (1978), and Beer (1987). Given the current alarming rates of decline in land productive capacity under most farming systems within the tropics, it is imperative that adapting trees to site-specific conditions be accorded a higher priority in developing MPTS for small farm use.

The Number of Potentially Useful MPTS Species

Both agricultural and forestry intensive production systems have relied on a very narrow range of species the world over. It is no surprise that serious concern has been expressed about the real threat to biological diversity with the rapid expansion of such monocultural production systems. In sharp contrast to the few products expected from traditional plantation forestry, the small-scale farmer relies on MPTS for many more products and services such as fuelwood, building poles, food, fodder, and medicine.

Different communities of farmers rely on assorted combinations of MPTS grown in their fields and home compounds to provide various goods and services. The number of potentially useful MPTS on a global basis can therefore be very large. For example, a list of over 2,000 candidate MPTS has been proposed for agroforestry by Burley and von Carlowitz

(1984). The International Council for Research in Agroforestry (ICRAF) has established an MPTS database containing some 1,400 entries of 650 MPTS species with agroforestry potential (von Carlowitz 1987).

It is unnecessary to stress that the task of effectively evaluating and improving this range of potentially useful MPTS on a national, regional and global scale is daunting. Furthermore, there is now a race against time as the current rapid rate of deforestation in tropical countries is threatening many potentially useful MPTS with extinction. Overwhelming as the research agenda may sound, it is suggested that concentration on several issues could yield valuable results in the immediate and distant future. These would include the quantification and prioritization of the farmers' present and future needs for a diversity of MPTS products and services; farmer-based surveys on MPTS species and trait preferences; botanical and gene pool explorations; and *ex-situ* conservation of endangered MPTS species.

Rationalizing the Specific Roles of MPTS on Farms

Many workers have recognized the urgent need to evaluate and improve MPTS for community forestry and agroforestry. They have responded to this need by quickly establishing species and provenance trials along time-tested forestry research lines. Some of this effort has assumed regional and international dimensions such as the Oxford Forestry Institute coordinated international trials, the Australian Centre for International Agricultural Research (ACIAR) trials, the Forestry/Fuelwood Research and Development (F/FRED) Project trials, the Nitrogen Fixing Tree Association (NFTA) trials and the Agroforestry Research Networks for Africa trials. While very valuable data and information is resulting from such efforts, its direct applicability to the small farm situation may be rather limited due to the fact that the trials are not always sufficiently rationalized on current farming systems.

An approach to rationalizing specific roles of MPTS on farms and the attendant research priorities has been proposed by ICRAF (1983). This approach, diagnostic and design methodology, involves an interdisciplinary systems appraisal of the needs of the farmer and the potential roles MPTS could play in satisfying those needs. Based on the identified MPTS roles on farms, evaluation and improvement research focuses on several species which have the highest potential to yield the desired results.

For example, out of such an interdisciplinary appraisal in an area of eastern Africa with a defined food crop farming system in a defined agro-climatic zone (bi-modal rainfall highlands), it was determined that the greatest needs for MPTS are as dry season fodder supplementation, and soil erosion control and fertility enhancement. The macro-analysis was then supplemented by MPTS-specific micro-analyses which incorporated such aspects as farmers' preferences to guide the researcher to species of the highest research priority.

Beyond recognizing the potential roles of MPTS in farming systems, identified specific attributes of MPTS worthy of evaluation and improvement included soil improvement such as total litter/mulch production, litter/mulch quality, rooting habits, and nitrogen fixation potential; fodder production including total annual fodder production, dry season fodder production, palatability, digestibility, and animal performance; and fuelwood/pole production to include total wood production, bole form, and wood density. Based on these analyses, researchers were able to work with a manageable number of MPTS species for the entire zone.

Ecological and Farming System MPTS Adaptation

Climatic and edaphic adaptation of MPTS for small farm use should be evaluated along the same general lines as for plantation forestry. However, special emphasis should be given to the following aspects:

- adaptation to seasonal climatic regimes. If, for example, the purpose of introducing MPTS is dry season fodder supplementation then the emphasis should be on MPTS provenances which are well adapted to dry season growth and which produce maximum amounts of fodder during this particular season;

- adaptation and optimal response to external soil inputs such as fertilizers and manures; and

- the ability to extract nutrients efficiently from nutrient deficient soils by root associations such as mycorrhizae and proteod root masses.

In addition to adaptation, tree growth characteristics must be carefully evaluated, taking into account possible effects on companion crops. Such factors as tree-crop competition above and below ground, weediness, etc. should be considered. Finally, MPTS adaptation to the intended management by the farmer deserves special mention. Characteristics such as ready coppicing, easy rooting and lack of thorns become additionally beneficial when MPTS are grown on farms.

Several comprehensive databases already exist which can provide useful guidance on the selection of MPTS for intensive screening in different parts of the world. However, in order to derive maximum benefit from such databases, the user must clearly define the required adaptation characteristics (von Carlowitz 1987).

Improvement of MPTS Yields

In all cases, large increases in MPTS yields can be achieved relatively inexpensively through improved husbandry such as good nursery practices including inoculation with appropriate rhizobium/mycorrhiza, weeding, pruning, thinning, coppicing, and rejuvenation. In the initial phases, emphasis should be on such MPTS management research. In cases where breeding programs are justified, a sequential approach starting with provenance screening and leading to individual tree selection and subsequent breeding should be adopted. It is important, however, to realize that breeding research is both long-term and expensive and should only be attempted with prior justification and the design of technically sound breeding plans.

Agroforestry Technology-Specific Experimentation

Several recognized agroforestry technologies are hedgerow intercropping (alley farming), trees on contour/bund strips, fodder banks, scattered trees on pasture/cropland, improved fallow, multi-strata arrangements, taungya, windbreak, live fencing, etc. While adaptation factors already discussed will apply to MPTS intended for such specific technologies, there may be a need to consider additional technology-specific factors such as the selection of appropriate crown ideotypes; plasticity in crown morphology; and possible use of MPTS species, variety and clone mixtures.

MPTS Germplasm Supply and Exchange

It is important to ensure that only well documented MPTS germplasm be used in all experiments and planting programs. Distinctions between unclassified seed, source-identified seed (seed stands), selected seed (parents known) and certified seed (seed orchards) should be maintained. Regulations of the International Seed Testing Association (ISTA 1976) should apply in all cases of seed exchange and in some cases, the Organization for Economic Cooperation and Development regulations may also apply (OECD 1974).

Experimental Design Implications

It is to be expected that research on MPTS evaluation and improvement would require special experimental design considerations. For example, large numbers of entries of species and provenances, widely replicated on-farm trials, and testing for response to soil amendments may all call for special designs. The following experimental design suggestions are worth considering for MPTS evaluation and improvement research:

- for testing large numbers of species/ provenances the use of incomplete block designs such as rectangular and cubic lattices, or alpha-designs;

- for combining replicated and non-replicated entries the use of designs such as augmented design, or blocks in replication designs;

- for testing the response of several provenances to different fertilizer levels the use of designs such as the split-plot design, or the randomized complete block design;

- experiments which involve the estimation of genetic parameters will call for the union of mating designs and field designs, for example: partial diallel mating design and incomplete block field design, or test cross-mating design and randomized block field design; and

- with regard to plot size and shape, the need will arise to move away from the traditional large square plots to smaller rectangular plots, towards double and single row plots and even single tree plots.

References

Beer, J. 1987. Advantages, disadvantages and desirable characteristics of shade trees for coffee, cacao and tea. *Agroforestry Systems* 5:3-13.

Bene, J.G., H.W. Beall and A. Cote. 1977. *Trees, food and people: Land management in the tropics*. Paper No. 84. Ottawa: IDRC.

Burley, J. 1980. Choice of Tree Species and Possibility of Genetic Improvement for Smallholder and Community Forestry. *Commonwealth Forestry Review* 59(3).

Burley, J. and P.G. von Carlowitz. 1984. *Multipurpose Tree Germplasm*. Nairobi: ICRAF/German Agency for Technical Cooperation (GTZ).

Food and Agriculture Organization of the United Nations. 1978. *Forestry for Local Community Development*. Forestry Paper No. 7. Rome: FAO

_____. 1981. *Forestry and Rural Development*. Forestry Paper No. 26. Rome: FAO.

ICRAF. 1983. *Draft Resources for Agroforestry Diagnosis and Design*. Working Paper No. 7. Nairobi: ICRAF.

ISTA. 1976. International Rules for Seed Testing. Rules 1976, *Seed Science & Technology* 4.

King, K.F.S. and M.T. Chandler. 1978. *The Wasted Lands*. Nairobi: ICRAF.

Nair, P.K.R. 1984. Soil productivity aspects of agroforestry. In *Tree Species for Energy Production*. Washington, D.C.: National Academy of Sciences.

Organization for Economic Cooperation and Development. 1974. *OECD Scheme for the Control of Forest Reproductive Material Moving in International Trade*.

Owino, F. 1989. The role of the International Council for Research in Agroforestry in the Improvement of Agricultural Production in Africa. Paper presented at the Workshop on Genetics and Genetic Engineering: their role in agricultural development in Africa, February 20-25. Nairobi: Association of Faculties of Agriculture in Africa.

Spears, J.S. 1983. *Tropical Reforestation: An Achievable Goal?* Summary of interim findings of a study prepared for the 9th World Forestry Congress in 1984. Washington, D.C.: World Bank.

Steppler, H.A. and B.O. Lundgren. 1988. Agroforestry: Now and in the Future. *Outlook on Agriculture* 17(4):146-152. Oxford: Pergamon Press.

von Carlowitz, P.G. 1986. *Multipurpose Tree and Shrub Seed Directory*. Nairobi: ICRAF.

_____. 1987. ICRAF's multipurpose tree and shrub information system. *Agroforestry Systems* 5:319-338.

World Bank. 1978. *Forestry Sector Policy Paper*. Washington, D.C.: World Bank.

Poster Session Presentations

On-Farm Communication: Three Systems

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Visits were made to three organizations in the Philippines to study their approaches in communicating technical information to individual farmers. All used field demonstration plots. One organization used "traditional" extension methods based on published information in conjunction with classes. The second used demonstration and instruction by technicians. The third utilized a method of farmer teaching farmer.

All were effective to a certain extent. The traditional system assumed a good literacy level and relatively easy conceptualization by the farmers. The technician demonstration and teaching incorporated a high technical level and full grasp of underlying principles. The farmer-to-farmer relationship was noticeably less firm technically, but was feasible and had been successful in the past. Integrating the three models appears to offer advantages over any one of them, but it is probably only possible for a very well-financed organization.

On-Site Field Visits

International Institute for Rural Reconstruction

A recent workshop[1] in the Philippines included extended visits to three organizations. The first was the International Institute for Rural Reconstruction (IIRR) at Silang, Cavite. IIRR has excellent classroom facilities, with audio-visual equipment for video displays and microphones placed strategically to facilitate discussions. A wide variety of field demonstrations are available on the surrounding campus.

IIRR provides a wide range of information in the form of brief notes or pamphlets of 2 to 6 pages. The notes are color coded by subject matter, are well written, and printed well. A twin series is particularly effective. New subjects, such as *Low-Input Rice*, *Grain Legumes*, or *Green Manures in Rice* are introduced in a series on pink paper. Most are 4 to 6 pages long and include some discussion.

That general series is accompanied by a second series on green paper, treating specific aspects of one subject. Currently available for low-input rice production, for example, are *Water Management in Rice for Drought-Prone Locations, SORJAN Rice-Based Integrated Cropping Systems, Green Manure Utilization in Lowland Rice, AZOLLA: A Bio-Fertilizer for Lowland Rice*, and others. These detailed notes address specific topics, and are 2 to 4 pages in length.

The general series also includes subject matter suitable for extension professionals, but for few small farmers, ie. *LIRRP: Cost-Benefit Analysis* and *Pinpointing Areas of Production to Work in Based on Costs of Production and Potential for Increases in Yield*. Such subjects are undoubtedly relevant to small-farm management, but only a limited number of farmers are prepared to deal with them.

Rural Life Center

The second visit was to the Rural Life Center (RLC), Davao del Sur, Mindanao, famous for its soil and water conservation work. In addition to contour hedgerow farming with SALT (Sloping Agricultural Land Technology), the Center also studies and promotes homegardens by FAITH (Food Always In The Home), lowland intensive farming through UPLIFT (Using Proper Lowland Integrated Farming Technology), and trains school dropouts in intensive farming through BOOST (Baptist Outside of School Training).

