PN-ABL-091

MPTS Research Supported by the Forestry/Fuelwood Research and Development Project (1987-1990)

Kenneth Cornelius Chicken
Clyde B. Lantican

PN-ABL-071

MPTS Research Supported by the Forestry/Fuelwood Research and Development Project (1987-1990)

Kenneth G. MacDicken

Celso B. Lantican

July 1990

MPTS Network Secretariat

Winrock International

Faculty of Forestry, Kasetsart University

Bangkok, Thailand

Table of Contents

1.0 Introduction
1.1 A Definition of Multipurpose Tree Species 1
1.2 The MPTS Research Network and the F/FRED Project 2
1.3 The Purpose of this Document 3

2.0 Research Support Activities
2.1 Seed exploration, production and dissemination 4
2.2 Annotated bibliographies 6
2.3 Methodology development 7
2.4 Training 7
2.5 Regional research plans 8
2.6 Soil characterizations 10

3.0 Network Field Trials
3.1 Humid Zone 11
3.2 Semi-Arid Zone 19
3.3 Arid Zone 24
3.4 International *Acacia auriculiformis* Provenance Trials 28
3.5 International *Dalbergia sissoo* Provenance Trial Series 30

4.0 Small Research Grants Program
4.1 Field Trials, Methods, Management 35
4.2 Tree Improvement 38
4.3 Pest and Disease Control 38
4.4 MPTS in Farm Systems 39
4.5 Policy and Economics 43
4.6 Tree Products 44

5.0 Leucaena Psyllid Control Research 46

6.0 Social Science Research
6.1 Regional Study on Farm and Village Forestry 53
6.2 Case Studies 53

7.0 Biotechnology 59

8.0 Tree Breeding Objectives 61

9.0 Economics Research
9.1 Economic Analysis of Tissue Culture Trials 67
9.2 Marketing of MPTS products 68

10.0 MPTS Research Compendium

11.0 Assistance to the Royal Project in Thailand
11.1 Testing indigenous species for agroforestry in the watershed 72
11.2 Development of MPTS on small farms 72

12.0 Literature Cited 74

Appendix 1 Research-related papers prepared with F/FRED support 75

Preface

Multipurpose tree species (MPTS) are increasingly seen as critical to the improvement of the quality of life in rural areas. The groundswell of interest in MPTS has resulted in increased attention to the research and development needs. The Forestry/Fuelwood Research and Development Project (F/FRED) is one response of the U.S. Agency for International Development to these needs.

The F/FRED Project over a three year period has supported over 130 studies on MPTS in Asia. While three years is a remarkably short period for a forestry research program to begin reporting results, we believe that interest in the research process and progress to date is strong enough to warrant a preliminary summary of results. Many of the research projects briefly described in this document are still on-going, some have not yet produced progress reports and even many of those which are now complete have not yet been published. Yet, even at this early stage, these studies represent an important set of research topics, strategies and methods which promise substantial and invaluable results.

The anticipated outputs of this work will come in the form of useful research results, increased capacity of research scientists in Asia, improved access to vital germplasm resources, development of standard research methods and increased cooperation and communication between researchers. We hope that this summary will provide a description of the breadth and scope of research support provided through the MPTS Research Network Secretariat based at the Kasetsart University Faculty of Forestry in Bangkok.

Any ommissions, mistakes, misinterpretations or other errors are solely our responsibility.

K.G. MacDicken
C.B. Lantican

July 1990
Bangkok, Thailand

1.0 Introduction

It is common knowledge that farmers on every continent have successfully grown and used trees for a wide variety of purposes for thousands of years. From this vast experience have come countless models for production and use of trees for construction, fuel, fiber, fodder, food, fertilizer and medicine. Yet, this experience also suggests that we have a great deal to learn before we understand how to improve the production and use of tree products which are of value and interest to the farmers who grow them. Scientific research on forestry has been conducted for over two hundred years and has provided us with some answers to a few of these questions. However, the vast majority of this work has been focused on either plantation forestry or natural forests.

In recent years there has been increased interest in helping farmers increase the productivity, profitability and sustainability of production on their land through increased production and use of trees. Regional research coordination efforts such as those supported by the International Union of Forest Research Organizations and the U.S. Agency for International Development (AID) have also concentrated on trees with multiple uses or "multipurpose tree species (MPTS)" (IUFRO 1984; Dixon *et al.*, 1989).

1.1 A Definition of Multipurpose Tree Species

While emphasis has been placed on MPTS, the question is often asked - Are not all trees multipurpose? The following definition may help make the distinction:

> Multipurpose tree species (MPTS) are purposefully grown to provide more than one significant product and/or service function in the land use systems they occupy. For small farm use this frequently means both significant wood and foliage use from the same tree.

Madamba (1984) reviewed research on some 98 species of MPTS in the tropics of Asia and identified the following important use categories for MPTS:

- fuel
- construction materials
- food, fruit, honey and beverages
- fodder
- pulpwood and small industrial use
- shelterbelts
- oil, tannins, medicinal and industrial uses

Research on multiple uses of trees has been underway in parts of Asia for decades, long before the terms multipurpose tree species and agroforestry were coined. Yet research on many aspects of MPTS still falls short of the needs of small farmers and researchers face enormous challenges if they are to contribute to meeting these needs through the use of these tree species.

Many lists of research priorities have been developed for MPTS since 1980 (see Lundgren, 1986; Burley and Von Carlowitz, 1984). These often include lists of priority species, silviculture research topics and tree improvement needs. Yet the focus of many of these priorities remains on traditional plantation uses of MPTS, rather than small farmer needs. In some cases, this makes no difference, since many of the practices used at the plantation scale can also be used by small farmers. However, there are striking differences in research needs for trees which are to be managed for multiple uses.

1.2 The MPTS Research Network and the F/FRED Project

The F/FRED Project is a ten-year effort funded by the U.S. Agency for International Development (USAID), designed to help scientists cooperatively address the needs of small-scale farmers for fuelwood and other tree products. The project has helped to initiate and support the establishment of the Multipurpose Tree Species Research Network which has some 29 participating institutions in 12 countries in Asia. Mechanisms for network development include scientific and organizational meetings, cooperative research projects, training, travel grants, publications and small research grants. The F/FRED project has worked with a number of donor organizations in supporting network activities in close collaboration with Kasetsart University.

The MPTS Research Network is regional, covering most of the non-Communist countries in Asia. However, it is built upon informal, national-level networks which are being established through a series of National MPTS Research Meetings held annually in most of the participating countries. A primary objective in encouraging these meetings is to provide an open forum for discussion of MPTS research issues and to provide national-level links to the regional research network. In addition, a number of countries have initiated formal national-level MPTS Research Network.

The field operations of the F/FRED project have been largely successful in establishing the MPTS Research Network (Butterfield et al., 1988). During the first three years of network establishment most network activities have been managed by the F/FRED Coordinating Unit housed at the Faculty of Forestry, Kasetsart University in Bangkok, Thailand. However, several important sub-projects such as a national-level network of researchers working on *Azadirachta indica* and *Melia azedarach*, also initiated by the Kasetsart University Faculty of Forestry, and a regional research program on the leucaena psyllid have been initiated, coordinated and managed by network participants.

The F/FRED Project has invested over US$8.9 million over a 4.5-year period in helping to establish the MPTS Research Network, support MPTS research and upgrade the training of MPTS researchers. AID has agreed to provide additional funding for a second five-year phase of F/FRED which began in May 1990.

Commitments from other donors to MPTS Research Network activities have exceeded US$500,000 in Phase 1. Indeed, donor and national support for network programs has been excellent, although it has always been for specific activities on a case by case basis. Participating network institutions have also contributed significantly to network programs through co-financing and provision of staff and facilities.

1.3 The Purpose of this Document

The F/FRED Project has supported a wide range of research in Asia. Although many of the studies supported are long-term field experiments (i.e. 2-10 years), there is substantial interest in the experiments funded by F/FRED in the three years of field research support in Phase 1.

This document is intended to provide a summary of the research supported by F/FRED from the period January, 1987 until the end of Phase 1 (May, 1990). In most cases these summaries are interim reports, as very few of the field experiments have been completed. Detailed research descriptions are available through the MPTS Research Network Secretariat in Bangkok.

2.0 Research Support Activities

A total of 137 studies were initiated through the MPTS Research Network with F/FRED support and are described in Sections 3-11. In addition to this direct support of field and laboratory research, F/FRED has provided substantial quantities of indirect research support. This section describes project-supported activities intended to enhance the research capacity of MPTS researchers in Asia.

2.1 Seed Exploration, Production and Dissemination

Genetic improvement of MPTS in Asia has been limited due to the lack of high-quality provenance collections. An example of this limitation is found with *Acacia auriculiformis*. The U.S. National Academy of sciences has promoted the improvement of *A. auriculiformis* since the late 1970's, but as of early 1987 no serious seed collection expenditions had been carried out. As a result, foresters are still grappling with the problems of poor tree form, variable reports of growth and yield, and the lack of systematic tree improvement programs.

Seed collection expeditions are often neglected because they are expensive and require more foreign exchange resources than most countries are willing, or able, to provide. Regional forestry research programs such as F/FRED must deal with the collection, distribution and evaluation of germplasm resources if significant improvements are to be made in the production and use of MPTS.

F/FRED has played an important role in facilitating and supporting seed collection and production programs involving some 15 tree species on three continents.

2.1.1 Leucaena seed collection and production

The leucaena psyllid problem has forced tree breeders to find or develop varieties and hybrids which are resistant or tolerant of the leucaena psyllid. While several accessions or hybrids have shown some resistance in Hawaii and elsewhere, insufficient quantities of seed have prevented thorough testing of these plant materials on other sites. F/FRED support was used to collect seed in Guatemala and Indonesia and to help increase seed of some of promising varieties/hybrids.

Seed collections were done in Guatemala in early 1989 and in Indonesia in April 1990 by F.J. Pan of the Taiwan Forest Research Institute. These collections were primarily of *Leucaena diversifolia*. Unfortunately, the Guatemala collection was seriously damaged by seed weevils before arriving in Bangkok for processing and storage. The Indonesian collection was done from materials introduced into eastern Java more than 50 years ago. In addition to the seed collected and distributed, Dr.

Pan was able to identify a diploid *L. diversifolia* which had previously been misidentified as *Leucaena pulverulenta.*

The Nitrogen Fixing Tree Association (NFTA) was contracted to work with organizations in India, Indonesia, Philippines, Republic of China and Thailand to establish and maintain seed orchards of promising Leucaena species and species hybrids (Table 1). These orchards have been established and plans are being developed for the distribution of seed through the MPTS Research Network.

Seed produced through these seed orchards will be provided to other network cooperators through a distribution arrangement with NFTA and the Network Secretariat.

Table 1. Leucaena seed orchards established with support from F/FRED

Seed Orchard ID	Organization	Project Manager
LSP88-1	BAIF/India	Narayan Hegde
LSP88-2	TISTR/Thailand	Panas Buranasilpin
LSP88-3	VISCA/Philippines	Rudolfo Escalada
LSP88-4	AARD/Indonesia	Ida N. Oka
LSP88-5	FRI/Taiwan	Fuh Juinn Pan

2.1.2 *Acacia auriculiformis* provenance seed collection

Collections were done in the center of origin in late 1987 by scientists familiar with the species and the collection sites. CSIRO of Australia provided the labor, technical supervision, equipment and facilities to collect and process the seed. Funds for these collections were provided by the F/FRED project, the Australian International Development Assistance Bureau (AIDAB) and CSIRO. F/FRED received approximately 50% of the seed collected for use by MPTS Research Network participants.

The Australian Tree Seed Centre of the Division of Forestry and Forest Products, CSIRO, supervised and managed the collections of in the Western Province of Papua New Guinea and northern Australia in September and October 1987.

A total of 163 mother trees of *A. auriculiformis* were sampled from 9 provenances. Other species included *A. leptocarpa* (26 trees, bulked), *A. aulacocarpa* (24 trees), *A. crassicarpa* (4 trees), *Eucalyptus "pellita"* (30 trees), *E. brassiana* (9 tree bulk), *Melaleuca brassii* (5 tree bulk), *M. acacioides* subsp. *acacioides* (5 tree bulk), *M. symphyiocarpa* (10 tree bulk). Natural hybrids were observed between *A. auriculiformis* and two other species, *A. mangium* and *A. leptocarpa* in the Balamuk

and Tonda areas respectively. A 3-tree collection from hybrids between *A. leptocarpa* and *A. auriculiformis* was of special interest, attaining heights of 18 m compared to *A. leptocarpa* with only 3-6 m in the same area. The trees were erect, single stemmed and would appear to have potential for planting on seasonally waterlogged sites in the wet/dry tropics.

These seed have been distributed to cooperators for use in the International *Acacia auriculiformis* Provenance Trial Series which was planted on some 12 sites in 1989-90.

2.1.3 *Acacia mangium* provenance seed collection

During September and October 1988, the Australian Tree seed Centre of CSIRO Division of Forestry and Forest Products, undertook seed collections in the Western Province of Papua New Guinea (PNG) and north Queensland. The purpose of these expeditions was to obtain seed of *Acacia mangium*, *A. crassicarpa*, *A. auriculiformis* and *A. aulacocarpa*. The collections were co-sponsored with the Centre Technique Forestier Tropical (CTFT), Swedish International Development Authority (SIDA) and Sabah foundation of Malaysia. Collaborators, which included the PNG Forest Department, received a share of the seed in proportion to their contributions.

A major limitation on the collections was the availability of seed. In 1988 seed crops were absent from *A. mangium* throughout Cape York Peninsula and much of the areas traversed in the Western Province of PNG. A total of 127 kg of seed was collected from about 695 trees in 33 provenances. The seed provided to F/FRED have been stored with the ASEAN-Canada Tree Seed Centre and are being periodically distributed to network cooperators.

2.1.4 *Dalbergia sissoo* provenance seed collection

Collections were supported in Pakistan through the Pakistan Forest Institute and in Nepal through the Dept. of Forestry and Plant Research. A total of 12 provenances were collected and have been distributed to cooperators in these countries and India for use in an International *Dalbergia sissoo* Provenance Trial Series which is to be planted in 1990.

2.2 Annotated Bibliographies

Access to references on MPTS is very limited for most scientists. Even when citations are available, abstracts or complete references are often difficult to obtain. One means of relieving this problem is the compilation of annotated bibliographies for high priority species. The following is the status of annotated bibliographies for the F/FRED priority species:

Priority species	Status of annotated bibliography
Acacia auriculiformis	Co-published by CSIRO and F/FRED in July 1990
Acacia mangium	Available from FRIM
Acacia nilotica	Available from CABI
Dalbergia sissoo	In preparation by F/FRED
Eucalyptus camaldulensis	Available from OFI
Leucaena leucocephala	Numerous bibliographies available
Prosopis cineraria	Unavailable
Prosopis juliflora	Unavailable

Publication of both the *Dalbergia sissoo* bibliography is anticipated by September 1990.

2.3 Methodology Development

One of the objectives of the network trials described in Section 3.0 is the development of standard methods for MPTS research. F/FRED support has been used to prepare a series of manuals to define and describe methods for use in F/FRED-sponsored network trials. In addition, a field trials manual was prepared by C.B. Briscoe as a general guide to methods for MPTS field research. (Briscoe, 1990). Experience with the network trials provides a unique opportunity to compare and revise research methods. A meeting is being planned for December 1990 to revise the Briscoe manual and prepare for new field experiments in the humid/sub-humid zone.

2.4 Training

Training helps enhance the capability of scientists to design, conduct and analyze MPTS experiments. Training is particularly needed in the implementation of multi-location experiments which require the use of a standardized methodology and which involve scientists from various institutions.

One of the training activities organized by the project in support of MPTS research was a short course designed to present the standardized methodology for the 1987 network trials and the use of the Information and Decision Support System (IADSS) for data entry and analysis. The course was held in all the countries participating in the network trials (Indonesia, Malaysia, Pakistan, Philippines, Republic of China, and Thailand). Participants included trial cooperators and field technicians. A roving course was also conducted in India, Nepal, Pakistan and Sri Lanka for participants in the Arid and Semi-Arid zone network experiments.

Other short courses that have been organized within the last three years include:

- research problem identification and proposal preparation
- design and analysis of MPTS experiments
- microcomputer applications in forestry research
- technical writing and presentation
- data analysis and interpretation (using IADSS)
- strategies, methods and research techniques for marketing tree products from small farms
- problem solving for agroforestry research
- social science concepts and methodologies for foresters
- forestry for social scientists

More than 300 Asian scientists have participated in these training courses.

2.5 Regional Research Plans

One means of encouraging and conducting regional research is in the preparation of regional plans. In early 1987, with assistance from Max McFadden of the U.S. Forest Service, F/FRED began the preparation of the first of two regional research plans. These plans were prepared during small meetings of 10-15 experts from Asia and the U.S and are intended to identify high priority research topics and opportunities for collaborative research and donor support.

2.5.1 Leucaena psyllid research

The leucaena psyllid is a tiny homopterous insect which has infested *Leucaena leucocephala* in Asia and the Pacific, causing widespread economic damage. The impact of this pest on leucaena production and use has resulted in leucaena psyllid research programs in more than ten countries in the region. Common interest in finding solutions to the psyllid problem has led to cooperative planning of research, increased communication and coordination between researchers and additional funding by institutions such as the International Development Research Centre (IDRC), U.S. Agency for International Development (AID) and national research programs.

The economic damage to leucaena by the psyllid has caused enough alarm in many countries in Asia and the Pacific for governments to assign significant manpower and financial resources to solving the problem. Research interest in the psyllid has resulted in the production of a regional research plan and regular communications between national programs (Napompeth *et al.*, 1987; MacDicken, 1989).

National psyllid research programs began independently in Asia and the Pacific as the infestation reached Australia, Indonesia, Malaysia, the Philippines, Taiwan, Thailand and the United States between 1983-86. This initially led to

communication between a few researchers on potential control measures. Notable among these early efforts were introduction of the predatory coccinellid, *Curinus coeruleus,* from Hawaii to Guam, the Commonwealth of the Northern Marianas, Indonesia, Philippines and Thailand. Seed of leucaenas with potential sources of resistance were also exchanged among researchers during these early years.

In November 1986 an international workshop was organized by the Nitrogen Fixing Tree Association in Hawaii to summarize research and develop a general action plan for future psyllid research. The meeting produced a proceedings which is a valuable reference to the early research on the psyllid and its control.

In early 1987 national research meetings were held in Thailand and the Philippines with support from the F/FRED Project to further define leucaena production objectives and psyllid research priorities. These national objectives and priorities were assembled during a meeting of national psyllid research coordinators in Manila in June 1987. The output from this meeting was a regional plan which summarized the national programs and recommended the support of research in 7 general areas. The plan was an important step in identifying researchers and gaps in the range of topics which needed attention.

The plan and the recommendations it contained were circulated widely among the research and donor communities. The Asian Development Bank (ADB) expressed interest in funding some form of psyllid research, but ultimately decided not to provide funding. However, the plan provided useful information which was used by the F/FRED Project, USAID and IDRC in their decisions to fund psyllid research.

Virtually all of the research conducted on the leucaena psyllid up to 1988 was funded by national or local sources. Some of this research continues, with current summaries of national program research projects under preparation for all of the countries involved in the regional program. In 1988, IDRC and USAID began to provide funding to the regional program. Development of studies with support from these two sources was done under direction of national psyllid research coordinators and resulted in a series of projects in Indonesia, Malaysia, Philippines, Republic of China (Taiwan) and Thailand.

In addition, national program funding of psyllid research has continued in all of the participating countries.

2.5.2 *Dalbergia sissoo*

Dalbergia sissoo Roxb. (shisham or sissoo) is widely recognized as an important multipurpose tree species in parts of India, Nepal and Pakistan. It is a highly valued timber and provides a range of other products such as fodder, fuelwood and medicine. Yet, it is a species which has been inadequately studied. As a result, little progress has been made in improving the cultivation and management of sissoo.

While sissoo has been used on small farms for centuries, and large-scale plantations have existed for over 100 years, research has been spotty and largely uncoordinated. Few studies have come up with results that are being implemented in the field. Seed for new plantings in both the private and public sectors are almost entirely from unimproved sources. As a result farmers probably manage and use sissoo timber, leaves and branches just as their ancestors did centuries ago. However, the popularity of the timber for furniture, carving and turning has resulted in the decimation of natural stands. If this species is to continue to be available for the consumer and at the same time make more money for growers, then an intensive, systematic research program is needed.

Since *D. sissoo* is indigenous in parts of India, Nepal and Pakistan, a coordinated regional effort is likely to yield greater results than independent research programs in each country. The sharing and evaluation of germplasm, cooperative research and information exchange on the silviculture, management and utilization of sissoo are likely to improve the effectiveness and efficiency of research on this important species.

A group of eight scientists representing three countries met in Bangkok from 26-28 September, 1989 to review sissoo research and prepare a draft research plan for consideration by national research programs. The research plan is intended as a step in enhancing regional research on *D. sissoo*. It is hoped that the Regional Research Plan will serve as a guide to research agencies and funding agencies, both national and regional, as they consider the needs and opportunities for sissoo research.

The Forestry/Fuelwood Research and Development Project (F/FRED) has made an initial commitment to support regional sissoo research in India, Nepal and Pakistan. It is hoped that this combination of national and regional effort will result in enhanced research on this important MPT species.

2.6 Soil Characterizations

Careful interpretation of results from multi-location network experiments requires a thorough description of soil characteristics. F/FRED, through the Univ. of Hawaii and Arlington offices, made arrangements with the U.S. Soil Conservation Service to carry out soil characterizations on most of the network trial sites in the humid, semi-arid and arid zones. This has included complete analysis of soil chemical and physical properties and classification of each soil pedon to the family level of USDA Soil Taxonomy. The data from these characterizations are entered into IADSS and are provided to each of the research cooperators.

3.0 Network Field Trials

Network experiments were initiated in 1986 with the following three purposes:

1. to enhance the knowledge of site requirements, growth rates, required management treatments and yield of priority MPTS.

2. to provide a focus for network development.

3. to help improve and standardize research methodologies used in priority MPTS research.

A major assumption in the support of network experiments with F/FRED funding is that the purposes of network development and knowledge generation through field experiments are compatible and can both be achieved through network trials.

The following features have been incorporated in network trials supported by F/FRED:

- common design and standardized methodology;
- common minimum data set to be collected;
- common germplasm;
- the same experiment on multiple sites;
- thoroughly described soils and climate at each site;
- data exchange and professional interaction between participants; and
- intersite combined analysis of data.

3.1 Humid Zone

At the 1986 Forestry Networks Workshop in Bangkok, there was a consensus to establish a standardized set of field trials in the humid and subhumid zone of Asia beginning 1987. The workshop was followed by a planning meeting in Kuala Lumpur, Malaysia in December, 1986, where Asian scientists designed the experiment.

The experimental design is a randomized complete block design using a factorial of 3 species x 2 provenances x 3 management treatments. The treatment combinations are noted in Table 2. Tree spacing was 1 x 2 m with plot layout of 49 trees in a 7 x 7 arrangement.

Table 2. Species, genotypes, and treatments for the 1987 humid zone network trials

Factor A Species and Code	Factor B Provenance and Seedlot	Factor C* Cutting Management C	PO	PR
Acacia mangium	Iron Range QLD, #15677	1	2	3
	Boite PNG, #15642	4	5	6
Acacia auriculiformis	Morehead QLD, #15477	7	8	9
	Bensbach/ Balamuk PNG, #15648	10	11	12
Leucaena diversifolia	Hawaii K156	13	14	15
	Hawaii hybrid KX3 (K743)	16	17	18

* C = control (no cutting)
PO = pollard (at 2m at 24 months)
PR = prune (50% of height at 18 months)

In general, the field trials aimed to improve the productivity and utility of short-term rotation trees in meeting fuelwood other needs (e.g fodder) of small-scale growers in developing countries, and provide growers with a number of options appropriate to their conditions.

The F/FRED Project has provided support in the following ways to facilitate the research:

- o Sponsorship of meetings at which Asian scientists developed a standardized field trial methodology.
- o Provision of research grant to every collaborator participating in the trials.
- o Supplying of germplasm for the trials.
- o Provision of a guide to experiment establishment and measurement (including a training video)
- o Soil characterization survey of almost all (12) the sites involved.
- o Provision of microcomputers to most of the institutions involved.
- o Provision of the Information and Decisions Support System (IADSS) software which contains:
    - a. primary databases for organising, storing and retrieving research information and data

b. research support databases for storing information on references on priority species, MPTS specialists worldwide, soil and climate.
c. a graphics and data analysis package called F/FRED Models (F/MOD).

- Conducting of training courses on mensuration, data collection and analysis (including the use of IADSS for entry and analysis of thee minimum data set).
- Organization of a field tour and travelling seminar for two weeks (October, 1988) for the collaborating scientists, during which time a refinement of the standardised methodology was made.
- Organization of a Workshop on Data Analysis and Interpretation (at GRU) to assist in the better utilization of IADSS and FMOD.
- Technical advice through the site visits by members from CUandGRU.

Though the success of these trials is unprecedented in Asia, there have been problems and constraints.

- Out of 15 sites, only 13 were successfully established one year after planting. The Nueva Ecija site in the Philippines was burned due to grass fire, and one of the TISTR sites in Thailand had very poor survival due to a serious drought in late 1987.

- Among the established 13 experiments, not all have the required numbers of plots due to one or more of the following reasons:

  a. Insufficient seedlings to begin with for establishing all the needed plots. Poor seed germination in 1 or 2 genotypes was one of the causes.
  b. Poor survival of certain genotypes or in certain blocks, probably because of the site effects or poor management.
  c. Damage by animals from the surrounding areas (e.g. cattle and elephant).
  d. Damage by typhoon (e.g. Baybay plot in Philippines)

- Not all cooperators have followed strictly the standard methodology agreed to when the experiment was designed. This could be due to the following reasons:

  a. Not all the eventual cooperators were involved in the initial planning of the experiment, and given the varied research background of the cooperators, the need to strictly adhere to the standardized methodology was not fully appreciated by all.

  b. Insufficient funds to carry out all the stipulated activities, because some institutions did not budget adequate funds.

c. Difficulty in getting the necessary materials, instruments or manpower required for the proper conduct of the experiment as defined by the standardized methodology.

- The exchange of data has been slow. This is due to the following reasons:

  a. Not all the cooperators have readily accessible computers for use in their institutions, nor are they themselves familiar with the use of personal computers and IADSS.
  b. For most cooperators, this experiment is one of the several they are conducting.
  c. Communication among the cooperators had generally been poor except between the cooperators and CU.

Geographical distribution of these experiments is shown in Figure 1. The trials are listed by country and briefly described below.

Indonesia

Locality	:	Dramaga, 6 km from Bogor
Researcher	:	Komar Soemarna
Agency	:	Forest Research and Development Centre
PSA No.	:	PSA87017
Date Approved	:	8.07.87
Duration	:	3 years
Amount	:	US$2,351.86
Counterpart	:	Not specified
Notes	:	Trial was well established, but data were not collected for basal diameter

Locality	:	Cikampek
Researcher	:	Komar Soemarna
Agency	:	Forest Research and Development Centre
PSA No.	:	PSA87018
Date Approved	:	8.07.87
Duration	:	3 years
Amount	:	US$2,645.00
Counterpart	:	Not specified
Notes	:	Trial was well established, but data were not collected for basal diameter

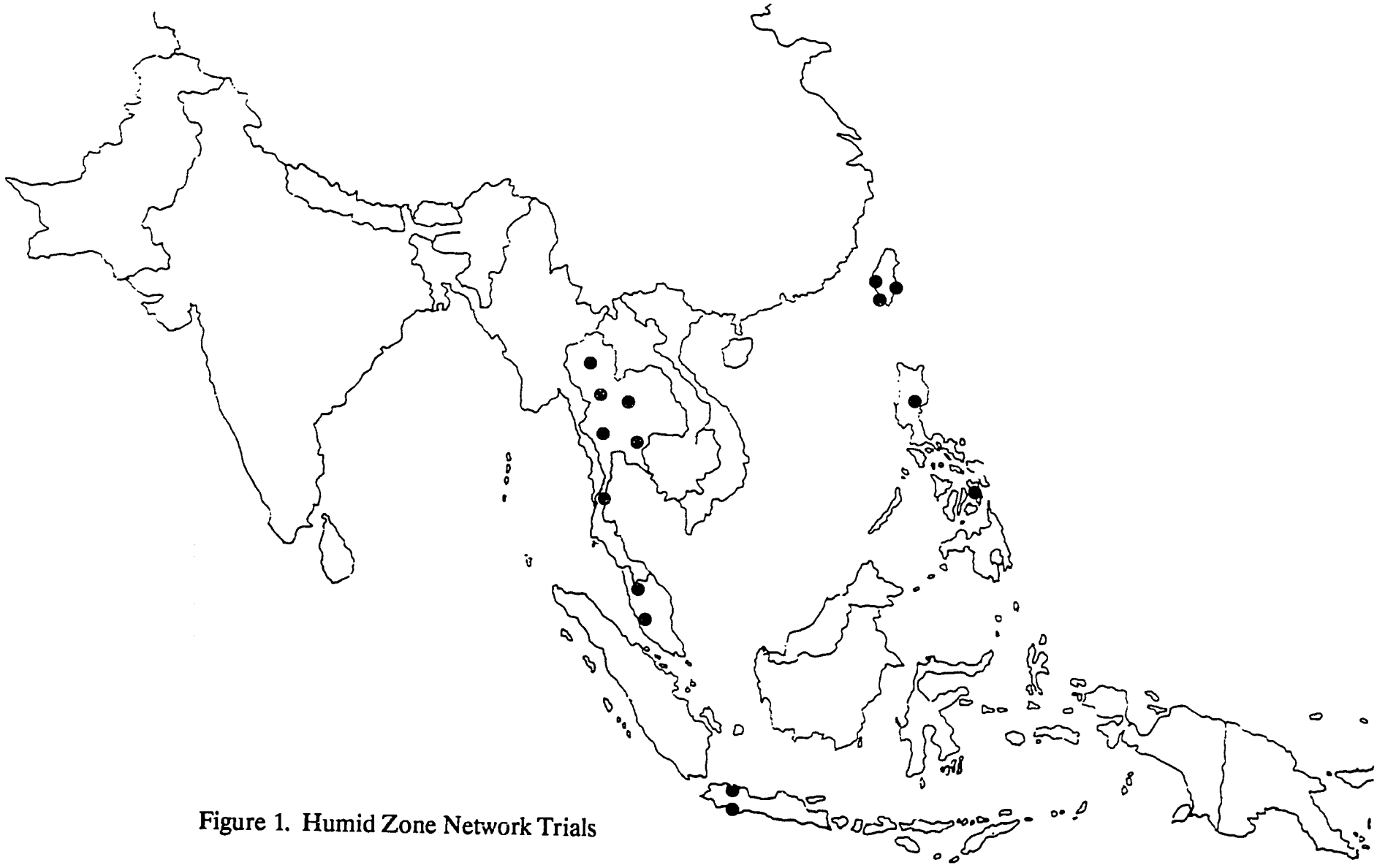

Figure 1. Humid Zone Network Trials

Malaysia

Locality	:	Campus, Universiti Pertanian Malaysia, Serdang, Selangor
Researcher	:	Kamis Awang
Agency	:	Universiti Pertanian Malaysia
PSA No.	:	PSA87008
Date Approved	:	5.05.87
Duration	:	3 years
Amount	:	US$5,140.82
Counterpart	:	Not specified
Notes	:	One additional treatment was added at the species level, *Casuarina equisetifolia*

Locality	:	Mata Air, Perlis
Researcher	:	Mohd. Lokmal B. Hj. Ngah
Agency	:	Forest Research Institute Malaysia
PSA No.	:	PSA87009
Date Approved	:	5.05.87
Duration	:	3 years
Amount	:	US$5,175.51
Counterpart	:	Not specified
Notes	:	Elephant damage and lack of seedlings have reduced the number of *Leucaena diversifolia* and K743 trees for measurement

Philippines

Locality	:	Caranglan, Nueva Ecija
Researcher	:	Enrique Crizaldo
Agency	:	Ecosystems Research and Development Bureau
PSA No.	:	PSA87014
Date Approved	:	5.05.87
Duration	:	3 years
Amount	:	US$5,101.09
Counterpart	:	Not specified
Notes	:	This site was burned in May 1988. Monitoring of regrowth is being carried out.