Although formal research is virtually absent from its program, the national and expatriate farmers have devoted years of intensive study and trials to develop practical soil and water conservation technologies, constantly tested by local farmers.

Outreach is primarily by trainee visits of several days to the Center (3-4 months for BOOST trainees) to gain actual hands-on experience. Demonstration plots are maintained to facilitate such training. Rice plots are planted at weekly intervals, for example, so a trainee can work with a different stage of rice development each day. Carefully planned bulletins are provided, but the quality of the printing indicates they receive lower priority and financial support than the field work and training.

In most cases, a trained agriculturalist visits the trainees after they have returned to their farms, to distribute sample seeds and provide technical advice on the ground. If a local group seriously adopts the technology, technical advice is continued indefinitely upon request.

In addition to the contour alley cropping, gardens, and snail-duck-pig-rice paddy cultivation, the Rural Life Center is notable for the amount of cost and yield information collected for woodlots and goat herds.

Mag-uugmad Foundation, Inc.

The third visit was with the Mag-uugmad Foundation, Inc. (MF), a locally managed organization based on an earlier World Neighbors project. It operates in the hills about 40 minutes from Cebu City, Cebu. MF still maintains ties with World Neighbors.

Normally, 3 - 5 representatives of a farmers' organization visit for a few days, living and working with MF farmers. After their return home, a small group of MF members will visit their farms upon request to help them get started with the new technology. The participating MF training officers and farmer leaders are reimbursed for the time spent in training by outside grant money.

Comparisons

All three organizations used field demonstration plots, covered similar technologies, and included overlapping methods of teaching, but there were obvious differences. IIRR was clearly oriented toward a more highly educated participant, both in the type of material used and the manner of communication.

The RLC personnel stated and demonstrated that they attach top priority to soil and water conservation for the long-term good of the farmer trainees. The Center's workers are dedicated and competent as shown by the high level of technical training, although trainees need not be literate. There was an impression that a conscious effort was necessary to avoid teaching visiting farmers more details than they can absorb.

The MF, on the other hand, uses practicing farmers as teachers. Their fields were generally not as well managed as those of IIRR or RLC, nor were they as consistent. Each farmer had his own priorities, which were obvious. One difficulty, it seemed, was that the farmers were taught a single generally usable technique for carrying out each needed step, which was not necessarily the best in every case, nor universally practical.

No information was available to evaluate the relative cost effectiveness, even approximately, of using paid farmers versus using educated national agriculturists.

All three organizations communicate effectively, to slightly differing audiences, and there is no reason why only one method should be used. Indeed, as mentioned above, more than one method is desirable.

The IIRR use of publications and trainee groups is an extremely effective way to reach large audiences who read and understand what they read, and who absorb concepts easily.

The MF farmer-to-farmer method, on the other hand, requires little literacy and is demonstrably practical. If farmer leadership participation were free of cost, the multiplier effect could be tremendous. However, farmers cannot afford to devote an appreciable amount of time to training others without some form of compensation.

To an extent, the RLC represents a compromise between the other two: high technical expertise, publications for the literate, and hands-on experience for all.

In an ideal world, each organization would have top quality publications and group training facilities, great field training conditions, dedicated agricultural specialists supervising the field experience, farmers interested in training, and funds to repay them for their time and trouble. In the meantime, while taking different routes, all three organizations are demonstrating practical communication methods and contributing significantly to improving the lives of small farmers.

Note: [1] Workshop on Sustainable Agriculture in the Uplands, August 25 - September 9, 1989 in the Philippines. Hosted by the Mindanao Baptist Rural Life Center, Mag-uugmad Foundation, Inc., and the International Institute of Rural Reconstruction.

Social Acceptability of Multipurpose Tree Species for Community-Based Tree Farms in Magallones, Cabagan, Isabela, Philippines

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The study aims to determine how the farmers' experience and knowledge about the attributes of selected MPTS affect their choices of tree crops for farm use. The extent of use of the species by the farmer and the perception of its suitability as a farm crop were used as measures to determine the level of preference.

Results of Fisher's Exact Probability Test at the 5% level of probability show that the farmers' awareness of the multiple uses of the species as well as its availability in the local area significantly affect their choice. Except for knowledge of the species' growth features, other factors such as knowledge of the agroforestry potential, presence of government support, and occurrence of associated problems also affect their decisions.

Therefore, to enhance the adoption of unfamiliar MPTS among farmers, localized training in agroforestry practices, appropriate extension strategies, and seed/seedling distribution are necessary. Emphasis should be focused on the farmer's livelihood as well as on the impact of tree farming on this standard of living as it affects the farm family's socioeconomic status and the immediate environment.

Methodology

A social survey was conducted using personal interviews with 31 respondents chosen at random from 92 heads of household at Centro Magallones, Cabagan, Isabela, Philippines.

The respondent's preference for selected MPTS was assessed in terms of prior experience in using the species as well as perceptions about their importance. In concept, the hypothesized relationship between variable factors is defined as:

$$FP = f(U, P)$$
$$U = f(X_1, X_2)$$
$$P = f(X_3, X_4, X_5, X_6)$$

Where:

- FP = farmer's preference
- U = extent of use of the species
- P = perception of the importance of the species
- X_1 = recognition of the availability of the species in the local area
- X_2 = recognition of the species' multiple uses
- X_3 = knowledge of the species' growth features
- X_4 = knowledge of the species' agroforestry potential
- X_5 = awareness of the presence of government/non-governmental organization (GO/NGO) support and related programs
- X_6 = awareness of drawbacks/problems associated with the species

Fisher's Exact Probability Test (at α = 5%) was used to determine the level of significance of the various correlates to farmer's preference. Frequency counting was used to measure the individual degree of preference among five test species: *Leucaena leucocephala*, *Acacia auriculiformis*, *A. mangium*, *Gliricidia sepium* and *L. diversifolia*.

Results

Recognition of the availability of the species in the local area

Among the five species subjected to the awareness test, *L. leucocephala* ranked highest, followed by *G. sepium* (Table 1). The least known species were *L. diversifolia*, *A. auriculiformis* and *A. mangium*, which are rarely planted in the area.

Recognition of multiple uses of the species

Three species were selected for comparative investigation -- *L. leucocephala*, *A. auriculiformis* and *A. mangium*. Among these, *L. leucocephala* is the most well known with fuelwood, posts and fodder as its most commonly known uses (Table 2). Both *A. auriculiformis* and *A. mangium* scored low in the assessment, an indication of the absence of previous information about their features and uses.

Extent of utilization of the species

The abundance of *L. leucocephala* makes it the most utilized MPTS with fuelwood, fodder, posts, and fencing as the major uses (Table 3). This is in contrast to *A. auriculiformis* and *A. mangium* which are regarded as ornamental trees.

Effect of farmer's awareness of the multiple uses and local availability of the species on the extent of its use

Results of Fisher's Exact Probability Test show that both awareness of the multiple uses of the species and its local availability significantly affect the farmer's extent of use of the test species (Table 4). This implies that the farmer's previous experience with certain MPTS influences his/her preference for such species.

Effect of farmer's knowledge about attributes of the species

Except for the respondents' knowledge of the species' growth features, knowledge about the species' agroforestry potential, presence of GO/NGO supports and the occurrences of associated problems significantly affect the choice of species for farm use (Table 5).

Implication of Results

The farmers' knowledge of the test species' growth features has no significant effect on the choice of tree crop for farm use. The great majority of the respondents are not familiar with the growth characteristics of the test species. The availability of planting materials and where to obtain free MPTS seeds and seedlings for trial testing is of more immediate concern to the farmers.

The farmer's awareness of the species' agroforestry potential significantly affects the preference for such species. This means that farmers are highly motivated to adopt MPTS if they recognize the direct benefits for their farming system.

The existence of GO/NGO support and related programs favoring the adoption of the test species affects the farmer's preference for such species. The advent of radio programs promoting the uses of leucaena increased the species' desirability among respondents. This promotion together with the wide proliferation of agroforestry projects with leucaena as the tree crop component enhanced the wide acceptability of the species in the area.

The farmer's awareness of drawbacks and problems associated with the test species affects the preference for such species. Almost all respondents are aware of the psyllid infestation of leucaena. Of the 26 respondents who recognized the problem, only one signified a preference for the species (Appendix).

However, in terms of individual species preference, the majority of the respondents still prefer leucaena over the other test species.

Conclusion/Policy Implications

The long experience of most upland farmers in the area with certain MPTS greatly influences their preference for those species for farm use. This implies the need to increase the accessibility of unfamiliar MPTS to the farmers for them to gain experience with the feasibility of such species for farm use.

The high correlation between the farmers' awareness of the agroforestry potential of MPTS and its acceptability as a farm crop reveals the need for localized farmers' training in agroforestry. Demonstration farms need to be established for instruction and species trials.

The greater concern of most farmers for the acquisition of MPTS seeds/seedlings over knowledge of their growth characteristics strongly suggests the need for community nurseries. Such nurseries can be managed by the villagers.

Prior to promoting any MPTS there is a need to determine the compatibility of the species with the current daily and socioeconomic needs of the villagers. A follow-up action-research study should be conducted with the incorporation of each development stage, ie. seedling production, farmers' training in agroforestry, and establishment of demonstration farms. This is to provide a sufficient basis to determine the social acceptability of newly introduced MPTS in terms of field adoption.

Table 1. Number of respondents aware of the availability of MPTS.

Species	Number of Respondents	Rating
L. leucocephala	30	High
G. sepium	18	Medium
L. diversifolia	1	Low
A. auriculiformis	6	Low
A. mangium	10	Low

Rating: Low (1-10), Medium (11-20), High (21-31).

Table 2. Number of respondents aware of the uses of selected MPTS .

Uses	*L. leucocephala*		*A. auriculiformis*		*A. mangium*	
	No.	: Rating	No.	: Rating	No.	: Rating
Fuelwood	30	High	3	Low	10	Low
Forage	25	High	2	Low	2	Low
Green manure	25	High	3	Low	3	Low
Intercrop	21	High	5	Low	5	Low
Lumber	11	Medium	1	Low	2	Low
Post/Fence	23	High	2	Low	2	Low
Ornamental/Shade	15	Medium	3	Low	9	Low

Rating: Low (1-10), Medium (11-20), High (21-31).

Table 3. Number of respondents with prior experience in using selected MPTS.

Uses	*L. leucocephala*		*A. auriculiformis*		*A. mangium*	
	No.	: Rating	No.	: Rating	No.	: Rating
Fuelwood	30	High	0	None	0	None
Forage	27	High	0	None	0	None
Green Manure	20	High	0	None	0	None
Intercrop	17	Medium	0	None	0	None
Lumber	2	Low	0	None	0	None
Post/Fence	17	Medium	0	None	0	None
Ornamental/Shade	6	Low	4	None	5	Low

Rating: Low (1-10), Medium (11-20), High (21-31).

Table 4. Probability significance (P) of farmer's preference of MPTS as affected by previous experience with such species.

Variable Factor (Experience)	*L. leucocephala*	*A. auriculiformis*	*A. mangium*
Recognition of the local availability of the species	.032*	.004**	.002**
Recognition of the species' multiple uses	.032*	.008**	.038**

* Significant at α = 5%
** Significant at α = 1%

Table 5. Probability significance (P) of farmer's preference of selected MPTS as affected by knowledge about such species.

Variable Factor (Knowledge)	*L. leucocephala*	*A. auriculiformis*	*A. mangium*
Knowledge of the growth features of the species	.72	.21	.11
Knowledge of the agroforestry potential of the species	.00004**	.002**	.002**
Awareness of the presence of GO/NGO programs favoring production of the species	.026*	.005**	.01**
Awareness of drawbacks/problems associated with the species	.008**	.019*	.035*

* Significant at α = 5%
** Significant at α = 1%

Appendix. Tabulated frequency of farmers' response to variables measuring the desirability of selected MPTS.