Locality	:	VISCA agroforestry experiment station
Researcher	:	Romeo S. Raros/J.Quimio
Agency	:	Visayas State College of Agriculture
PSA No.	:	PSA87015
Date Approved	:	5.05.87
Duration	:	3 years

Amount : US$4,970.18
Counterpart : Not specified
Notes : Typhoon damage in late 1988 blew down >90% of the *A. mangium.*

Republic of China

Locality : Heng-Chung Branch Station
Researcher : Fuh-Jiunn Pan
Agency : Taiwan Forestry Research Institute
PSA No. : PSA87006
Date Approved : 5.05.87
Duration : 3 years
Amount : US$4,800.00
Counterpart : Not specified
Notes :

Locality : Tai Ma Li Branch Station
Researcher : Fuh Jiunn Pan
Agency : Taiwan Forestry Research Institute
PSA No. : PSA87007
Date Approved : 5.05.87
Duration : 3 years
Amount : US$4,800.00
Counterpart : Not specified
Notes :

Locality : Hwa Lin
Researcher : Ta-Wei Hu
Agency : Department of Forestry, Chinese Culture University
PSA No. : PSA87016
Date Approved : 5.05.87
Duration : 3 years
Amount : US$5,000.00
Counterpart : Not specified
Notes : Only isothermic site in this series.

Thailand

Locality : TPC Seed Centre, Uthaithani
Researcher : Suree Bumibhanon
Agency : Faculty of Forestry, Kasetsart University
PSA No. : PSA87010

Date Approved : 5.05.87
Duration : 3 years
Amount : US$5,001.95
Counterpart : Not specified
Notes :

Locality : Lad Krating Plantation, Cha Choeng Sao Province
Researcher : Suree Bumibhanon
Agency : Faculty of Forestry, Ksaetsart University
PSA No. : PSA87011
Date Approved : 5.05.87
Duration : 3 years
Amount : US$4,923.86
Counterpart : Not specified
Notes :

Locality : Chumphon Province
Researcher : Kovith Yantasath
Agency : Thailand Institute of Scientific and Technological Research
PSA No. : PSA87012
Date Approved : 5.05.87
Duration : 3 years
Amount : US$5,008.98
Counterpart : Not specified
Notes : Very poor survial due to severe drought.

Locality : Chiang Mai Province
Researcher : Kovith Yantasath
Agency : Thailand Institute of Scientific and Technological Research
PSA No. : PSA87013
Date Approved : 5.05.87
Duration : 3 years
Amount : US$5,008.98
Counterpart : Not specified
Notes : Inadequate seedling numbers and cattle damage have excluded this site from combined analysis and modelling.

Locality : Khon Kaen
Researcher : Kamolwat Visetsiri
Agency : Division of Silviculture, Royal Forest Department
PSA No. : PSA87022
Date Approved : 19.06.87
Duration : 3 years

Amount : US$5,060.52
Counterpart : Not specified
Notes :

Locality : Ratchaburi Province
Researcher : Bunyalid Puriyakorn
Agency : Division of Silviculture, Royal Forest Department
PSA No. : PSA87023
Date Approved : 19.06.87
Duration : 3 years
Amount : US$5,060.52
Counterpart : Not specified
Notes :

3.2. Semi-Arid Zone

These experiments were designed in a meeting held in Kathmandu in March, 1988. Seeds were distributed in late 1988 and through 1989.

The experimental design is a randomized complete block using a factorial of 4 species x 2 pruning regimes. Treatment factors are species and pruning. Three species are common to all locations and each cooperator is to select one additional species of their own choice. The common species are *Acacia nilotica, Dalbergia sissoo* and *Eucalyptus camaldulensis.*

Rows are 10m apart and trees are 1m apart within rows. Eight meters of the 10m between rows was to be planted to a cover crop, *Stylosanthes hamata,* at approximately the same time as the trees were planted, leaving 1m unplanted on each side of all three rows on each plot.

The geographical distribution of these experiments is shown in Figure 2. Brief descriptions of the trials are given below.

India

Locality : Gwal Pahari - Teri Field Station (30 km from Delhi)
Researcher : A. N. Chaturvedi
Agency : Tata Energy Research Institute
PSA No. : PSA88040
Date Approved : 17.08.88
Duration : 2 years
Amount : US$1,822.00
Counterpart : Not specified

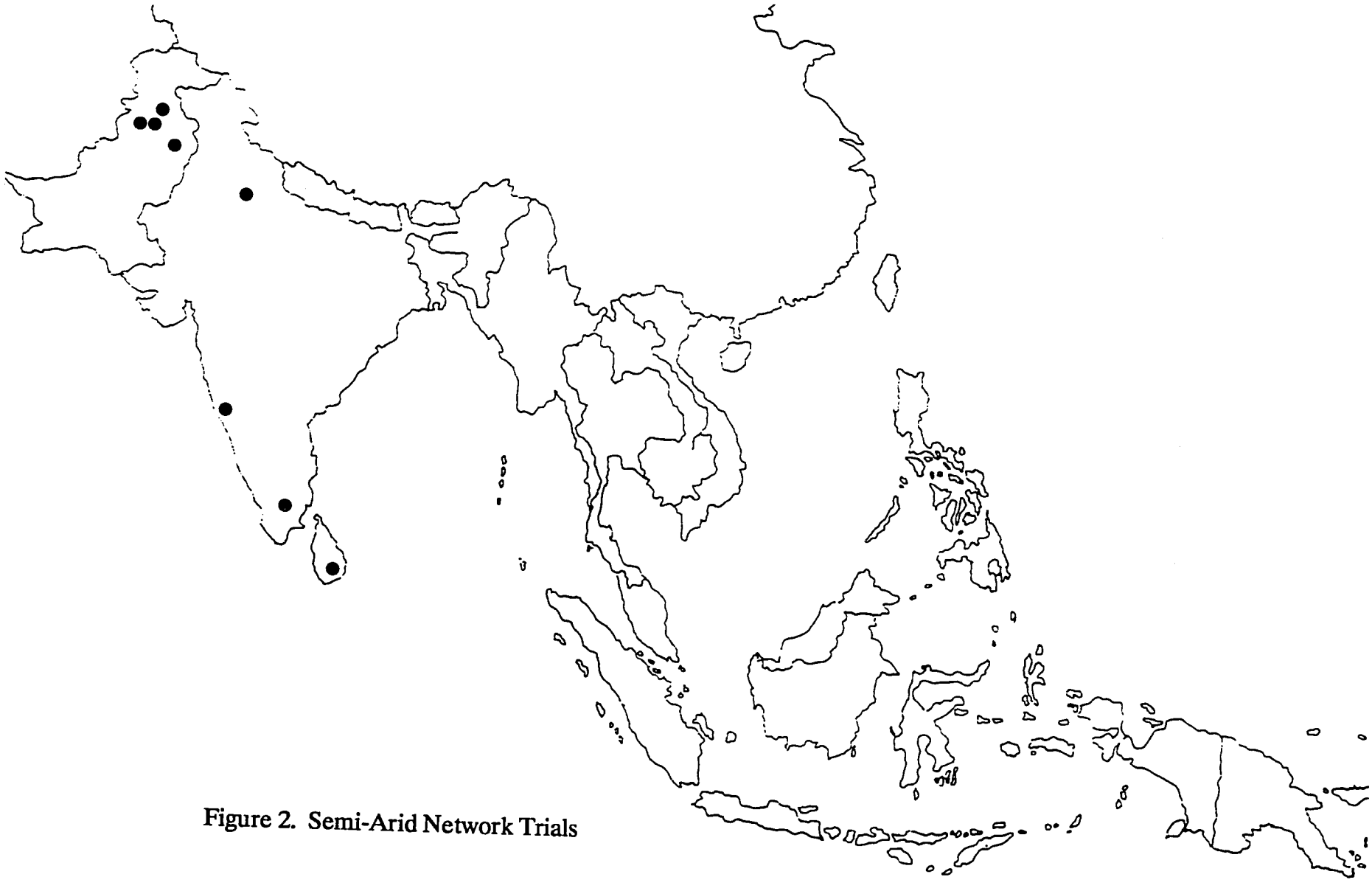

Figure 2. Semi-Arid Network Trials

Notes	:	Planted August, 1989; local species: *Cassia siamea*; Germination of *Eucalyptus camaldulensis* was poor. For this species only 6 trees were planted per row and spacing has been changed to 2 meters between trees.

Locality	:	BAIF Institute for Rural Development (Karnataka), Lakkihalli Campus, Taluka : Arsikere, Tiptur
Researcher	:	Narayan G. Hegde
Agency	:	Bharatiya Agro-Industries Foundation
PSA No.	:	PSA88075
Date Approved	:	12.10.88
Duration	:	2 years
Amount	:	US$1,755.00
Counterpart	:	Not specified
Notes	:	

Locality	:	ICRISAT Campus, Hyderabad
Researcher	:	Chin K. Ong/M. M. Sharma
Agency	:	ICRISAT
PSA No.	:	
Date Approved	:	
Duration	:	2 years
Amount	:	
Counterpart	:	Not specified
Notes	:	Planted August, 1989; local species pigeon pea; seeds of *Eucalyptus camaldulensis* and *Dalbergia sissoo* obtained from local sources.

Locality	:	Madurai
Researcher	:	J. S. Rawat
Agency	:	Madurai Kamaraj University
PSA No.	:	PSA88081
Date Approved	:	1.11.88
Duration	:	2 years
Amount	:	US$4,500.00
Counterpart	:	Not specified
Notes	:	Planted December, 1989; local species: *Albizia lebbek*; local seed source used for *Eucalyptus camaldulensis* because seeds sent by CU failed to germinate.

Nepal

Locality	:	Ganj, terai area of Mid Western Development region and Dang inner valley of Mid Western Development region
Researcher	:	Jyoti N. Rayamajhi
Agency	:	Institute of Forestry
PSA No.	:	PSA89006
Date Approved	:	12.01.89
Duration	:	2 years
Amount	:	US$3,468
Counterpart	:	Not specified
Notes	:	

Locality	:	Chitrasari Village, about 15 km southeast of IAAS
Researcher	:	Khem Raj Dahal
Agency	:	Institute of Agriculture and Animal Science
PSA No.	:	PSA89007
Date Approved	:	12.06.89
Duration	:	2 years
Amount	:	US$2,573.00
Counterpart	:	Not specified
Notes	:	

Locality	:	Dang, Inner Valley of Mid Western Development Region
Researcher	:	Jyoti N. Rayamajhi
Agency	:	Institute of Forestry
PSA No.	:	PSA89008
Date Approved	:	13.01.89
Duration	:	2 years
Amount	:	US$3,468.00
Counterpart	:	Not specified
Notes	:	

Locality	:	Bacheuli village. 25 km southeast of IAAS, Chitwan.
Researcher	:	Fanindra Thapa
Agency	:	Institute of Agriculture and Animal Science
PSA No.	:	PSA89009
Date Approved	:	16.01.89
Duration	:	2 years
Amount	:	US$2,770.00
Counterpart	:	Not specified
Notes	:	

Pakistan

Locality	:	Kharian, Punjab
Researcher	:	Mohammad Hafeez/Zafar Islam
Agency	:	Punjab Forestry Research Institute
PSA No.	:	PSA89002
Date Approved	:	12.01.89
Duration	:	2 years
Amount	:	US$2,017.00
Counterpart	:	Not specified
Notes	:	Planted March, 1990; local species: *Albizia lebbek.*

Locality	:	Sialkot, Punjab
Researcher	:	Shams-ur-Rehman/Mr. Zaheer
Agency	:	Pakistan Forestry Institute
PSA No.	:	PSA89004
Date Approved	:	12.01.89
Duration	:	2 years
Amount	:	US$2,017.00
Counterpart	:	Not specified
Notes	:	Located on a private farmland; area not fenced but is not heavily grazed; a watchman looks out for the trial.

Locality	:	NARC, Islamabad
Researcher	:	Mohammad Hanif Quazi
Agency	:	Pakistan Agricultural Research Council
PSA No.	:	PSA90015
Date Approved	:	2.05.90
Duration	:	2.5 years
Amount	:	US$5,238.00
Counterpart	:	Not specified
Notes	:	

Locality	:	Barani Research Institute, Chakwal
Researcher	:	Mohammad Hanif Quazi
Agency	:	Pakistan Agricultural Research Council
PSA No.	:	PSA90016
Date Approved	:	12.05.90
Duration	:	2.5 years
Amount	:	US$5,238.00
Counterpart	:	Not specified
Notes	:	

Sri Lanka

Locality	:	Badulla
Researcher	:	W. Weerawardene
Agency	:	Forestry Department
PSA	:	In process
Date Approved	:	-
Duration	:	2 years
Amount	:	
Counterpart	:	Not specified
Notes	:	Planted November, 1989; local species: *Calliandra calothyrsus.*

3.3 Arid Zone

Experimental design: Randomized complete block using a factorial of 4 species x 2 pruning regimes = 8 treatment per block x 3 replications = 24 plots. Blocks are located to minimize variation within each block. Treatments are randomly assigned to plots in complete blocks of eight plots.

Treatments: Treatment factors are species and pruning. Three species are common to all locations and each cooperator is to select one additional species of their own choice. The common species in the arid zone trials include *Acacia nilotica, Prosopis pallida* and *Prosopis cineraria.*

Layout: In the arid zone, each plot is uniquely numbered and consists of eight rows with twelve trees each. Rows are 2m apart, and trees within rows are also 2m apart.

The geographical disrtibution of these experiments is shown in Figure 3. The experiments are listed and briefly described below.

India

Locality	:	Hyderabad (on land owned by the Government of Andhra Pradesh)
Researcher	:	R. K. Rao
Agency	:	Indian Forest Service
PSA No.	:	
Date Approved	:	
Duration	:	2 years
Amount	:	
Counterpart	:	Not specified
Notes	:	Planted August, 1989; local species *Albizia lebbek.* 10 - 15% of the trees have been lopped by rabbits.

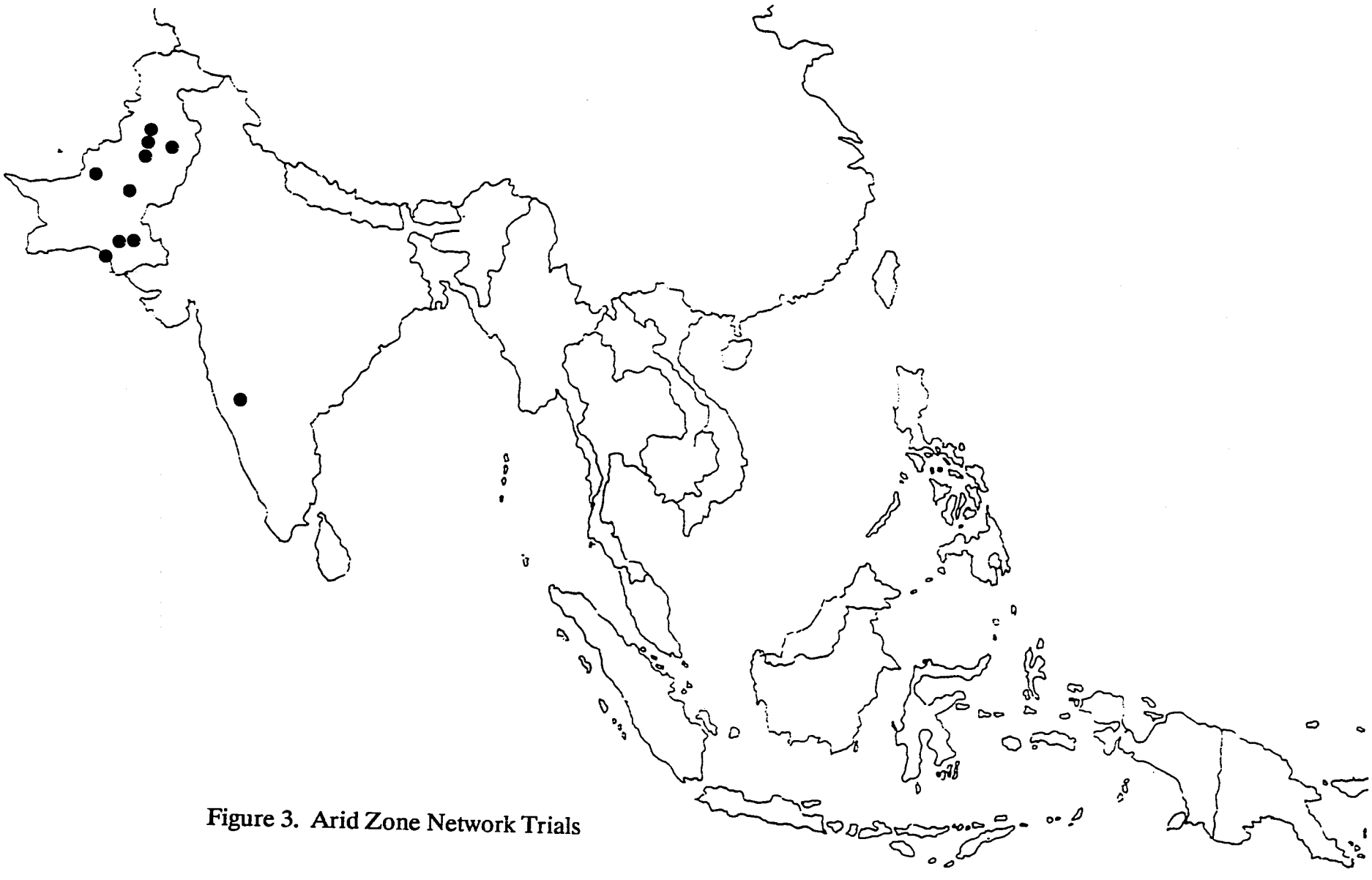

Figure 3. Arid Zone Network Trials

Locality	:	Urulikanchan
Researcher	:	Narayan G. Hegde
Agency	:	Bharatiya Agro-Industries Foundation
PSA No.	:	
Date Approved	:	
Duration	:	2 years
Amount	:	
Counterpart	:	
Notes	:	

Pakistan

Locality	:	Gatwala, Faisalabad, Punjab
Researcher	:	Mohammad Hafeez
Agency	:	Punjab Forestry Research Institute
PSA No.	:	PSA89001
Date Approved	:	12.01.89
Duration	:	2 years
Amount	:	US$3,530.00
Counterpart	:	Not specified
Notes	:	Local species *Albizia lebbek*; *Prosopis cineraria* reduced to 48 trees per plot due to poor seed ermination.

Locality	:	Ratta, Kualchi, D. I. Khan
Researcher	:	Shams-ur-Rehman
Agency	:	Pakistan Forestry Institute
PSA No.	:	PSA89003
Date Approved	:	12.01.89
Duration	:	2 years
Amount	:	US$3,530.00
Counterpart	:	Not specified
Notes	:	Planted January, 1990; local species *Acacia modesta*; plot layout 8 x 8 trees instead of 8 x 12 trees.

Locality	:	AZRI, Quetta
Researcher	:	Mohammad Hanif Quazi
Agency	:	Pakistan Agricultural Research Council
PSA No.	:	PSA90017
Date Approved	:	2.05.90
Duration	:	2.5 years
Amount	:	US$5,386.00
Counterpart	:	Not specified
Notes	:	

Locality	:	Islamabad
Researcher	:	Noor Mohammad
Agency	:	National Agricultural Research Centre
PSA No.	:	
Date Approved	:	
Duration	:	2 years
Amount	:	
Counterpart	:	Not specified
Notes	:	Planted July, 1989; local species *Leucaena leucocephala.*

Locality	:	Tando Jam
Researcher	:	Raziuddin Ansari
Agency	:	Atomic Energy Agricultural Research Centre
PSA No.	:	PSA88047
Date Approved	:	12.10.88
Duration	:	2 years
Amount	:	US$6,000.00
Counterpart	:	Not specified
Notes	:	Seeds of *Acacia nilotica* and *Prosopis pallida* hand delivered by Lee Medema in May, 1990; seeds of *Prosopis cineraria* sent by mail in June, 1990.

Locality	:	Forage Research Unit, Dhabeji, Sind
Researcher	:	Mohammad Hanif Quazi
Agency	:	Pakistan Agricultural Research Council
PSA No.	:	PSA90018
Date Approved	:	2.05.90
Duration	:	2.5 years
Amount	:	US$5,386.00
Counterpart	:	Not specified
Notes	:	

Locality	:	AZRSS, D. I. Khan
Researcher	:	Mohammad Hafeez Quazi
Agency	:	Pakistan Agricultural Research Council
PSA No.	:	PSA90019
Date Approved	:	2.05.90
Duration	:	2.5 years
Amount	:	US$5,386.00
Counterpart	:	Not specified
Notes	:	

3.4 International *Acacia auriculiformis* Provenance Trials

The F/FRED project is providing support for a series of International Provenance Trials for *Acacia auriculiformis* in co-sponsorship with the Australian Centre for International Agricultural Research (ACIAR). The German Technical Coorporation Agency (GTZ) and the Finland International Development Authority (FINNIDA). Partial financial support of the experiments to a maximum of US$2,000 per site has provided to cooperating institutions for the sites supported by the F/FRED project. These fixed amount grants are to assist with the costs of establishment, maintenance and monitoring of these experiments.

F/FRED began support of *Acacia auriculiformis* tree improvement in 1987 with the co-sponsorship of a seed collection expedition in the center of origin for this species. This important collection now serves as the basis for provenance evaluation of *Acacia auriculiformis* in the humid tropics.

Data from these provenance trials is being collected by cooperators and entered into the F/FRED Information and Decision Support System data base for analysis by cooperators. Assistance with combined data analysis will also be provided by the project. In conjunction with these provenance studies, F/FRED and ACIAR has co-sponsored additional research on the inter-specific variation of *Acacia auriculiformis*. These studies have included the establishment of provenance zones, and evaluation of intraspecific variation through glasshouse studies.

Experimental design:	Randomized complete block design with 25 provenances, 6 blocks per site.
Spacing and plot size:	3 x 3 m with 16 trees per plot (4 rows of 4 trees). Total experiment would be 2.16 ha plus border around the entire experiment.
Minimum data set:	Survival, stem height and diameter at 10 cm and 1.3m will be measure every six months beginning at six months after transplanting. The number of stems and a form rating will be recorded at 24 months. Data will be exchanged through the IADSS software system as per the F/FRED-funded humid zone network trials.

The geographical disrtibution of these experiments is given in Figure 4. The trials supported by F/FRED are listed and described below. Those sponsored by GTZ, FINNIDA and ACIAR are not noted.

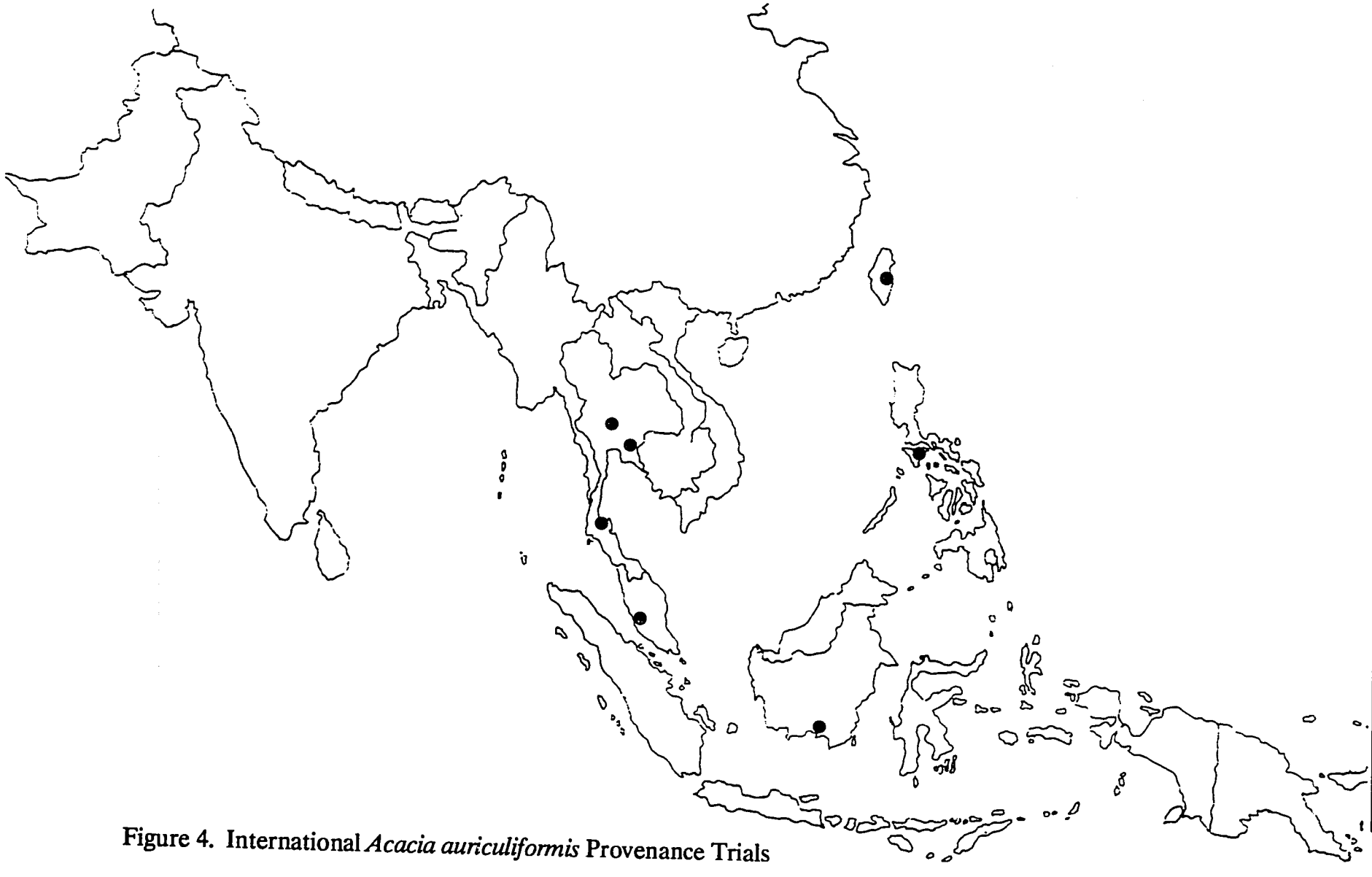

Figure 4. International *Acacia auriculiformis* Provenance Trials

Researcher	:	Fuh-Jiun Pan
Agency	:	Taiwan Forestry Research Institute
Country	:	Republic of China (Taiwan)
PSA No.	:	PSA88088
Date Approved	:	1.12.88
Duration	:	1 year
Amount	:	US$2,000.00
Counterpart	:	Not specified

Researcher	:	Suree Bumiblhanon
Agency	:	Faculty of Forestry, Kasetsart University
Country	:	Thailand
PSA No.	:	PSA88089
Date Approved	:	1.12.88
Duration	:	1 year
Amount	:	US$2,000.00
Counterpart	:	Not specified

Researcher	:	Kamis Awang
Agency	:	Fakulti Perhutanan, Universiti Pertanian Malaysia
Country	:	Malaysia
PSA No.	:	PSA88090
Date Approved	:	1.12.88
Duration	:	1 year
Amount	:	US$2,000.00
Counterpart	:	Not specified
Researcher	:	Elpidio Rimando
Agency	:	Ecosystems Research and Development Bureau
Country	:	Philippines
PSA No.	:	PSA88091
Date Approved	:	1.12.88
Duration	:	1 year
Amount	:	US$2,000.00
Counterpart	:	Not specified

3.5 International Dalbergia Sissoo Provenance Trial Series

An integral part of the proposed Regional Research Plan for *Dalbergia sissoo* is an International *Dalbergia sissoo* Provenance Trial Series. Collaboration for these experiments has been arranged in India through the BAIF Development Research Foundation in Pune, in Nepal through the Dept. of Forest and Plant Research and in

Pakistan through the Pakistan Forest Institute for seed collections and provenance trials.

A total of 10 sites have been proposed for this series of experiments with seed distributed for seven sites so far. The experiment has been designed as follows:

Experimental design:	Randomized complete block design with 15 provenances, 4 blocks per site
Spacing and plot size:	2 x 2 m with 49 trees per plot (7 rows of 7 trees). Total experiment would be 1.17 ha.
Minimum data set:	Survival, stem height and diameter at 10 cm and 1.3m will be measured every six months beginning at six months after transplanting. The number of stems and a form rating will be recorded at 24 months. Data will be exchanged through the IADSS software system as per the F/FRED-funded humid zone network trials.

Seed for the experiment were sent out by April-May, 1990.

The geographical distribution of these experiments is shown in Figure 5. The trials funded by F/FRED are listed and described below. Experiments in Nepal are supported by the Dept. of Forest and Plant Research and the Overseas Development Administration (ODA).