	Number of farmers responding					
	L. leucocephala		*A. auriculiformis*		*A. mangium*	
Experience	Use	Don't Use	Use	Don't Use	Use	Don't Use
X_1 Availability of the species in the local area						
Recognize	30	0	4	2	4	6
Not recognize	0	1	0	25	1	20
X_2 Multiple uses of the species						
Recognize	30	0	3	0	4	6
Not recognize	0	1	1	27	1	20
Knowledge	Prefer	Don't Prefer	Prefer	Don't Prefer	Prefer	Don't Prefer
X_3 Species' growth features						
Known	25	3	4	6	4	5
Not known	3	0	5	16	4	18
X_4 Species' agroforestry potential						
Known	21	0	4	1	4	1
Not known	3	7	2	24	2	24
X_5 Presence of GO/NGO support						
Aware	23	4	5	3	5	2
Not aware	1	3	2	21	3	21
X_6 Associated problems of the species						
Aware	1	25	2	24	2	23
Not aware	3	2	3	2	3	3

Research on Intercropping Paulownia on Small Farms

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Recently, systematic research on improved varieties, cultivation techniques and intercropping utilizing Paulownia has been completed under the sponsorship of the Chinese Academy of Forestry with financial support from the International Development Research Centre of Canada (IDRC) Considerable progress has been made and utilization of the research results has been widespread. The area now intercropped with Paulownia has reached 2.33-2.67 million hectares over 10 provinces. These provinces, the major wheat producing areas in China, are densely populated with each farm household subsisting on only 0.6ha of cultivated land. The effects of intercropping with Paulownia on food production, farmers' income and the Paulownia timber market (both supply and demand) need to be studied. After more than 10 years of research, the favorable results have increased small-scale farmers' interest in intercropping.

Rationale

A basic problem in densely populated rural areas suffering from a lack of available cultivated land is that farmers can not afford to reduce their food production by diverting cropland to tree production, while at the same time, these areas urgently need productive and protection forests. One way to solve this dilemma is to interplant crops with trees on the same land. Paulownia is one of several multipurpose tree species (MPTS) appropriate for such a system. An analysis of intercropping wheat with Paulownia provides an example of the efficient use of scarce land resources.

Ecological Economic Efficiency Analysis

Intercropping wheat with Paulownia can increase farm productivity about 50 percent compared to planting only wheat. Several reasons for this include the fact that the utilization ratio of field space can be increased by intercropping, the amount of time cropland is utilized for production each year is extended, and the nutrient needs of wheat and Paulownia are complementary so that soil fertility can be fully utilized.

The trees can alter the microclimate of the field to create an environment favorable for improved crop yields. They can regulate the temperature and sunlight in the wheat growth stage to raise wheat yields and ameliorate the harmful effects of dry winds. Paulownia has few deleterious effects on wheat growing. When the wheat is fertilized and weeded, the Paulownia is indirectly managed, which accelerates its growth.

Intercropping Models

Three models were developed for the research trials. In the first model, crops are the dominant feature, accounting for 80% of the total planted area. The trial was designed with the rows of Paulownia spaced at 30-50m from north to south, with trees planted every 5-6m along the rows. The density of trees was 45-90/ha with a rotation of 10 years, and each year one wheat and one autumn crop were harvested.

A second model with equal emphasis on both the crop and trees was used in flat areas on both sides of a river where wind and sand were constraints to growth, about 15 percent of the total area under study. In that area the distance between rows was 10m, with the rows running parallel to the plowing contours. Trees were planted every 5-6m at a density of 165-195 trees/ha. Again, the rotation was 10 years, with a thinning after 5-6 years, with one wheat and one autumn crop harvested each year.

A model with Paulownia as the dominant feature was carried out over 5 percent of the study area. Paulownia grows fast on moist, fertile land. However, small plots of farmland not suited for crops can be utilized to plant the trees and more intensive measures can be taken to realize high yields. The trees were spaced at 5x5 or 5x6m at a density of 330-390 trees/ha. After 4-5 years when the canopy closed, every other tree was thinned. At 7-8 years, the same

Table 1. A comparison of intercropping with the control.

		Quantity/ha	Value/ha CNY*
Intercropped			
	Timber	$5.3m^3$	1846.2
	Wheat	4,999kg	4499.4
	Total		6345.6
	Inputs		1506.2
	Net profit		4839.4
Control			
	Wheat	4,513kg	4061.7
	Inputs		1353.9
	Net profit		2707.8

*Note: US$1 = 4.5 Yuan Renminbi (CNY).

thinning procedure was applied and in this way, after 14-15 years, large diameter timber is produced. Before the canopy closes two crops can be harvested, one wheat and one autumn crop. After closing only one wheat crop is harvested each year.

Economic Efficiency of the Intercrop

Research results analyzed by the Forest Research Institute demonstrate that income from the model with crops as the dominant factor was 150% higher than the non-intercropped control, while the income from the model with Paulownia as the dominant feature was 190% higher than the control. To illustrate, Zhang-Wang village, Xiao-Mong township, Yan Zhou county had 6.9ha of cropland intercropped with 383 Paulownia trees at a spacing of 6x30m for 12 years (1976-1987). Table 1 presents the income per hectare of the wheat and timber harvest. The autumn crop yield was the same as the control, so it is not included.

The net profit for intercropping was 2,131.6 CNY/ha higher than the control, equivalent to a 78.7% increase in income per hectare.

The Paulownia Timber Market

It is estimated that approximately 2 million cubic meters of Paulownia timber are produced in China each year, 600 thousand cubic meters of which are from He Nan province and 300-500 thousand from Shan Dong province. The annual timber output will gradually increase in the future. The market for Paulownia timber exists for both export and domestic consumption.

Export

Paulownia timber is exported as logs, sawn timber and boards to Japan. Total exports converted into log equivalents are presented in Table 2.

From 1986 through 1988, the total quantity exported remained at the 50-70 thousand cubic meter level.

Domestic Market

Paulownia timber is used primarily for house construction in the countryside, and to a lesser extent for furniture and other solid wood products. Estimated domestic demand by use is presented in Table 3.

Paulownia logs sell for 380-700 CNY/m3. Boards purchased by foreign trade companies sell for 1,200-1,900 CNY/m^3.

Genetic Tree Improvement

Because of its rapid growth, Paulownia responds well to genetic improvement to produce a variety of special timber. For example, timber bred for civil construction in Tai He and Jie Shou counties planted at an

Table 2. Annual Paulownia exports, 1982-85.

Year	Quantity Exported (m^3)
1982	68,576
1983	58,793
1984	55,872
1985	46,052

average density of 1,290 trees/ha, reaching a dbh of 14cm in 6 years, creates an average income of 6,000 CNY/ha per year with intercropped wheat and other crops, and exceeds the income from non-intercropped land by over 50 percent.

An experiment in which Paulownia leaves and flowers were used to feed pigs has had good results. As long as the prescribed mixture is maintained, piglets fed with the fodder show gains of 1.5-2.5 kg/month, and middle aged pigs gain 2.5-4.0 kg/month.

Paulownia and Rural Economic Development

The promotion of Paulownia has played an important role in improving rural economic development in the Huang Huai plains region.

A village fund for agriculture was established in the Dacui village of 2,090 people, in Tai Qing township of Lu Yi county. Ninety-three hectares of a total 327ha of cropland are now intercropped with Paulownia. In the same area, there are 70 thousand trees of a variety of species, including 50 thousand of Paulownia.

From 1978 to 1981, a total of 510m^3 of Paulownia timber was harvested from the collective forest with a value of 136 thousand CNY. Private plantings yielded an additional 800m^3 for another 160 thousand CNY. With this money, the villagers bought 10 tractors, two harvesters, 13 diesel engines, 40 water pumps, 26 electric motors and sank 12 wells. In addition, they set up a flour mill and a brick kiln. They have mechanized their systems of cultivation, food processing, transportation and irrigation as a result of the output from just one tree species.

Cottage industries evolved around this increasing timber trade. Paulownia timber provides the raw material for a large variety of products such as cooking utensils, furniture, picture frames, coffins, funerary urns, and so on. Many small-scale sawmills were established. It is estimated that one additional job is created for each 15-20m^3 of Paulownia timber processed.

An added benefit is the large quantity of fuelwood produced from the branches and roots of the tree during harvesting and pruning operations. The Lu Yi county of He Nan province estimates that this source of fuelwood can meet 40 percent of the total fuelwood demand in the countryside.

Table 3. Estimated domestic demand for Paulownia.

Item	Quantity (1,000 m^3)	Percent
Construction	1,600	70 - 80
Furniture	250	12 - 13
Farm Implements and Other Solid Wood Products	75	4

Conclusion

Paulownia is a good multipurpose tree species appropriate for small farm development. Technological improvements in growing and utilizing Paulownia need to be investigated further. The development strategy should focus on breeding and selection, seed production, plantation management, harvesting and processing techniques, and marketing in a systems approach to develop intercropping combinations that will promote economic development on small farms.

Production Potential of Degraded Lands with Multipurpose Tree Species

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Forest policy formulated in India as early as 1894 stressed the need for forest conservation for environmental protection. The first National Forest Policy of Free India, drafted in 1952, reaffirmed this concept and suggested complementary land uses and reforestation of land other than that under the control of the Forest Service. The latest policy, revised in 1988, again urged stewardship of eroded slopes and degraded lands for soil and water conservation, and to improve productivity and meet local needs for fuel and fodder. Tree felling on sensitive slopes has since been banned, and large-scale community plantations have been established on degraded land to meet local needs for fuel, fodder, fibers and small timber. These policies indicate the presence of political will and a concern for reforestation of degraded land, but this can not be achieved unless considerable sums of money are appropriated.

The present Indian population of 810 million may exceed one billion by the close of this century. The availability of fuelwood, the main source of energy for the rural masses, is 40 million m^3/yr compared to a demand of 240 million m^3/yr. Per capita forest area in India is 0.11ha compared to the world average of 1.04ha. Merchantable gross annual increment varies between 0.5-0.9m^3/ha as opposed to 2.5m^3/ha for the world. This shortfall requires efforts on the scale of an all-out war to escalate wood production as fast as possible.

Fuel and fodder are scarce commodities, vegetative resources are overexploited, and the person days of labor expended in their collection is staggering. Verma (1989) estimated that on average, 0.5 to 1.0 person days per family per week is spent collecting fuelwood and fodder, and suggests that 3.4 million people are involved in this who could more profitably be diverted to more useful activities. Degraded habitats are a potential area for reforestation and can improve the outlook for the future with the people's involvement and careful planning.

Degraded lands are either inherently unproductive or have been made so due to faulty soil management practices. Waste lands with tree production potential suffer from constraints which need to be addressed for economic tree growth. An often overlooked area for profitably cultivating trees is the fringe areas of fertile land along roads, canals, and around buildings.

Identification of Constraints

Four major categories of constraints can be broadly characterized as physical, environmental, biological and socioeconomic.

Physical constraints include conditions such as rocky outcrops; the presence of boulders and gravel in the soil; a high degree of slope; salinity, alkalinity and waterlogging; landslides, exposed sites; and poor nutrient and moisture conditions.

Biological constraints include interactions of humans and animals with the resources; pests and diseases; and ecological imbalances.

Environmental constraints are imposed by the interaction of rainfall and temperature; erosivity of rain and wind; moisture and nutrient balance; and overexposure to radiant energy.

Socioeconomic constraints include the attitudes and reaction of the people collectively as a community, or as a family unit, playing a pivotal role in the effective development of a people's program. The success or failure of a program depends on the value attributed to the person days of labor spent in fuel and fodder collection. Ready cash in hand for forest enrichment planting, marketability of the output, and the sharing of benefits promote interest and identification with the project.

Management Practices

To improve the productivity of degraded lands, the above constraints need careful consideration. Economic viability is the key for successful implementation of rehabilitation measures to promote the involvement of farmers. Multipurpose trees can improve production per unit area and increase the quantity of benefits. Tangible benefits promote more people's participation which improves the ecological environment and consequently restores nutrients for sustained productivity. The integration of rapidly growing nitrogen-fixing trees has the potential to enhance the rehabilitation process and increase production.

The Strategy

The first step in the rehabilitation of degraded land is to identify the constraints and select trees that fit into the climatic and edaphic parameters, preferably species which meet with local approval. This is followed by maintenance which enhances the successful establishment of seedlings for the first two to three seasons.

The next step would be to apply soil amendments to enhance growth, allowing the plants to utilize radiant energy, moisture and nutrients; and control pests and diseases to improve the quality and quantity of produce.

The third consideration to promote and enhance nutrient cycling for sustained production is to adopt moisture conservation practices, slowing runoff to optimize production.

The fourth consideration is the marketability of the surplus at a reasonable price. The income from forestry practices should aim to equal or exceed that from agricultural crops under similar site conditions, and the farmer must be convinced of its profitability.

The last consideration is the social milieu and the involvement of the rest of the community. Developing cottage industries will increase the employment potential and help to improve the economic conditions in rural areas.

Discussion

Observations from studies carried out at the Central Soil and Water Conservation Research and Training Institute (SC&WCR&TI), Dehra Dun, and its research centers located in differing agroecosystems of the country are discussed.

Plant material

Species recommended for degraded habitats are presented in Table 1. In general, trees and grasses with potential for production include *Acacia nilotica*, *A. catechu*, *A. tortilis*, *Albizia lebbek*, *Bauhinia purpurea*, *B. variegata*, *B. retusa*, *Bambusa giganteus*, *Dalbergia sissoo*, *Dendrocalamus strictus*, *Grewia optiva*, *Leucaena* spp., *Morus alba*, *Pinus roxburghii*, *P. caribaea*, *P. kesiya*, and *P. pseudostrobus* among the trees, and *Cenchrus ciliaris*, *C. setigerus*, *Chrysopogon fulvus*, *Dichanthium annulatum*, *Eulaliopsis binata*, *Panicum maximum* and hybrid napier among the grasses.

Overcoming physical impediments

Constraints such as poor soil texture, rockiness, and mixtures of boulders and gravel in the soil provide an unfavorable environment for young root systems, resulting in poor survival and growth of the plants. These impediments should be broken up for best root development. On degraded sites the plants tend to develop apical mortality, are short-lived, and consequently need to be harvested when they are at their peak of growth. They are therefore only suitable for providing fuelwood and small timber.

Drilling 100cm holes for Eucalyptus hybrids and *B. purpurea*, thus breaking up the impediments, showed a high mean annual increment of 1.32m in height and 0.52cm in dbh in the Eucalyptus, and a 0.90m increase in height and 1.85cm dbh in Bauhinia as compared to working the soil to a depth of 50cm. However, depth of soil tilling did not show any response in *G. optiva* or *M. alba*.

The growth of *Leucaena* cv K-8 in degraded soil was compared with growth in good soil more than 1m in depth. In 45cm holes, the growth in height was 4.1m higher with an increase of 4.5cm dbh in the deep soil. The root studies on Leucaena, Eucalyptus, Bauhinia, Grewia and mulberry suggest that the root systems of Grewia and mulberry are confined to the upper few centimeters, regardless of the depth of the hole in which it is planted. Further studies are in progress, but it suggests that the root system has a role to play in the depth of soil that needs to be plowed or dug up, which may have a direct effect on the cost of establishment.

A spacing of 2x2m for fuel and small timber on degraded lands is observed to be optimum. To improve the health and yield of the stand, the application of interim thinning to provide an intermediate yield is suggested. For example, in the case of the Eucalyptus hybrid, a thinning applied at the age of 4 years yielded 1.4 t/ha of fuelwood, and the coppice shoots grew vigorously, reaching the pre-thinned height in about two years. Similarly, a mechanical thinning of *Leucaena* cv K-8 at 2 years yielded 26.4 t/ha of fuel followed by another 46.4 t/ha at the final harvest in the 4th year.

For fodder, pollarding of Grewia spaced at 2x2m beginning at the age of 4 years yielded 3.3 t/ha of fodder and 8.09 t/ha of fuel annually. Ten year old mulberry plants have shown average yields of 32.98 t/ha of fodder and 34.93 t/ha of fuel annually. The leaves of Grewia provide good fodder for cattle and those of mulberry for silkworms. It provides off-farm income and additional employment for small-scale farmers.

These management practices reduce the waiting time for tangible returns, and inspire confidence of future benefits in the farmers.

Fuel/Fodder Combinations

Mixtures of forage/fiber grasses in the spacings between the rows of trees on degraded lands produce fodder within one year, which meets the need for fodder and reduces the waiting period for a return. In the following two years, at age 3-4, leaf fodder and fuel is available for the farmers. Because it is located nearby, it saves time and effort in hauling the fuelwood and fodder, which are integral to the small farm economy. The yield potential for some of the combinations at the Institute are presented in Table 2. Degraded lands can best be utilized to lessen the drudgery of women and the elderly who are normally responsible for collecting fuelwood and fodder.

Multipurpose Trees

Degraded lands are an ideal site for short rotation species to produce fuelwood, fodder, fiber, small timber and fruit trees. These have a high production potential with suitable management practices. The production varies with the felling cycle and age of the species. When harvested at the peak of growth, the production per unit area is maximized. For example, 21.6 t/ha of fuel in eight years with *A. tortilis* in Agra, and 334.04 t/ha from *P. caribaea* at the age of 14 in Dehra Dun have been recorded. The production potential of species with a rotation up to 17 years is given in Table 3. The study shows that the benefit/cost ratio with a monoculture varies between 1.37 to 1.9 in Eucalyptus, and *D. strictus* reached 4.0, but this was very site-specific.

Forage/fiber grasses

Sites with a thin mantle of soil are the best natural habitats for forage grasses and have been utilized for fodder production for generations. The forage yield potential works out to 39.0 t/ha with hybrid napier. The average yield for perennial forage grasses was 5 t/ha for *C. ciliaris*.

Conclusion

Food scarcity is a chronic problem in developing countries, and productive lands (Class I-IV) can not be diverted for tree production except under agroforestry systems. Reforestation programs should, therefore, be restricted to non-arable lands.

In recent years, development projects and self-sufficiency in food programs have led to better education, higher per capita income and better living standards. This has increased the demand for land for housing, open space, green belts, industries, educational and social institutions, etc. The pressure on the land has increased exponentially. The concept of the potential for fuelwood and charcoal production on degraded land is becoming more important in order to maximize the output of these products. These lands need judicious management and invite the direct involvement of small-scale farmers to explore a technology which may be in their best interest. It has the potential to alleviate some of the hardships of small-scale farm families.

Suggestions for the Future

Short-term economic benefits should be emphasized by the judicious utilization of water and allied resources with the integration of two and three tiered crop mixtures. MPTS should be incorporated into the farming system to provide fuel, fodder, fruit, resin, and gum. Cottage industries and off-farm employment generation should be promoted, and trees which have an existing demand in the marketplace should be emphasized.

References

Central Soil & Water Conservation Research and Training Institute. 1980. *25 Years of Research in Soil and Water Conservation in Semi-arid Black Deep Soils, Bellary.* Monograph No. 1. Dehra Dun: CS&WCR&TI.

_____. 1980-1988. *Annual Progress Report.* Dehra Dun: CS&WCR&TI.

Mathur, H.N., M.C. Aggarwal, Ram Babu and P. Joshie. 1979. Benefit cost ratio of fuel cum fodder plantation in Doon Valley. *Indian Journal of Soil Conservation* 7(2):53-58.

Puri, D.N., J.P. Singh, and Ram Babu. 1977. *Fuel yield estimation from ravines at Agra*. Tech. Manual. Dehra Dun: CS&WCR&TI.

Puri, D.N., M.K. Vishwanatham and S.K. Dhyani. 1988. Production potential of *Leucaena leucocephala* in Doon Valley. *Social Forestry for Rural Development* pp. 96-102. ISTS.

Puri, D.N., M.K. Vishwanatham and P. Joshie. 1988. Social forestry on flood prone lands. *Trends in Tree Sciences* pp. 18-24. ISTS.

Puri, D.N. and S.K. Dhyani. 1986. Scope of *Eucalyptus citriodora* under transmission lines. *Van Vigyan* 3-4.

Puri, D.N. and M.L. Khybri. 1975. Economics of ravine afforestation. *Indian Forester* 104(5): 440-452.

Ram Babu, D.N. Puri, J.P. Singh and S.K. Sharma. 1984. Economics of mixed plantation of *Prosopis juliflora* and *Acacia nilotica* for fuel in Agra ravines. *Annals of Arid Zones* 3:221-224.

Samraj, P. and V.N. Sharda. 1984. A review of work done on *Eucalyptus globulus* Babill (Blue gum). Paper presented at the Nilgiries National Seminar on Eucalyptus, Jan. 30-31. Peechi (Tridiv), Kerala: FRI.

Sharma, A.K., P. Pradhan, J.P. Nema and K.G. Tejwani. 1981. *25 Years of Research on Soil and Water Conservation in Ravine lands in Gujarat*. Monograph No. 2. Dehra Dun: CS&WCR&TI.

Singh, H., P. Joshie, and M.L. Khybri. 1984. Fodder, fibre and fuel from degraded bouldry riverbed lands under rainfed conditions. Paper presented at the Seminar on Soil Resources and Productivity.

Verma, D.P.S. 1989. Some Emerging Issues of Social Forestry Programmes. Paper presented at the 3rd Forestry Conference: FRI.

Vimal Kishore, P.R. Mishra, R.C. Bansal. 1982. Soil and water conservation measures on degraded watersheds in the Siwalik region are economical. *Soil Cons. Newsletter* 1(2).

Vimal Kishore, K.T.N. Kambiar, and S. Chandra. 1982. *Economics of fuel cum fodder plantation of the Mahi ravines of Gujarat State*. p. 229. Dehra Dun: CS&WCR&TI.

Table 1. List of species for degraded lands.

Species	Climatic Zone	Uses
Multipurpose Trees		
Acacia catechu	Dry + moist tropical	F, I
A. nilotica	Dry + moist tropical	F, Fo, G, ST,I
A. tortilis	Dry tropical, arid	F, Fo, ST
Albizia lebbek	Sub-tropical and montane, sub-humid	F, Fo, T, ST
Bauhinia purpurea	Moist tropical	F, Fo, G
Dalbergia sissoo	Moist tropical, sub-tropical	F, Fo, T, ST,I
Dendrocalamus strictus	Tropical, sub-tropical, moist tropical and dry	F, ST
Eucalyptus camaldulensis	Sub-tropical, sub-humid to semi-arid, dry, moist tropical	F, I, ST
E. citriodora	Sub-tropical, moist tropical	F, ST, I
E. globulus	Montane, temperate sub-montane, humid	F, ST, I
E. hybrid	Sub-tropical to sub-montane, sub-humid to semi-arid	F, ST, I
E. tereticornis	Dry tropical, moist tropical, sub-tropical, sub-humid to semi-arid	F, ST, I
Grewia optiva	Sub-tropical to montane, sub-humid	F, Fo
Morus alba	Montane to sub-tropical, sub-humid, lower hills and valleys	F, Fo, I
Pinus caribaea	Sub-tropical, semi-humid	F, ST, I, G
Leucaena leucocephala (K-8)	Sub-tropical to tropical sub-humid	F, Fo, ST
Grasses		
Cenchrus ciliaris	Sub-tropical, tropical, semi-arid	Fodder
C. setigerus	Sub-tropical, tropical, semi-arid	Fodder
Dichanthium annulatum	Sub-tropical, tropical, sub-humid to semi-arid	Fodder
Chrysopogon fulvus	Sub-tropical to montane, sub-humid	Fodder
Eulaliopsis binata	Sub-tropical, semi-arid	Fodder, Fiber

F = Fuelwood G = Gum T = Timber
Fo = Fodder ST = Small Timber I = Industrial

Table 2. Production potential of fuel, forage/fiber combinations.

Trees(T), Forage(G), Fiber(F)	Spacing (m^2)	Rotation (years)	Yield (t/ha)
Acacia catechu (T) + *Eulatiopsis binata* (F)	4.5 0.75	19 1	71 5.0
Acacia nilotica + *Prosopis juliflora*	4	20	108
Dendrocalamus spp. (T) + *Dichanthium annulatum* (G)	0.75	1	03
Acacia nilotica + *Prosopis juliflora*(T) + *Cenchrus ciliaris* (G)	3.4 -	15 1	39 1
Acacia catechu + *D. sissoo* (T) + *E. binata* (F)	- -	17 1	20 3
A. nilotica (T)	-	15	26
C. ciliaris + *D. annulatum* (G)	-	1	5
Dalbergia sissoo (T) + *Chrysopogon fulvus* (G)	0.09 0.75	17 1	64 06
Eucalyptus hybrid (T) + *E. binata* (G)	2 0.75	8 1	167 5.7
E. hybrid (T) + *Chrysopogon fulvus* (G)	0.5 0.75	7 1	105.7 4.5
Fodder/Fiber Alone			
Cenchrus ciliaris	1	1	5.0
C. ciliaris	0.5	1	8.4
Chrysopogon fulvus	-	1	7.5
Dichanthium annulatum	-	1	5.3
Eulaliopsis binata	1.0 x 0.5	1	5.6
Hybrid napier	-	1	39.1

Table 3. Productivity potential of degraded lands.