Researcher	:	Shams-ur-Rehman
Agency	:	Pakistan Forest Institute
Country	:	Pakistan
PSA No.	:	PSA90010
Date Approved	:	31.03.90
Duration	:	6 months
Amount	:	US$2,000.00
Counterpart	:	None

Researcher	:	Shams-ur-Rehman
Agency	:	Pakistan Forest Institute
Country	:	Pakistan
PSA No.	:	PSA90011
Date Approved	:	31.03.90
Duration	:	6 months
Amount	:	US$2,000.00
Counterpart	:	None

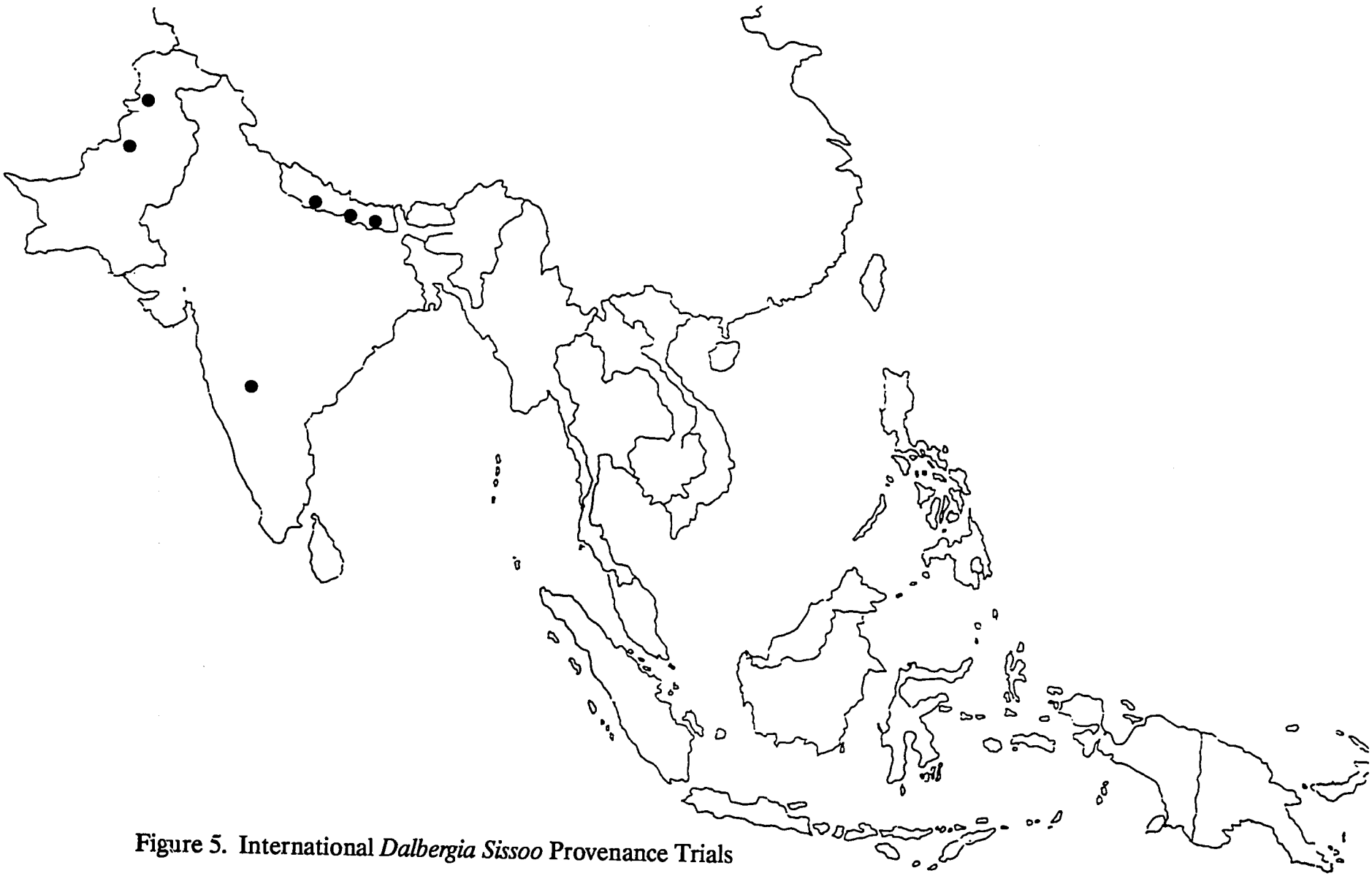

Figure 5. International *Dalbergia Sissoo* Provenance Trials

Researcher	:	Narayan G. Hegde
Agency	:	Bharatiya Agro-Industries Foundation
Country	:	India
PSA No.	:	PSA90012
Date Approved	:	31.03.90
Duration	:	6 months
Amount	:	US$2,000.00
Counterpart	:	None

3.6. Tissue Culture

As a promising form of vegetative propagation, tissue culture offers potential advantages in uniformity of plantlets and large-scale production. Plantek International, a private corporation, is managing a series of international field trials comparing growth of tissue culture plantlets with seedlings from the same parent stock. Protocols have been established and work on the trials has begun in India, Malaysia, Nepal, Philippines, and Thailand. *Acacia mangium, A.auriculiformis, Leucaena leucocephala, Eucalyptus camaldulensis,* and *Dalbergia sissoo* are the species being tested.

Objectives:

1. To scale-up existing experimental tissue culture protocols for large-scale or seed orchard production of planting materials.
2. To evaluate the advantages of plants derived by tissue culture from 'elite' individuals over seedling progeny.
3. To determine the survival and performance of tissue cultured plants in the field compared to seed-derived plants.
4. To investigate advantages, if any, of tissue cultured trees over seed derived trees in terms of biomass gains and early harvesting.
5. To obtain data for economic analysis of experimental treatments.

Additional information about the project is given below. Plantek sub-contract cooperators are listed in Table 3.

Researcher	:	Paiboolya Gavinlertvatana
Agency	:	Plantek International (Pte) Ltd.
Country	:	Singapore
Subcontract No.	:	293-88-01
Date Approved	:	15.04.88
Duration	:	33 months

Amount : US$116,933
Counterpart : Not specified

Table 3. Plantek tissue culture trials cooperators.

Cooperator	Institution	Country
P. K. Pachauri	Tata Energy Research Institute	India
Vibha Dhawan	Tata Energy Research Institute	India
S. B. R. Bhandari	Department of Medicina Plants	Nepal
Boonchob Boontawe	Royal Forest Department	Thailand
Nuttakorn Sermsuntud	Royal Forest Department	Thailand
Rungnapa Vongvijitara	Royal Forest Department	Thailand
Cyril Pinso	Yayasan Sabah	Malaysia
Ruben C. Umaly	SEAMEO-BIOTROP	Indonesia
Irene Umbol	SEAMEO-BIOTROP	Indonesia
Eduardo B. Principe	Department of Environment and Natural Resources	Philippines

4.0 Small Research Grants Program

Twenty-one small research grants were awarded in September 1988 to scientists in the region after screening and expert review of proposals received in July of that year. The small research grants program encourages independent research on priority MPTS topics in biological and social sciences, as determined by the Research Committee. All studies are to be reported as journal-style articles ready for submission to an appropriate journal.

The geographical distribution of these studies is shown in Figure 6.

4.1. Field Trials, Methods, Management

Title	:	Improvement and standardization of nursery stock production methods for multipurpose tree species.
Researcher	:	Maheshwar Sapkota
Agency	:	Institute of Agriculture and Animal Science, Tribhuvan University
Country	:	Nepal
PSA No.	:	PSA88061
Date Approved	:	15.09.88
Duration	:	2 years
Amount	:	US$4,752.00
Counterpart	:	US$1,225.00
Expected Output	:	Appropriate growing media for healthy seedling production. Cutting techniques for propagation. Presowing seed treatments to enhance germination. Optimum size of polypot for healthy seedling production.
Results to date	:	Seeds of *Tectona grandis, Leucaena leucocephala, L. diversifolia, Dalbergia sissoo* and *Melia azedarach* collected. Seed collection for other species in progress. Seeds have been sown in the nursery. Cuttings obtained from several species and planted.

Title	:	Alley cropping with Leucaena leucocephala.
Researcher	:	Chalermpone Sampet
Agency	:	Faculty of Agriculture, Chiangmai University
Country	:	Thailand
PSA No.	:	PSA88071
Date Approved	:	15.09.89
Duration	:	2 years
Amount	:	US$5,960.00

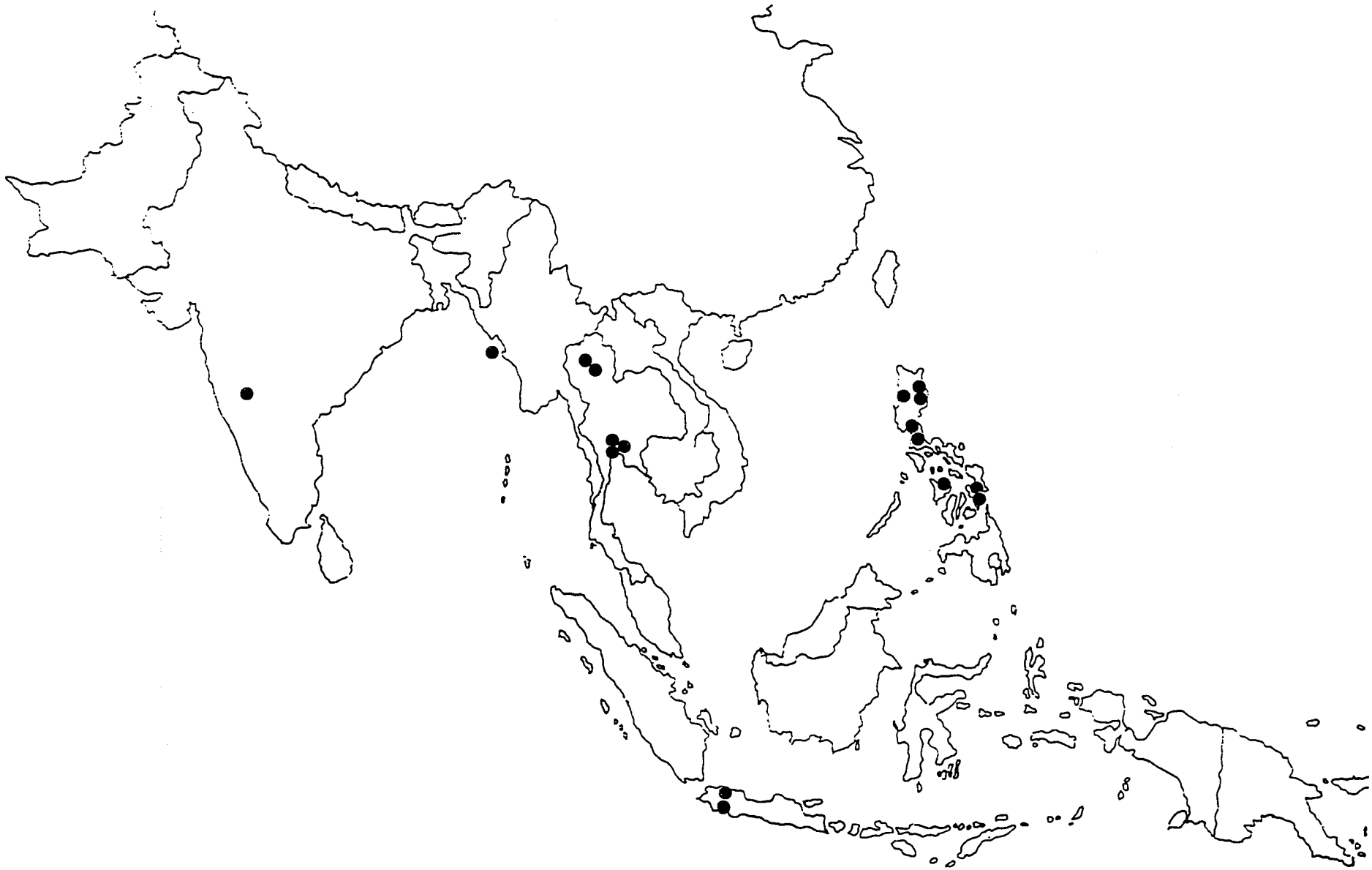

Figure 6. Geographical Distribution of Research Supported from the Small Grants Program

Counterpart : None
Expected Output : Information on dry matter and nitrogen contents of *Leucaena leucocephala* grown with maize.
Results to date : Alley cropping with leucaena appears to help maintain soil fertility and improve crop yield after the year 1 maize harvest.

Title : On farm trials of MPTS suitability for agroforestry systems.
Researcher : Rodel D. Lasco
Agency : UPLB College of Forestry
Country : Philippines
PSA No. : PSA88064
Date Approved : 15.09.89
Duration : 2 years
Amount : US$2300.00
Counterpart : US$3,400.00
Expected Output : Information on the suitability of four priority MPTS for alley cropping and multistory systems through on farm trials.
Results to date : No report as of June 30, 1990.

Title : Effects of site preparation and fertilization on the early growth and development of *Acacia auriculiformis* planted in Alimodian clay loam soil of abandoned sugar cane lands.
Researcher : Bernabe Garnace
Agency : Ecosystems Research and Development Bureau
Country : Philippines
PSA No. : PSA88054
Date Approved : 15.09.88
Duration : 16 months
Amount : US$3,045.00
Counterpart : US$899.00
Expected Output : Improved yield of *Acacia auriculiformis* through fertilization and site preparation.
Results to date : Seeds collected and germinated. Planting site identified (in Capiz, Panay Island) and soil samples taken and brought to Los Ba9os for nutrient analysis

Title : Improved single tree silvicultural management for increasing fuelwood biomass yields from *Dalbergia sissoo* in Terai small farm
Researcher : Amulya R. Tuladhar
Agency : Institute of Forestry, Tribhuvan University
Country : Nepal
PSA No. : PSA88063

Date Approved : 15.09.89
Duration : 2 years
Amount : US$2,550.00
Counterpart : US$3,345.00
Expected Output : Identification of factors associated with increased biomass yield in *Dalbergia sissoo*.
Results to date : No report as of June 30, 1990. Micropropagation techniques successful with both juvinille and mature tissues.

4.2 Tree Improvement

Title : Tissue culture and conventional propagation of neem (*Azadirachta indica*).
Researcher : Kamolpun Namwongprom
Agency : Faculty of Science, Kasetsart University
Country : Thailand
PSA No. : PSA88053
Date Approved : 15.09.88
Duration : 1 year
Amount : US$2,000.00
Counterpart : US$4,000.00
Expected Output : Micropropagation and conventional cutting techniques for mass multiplication of neem.
Results to date : No report as of June 30, 1990.

4.3 Pest and Disease Control

Title : Survey of insect pests associated with fuelwood trees in Nepal.
Researcher : Fanindra Prasad Neupane
Agency : Institute of Agriculture and Animal Science, Tribhuvan University
Country : Nepal
PSA No. : PSA88059
Date Approved : 15.09.89
Duration : 14 months
Amount : US$3,000.00
Counterpart : US$3,050.00
Expected Output : Identification of insect pests associated with fuelwood trees and an assessment of their damage.
Results to date : Insect pests associated with *Acacia auriculiformis*, *A. catechu*, *Albizzia spp.*, *Dalbergia sissoo*, *Leucaena spp.*, and *Melia*

azedarach in Chitwan District and some other places in Nepal were investigated. Brief descriptions of the pests have been made.

Title	:	Biological field efficacy studies of neem *(Azadirachta indica* A. Juss) for pest control in rice, corn and mungbean.
Researcher	:	Ruth Sarra Guzman
Agency	:	Isabela State University
Country	:	Philippines
PSA No.	:	PSA88066
Date Approved	:	15.09.88
Duration	:	2 years
Amount	:	US$4,970.00
Counterpart	:	US$1,200.00
Expected Output	:	Information on the efficacy of neem as means for controlling pests in rice, corn and mungbean.
Results to date	:	No report as of June 30, 1990.

Title	:	Etiology and control of root rot disease of Acacia mangium
Researcher	:	Simon Taka Nuhamara
Agency	:	Faculty of Forestry, Bogor Agricultural University
Country	:	Indonesia
PSA No.	:	PSA88058
Date Approved	:	15.09.88
Duration	:	2 years
Amount	:	US$2,400.00
Counterpart	:	US$2,900.00
Expected Output	:	Identification and information on life cycle of causal agents; assessment of the factors affecting the development of the disease; and more sound control measures.
Results to date	:	Based on field observations and laboratory examination, *Ramara camelicolor*, Clavariaceae, Basidio mycetes, has been found to be consistently associated with *Acacia mangium*, not only in young plantations but also in inoculated four-month old seedlings. The pathogen infected lateral roots of young trees and emerged above the ground level. In seedlings it can infect up to the root collar. The pathogen can be cultured at a temperature of 5 -10 ^{o}C on PDA medium.