Species	Spacing (m)	Rotation (yrs) n	Yield (t/ha)
Trees Alone			
Acacia nilotica	4 x 3	15	66
A. tortilis	3 x 3	3	22
Dalbergia sissoo	4.5 x 4.5	19	126
Dendrocalamus strictus	-	30	2200 x 5 (clumps)
Eucalyptus camaldulensis	2 x 2	8	86
E. citriodora	2 x 2	5	4
E. globulus	2 x 2	10	100
E. hybrid	-	24	56
	3 x 3	10	15
	2 x 2	5	60
E. tereticornis	2 x 2	5	60
Leucaena cv K-S (F 205)	2 x 2	4	73
cv Salva (F-132)	2 x 2	4	62
Pinus caribaea	2 x 2	14	334
P. pseudostrobus	2 x 2	14	24
Sesbania aegyptica	2 x 2	1	04

Multipurpose Shrub Legumes for Infertile Soils in the Tropics

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Experiments have been established at four sites to identify high-yielding shrub legumes and to study nutrient responses in three key species. The sites were chosen for their soil properties and are representative of major areas to be developed for agriculture in Southeast Asia. All experiments are being harvested at three month intervals. Legumes with great promise include *Codariocalyx gyroides*, *Sesbania sesban*, and *Cajanus cajan*, while the effect of the leucaena psyllid has severely reduced the yield of *Leucaena leucocephala* at most sites. Nutritional experiments have highlighted the general responses to phosphorus and calcium (as a nutrient), and the importance of lime-induced trace element deficiencies.

Background

In many tropical countries, shrub legumes are multipurpose plants used for fodder, living fences, hedges, shade, fuelwood, erosion control, and as a source of nitrogen for other crops. They are considered to have the potential for higher yields than herbaceous legumes, and to retain their leaves longer into the dry season. In the southern Philippines and eastern Indonesia, farmers have widely adopted shrub legume-based cropping systems, which represent one of the few sustainable food production systems suitable for the uplands of Southeast Asia.

The predominant shrub legume grown is Leucaena which has adapted to neutral and alkaline soils, but does not thrive in the acid soils common in the tropics. At present there is little knowledge of what species are most suitable for specific soils or particular environments, or how the plants can be managed to give sustainable levels of increased growth.

Recently, Leucaena has been severely attacked by the psyllid, thus intensifying the need to search for possible alternative species.

The research objectives are to evaluate the performance of a range of shrub legumes in diverse soil/climatic environments; to characterize the nutrition requirements of a range of shrub legumes and define the soil factors limiting their growth; and to collect and maintain shrub legume genetic resources.

Some of the earlier research results have been presented elsewhere (Gunawan *et al.* 1987; Bray *et al.* 1988).

Methodology

The experiments consist of two types of trials: nutritional trials and species comparison trials.

The four sites chosen for this work were Sei Putih and Sembawa in Indonesia, and Utchee Creek and Silkwood in Australia. Relevant soil characteristics are presented in Table 1.

The sites were carefully chosen so that all were acidic and represented the soils of lowest fertility in the region. There were similarities between the soils at Sei Putih and Utchee Creek in that both have low exchangeable calcium and low aluminum saturation. The soils at Sembawa and Silkwood both have low exchangeable calcium and high aluminum saturation. However, the former pair of soils have developed with a relatively higher fertility status and are expected to support higher production.

The field experiments at Sembawa and Sei Putih were planted at the beginning of December 1986 in good soil conditions after adequate rainfall. The experiments at Utchee Creek and Silkwood were planted in late February of 1987 in good soil conditions after an excellent month's rain.

To be successful as a multipurpose shrub legume for the infertile soil of the tropics any candidate must withstand certain edaphic constraints. Forage production must be maintained for most of the year, or be part of a system which can support a sustainable forage supply.

Nutritional Trials

Rates of fertilizer application are given in Table 2. All fertilizers were applied in a band 50cm wide along the rows of trees and were raked in to a depth of 10cm. Potassium sulphate was applied as a split dressing; all other fertilizers were applied at transplanting. Three species of shrub legumes were used in this study: *L. leucocephala* cv. Cunningham, *Calliandra calothyrsus* and *Gliricidia sepium*. In the species comparison experiments, treatments coded F1 and F6 were used, whereas in the nutritional trials, treatments coded F1 through F6 were applied.

Species Trials

Twenty accessions from the CSIRO shrub legume collection have been grown at each of the four experimental locations. These include nine Leucaena genotypes: four of *L. leucocephala*, two of *L. diversifolia*, two of *L. pallida* and one of *L. collinsii*. *L. leucocephala* cv. Cunningham was included both with and without spraying for psyllids. The genus Acacia was represented by *A. angustissima* and an unidentified accession, *A.* spp., collected from the drier regions of Mexico which were chosen for their tolerance to soil acidity. *Sesbania sesban* and *S. grandiflora* were included -- this genus is commonly grown in Indonesia. The two genera, Desmodium and Codariocalyx (previously regarded as synonymous) are represented by *D. rensonii*, *D. discolor* and *C. gyroides*. Both genera are native to Indonesia but the Desmodium species used were imported from Central America. *C. gyroides*, a browse plant deemed important in Central America, is native to Indonesia. A line of *Cajanus cajan* with reported perennial characteristics was also included with two lines of *G. sepium* and *C. calothyrsus*. Gliricidia and Calliandra are commonly grown in Indonesia and are variously reported as being of economic value as forage plants. A listing of the accessions used with their CPI (Commonwealth Plant Introduction) numbers is presented:

Acacia angustissima	40175
A. spp.	84998
Cajanus cajan	65946
Calliandra calothyrsus	110395
Codariocalyx gyroides	76104
Desmodium discolor	39075
D. rensonii	46562
Gliricidia sepium	60796
G. sepium	110397
Leucaena collinsii	46570
L. diversifolia	33820
L. diversifolia	46568
L. leucocephala cv. Cunningham	
L. leucocephala cv. Cunningham with insect control	
L. leucocephala	85929
L. leucocephala	90814
L. leucocephala	85176
L. pallida	84581
L. pallida	85891
Sesbania grandiflora	96461
S. sesban	69484

Results

Nutrition Experiments

Sembawa

Three harvests have been taken at Sembawa, but the results of the third harvest are too recent for inclusion in this report, so the discussion will be restricted to harvests 1 and 2. The dates of these harvests were May and December 1987. Table 3 shows the analysis of variance for leaf yield at the Sembawa site. There were significant main effects of fertilizer and species with an additional fertilizer by species interaction. Where comparisons are made over harvests, there was a main effect of harvest time, with a significantly higher level of productivity at harvest 2. Calliandra gave the best overall yield, especially after the application of lime, whereas when phosphorus alone was applied and calcium was applied as a nutrient the Gliricidia gave the highest yield. At this site the Leucaena gave the lowest yield for all fertilizer treatments.

The analysis of variance for stem yields shows similar trends (Table 3) except that the harvest effect is a harvest by fertilizer interaction.

Sei Putih

At the Sei Putih site five harvests have been taken -- May, August and November 1987, and January and April 1988. Analysis of variance (Table 4) shows significant effects for fertilizer application, species, and harvests, with a significant interaction between harvest and fertilizer treatment, and between harvest and species. Calliandra gave the best yield for all fertilizer treatments, followed by Gliricidia and then Leucaena. In the case of Calliandra the major response was to the phosphorus application, whereas in the case of Gliricidia, the major response was to trace elements after the application of phosphorus and calcium as a nutrient. No significant responses were observed to lime application for any species.

An analysis of cumulative yields for this site shows similar trends to those described for leaf yields. They demonstrate the lower stem to leaf ratio for Gliricidia compared to Calliandra and Leucaena.

At the first harvest there was a reduction in yield with the lime application which was restored by trace element application for Calliandra and Leucaena. This effect may be brought about by either a zinc or magnesium deficiency induced by the lime addition.

At these two Indonesian sites the generalized recommendation would be to apply triple superphosphate to take care of any phosphorus and calcium deficiencies, and to show caution where lime application is indicated, as trace element deficiencies may be induced.

Silkwood

At the Silkwood site, where no fertilizer was applied, no yield was recorded for any species. At harvest 2, no yields were recorded for Leucaena where no fertilizer was applied, and only in one replicate for Gliricidia. Even at harvest 3 the Gliricidia did not achieve the cutting height in any replicate. The analysis of variance shown in Table 5 for the cumulative leaf yield taken over three harvests (August 1987, January and May 1988) shows significant differences between fertilizers and between species but gain no fertilizer by species interaction. There is also a main effect of harvest with additional harvest by fertilizer, harvest by species, and harvest by fertilizer by species interaction.

The cumulative leaf yield data for each species at each fertilizer treatment were very high for Calliandra. No explanation for the inordinately high yield of Calliandra where phosphate alone was applied is offered at this time. As previously described, severe symptoms of zinc deficiency were seen where lime was applied, this deficiency was overcome when trace elements were applied.

As at the acid Sembawa site, the stem production for Calliandra was much greater than for the other species, and showed some increase with lime application. Again, the authors' recommendation for fertilizer application would be to use either superphosphate as triple super, with caution taken where lime is indicated. The superior performance of Calliandra as a wood producer where no fertilizer is applied to acid soils is obvious.

Utchee Creek

At the higher fertility Utchee Creek site, four harvests have been taken (August, October and December 1987, and March 1988). Analysis of variance (Table 6) shows that species differences were markedly significant, with a further significant difference in response to fertilizer. There was species by fertilizer interaction due entirely to the reduction in the yield of Gliricidia after lime addition. It is felt that this difference was again due to an induced trace element deficiency which was not alleviated by the level of trace elements applied.

Data for stem production at this site show the low production of stem for Gliricidia. No main effects of fertilizer are indicated, however harvest effects, and the harvest by fertilizer interaction are all significant, but probably not biologically meaningful.

Species Trials

The species trials have had the same number of harvests as the nutrient trials. However, in Australia, due to manpower constraints, harvests of the two sets of experiments were not always synchronized. At each site the most promising species have been selected for discussion. Selection was made for species having high yield or potential for the particular site. Eight entries were selected for at least three sites. The *C. cajan*, *C. gyroides*, and *S. sesban* are at best weakly perennial, as demonstrated by the general reduction in yield at later harvests. The other promising lines include *A.* spp., *C. calothyrsus*, Lp-8, *G. sepium*, and Ld-6. It is worthy to note that these two Leucaenas show some resistance to the psyllid. The importance of the psyllid can be gauged from the difference between the sprayed and unsprayed plots of *L. leucocephala* cv. Cunningham at the Sill wood and Utchee Creek sites.

Sembawa

Analysis of variance of the leaf yields at the Sembawa site (Table 7) shows significance for all factors. Many of these effects should be interpreted with caution due to the problems arising from the fact that at the first harvest many entries barely reached the required cutting height, and by the second harvest entries that were not strongly perennial that had yielded well at the first harvest were declining. It is apparent from the high yields at the first harvest of the "annual" species with fertilizer applied that this strategy offers potential for forage production in the first year. *G. sepium*, *A*. spp., and *C. calothyrsus* however, will probably offer a more sustained yield over time. A practical strategy would be to intercrop the "annuals" with these perennials in order to support animal production.

Sei Putih

At Sei Putih there was no main effect of fertilizer but a major species effect (Table 7). However, in the data selected for presentation there is some suggestion of response. There is a significant effect of harvest together with the associated first and second order interactions. Again, these interactions can be partially explained by the decline in yield with time of the more annual Cajanus and Sesbania as compared to the perennial *A*. spp. and *C. calothyrsus*. It is of importance to note that several of the Leucaenas (ie. L1-3, Lp-8, Ld-6, and L1-1) did very well at this site. Again, this data suggests the potential usefulness of combining perennials with annuals.

Silkwood

At Silkwood there was a significant response to fertilizer application, and differences between species, together with a species by fertilizer interaction (Table 8). All effects including harvests were also highly significant. At this site, where no fertilizer was applied there was no yield at the first harvest, with many entries giving no yield at the second, either. At the time of the second harvest all plants were living but many did not reach the required initial cutting height. It has been observed that since the third harvest, several plants in the Sesbania and Cajanus plots are unlikely to survive and possibly some plants in the Codariocalyx plots will not reach the next harvest. The *C. calothyrsus*, the Acacia lines and Ld-6 and Lp-8 show potential at this site. The *C. calothyrsus* and *A*. spp. show particular promise where no fertilizer was applied.

Utchee Creek

At the Utchee Creek site no responses to fertilizer were shown in this experiment. However, species, harvest, and harvest by species interaction were significant (Table 8). Again the more "annual" entries showed a decline with time. The high production of the Acacia lines is noteworthy and will serve a useful role if they are eaten by animals and give the required weight gains. As previously mentioned, the seriousness of the leucaena psyllid is well demonstrated in the comparison of the L1-1 sprayed and unsprayed for insect pests.

Although the entries at the four sites display many common responses, it is evident that many interactions exist between sites. A full analysis of these interactions must await the accumulation of data from further harvests. Considerable thought will need to be given to determine the most suitable method of analysis.

Conclusion

There is a need to extend the present experiments to a wider range of environments. Where the demand exists, such as in the Philippines, such experiments should be specifically designed for the situation, and not merely duplicates of the authors' established trials. In this way the specific nutrient problems at any site can be assessed.

There is a need to follow up the results of the present species testing. Options include:

- investigation of species not presently under study (ie. *Acacia villosa*, *Schleinitzia* spp., acid-tolerant Leucaena);

- wider testing of perhaps the best 10 from the present trials, with treatments to include cutting height and frequency;

- more intensive agronomic testing of the less perennial but high-yielding species such as Codariocalyx, Sesbania, and Cajanus;

- investigation of ways of combining productive short-lived species with high-yielding long-term perennials; and

- investigation of a wider range of selected species, similar to work being done -- Gliricidia, Sesbania and Calliandra are obvious choices.

The leucaena psyllid still represents a major threat in most areas where Leucaena is grown. There is an urgent need to follow up the full range of control/prevention options, biological control, selection/breeding, management, and use of alternative species. This last approach should include species of Leucaena other than *L. leucocephala*.

There is a lack of well documented evidence on the nutritional quality of shrub legumes, both in relation to animal acceptability and nutritional quality. For example, although Calliandra is not usually considered suitable for animal production, recent discussions with Barry Norton (University of Queensland) revealed that animals were readily eating Calliandra, with a consequent weight gain. There is clearly a major need to study both the animal/plant interactions and the nutritional chemistry. It is also important to look at management systems, and ways of getting shrub legumes into farming systems.

There is a need for seed production of promising lines such as Codariocalyx, for further trials and distribution.

There is also a need to follow up the preliminary plant nutrition work to achieve some of the original objectives of the project, such as better definition of selection criteria for selecting plants for acid soils.

References

Bray R.A., B. Palmer and T. Ibrahim. 1988. Some nutritional constraints for the growth of shrub legumes on acid infertile soils in the tropics. In *Multipurpose Trees for Small-Scale Farm Use*, eds. D. Withington, K.G. MacDicken, C.B. Sastry and N. Adams. Arlington, Virginia: Winrock International and IDRC.

Gunawan B., R.A. Bray, B. Palmer, T. Ibrahim, Hardjowalujano and T. Abas. 1987. Multipurpose shrub legumes for infertile soils in the tropics. Poster Paper at BNF Symposium, Cisarua: Australian Centre for International Agricultural Research.

Table 1. Soil properties from the experimental sites.

SITE	Depth	pH	Exchangeable Cations (meq/100 g) Ca	Mg	K	% Al Sat
Sei Putih	0-10 cm	5.3	1.76	0.50	0.41	8
	30-40 cm	5.1	0.72	0.17	0.12	51
Sembawa	0-10 cm	4.9	0.42	0.32	0.11	85
	30-40 cm	5.0	0.12	0.04	0.03	97
Utchee Creek	0-10 cm	5.3	1.44	0.60	0.23	11
	20-30 cm	5.1	0.53	0.19	0.09	14
Silkwood	0-10 cm	5.3	0.34	0.23	0.15	77
	20-30 cm	5.0	0.03	0.05	0.03	91

Table 2. Rates and type of fertilizer applied to field experiments.

Fertilizer	Product	kg element/ha	Lime t/ha
P	Diammonium phosphate[1]	33	
	Monoammonium phosphate[2]	33	
Ca (nutr)	Gypsum	40	
Ca (lime)	Calcium hydroxide		Sembawa 2.0 Silkwood 2.0 Sei Putih 0.4 Utchee Creek 0.4
Trace Elements (TE)			
Cu		3.0	
Zn		3.0	
Mo		0.2	
B		1.5	
Mg		20.0	
Basal treatment K;S		30/18; 16/8[3]	

[1]Indonesia [2]Australia [3]split dressing

Fertilizer treatment codes referred to under Nutritional Trials were:

No fertilizer applied	(F1)
P	(F2)
P + Ca (nutr)	(F3)
P + Ca (nutr) + TE	(F4)
P + Ca (nutr) + Ca (lime)	(F5)
P + Ca (nutr) + Ca (lime) + TE	(F6)

Table 3. Analysis of variance of Sembawa nutritional trial yield log(X + 1) transform.

Source[1]	DF	F ratios	
		Leaf Yield	Stem Yield
R	2	1.74	2.02
F	5	21.76***	25.39***
S	2	49.06***	38.96***
FS	10	2.60*	2.41*
H	1	50.38***	3.10
HF	5	1.89	5.84***
HS	2	2.91	4.64*
HFS	10	1.18	1.43

Table 4. Analysis of variance of Sei Putih nutritional trial yield log(X + 1) transform.

Source[1]	DF	F ratios	
		Leaf Yield	Stem Yield
R	2	0.92	1.79
F	5	10.51***	7.97***
S	2	13.69***	16.62***
FS	10	0.74	0.96*
H	4	113.22***	172.61***
HF	20	3.96***	4.33***
HS	8	2.46*	5.17***
HFS	40	0.77	1.24

Significant at α = 5% *
Significant at α = 1% **
Significant at α = 0.5% ***

[1]Note:

R = Replicates
F = Fertilizer
S = Species
FS = Fertilizer by Species

H = Harvest
HF = Harvest by Fertilizer
HS = Harvest by Species
HFS = Harvest by Fertilizer by Species

Table 5. Analysis of variance of Silkwood nutritional trial yield log (X + 1) transform.

Source[1]	DF	F ratios	
		Leaf Yield	Stem Yield
R	2	0.82	1.04
F	5	18.37***	24.63***
S	2	8.27**	19.89***
FS	10	1.63	1.42
H	2	81.51***	191.48***
HF	10	6.43***	5.68***
HS	4	3.99**	6.07***
HFS	20	4.45***	5.75***

Table 6. Analysis of variance of Utchee Creek nutritional trial yield log (X + 1) transform.

Source[1]	DF	F ratios	
		Leaf Yield	Stem Yield
R	2	9.17***	10.17***
F	5	3.85***	2.14
S	2	107.20***	7268.33***
FS	10	2.75 *	0.85*
H	3	165.54***	2265.59***
HF	6	56.21***	11.75***
HS	15	2.62**	836.49***
HFS	30	1.31	0.96

Significant at α = 5% *
Significant at α = 1% **
Significant at α = 0.5% ***

[1]Note:

R = Replicates
F = Fertilizer
S = Species
FS = Fertilizer by Species

H = Harvest
HF = Harvest by Fertilizer
HS = Harvest by Species
HFS = Harvest by Fertilizer by Species

Table 7. Analysis of variance of species trial leaf yield log(X + 1) transform.

Source[1]	DF	F ratios Sembawa	DF	F ratios Sei Putih
R	1	67.02	1	0.95
F	1	96651.07**	1	5.13
S	21	5.92***	21	33.93***
FS	21	4.12***	21	0.92
H	1	9.88**	4	43.78***
HF	1	26.21***	4	3.98**
HS	21	5.82***	84	1.79***
HFS	21	3.80***	84	1.44*

Table 8. Analysis of variance of species trial leaf yield log(X + 1) transform.

Source[1]	DF	F ratios Silkwood	F ratios Utchee Creek
R	1	1.02	3.00
F	1	1481.06*	3.50
S	21	9.93***	10.36***
FS	21	3.17***	0.75
H	2	210.75***	33.36***
HF	2	127.61***	2.26
HS	42	4.39***	15.87***
HFS	42	4.02***	0.73

Significant at α = 5% *
Significant at α = 1% **
Significant at α = 0.5% ***

[1] Note:
R = Replicates
F = Fertilizer
S = Species
FS = Fertilizer by Species

H = Harvest
HF = Harvest by Fertilizer
HS = Harvest by Species
HFS = Harvest by Fertilizer by Species

Capsule Method of Cultivation in Semi-arid Tropical Areas

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Agricultural land in Indonesia consists of 30% wet land and 70% dry land. Dryland agriculture has a dry season of up to 10 months when it lies in fallow, devoid of vegetation. The farmer has no means of earning an income during this time.

During the dry season, the soil is exposed to direct solar radiation and breaks down into small, loose particles which are easily eroded. As a result, the soil becomes less productive over time. To reduce erosion, the soil should be covered by vegetation useful to the farmer.

Plants use only 1% of the water they absorb for growth, while 99% is transpired. The evaporation rate on agricultural land is approximately 50% of the water available in the soil. Therefore, an important research activity in tropical semi-arid areas is searching for plants or cultural techniques which use water efficiently.

One means of improving the water use efficiency is the capsule, or isolation method. Within the capsule, the water vapor in the air condenses, returns to the soil and is reused for plant growth. Experiments have shown that plant growth using the capsule method is superior to the control group. Because the capsule method is unaffected by the weather, crops can be planted at any time, in rainy or dry seasons.

Background

Agriculture in Indonesia is dominated by small-scale and landless farmers. Small farms are characterized by a lack of productive agricultural land and a limited production capacity due to a lack of capital, labor and knowledge. The goal of subsistence farmers is to provide enough food for the family. In a good year, there may be a small surplus to sell in the market. A critical priority is to minimize risks.

One of the dilemmas facing developing countries today is how to improve the standards of living for small-scale farmers in tropical semi-arid areas while protecting the soil from erosion and a loss of productivity.

Tropical areas are characterized by heavy rainfall in a short period of time with long dry seasons. This pattern results in high levels of erosion. In tropical semi-arid areas rainfall is unpredictable and the living and working conditions are harsh. Traditional agriculture in these areas is based on a pattern of polyculture or mixed cropping. Mixed cropping systems were developed over centuries with adaptations to differing environmental and economic conditions. Mixed cropping systems are highly site-specific, depending on soil conditions and local climate.

Two common techniques used for preventing erosion are terracing and the planting of dense vegetation. Bench terraces have been used by farmers to prevent erosion on land of volcanic origin. Bench terracing is effective and can absorb a large labor force, but is very costly. The best land use pattern covers the land all year and produces large quantities of green manure to add organic material to the soil.

A low tech, low input, low cost system of cultivation is needed which can produce high crop yields even under conditions of limited water availablity. The capsule, or isolation method meets these requirements.

Karangsari Demonstration Farm

Field trials were conducted at the Karangsari Demonstration Farm in West Java with capsules of 1.7 x 1.0 x 3.0m covered by thin white plastic sheets to isolate the air inside the capsule from ambient conditions. Karangsari receives up to 3,000mm of rainfall annually.

The plants used in the trials were soybeans (*Glycine max*), greengram (*Phaseolus radiatus*), peanuts (*Arachis hypogea*), and corn (*Zea mays*). In this non-irrigated system, water available to the plants depends on the evaporation and transpiration inside the capsule. The water vapor condenses on the plastic, drips back down to the soil and is reused for plant growth. The size of the capsule depends on the crops planted.

Plant treatment inside the capsule is in line with typical on-farm conditions and includes no fertilizer. The cost of building the capsules is very low, approximately US$1 per capsule which lasts for four years.

The data collected for comparison with the control plots include soil temperature, air temperature, stem growth, leaf and fruit production.