4.4 MPTS in Farm Systems

Title	:	Field level practices and problems in the establishment, maintenance, harvesting and utilization of multipurpose tree

species in selected sites of Leyte.

Researcher : Buenaventura Dargantes
Agency : Center for Social Research, Visayas State College of Agriculture
Country : Philippines
PSA No. : PSA88055
Date Approved : 15.09.89
Duration : 8 months
Amount : US$4,600.00
Counterpart : US$1,400.00
Expected Output : Information on the field level practices and farmers' problems in the establishment, maintenance, harvesting and utilization of MPTS and factors affecting implementation of field level practices and solution of farmers' problems.
Results to date : Data collection instruments designed and tested in Baybay, Leyte. Data on selected characteristics of study villages collected. Found that presence of MPTS in the farms can only be ascertained by complete enumeration and not by interviews. Farmer seed exchange and propagation practices demonstrate the on-going process of farmer improvement of MPT tree species. Draft paper for agroforestry systems completed.

Title : Social acceptability of some MPTS for community-based tree farms at Quibal, Penablanca, Cagayan, Philippines.
Researcher : Paulo Pasicolan
Agency : College of Forestry, Isabela State University.
Country : Philippines
PSA No. : PSA88068
Date Approved : 16.11.88
Duration : 2 years
Amount : US$4,350.00
Counterpart : US$4,118.00
Expected Output : An assessment of the acceptability of some MPTS for community tree farm projects and the social viability of such species for reforestation; strategies for rapid and effective promotion of the uses and adoption of such species.
Results to date : Tests showed that farmer's awareness of the multiple uses and availability in the locality of the species affect significantly his choice. Almost all respondents prefer *L. leucocephala* over *L. diversifolia, A. auriculiformis* and *A. mangium.*

Title : Trial planting of *Acacia mangium* and *A. auriculiformis* on small upland farms in Leyte, Philippines: an assessment of farmers'

		responses to MPTS introduction.
Researcher	:	Audimar Bangi
Agency	:	Visayas State College of Agriculture
Country	:	Philippines
PSA No.	:	PSA88056
Date Approved	:	23.11.88
Duration	:	2 years
Amount	:	US$3,651.00
Counterpart	:	US$2,349.00
Expected Output	:	An assessment of the adaptability and overall utility of the two species, as well as possible constraints to and requirements for the effective promotion of MPTS.
Results to date	:	Initial observations indicate that while farmers'response to species introduction may appear positive as a result of some forms of motivational tactics (e.g. inviting farmers to work as a group with food and drinks and providing free planting materials) it remains to be seen whether or not the farmers are motivated by their own interest or merely following what they are told to do. There are strong indications pointing to inter-personal relationships within the community and the usually negative influence of local political leaders as critical factors to consider when attempting to get farmers' participation in a project. The percentage of actual plantings appears to be higher in the site where seedlings were mass-produced in a community-managed nursery.

Title	:	Crop productivity and soil fertility aspects of alley cropping scheme using tree legumes as hedgerows.
Researcher	:	Honorio Soriano, Jr.
Agency	:	Tarlac College of Agriculture
Country	:	Philippines
PSA No.	:	PSA88065
Date Approved	:	15.09.88
Duration	:	2 years
Amount	:	US$2,146.00
Counterpart	:	US$2,900.00
Expected Output	:	Yield evaluation of corn crop grown between hedgerows of leguminous trees in a typical upland area in the Philippines.
Results to date	:	Soil properties and corn yield not affected by hedgerows. This was expected because no pruning and green manuring was done during the first cropping of corn. Runoff and sediment yield was generally lower in plots with hedgerows.

Title : Productivity of *Leucaena leucocephala* and food crops in alley cropping technique.
Researcher : Taulana Sukandi
Agency : Forest Research and Development Centre
Country : Indonesia
PSA No. : PSA88062
Date Approved : 15.09.88
Duration : 18 months
Amount : US$3,805.00
Counterpart : US$2,800.00
Expected Output : Information on the effects of pruning frequency and leaf fertilizer of *L. leucocephala* on the growth of *L. leucocephala* and the production of food crops planted between *L. leucocephala* rows.
Results to date : No report as of June 30, 1990.

Title : Comparative effects of agroforestry schemes on soil erosion and NPK dynamics.
Researcher : Preston Dazon
Agency : Don Mariano Marcos Memorial State University
Country : Philippines
PSA No. : PSA88069
Date Approved : 16.11.88
Duration : 2 years
Amount : US$4,103.00
Counterpart : US$1,897.00
Expected Output : An evaluation of the effects of different ground covers and agroforestry schemes on soil and nutrient losses, soil fertility and crop productivity.
Results to date : Eight agroforestry schemes and a control (bare, without MPTS and hedgerows) were used as treatments. The experiment was laid out in a randomized complete block design with two replicates. Double hedgerows were established using potted seedlings of *Gliricidia sepium*, *Cassia spectabilis*, and suckers of *Thysaloneana maxima* or Tiger grass. Seedlings of *Acacia auriculiformis* were introduced in between double hedgerows. Sweet potato and peanut were used as alleycrops in the rotation. Surface runoff were collected from all the plots for soil loss and sediment load determination. Aside from runoff, tissue samples from trimmings of hedgerows, vegetative and reproductive parts of the alleycrops and *Acacia auriculiformis* including litterfall were taken for NPK analysis. Likewise, some physical and chemical characteristics of the soils were determined prior to

the establishement of the hedgerows and after harvesting the alleycrops in order to account for the fertility changes brought about by the different schemes. Statistical analysis on the performance of sweet potato alleycrop generally revealed insignificant results.

Title : Fast growing legumes as dairy feeds.
Researcher : Sakon Kaicom
Agency : Maejo Institute of Agricultural Technology.
Country : Thailand
PSA No. : PSA88072
Date Approved : 15.09.88
Duration : 2 years
Amount : US$4,360.00
Counterpart : US$3,320.00
Expected Output : Information on species suited for planting in Northern Thailand and their potential for dairy cattle feed.
Results to date : No report as of June 30, 1990.

4.5 Policy and Economics

Title : Yield and financial analysis of *Azadirachta indica.*
Researcher : Wuthipol Hoamouangkaew
Agency : Faculty of Forestry, Kasetsart University
Country : Thailand
PSA No. : PSA88070
Date Approved : 15.09.89
Duration : 1 year
Amount : US$3,780.00
Counterpart : US$1,400.00
Expected Output : Information on growth and yield of *Azadirachta indica* in terms of volume and biomass; financial analysis of the cultivation of the species.
Results to date : Yield models developed for three site indices. IRR values indicated that under given conditions of survival rate, site index and spacing, early harvest will give the highest return. Spacing of 2 x 4 m gives higher return than 4 x 4 m spacing. Draft paper ready for submission to Jour. of Tropical Forest Science.

Title : Effects of land and tree tenure systems on villager's use of trees in Northern Thailand.
Researcher : Sureerat Lakanavichian

Agency	:	National Biological Control Research Center, Kasetsart University
Country	:	Thailand
PSA No.	:	PSA88043
Date Approved	:	15.08.88
Duration	:	10 weeks
Amount	:	US$5,000.00
Counterpart	:	None
Expected Output	:	Identification of tree species favored by villagers for planting in their respective villages based on existing land and tree tenure arrangements in selected villages in Northern Thailand.
Results to date	:	Sites used: Ban Mae Talob and Ban Kim Thuia. Interviews of 73 households indicated 110 species favored. Data analysis to be conducted at Berkeley, University of California.

Title	:	Impact of social forestry programs on small farmers.
Researcher	:	Narayan Hegde
Agency	:	The Bharatiya Agro-Industries Foundation
Country	:	India
PSA No.	:	PSA88041
Date Approved	:	15.08.89
Duration	:	16 months
Amount	:	US$5,000.00
Counterpart	:	None
Expected Output	:	Information on the effectiveness of different afforestation schemes in reaching the farmers and the direct and indirect benefits received by small farmers from afforestation projects done by government and non-government agencies.
Results to date	:	Survey in five villages in Pune completed. It has been decided to cover a larger number of voluntary organizations working in the entire state of Maharashtra by sending the questionnaire by mail.

4.6 Tree Products

Title	:	Torrefication of red gum.
Researcher	:	Preecha Kiatgrajai
Agency	:	Faculty of Forestry, Kasetsart University
Country	:	Thailand
PSA No.	:	PSA88084
Date Approved	:	16.11.88
Duration	:	2 years
Amount	:	US$6,000.00

Counterpart : None

Expected Output : Information on the basic properties of torrefied red gum wood; an assessment of torrefied wood from red gum for fuel.

Results to date : Beehive kilns constructed and tested. Difficulty encountered in getting adequate samples due to logging ban in Thailand

5.0 Leucaena Psyllid Control Research

The leucaena psyllid is a tiny homopterous insect which has infested Leucaena leucocephala in Asia and the Pacific, causing widespread economic damage. The impact of this pest on leucaena production and use has resulted in leucaena psyllid research programs in more than ten countries in the region. Common interest in finding solutions to the psyllid problem has led to cooperative planning of research, increased communication and coordination between researchers and additional funding by institutions such as the International Development Research Centre (IDRC), U.S. Agency for International Development (USAID) and national research programs.

Specific information about the different components of the program are given below.

Malaysia

Coordinator	:	Lim Guan Soon
Agency	:	Malaysian Agricultural Research an Development Institute
Subcontract No.	:	293-88-07
Date Approved	:	November 1, 1988
Duration	:	25 months
Amount	:	US$19,020.00
Counterpart	:	Existing personnel, equipment and other facilities

Project No. : 1

Title	:	The biology, sampling and population dynamics of leucaena psyllid.
Researcher	:	Tho Yow Pong, Lim Guan Soon and Mohd. Rani Yusoh
Agency	:	Forest Research Institute Malaysia and Malaysian Agricultural Research and Development Institute
Expected Output	:	Report on life cycle, survivorship, population fluctuation related to climatic condition andcultural practices and sampling techniques using various methods.

Project No. : 2

Title	:	Screening for psyllid resistance in leucaena.
Researcher	:	Francis Ng, Zakaria and Wong Choi Chee
Agency	:	Forest Research Institute Malaysia and Malaysian Agricultural Research and Development Institute

Expected Output : Report on resistant varieties, infestation levels for the different varieties.

Project No. : 3

Title : Biological control of leucaena psyllid.
Researcher : Tan Chai Lin and Norowi Abd. Hamid
Agency : Malaysian Agricultural Research and Development Institute
Expected Output : Report on local biological control agents associated with leucaena psyllid, extent of occurrence, relationship of the agents and their relative importance, and introduction of exotic natural enemies.

Project No. : 4

Title : Entomophatogens of leucaena psyllid.
Researcher : Ahmad Said
Agency : Universiti Pertanian Malaysia
Expected Output : Report on local entomophatogens associated with leucaena psyllid, their relative importance to psyllid control, nature and mode of infection, and effects on other homopterans.

Philippines

Coordinator : Fernando F.Sanchez
Agency : National Crop Protection Center
Subcontract No. : 293-88-04
Date Approved : November 11, 1988
Duration : 25 months
Amount : US$37,449.00
Counterpart : Existing personnel, equipment and other facilities

Project No. : 1

Title : Biology and mass-rearing of two predators of leucaena psyllid.
Researcher : Clare R. Baltazar and Victor P. Gapud
Agency : University of the Philippines at Los Banos
Expected Output : Report on biology and life history of two mirid egg predators, their potential as biological control agents, mass-rearing techniques; field releases and their performance.

Project No. : 2

Title : Socio-economic impact on leucaena tree farmers and end-users in the Philippines.

Researcher : Merlyn N. Rivera and Arsenio J. Tabiar
Agency : Ecosystems Research and Development Bureau
Expected Output : Report on socio-economic profile of leucaena tree farmers and end-users, cost and benefit before and after psyllid infestation, socio-psychological changes, alternative courses of action, and formulation of suggestions and/or recommendations.

Project No. : **3**

Title : Seed production and evaluation of psyllid resistant leucaena selections.
Researcher : Enrique N. Crizaldo
Agency : Ecosystems Research and Development Bureau
Expected Output : Report on procurement and production of seeds of psyllid resistant lines and their performance on growth and biomass production under varying elevation and soil pH.

Republic of China

Coordinator : Fuh-Jiunh Pan
Agency : Taiwan Forestry Research Institute
Subcontract No. : 293-88-06
Date Approved : November 11, 1988
Duration : 25 months
Amount : US$33,800.00
Counterpart : Existing personnel, equipment and other facilities

Project No. : **1**

Title : Searching for indigenous predators and parasites and studying their life histories.
Researcher : An-Ly Yao and Chien-Chung Cheng
Agency : Institute of Zoology, Academia Sinica
Expected Output : Report on parasites and predators demonstrated to be effective in laboratory.

Project No. : **2**

Title : Isolation of local entomogenous fungi pathogenic to leucaena psyllid and selection for dry and hot isolates.
Researcher : Wei-Yang Wang and Huan-Ju Hsieh
Agency : Taiwan Forestry Research Institute and Department of Pathology and Entomology, National Taiwan University

Expected Output : Report on fungi species usable as biological control agents, satisfactory types of inoculum for use in field conditions, and hot and dry tolerant strains for laboratory and limited field test.

Project No. : **3**

Title : Selection and hybridization of potentially resistant and vigorous leucaena.
Researcher : Fuh-Jiun Pan
Agency : Taiwan Forestry Research Institute
Expected Output : Report on fast-growing and psyllid-resistant hybrids.

Project No. : **4**

Title : Exploration of new genetic material of psyllid resistant leucaena in Mexico and Central America.
Researcher : Fuh-Jiun Pan
Agency : Taiwan Forestry Research Institute
Expected Output : Broadened germplasm base of leucaena species.

Project No. : **5**

Title : Exploration for and evaluation of field resistant genotypes of Leucaena leucocephala from existing stands in Taiwan.
Researcher : Fuh-Jiun Pan
Agency : Taiwan Forestry Research Institute
Expected Output : Reports on resistant trees of leucaena leucocephala from existing stands in Taiwan.

Thailand

Coordinator : Banpot Napompeth
Agency : National Biological Control Research Center
Subcontract No. : 293-88-03
Date Approved : November 11, 1988
Duration : 25 months
Amount : US$56,250.00
Counterpart : Existing personnel, equipment and other facilities

Project No. : **1**

Title : Ecological investigations on the life history of leucaena psyllid and its sampling techniques, seasonal abundance, life table studies and key factor analysis of leucaena psyllid populations.

Researcher : Banpot Napompeth
Agency : National Biological Control Research Center
Expected Output : Reports on life cycle, sampling techniques, seasonal abundance, construction and analysis of life tables, population parameters and key factors regulating psyllid populations.

Project No. : 2

Title : Determination of economic threshold levels for various control options.
Researcher : Banpot Napompeth
Agency : National Biological Control Research Center
Expected Output : Reports on various economic threshold levels and further utilization to develop sequential sampling plans for psyllids.

Project No. : 3

Title : Evaluation of native natural enemies and their potential for augmentation.
Researcher : Banpot Napompeth
Agency : National Biological Control Research Center
Expected Output : Reports on the potential and effectiveness of native natural enemies together with their possible utilization in augmentative biological control.