The soil temperature at 0.5m in the control plots was higher than in the capsule, but at 1m in depth the soil temperature inside the capsule was higher. The air temperature inside the capsule was 3.3 °C higher than the control.

The humidity inside the Capsule was 56% higher than the humidity in the control plots. The plants inside the capsule were 1.25-1.50 times bigger than the control group. The percent increase of the stem height of the four test species inside the capsule are presented in Table 1.

Field conditions at the time were in fallow, with little vegetative growth possible until the first rains. The growth of plants inside the capsule is a good use of the fallow period for production.

In *G. max*, *P. radiatus*, and *Z. mays* there was a lot of empty fruit without seeds, both inside the capsule and in the control group. These three species produce aerial fruits. The successful crop was the peanut, which fruits under the soil, with production 25% higher inside the capsule than in the control plot.

In point of fact, farmers do not like to cultivate soybeans, greengram or corn, but prefer to plant cassava (*Manihot esculenta*), *Ipomea batatas*, and *Arachis hypogea*. The capsule method may be most suitable for producing higher yields in tuberous and other underground crops, and crops where the production of stem growth is of value.

Temayang, East Java

Another series of field trials were conducted in Temayang (Bojonegoro, East Java), where the annual average rainfall is 1,872mm. This area is drier than in Karangsari, West Java.

The capsule was 1 x 3 x 0.6m covered by thin white plastic. The trials were conducted in three blocks, each block consisting of a capsule and a control with *P. radiatus* in the rainy season.

Fruit production was 40% higher inside the capsule than in the control plots. Average stem height is compared in Table 2.

The results seem to indicate that in regions with an annual rainfall of 1,872mm per year, even planting in a wet month yields better results inside the capsule than in the control plots.

Observations from Karangsari, cultivated in the dry season, also indicate that production

Table 1. Percent increase in stem height inside the capsule, Karangsari.

Species	Age (days)				
	35	40	45	50	63
Phaseolus radiatus	26.9	26.8	19.2	22.9	43.9
Arachis hypogea	40.3	58.6	40.1	36.2	21.4
Glycine max	64.4	18.7	29.0	55.5	52.2
Zea mays	10.5	21.5	37.2	45.0	23.0

Table 2. Comparison of average stem height inside capsule and control, Temayang.

Week	Average Height (cm) Capsule	Control	Difference (cm)	Difference (%)
2	22.87	12.20	10.67	87.46
4	34.77	23.40	11.37	48.59
6	48.03	29.40	18.63	63.37
8	49.97	28.00	21.97	78.46
Total average increase in height (weeks 2-8)				
	27.1	15.8	11.3	71.52

inside the capsule is higher than the control. These findings indicate that the capsule method is unaffected by the weather so cultivation can be carried out at any time.

An adequate supply of water enhances plant development in the capsule, but fruiting may be a problem in some species.

Conclusion

Small-scale farmers can cultivate/plant at any time with the capsule system and expect higher yields and income than with the control (non-capsule), based on traditional soil and water conservation techniques. With the capsule system, fallow seasons in tropical semi-arid areas could become as productive as the rainy season.

A Case Study on Small-Scale Farm Use of Jeungjing (*Paraserianthes falcataria*) in Sukabumi, West Java

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The main focus of forestry at the present time is to produce raw materials for commercial use. However, attention needs to be focused on the welfare of the communities in rural areas, where poverty is a major problem. Under these conditions it is extremely difficult to meet daily needs for fuelwood, building supplies, and fodder for livestock. To meet these needs, villagers living near forested areas tend to destroy the forest. That quickly leads to erosion, causing floods and loss of soil fertility which has a devastating impact on agricultural production.

Introducing multipurpose tree species (MPTS) is one way to help in reversing deforestation while meeting the needs of rural residents. In the Sukabumi District of West Java the most popular MPTS is Jeungjing (*Paraserianthes falcataria*).[1]

P. falcataria has long been planted by the villagers in their fields or gardens in agroforestry associations with crops, especially in the western and southern parts of Sukabumi. The wood is used for building supplies, boxes, furniture, household needs, etc. For the last five years *P. falcataria* from the Sukabumi District has been used as a raw material in both the paper and molding industries.

The purpose of this paper is to review some of the uses of *P. falcataria* in the rural communities of Sukabumi, and to propose several recommendations for the creation of a research and development strategy.

Technical Profile

Potential

P. falcataria has been planted in Sukabumi since the turn of the century, having originated in Maluku. It is planted on almost any available community land either in mixed associations or in pure stands. Several factors that promote its planting are its rapid growth, the availability of ready markets, and government encouragement.

P. falcataria is commonly planted at a spacing of 2x3m, with a density varying between 1,600 and 2,000 trees/ha. Thinning can be applied when the trees are two years old and can be repeated every two years thereafter. After 6-7 years, stands are clear-cut. By that time, the density is approximately 200 trees/ha with an average diameter of 28cm and a height of 22m. Based on these data, wood production of *P. falcataria* in Sukabumi is approximately 271m^3/ha.

Data collected on the community forests by Sukabumi's Sub Office of Forestry Research (RLKT), Region IV, West Java (1987) are summarized in Table 1.

In addition to community forests, *P. falcataria* has been planted by the Perum Perhutani (the State Forest Enterprise) since 1985. Details follow in Table 2.

In Sukabumi, 67,431ha have been set aside for production forest use. By the end of 1988, 9,829ha were still available for planting under the 1989-93 Reforestation Plan using fast growing species such as jeungjing, sungkai, Acacia, and pine. Based on data gathered from the Balai RLKT (Forestry Research Office), Region IV, West Java, plantings and stands owned by the communities amounted to 17,954ha in 1989. A program is planned to encourage further planting of *P. falcataria* in the district.

Properties and Utilization

P. falcataria from Sukabumi varies in color from white to pinkish. The preferred color is light white for manufacturing furniture, molding and furniture components for export. There is no clear explanation for the difference in color. Many villagers believe that trees cut after reaching the age of seven years will result in a pinkish colored wood. Others claim that growth on differing sites may affect the color. General properties of *P. falcataria* reported to the author are presented in Table 3.

[1]Note: *Paraserianthes falcataria* was previously known as *Albizia falcataria* and *Albizia falcata*.

Table 1. Area and species planted in Sukabumi community forests.

Tree species	Area (ha)
Jeungjing (*P. falcataria*)	718.50
Manii (*Maesopsis eminii*)	159.25
Mahoni (*Swietenia mahagani*)	10.75
Jabon (*Antocephalus chinensis*)	1.50
Puspa (*Schima wallichii*)	0.50
Others	8.00

Source: Sukabumi/Balai RLKT Ciujung - Ciliwung, DS (1986).

Table 2. Perum Perhutani's Plantations of *P. falcataria.*

Year of planting	Area (ha)	Location
1985	7	Cikawung
1987	32	Cikawung
1989	1,008*	Cikawung, Lengkong, P. Ratu, Segaranten
Total	1,047	

*Note: Planting goal for 1989.
Source: Perum Perhutani, KPH Sukabumi (1988).

Recently developed sawmills in the Sukabumi District use circular saw blades powered by car engines. Yields of usable wood produced by this method range from 40-50 percent. These milling techniques could be improved as they produce sawn wood with rough, rather hairy surfaces. Blue stain prevention methods include using freshly cut logs as a raw material and air drying the sawn timber in the sun.

Secondary wood processing industries common to the district include the manufacture of tea boxes, soap boxes, and crates for bottled drinks and soy sauce bottles. Cottage industries producing boxes are run either by a single family employing 2-3 people or as a small scale enterprise of 6-15 employees.

In the past several years *P. falcataria* use in rural areas has expanded into furniture manufacturing, especially beds with carved headboards, and carved handicrafts. The consumers are generally low income villagers from the surrounding communities. Processed wood products are in great demand and can be marketed as far as Sumatra. One particular factory in Cibeureum with 30 employees is capable of producing 20 sets of carved beds per day. A listing of enterprises and their location is presented in Table 4.

Economic Profile

Planting of *P. falcataria* by the villagers is normally not on a commercial scale. They generally plant on their own unused land to earn supplementary income. The planting process is relatively simple, following the traditional

Table 3. General properties of *P. falcotaria*.

Properties	Remarks
Tree height	7m (at 1-2 years) 13-18m (at 3 years) 21m (at 4 years) 30m (at 9-10 years) 45m (maximum height)
Increase in dbh	5-7cm/year
Growth increment	25-40m^3/yr/ha
Specific gravity	average 0.33
Strength class	IV - V
Durability class	IV - V
Wood color	white to pink
Fiber length	average 1.15mm with thin-walled fibers
Wood shrinkage	radial direction: 2.5% tangential direction: 5.2%

Source: National Academy of Sciences (1979) and Sutigno (1987).

farming or self sufficiency system. As a result, the farmers seldom take the cost of labor into account in determining the cost of production because labor is generally supplied by the farm family itself, except in the planting and harvesting stages.

Cost/Benefit Analysis

The results of a preliminary survey of several farmers and craftsmen yield a variety of economic details:

Farming

The calculation of production costs was based on the following assumptions (US$1 = Rp1,770):

- the seedling/stump cost = Rp25 per stem; the number of seedlings needed including replacement of dead plants = 2,000 stems/ha;

- the spacing of seedlings is 2x3m; they are intercropped with food-producing plants in agroforestry systems;

- wages for planting is based on 8 man days of labor per hectare;

- wages for harvesting (with an average volume of 271m^3/ha) is based on 67.75 man days of labor/ha;

- the cost of maintaining and thinning is compensated for by thinning yields;

- the average age of the harvested trees is 7 years; and

- the Rural Loan Interest (RLI) rate is 15 percent/yr.

Table 4. *P. falcataria* related enterprises in Sukabumi.

Activity	Location
Seed processing	Nagrak - Karang Tengah
Seedling production	Nagrak, Cibadak, Parakan, Salak.
Plantations	Mangkalaya, Cikawung, Ciparay.
Industries:	
- Furniture	Cibeureum, Cibadak
- Handicrafts	Cibeureum
- Boxes	Parungkuda, Kelapa Nunggal Cibadak, Cisaat
- Sawmills	Parungkuda, Cibadak, Cicurug

Source: Field orientation and observation (1989).

Based on the previous assumptions, the cost calculations are as follows:

- seedlings: 2,000 seedlings/ha x Rp25/seedling = Rp 50,000/ha;

- wages for planting = 8 man days/ha x Rp 2,500/man day = Rp 20,000/ha; and

- wages for felling = 67.75 man days/ha x Rp 2,500/man day = Rp 169,500/ha.

Therefore, the calculated cost at the time of harvest is (Rp 50,000 + 20,000)$(1.15)^7$ + 169,500 = Rp 355,700/ha. Considering that the land owned by the villagers is relatively small (varying from 0.25 to 0.50 hectare), the cost per farmer ranges from Rp 88,925 - 177,850.

The average selling price at the level of the farmer is Rp 20,000/m^3. As a result, gross revenue earned is Rp 5,420,000/ha. Depending on the size of the planted area, a farm family can earn a net income of between Rp 1,266,075 - 2,532,150 in seven years.

Small-scale Sawmilling

In Sukabumi there are now 31 small-scale sawmills with a production capacity ranging from 50-150m^3 per month, and an employment generating capacity of up to 102 people. In general, the sawmill operations are only cottage industries, using relatively simple techniques.

Results of a case study on small-scale sawmills with a production capacity of 50m^3 each per month are presented. Most small-scale sawmills are powered by engines from used cars. The average price of the engine is Rp 300,000 per unit. Each engine is equipped with two circular saw blades 60cm in diameter at a cost of Rp 75,000 each. 500 liters of gasoline and 2 liters of oil are used each month. Monthly expenditures for gasoline may run as high as Rp 192,500 and Rp 4,000 for oil. Based on these figures, the monthly processing costs of sawn timber can be calculated as follows:

- raw material (logs) 100m^3 x Rp21,000/m^3	= Rp 2,100,000
- fuel and oil Rp192,500 + Rp4,000	= Rp 196,500
- depreciation of the engine (3 years)	= Rp 8,333
and saw blades (1 year)	= Rp 12,500

- wages: 4 employees x 24 work days/mo x Rp2,500/work day	= Rp 240,000
- other costs	= Rp 130,360
Total	Rp 2,687,693

Therefore, average production costs/m^3 amount to 1/50 x 2,687,693 = Rp 53,754/m^3. The average selling price is Rp 60,000/m^3. If production costs are subtracted from this figure, receipts will amount to Rp 60,000 - 53,754 = Rp 6,246/m^3 or Rp 312,300 per month. If taxes of 10 percent of the selling price are deducted, a net profit of Rp 5,621/m^3 or Rp 281,070 can be generated each month.

In addition to sawmills which process logs and sell the sawn timber, there are others which charge fees of Rp 15,000/m^3 for sawing only. Assuming the same production costs as the sawmills which buy and process the logs, the production costs for sawing only would be Rp 587,693 per month or Rp 11,754/m^3. The net profit generated would be Rp 15,000 - 11,754 = Rp 3,246/m^3 or Rp 162,300 per month (with little capital outlay). Small-scale manually operated sawmills process wood in addition to those using simple engines.

Box Production

Another common cottage industry is the production of boxes from *P. falcataria* wood. As many as 33 small-scale box producers have been recorded, employing up to 616 people with an annual production capacity of 4.5 million boxes.

Box production units, producing 100 boxes (60x35x16cm) daily with 3 employees, incur the following production costs:

- 100 boards (200 x 16 x 1.5cm) x Rp150/board	= Rp 15,000
- 100 boards (10 x 1.5 x 1.5cm) x Rp75/board	= Rp 7,500
- 5kg of small nails x Rp1,000/kg	= Rp 5,000
- labor: Rp70/box	= Rp 7,000
- other costs	= Rp 1,750
Total	Rp 36,250

The selling price is Rp450/box, yielding Rp 45,000/day for a daily profit of Rp 8,750. After deducting 10 percent sales tax, the net profit generated is Rp 7,875/day or Rp 196,875/month.

Small-scale Bed Industry

One of several types of furniture produced by *P. falcataria* cottage industries are beds with carved headboards. Results of a survey of several manufacturers in Cibeureum produced the following:

The selling price on-site is Rp 25,000/set bringing in a profit of Rp 8,000/set. After subtracting 10 percent tax, the net profit is Rp 7,200/set. Factories producing 20 sets per month will earn up to Rp 144,000 monthly. If market conditions are favorable, bed manufacturers can produce as many as 60-100 sets per month.

- 5 boards (200x20x2cm) x Rp500/board	= Rp 2,500
-1 scantling (200x6x4cm) x Rp230/piece	= Rp 230
- 9 strips (150x5x2cm) x Rp130/piece	= Rp 1,170
- 1/5 piece of triple-plywood x Rp3,000	= Rp 600
- 1/2kg of nails x Rp1,200/kg	= Rp 60
- 5 lathe blades x Rp300 each	= Rp 1,500
- 4 lathe poles x Rp275 each	= Rp 1,100
- wages for carving	= Rp 1,000
- wages for finishing and materials	= Rp 2,000
- wages for manufacturing/ installing	= Rp 3,500
- one set of mattresses	= Rp 2,000
- other costs	= Rp 800
Total	Rp 17,000

The Marketing System

The marketing of *P. falcataria* wood and processed products needs to be improved. Current market conditions are unfavorable for the farmers and wood processors.

Planting sites are relatively small and widely scattered, therefore, the role of the collecting agent or middleman is very significant.

Unfortunately, some of the middlemen are dishonest and take advantage of the farmers. They buy the timber before the proper harvesting age of seven years at a very low price. The farmers are forced to sell their trees due to poverty. Consequently, only the middlemen profit from the harvest. To deal with this problem, planned cooperatives will provide temporary loans to the farmers so they can market their wood directly to consumers either locally or outside the region.

Another weakness exists in the marketing system of the processed products, with the exception of sawn wood. Most of those involved in the processed product industry buy their wood directly from the sawmills. However, it is very common for middlemen to obtain finished commodities on consignment, and do not pay for the merchandise until after it is sold. By this means they often manipulate the prices and even refuse to pay for merchandise, arguing that the products have not been sold. This puts many small-scale entrepreneurs out of business. To resolve this problem, the authors consider it necessary to form cooperatives among wood producers capable of marketing both logs and processed products. This will help to overcome the financial difficulties of the members.

Conclusion and Action Plan

Results of the case study on *P. falcataria* use in the rural communities of Sukabumi District demonstrate that this species is worth promoting. An appropriate research strategy should focus on increasing villagers' incomes at all levels, from the farmers to the entrepreneurs, as well as increasing the value added. Research priorities should include efforts to improve:

- the efficiency of utilizing small farmers' land;
- the efficiency and productivity of wood processing; and
- the marketing system of logs and processed products.

Surveys are needed to collect data on the following topics: the role of existing MPTS, socioeconomic background statistics, wood utilization technology, fragile land use, volume of rural wood production, institutional linkages, marketing systems, and problems faced by rural villagers.

Project design criteria would be based on this data. The analysis of the data is needed to understand how MPTS affect the lives of the villagers, and to formulate program development policies to expand the role of MPTS in rural communities.

A pilot project should be established to transfer technology pertaining to the management, utilization, and marketing of MPTS. The pilot project location should be a rural area representative of MPTS producing areas in Sukabumi. Activities should include:

- management and utilization of the villagers' plantation;
- establishment of a portable sawmill;
- establishment of a farmers' cooperative;
- establishment of a wood processors' cooperative; and
- promotion of the production and marketing of processed products of *P. falcataria*.

References

Board of the Forest Authority of Indonesia. 1988. *Report of Results to Date*. Sukabumi: Perhum Perhutani KPH.

National Academy of Sciences. 1979. *TROPICAL LEGUMES: Resources for the Future*. Washington, D.C.: National Academy Press.

Sub Office of Forestry Research RLKT. 1987. *Data on Sukabumi's community forests*. Region IV, West Java, Indonesia: Sub Balai RLKT.

Sutigno, P. 1987. *Properties and Uses of* Albizia falcata. The keynote address at the Industrial Forestry Roundtable. Jakarta, Indonesia.

Appendices

Conference Field Trip

The field trip, organized by the Forest Research and Development Centre at Bogor, was scheduled to productively utilize every minute of the day, with five stops planned to see agroforestry systems and the industry that has evolved around *Paraserianthes falcataria* in the Sukabumi District of West Java. After leaving Jakarta at 6:30 am, the early risers were rewarded with beautiful scenic views of volcanoes in the distance and agroforestry systems all along the highway.

The tour visited sites varying in altitude from 400-900m, with slopes of 30-50% which receive up to 4,761mm of rain annually. Scheduled stops included a small farm of 2ha growing *P. falcataria* at the top of a hill terraced with rice paddies; a small-scale local sawmill producing pallets; a sawmill where boxes were being manufactured to transport money for the banking industry; and a plantation of tung oil or candlenut (*Aleurites moluccana*) interplanted with citronella grass (*Cymbopogon nardus*) where terrace construction in progress, nursery operations, and fields of tea were observed with great interest. Small-scale cottage industries that manufacture carved furniture were selling their products in the towns and villages. At each site we were warmly greeted by officials of the Indonesian Forest Service

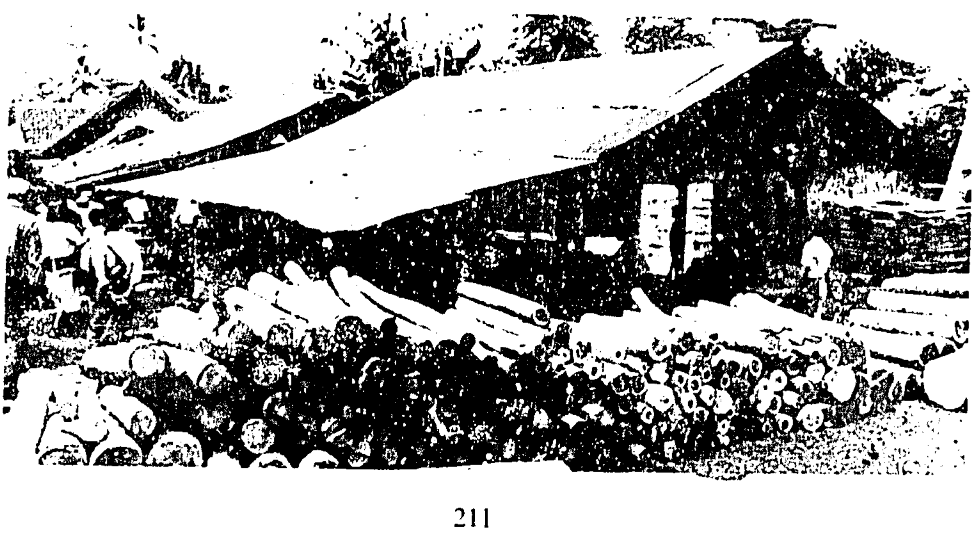
Along the roads and highway, interesting examples of agroforestry practices were evident in the celebrated Javan homegardens with fish ponds in front of most of the houses. Rice paddies and terraces were bordered by a lush variety of multipurpose trees and crops.

The field trip was a lesson in itself regarding the importance of the agricultural sector in the economy of the Sukabumi District of the Province of West Java. Forty-nine percent of Sukabumi's population are farmers. Fortunately, the area has been favored with rich volcanic soils and an abundance of rainfall. Agroforestry is the predominant cropping system combining *P. falcataria*, *Maesopsis eminii*, durian (*Durio zibethinus*), langsat (*Lansium domesticum*), jackfruit (*Artocarpus heterophylla*), bananas, rice and a variety of other fruits and vegetables.

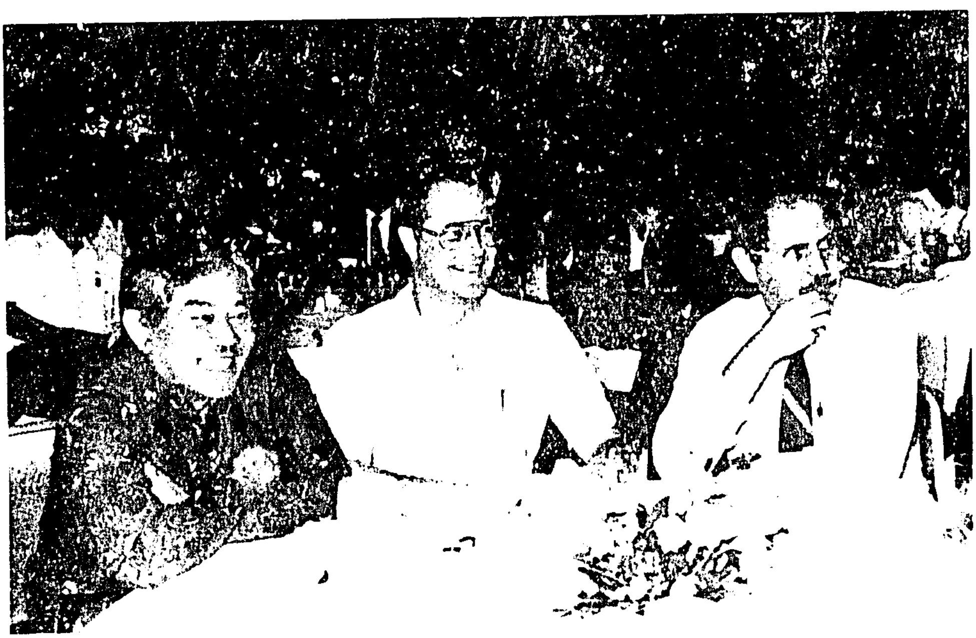
Cassava (*Manihot esculenta*) is intercropped in stands of *P. falcataria* during the first year after planting. The stands are harvested after 5-7 years and coppice well for 3 rotations. The average price paid per tree on-site is Rp 3,000-4,000 (US$1 = Rp1,788). The average annual income per farm household in Sukabumi is Rp 74,000-124,000. Tree farming with *P. falcataria* thus represents a significant proportion of the farm family's annual income, with timber sales providing from 28-47% of the total.

Raising *P. falcataria* and several related wood-processing cottage industries are major local employers, as there is a significant market for the timber and processed products. Important economic activities include small-scale sawmills, box and crate production, and the manufacture of carved furniture.

The trip was a delightful experience and the conference participants will long remember the warm, genuine hospitality extended to us by the Forest Research and Development Centre, the Agency for Forest Research and Development, the Indonesian Forest Service, the Ministry of Forestry, and the people of West Java. Indonesia.



Welcome Banquet



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