Project No. : 4

Title : Introduction of exotic natural enemies, quarantine screening, cutlturing and mass-rearing for field releases and supply to other countries.
Researcher : Banpot Napompeth
Agency : National Biological Control Research Center (In collaboration with Department of, Agriculture, State of Hawaii)
Expected Output : Reports on the introduction of *Curinus cocruleus* and *Psyllaephagus rotundiformis* from Hawaii, and possibly other agents from other sources.

Project No. : 5

Title : Search and evaluation of endemic microbial control agents and field tests of commercial microbia preparations.
Researcher : Banpot Napompeth
Agency : National Biological Control Research Center

Expected Output : Reports on kinds and effectiveness of various endemic microbial control agents, and field tests and efficiency of some commercially available microbial agents such as mycar.

Project No. : 6

Title : Development of an IPM program and implementation.
Researcher : Banpot Napompeth
Agency : National Biological Control Research Center
Expected Output : Reports on field tests of appropriate surveillance systems, practicability and simoplification of sequential sampling plans appropriate and practical recommendations for IPM strategies for leucaena psyllid management.

Project No. : 7

Title : Determination of the nature and effectiveness of different source of psyllid resistance in leucaena.
Researcher : Panas Buranasilpin
Agency : Thailand Institute of Scientific and Technological Research
Expected Output : Report on ontogenic, phenologic as well as coppicing ability of leucaena together with psyllid behavior as sources and mechanism of psyllid resistance in leucaena.

Project No. : 8

Title : Exploration and evaluation of psyllid resistant genotype of Leucaena leucocephala from existing stands in Thailand.
Researcher : Panas Buranasilpin
Agency : Thailand Institute of Scientific and Technological Research
Expected Output : Reports on psyllid resistant genotypes obtained from research and commercial leucaena plantations in Thailand using standard methods developed by NFTA.

Project No. : 9

Title : Evaluation of psyllid population monitoring methodologies.
Researcher : Jutharat Attajarusit
Agency : Department of Agriculture
Expected Output : Reports on appropriate and practical "within plant" sampling technique and development of "among-plant" sampling technique for monitoring psyllid population on a large scale under field conditions using various sampling methods.

Project No. : **10**

Title : Evaluation of farmer-generated leucaena psyllid control techniques.

Researcher : Charuchai Manidool

Agency : Department of Livestock Development

Expected Output : Reports on various psyllid control measures practiced by farmers and verification of such techniques together with evaluation of economic feasibility.0 Social Science Research

6.0 Social Science Research

Social science research in the area of land and forest management was an important component designed into the F/FRED Project. The need for the use of social science tools in understanding existing and potential roles of trees growing on small farms has been recognized by project staff and network participants. F/FRED has supported a series of case studies and regional network studies to identify farmers tree-growing practices and socioeconomic factors that may influence the adoption and use of improved MPTS or management practices developed through biological research.

The geographical distribution of social science studies is shown in Figure 7

6.1 Regional Study on Farm and Village Forestry

A regional study began in early 1989 to determine the effect of demographics, agro-ecological setting, and land tenure on the way villagers obtain, manage and use tree and forest products. Researchers collected information on the tree products used by farm households and their sources, the seasonality of their use, and the species preferred. Of particular interest were the practices of small-scale farmers and the landless.

The focus of the study, initially designed as a broader effort, was narrowed to analyze a few key topics that could be compared across cultures after discussions with network scientists and the A.I.D. project evaluation team.

In late February 1989, 14 study participants from 6 countries met in Bangkok to review the study proposal and finalize the content of the data set and methods to be used. In addition to collecting data for the regional study, each researcher conducted a topic of his or her choice with F/FRED support.

Field research for the study was completed in late 1989, and data submitted by early 1990. Other support for the study comes from the Ford Foundation's offices in the Philippines and Thailand, the GTZ-funded Upper Mahawell Watershed Management project, and the FAO Wood Energy Project. Regional analysis of this data had not been completed by 30 June, 1990.

6.2 Case Studies

Three of the five case studies commissioned in conjunction with the first series of network trials were completed satisfactorily. The first, *Survey of Farmers' Current*

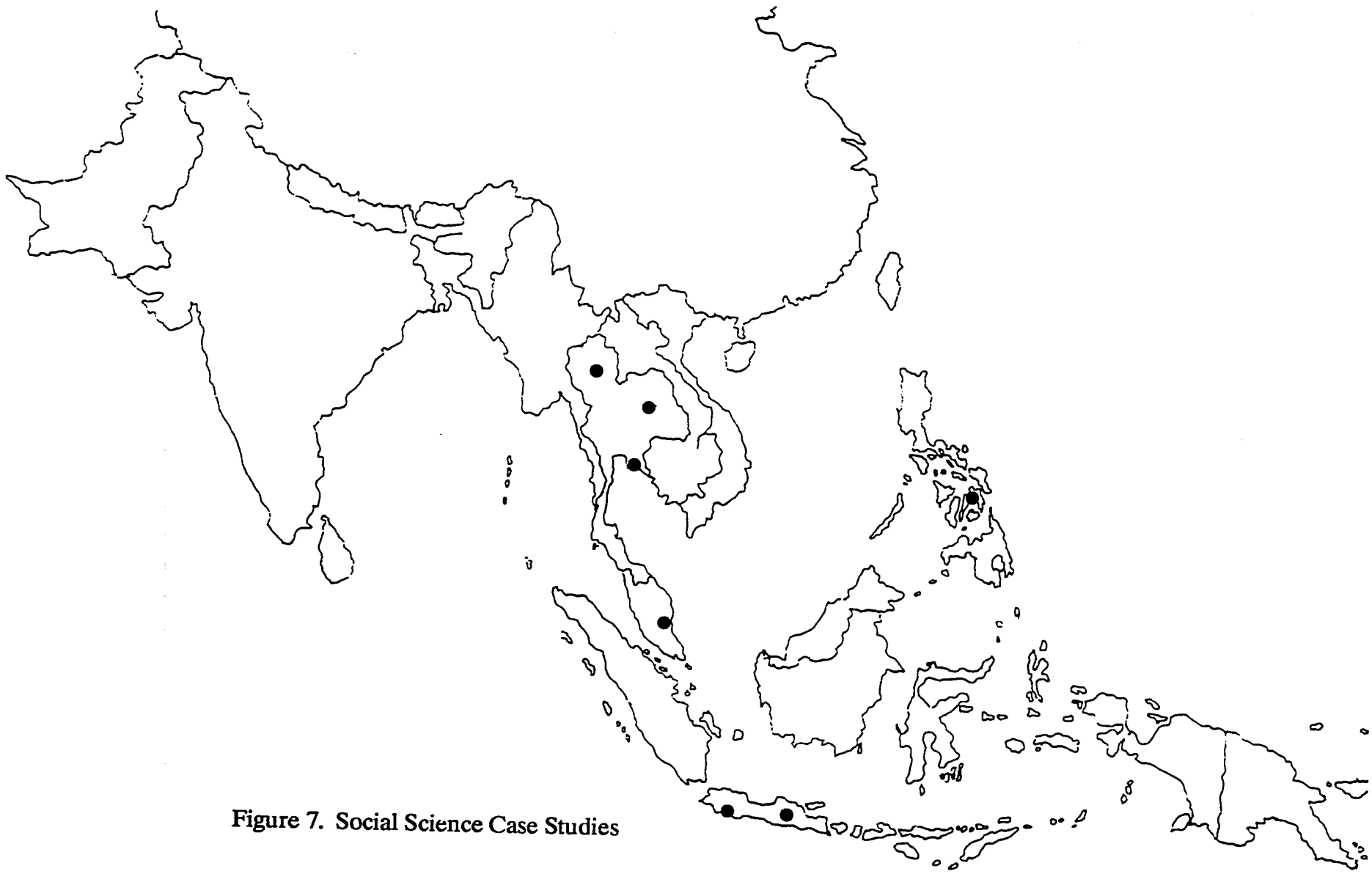

Figure 7. Social Science Case Studies

Use of Multipurpose Tree Species on Small Upland Farms in Eastern Visayas, Philippines, appeared in the project's Research Series in August 1989. Final drafts of *Access to, Use and Production of Trees by Small Farmers* and *A Case Study of Major Socio-economic Factors Affecting the Production and Use of Trees on Small Farms in Thailand* were added to the series in September. Authors of the other two case studies have been asked to revise their drafts.

A study of homestead forestry in Bangladesh, commissioned in 1987 by F/FRED with the FAO Wood Energy Project, was completed in mid-1989. The On-Farm Research Division of the Bangladesh Agricultural Research Institute is publishing *Homegardens in Some Locations in Bangladesh* with FAO and F/FRED. The study analyzes the nature and extent of fuelwood shortages in areas of Bangladesh and the implications for nutrition and crop production. It also examines the role of homegardens in alleviating these shortages and meeting other household needs.

Some information about the different studies are presented below.

Bangladesh

Title	:	Social classes and fuel use in rural Bangladesh.
Researcher	:	Syed Zahir Sadeque
Agency	:	
PSA No.	:	PSA89019
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Indonesia

Title	:	Comparison of the planting and use of trees between forest village and agricultural village in Java.
Researcher	:	Junus Kartasubrata
Agency	:	Faculty of Forestry, Bogor Agricultural University
PSA No.	:	PSA89020
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Nepal

Title	:	Case study of farm forestry activities of the Lumle Agricultural Centre.
Researcher	:	Abhoy Kumar Das
Agency	:	Institute of Forestry
PSA No.	:	PSA89021
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Title	:	Role expectations of foresters in Nepal.
Researcher	:	Kailash Pyakuryal
Agency	:	Department of Sociology and Anthropology
PSA No.	:	PSA89022
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Philippines

Title	:	Changes in forest land use with the development of a local wood-carving industry.
Researcher	:	Bienvenido B. Maligalig
Agency	:	Ecosystems Research and Development Bureau
PSA No.	:	PSA89023
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,368.00
Counterpart	:	None

Title	:	Cultural aspects and traditions in the forest use practices of ethnic minorities in Oriental Mindoro.
Researcher	:	Fe Mallion
Agency	:	College of Forestry, University of the Philippines at Los Banos
PSA No.	:	PSA89024
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Title	:	Property rights and man's relationship to the forest in an ethno-community setting in Benguet Philippines.
Researcher	:	Herminia Francisco
Agency	:	Department of Agri-Economics, Benguet State University
PSA No.	:	PSA89025
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Title	:	Effects of beliefs, customs and agricultural practices on the use of MPTS and other trees by farm households in Leyte.
Researcher	:	Eliseo Ponce
Agency	:	Visayas State College of Agriculture
PSA No.	:	PSA89026
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Thailand

Title	:	The effect of local institutions on tree planting by small-scale farmers, with special reference to land issues and the implementation of social forestry programs in selected land reform areas.
Researcher	:	Charit Tingsabadh
Agency	:	Chulalongkorn University Social Research Institute
PSA No.	:	PSA89045
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Title	:	Effects of migration on village economy and the use of forest and tree products.
Researcher	:	Lert Chuntanaparb
Agency	:	Faculty of Forestry, Kasetsart University
PSA No.	:	PSA89046
Date Approved	:	7.04.89
Duration	:	11 months

Amount	:	US$5,000.00
Counterpart	:	None

Title	:	Upland community forestry and tree farming in tea- growing areas of Northern Thailand.
Researcher	:	Uraivan Tam-Kim Yong
Agency	:	Faculty of Social Sciences
PSA No.	:	PSA89047
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

Title	:	Analysis of the effects of urban fuelwood and charcoal demand, deforestation and government prohibitions against logging on the fuelwood and charcoal production and use in rural communities near provincial urban centers.
Researcher	:	Yongyuth Chalamwong
Agency	:	Faculty of Economics and Business Administration, Kasetsart University
PSA No.	:	PSA89048
Date Approved	:	7.04.89
Duration	:	11 months
Amount	:	US$5,000.00
Counterpart	:	None

7.0 Biotechnology

One of the goals set earlier in 1987 was to complete an assessment of the potential for improving small farm MPTS using biotechnology. Several promising biotechnologies were identified and a number of studies were supported to look into the potential social and economic impacts of the improvement of MPTS through these promising technologies. The studies that were conducted are described below.

Title	:	The potential impact of biotechnology research for multipurpose tree species
Researcher	:	Wilfrido D. Cruz
Agency	:	UPLB College of Economics and Management
Country	:	Philippines
PSA No.	:	87046
Date Approved	:	30.11.87
Duration	:	2 months
Amount	:	US$6,000.00
Counterpart	:	None
Expected Output	:	Analysis of potential socio-economic effects in Nepal, Philippines and Thailand of biotechnologies for multipurpose tree species.
Results to date	:	Study completed. The general result of the assessment is that there will be value in research investment in biotechnology, but not all types will lead to significant contributions.

Title	:	Feasibility study on tissue culture for multipurpose forest tree species.
Researcher	:	Paiboolya Gavinlertvatana
Agency	:	Plantek International
Country	:	Singapore
PSA No.	:	PSA87004
Date Approved	:	8.04.87
Duration	:	3 months
Amount	:	US$9,178.00
Counterpart	:	None
Expected Output	:	A report summarizing what is known about tissue culture with the F/FRED priority species and provide recommendations on potential areas of micropropagation for additional F/FRED support.
Results to date	:	Report completed. Results published as Research Paper No. 1, MPTS Network Research Series, 1987.

Title	:	Socio-economic impacts of MPTS biotechnology for small farmers: Philippines, Nepal, Thailand
Researcher	:	Charit Tingsabadh
Agency	:	Chulalongkorn University Social Research Institute Country: Thailand
PSA No.	:	PSA87047
Date Approved	:	30.11.87
Duration	:	2 months
Amount	:	US$6,000.00
Counterpart	:	None
Expected Output	:	Analysis of farmers' potential access to biotechnologies for multipurpose tree species.
Results to date	:	Study completed.Technical and institutional recommendations given in the final report.

Title	:	Feasibility study on small-farm production of gums, resins, exudates, and other non-wood products
Researcher	:	James W. Hanover
Agency	:	Department of Forestry, Michigan State University
Country	:	United States
PSA No.	:	
Date Approved	:	
Duration	:	two months
Amount	:	
Counterpart	:	None
Expected Output	:	Evaluation of the present status and future potential of small-farm production of gums, resins, and exudates from MPTS in Asia. Recommended research and development needed to help farmers improve their use of non-wood products from tropical trees.
Results to Date	:	Study completed in 1988. Opportunities and constraints identified and specific recommendations provided. Report published in 1988 as Paper No. 4, MPTS Network Research Series.

8.0 Tree Breeding Objectives

In early 1989, the project initiated a regional, multidisciplinary study aimed at determining farmers' preferences for individual tree characteristics. Once identified, these preferences will describe bideotypes, or "ideal trees," and provide the basis for genetic improvement of MPTS by researchers in Asia. The study was designed and is managed by a group of four scientists: Kenneth MacDicken (Network Team Leader), Charles Mehl (Land and Forest Management Specialist), Lert Chuntanaparb (coordinator for Southeast Asia), and Radha Ranganathan (coordinator for South Asia). Many of the researchers involved in the network study on farm and village forestry are conducting this study also. Information from the farm and village forestry study is being used to direct the study on tree-breeding objectives.

The study is using a series of line drawings of tree "types" to help farmers compare and suggest preferred characteristics in discussions with the researchers. Each scientist discusses current uses of trees with villagers in the study communities, then elicits ideas for possible improvements. Discussions will be held with separate groups of men and women, and with other distinct ethnic or social groups in the village. This will explore any differences these groups may exhibit in their tree-breeding preferences.

The researchers will summarize their initial findings, then discuss the results in group meetings with villagers using the line drawings. At least one meeting should be held with a group of women. These meetings will attempt to obtain a consensus on the ideotypes described.

Each researcher will provide the Coordinating Group with summaries of up to six composite ideotypes agreed upon by the villagers. The four scientists managing the study will assemble all the ideotype descriptions from the final reports and develop four to six generalized ideotypes for the final report.

The geographic distribution of the different studys sites is shown in Figure 8.

Bangladesh

Researcher	:	Syed Z. Sadeque
Agency	:	Department of Sociology, Rajshahi University
PSA No.	:	PSA89040
Date Approved	:	31.03.89
Duration	:	6 months
Amount	:	US$1,500.00
Counterpart	:	None

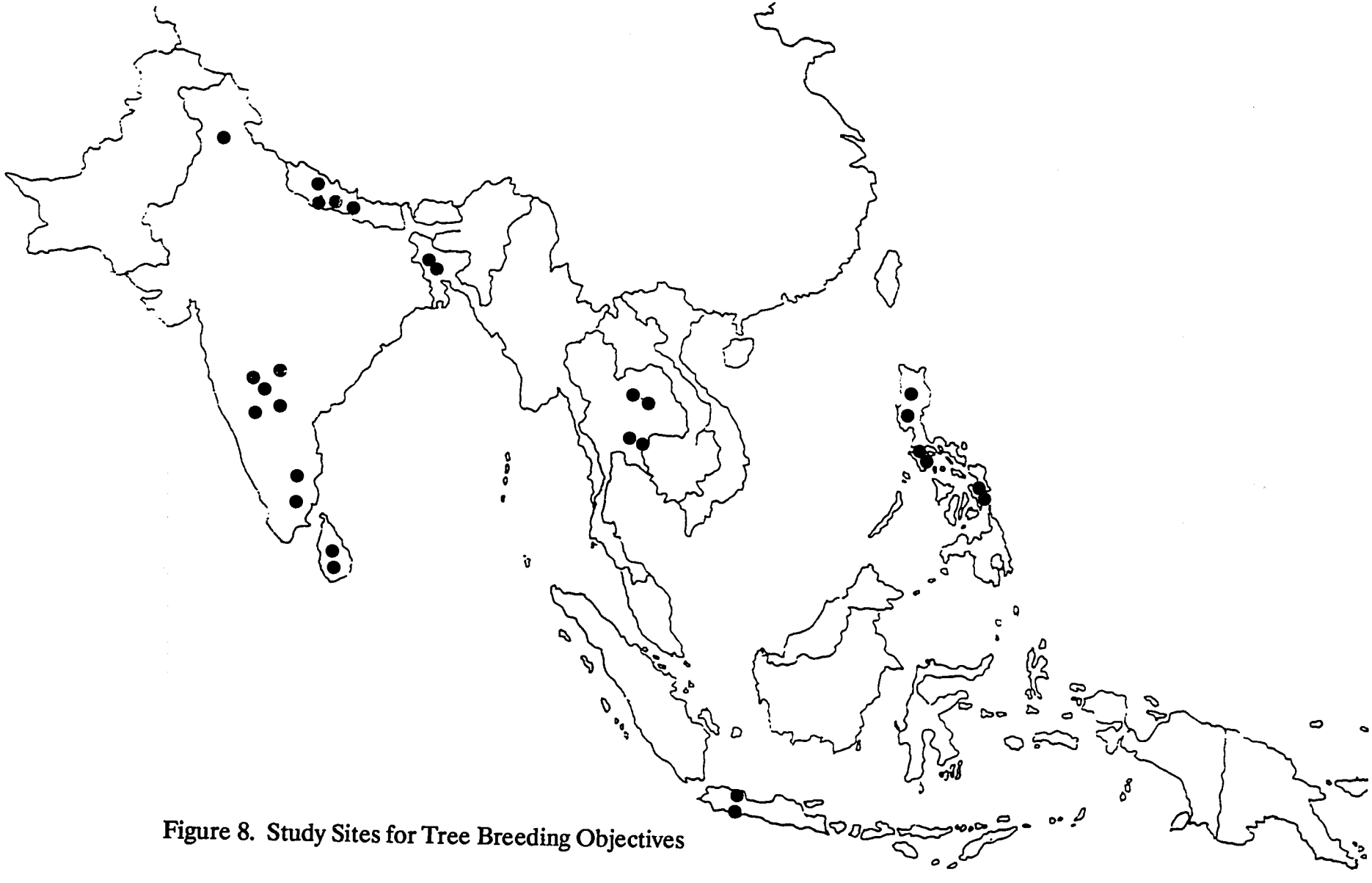

Figure 8. Study Sites for Tree Breeding Objectives

India

Researcher	:	Radha Ranganathan
Agency	:	International Center for Research in the Semi-Arid Tropic
PSA No.	:	PSA89056
Date Approved	:	10.05.89
Duration	:	6 months
Amount	:	US$6,000.00
Counterpart	:	None

Researcher	:	Narayan Hegde
Agency	:	BAIF Development Research Foundation
PSA No.	:	PSA89057
Date Approved	:	17.05.89
Duration	:	6 months
Amount	:	US$2,500.00
Counterpart	:	None

Researcher	:	Narayan Hegde
Agency	:	BAIF Development Research Foundation
PSA No.	:	PSA89058
Date Approved	:	17.05.89
Duration	:	6 months
Amount	:	US$2,500.00
Counterpart	:	None

Researcher	:	Kanchan Chopra
Agency	:	Institute of Economic Growth, University Enclave
PSA No.	:	PSA89059
Date Approved	:	17.05.89
Duration	:	6 months
Amount	:	US$2,500.00
Counterpart	:	None

Researcher	:	L. Thara Bhai
Agency	:	Madurai Kamaraj University
PSA No.	:	PSA89060
Date Approved	:	17.05.89
Duration	:	6 months
Amount	:	US$1,250.00
Counterpart	:	None

Researcher	:	C. Thangamuthu
Agency	:	Bharathidasan University
PSA No.	:	PSA89071

Date Approved : 17.07.89
Duration : 6 months
Amount : US$1,250.00
Counterpart : None

Indonesia

Researcher : Junus Kartasubrata
Agency : Faculty of Forestry, Bogor Agricultural University
PSA No. : PSA89044
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Nepal

Researcher : Abhoy Kumar Das
Agency : Institute of Forestry
PSA No. : PSA89041
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Researcher : Kailash Pyakuryal
Agency : Department of Sociology and Anthropology
PSA No. : PSA89043
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Philippines

Researcher : Herminia Francisco
Agency : Department of Agri-Economics, Benguet State University
PSA No. : PSA89036
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Researcher : Fe K. Mallion
Agency : College of Forestry, University of the Philippines at Los Banos
PSA No. : PSA89037

Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Researcher : Bienvenido Maligalig
Agency : Ecosystems Research and Development Institute
PSA No. : PSA89038
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Researcher : Eliseo Ponce
Agency : Visayas State College of Agriculture
PSA No. : PSA89039
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Sri Lanka

Researcher : Anoja Wickramasinghe
Agency : Department of Geography, University of Peradeniya
PSA No. : PSA89034
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Thailand

Researcher : Lert Chuntanaparb
Agency : Faculty of Forestry, Kasetsart University
PSA No. : PSA89042
Date Approved : 31.03.89
Duration : 7 months
Amount : US$1,500.00
Counterpart : None

Researcher : Lert Chuntanaparb
Agency : Faculty of Forestry, Kasetsart University
PSA No. : PSA89061
Date Approved : 22.05.89
Duration : 7 months

Amount	:	US$6,000.00
Counterpart	:	None

Researcher	:	Charit Tingsabadh
Agency	:	Chulalongkorn University Social Research Institute
PSA No.	:	PSA89033
Date Approved	:	31.03.89
Duration	:	7 months
Amount	:	US$1,500.00
Counterpart	:	None

9.0 Economics Research

9.1 Economic Analysis of Tissue Culture Trials

The study was developed to undertake an economic analysis of an on- going study being conducted by Plantek International.

Its objective is to compare the costs of producing, distributing, and planting the seed and clonal materials using plant survival as a measure of the effectiveness of each technique.

The international tissue culture trials are assessing the potential of tissue culture as a form of large-scale vegetative propagation by comparing growth of tissue-cultured plantlets with seedling progeny from the same parent stock of five priority species.

In carrying out the cost-effectiveness study, the project is collaborating with four institutions conducting the tissue culture trials. The collaborators have received training and data collection is currently underway.

Meetings have been held with representatives of Plantek and its study cooperators regarding the nature of the economic analysis, and all agreed to cooperate through the collection of the necessary data. The study involved no additional contracts, as the collection of the economic data by Plantek and its cooperators was merely to be absorbed in the on-going study contracts. The study cooperators include Raj Bhandari, Department of Forest and Plant Research, Nepal; Eduardo B. Principe, Department of Environment and Natural Resources, Philippines; Cyril Pinso, Yayasan Sabah, Malaysia; Vibha Dhawan, Tata Energy Research Institute, India; and Boonchoob Boontawee, Royal Forest Department, Thailand. The actual analysis of the data will be conducted by the Coordinating Unit forest economist.

Forms for the collection of the economic data have been designed and distributed to the cooperators. In August, 1989 these forms were discussed and approved during a meeting of the cooperators at the Plantek office in Singapore.

Data on the costs of plantlet propagation have been collected and submitted to the Coordinating Unit. Certain difficulties in the propagation of *Acacia mangium* and *Acacia auriculiformis* have resulted in delays in implementing the field trials. The portion of the trials which include *Eucalyptus camaldulensis* and *Leucaena leucocephala* will begin in the near future.

The results of this analysis will be written up for publication in a journal. Recommended outlets include Agroforestry Systems or the Journal of Tropical Forest Science.

9.2 Marketing of MPTS products

The study was developed as a pilot project to design and test a questionnaire to determine some economic inferences of the utilization of tree products. A questionnaire was developed for testing in conjunction with the regional social science study.

The questionnaire was tested in six villages in the Philippines. Although the questionnaire was originally designed to include several tree products, the participants agreed to only test that portion of the questionnaire dealing with fuelwood and charcoal. In general, under the TOR of the PSA, the contractors agreed to collect the economic data.

Marian de los Angeles (PSA 89052) agreed to serve as the study coordinator. The TOR of the PSA state that:

> "The contractor will formulate meaningful economic hypotheses and conduct statistical analyses to test these hypotheses. The contractor will also make suggestions and recommendations for improvement of the questionnaire and analyses."

Data collection has been completed but the required analyses have not yet been accomplished.

10.0 MPTS Research Compendium

The MPTS research compendium is an inventory of completed and on-going research on multipurpose trees in Asia. When completed, it will provide valuable information on the state of MPTS research, permitting computer searches by the categories of:

- executing agency
- funding agency
- name(s) of researcher(s)
- research title
- status (on-going or completed; if completed whether published or unpublished)
- complete citation, key words and language of publications
- species studied
- sites (names and elevations)
- date started
- date completed
- notes (abstract and other relevant information)

The compendium will include studies:

- based on actual MPTS research or related social or economic research
- completed within the last 15 years (1976 - 1990) whether or not the results have been published
- that are currently underway
- involving network priority species (*Acacia auriculiformis, A. mangium, A. nilotica, Dalbergia sissoo, Eucalyptus camaldulensis, Leucaena* spp., *Melia azedarach, Prosopis cineraria, P. juliflora*) or others commonly planted on small farms.

Work on the compendium is being undertaken in six countries. Information regarding this is given below.

Bangladesh

Researcher	:	Md. Millat E. Mustafa
Agency	:	Institute of Forestry, University of Chittagong
Country	:	Bangladesh
PSA No.	:	PSA89077
Date Approved	:	19.08.89
Duration	:	6 months
Amount	:	US$1,000.00
Counterpart	:	None

Indonesia

Researcher	:	Junus Kartasubrata
Agency	:	Forestry Faculty, Bogor Agricultural University
Country	:	Indonesia
PSA No.	:	PSA89070
Date Approved	:	10.07.89
Duration	:	6 months
Amount	:	US$1,200.00
Counterpart	:	None

Malaysia

Researcher	:	Kamis Awang
Agency	:	Fakulti Perhutanan, Universiti Pertanian Malaysia
Country	:	Malaysia
PSA No.	:	PSA89065
Date Approved	:	8.06.89
Duration	:	6 months
Amount	:	US$1,200.00
Counterpart	:	None

Philippines

Researcher	:	Cesar Nuevo
Agency	:	College of Forestry, University of the Philippines at Los Banos
Country	:	Philippines
PSA No.	:	PSA89068
Date Approved	:	22.06.89
Duration	:	6 months
Amount	:	US$1,200.00
Counterpart	:	None

Sri Lanka

Researcher	:	Anoja Wickramasinghe
Agency	:	Department of Geography, University of Peradeniya
Country	:	Sri Lanka
PSA No.	:	PSA89069
Date Approved	:	6.07.89
Duration	:	6 months
Amount	:	US$1,000.00
Counterpart	:	None

Thailand

Researcher	:	Hatairat Nukool
Agency	:	Faculty of Forestry, Kasetsart University
Country	:	Thailand
PSA No.	:	PSA89062
Date Approved	:	30.04.89
Duration	:	6 months
Amount	:	B30,000.00
Counterpart	:	None

11.0 Assistance to the Royal Project in Thailand

In March 1989, following discussions with Kasetsart University, members of the Thai Royal Family, and the Royal Forest Department, F/FRED was requested to cooperate on a Royal Project in Chiang Mai Province. The research will evaluate indigenous tree species at Huay Hong Krai and help identify farmer needs and nearby markets for MPTS products. The proposal was prepared by F/FRED project staff with Kasetsart University's Faculty of Forestry and the manager of the Huay Hong Krai site.

The research involves two related sub-projects, each in two phases. The first phase of these projects ended in March 1990, with the second phase contingent upon the availability of Phase 2 funds.

11.1 Testing indigenous species for agroforestry in the watershed

Given the interest in indigenous species and the largely untapped genetic resources of small-statured trees and shrubs in Northern Thailand, the following workplan has been proposed.

1. Identify promising indigenous shrubs and lesser-known tree species for use in the Huay Hong Krai watershed, noting promising species and existing knowledge of their economic uses and management. Species will be assessed by their economic potential, ability to fix nitrogen, seeding and propagation characteristics, and adaptability to sites.

2. Collect seeds of the identified species from a wide range of sources and identify provenances. Testing and storage characteristics will be studied if not available in the literature.

11.2 Development of MPTS on small farms

The Huay Hong Krai project will help farmers on adjacent lands to improve their livelihoods with the introduction and use of trees. Lands bordering the watershed are legally forest reserves but are largely devoid of trees and are used for agriculture. While using trees may be one way that farmers can increase their incomes and diversify their farming systems, little is known about farmers' needs and markets for MPTS product. This study will evaluate needs, markets, and site characteristics for a detailed research plan.

1. Characterize the edaphic and climatic environments. The "recommendation domain" and possible experimental sites will be described for future

2. Evaluate farmer needs and interests, using rapid rural appraisal or Diagnosis and Design to determine the most pressing needs and suggest planting niches and production for tree species. This will begin in October 1989.

3. Survey marketing opportunities for MPTS products. A marketing study will describe market potentials for various MPTS products. This will be conducted in January and February 1990.

Descriptions of the studies under this project are presented below.

Title	:	Evaluation of farmer needs and markets for MPTS.
Researcher	:	Forestry Research Center
Agency	:	Faculty of Forestry, Kasetsart University
Country	:	Thailand
PSA No.	:	PSA89073
Date Approved	:	30.09.89
Duration	:	7 months
Amount	:	B84,420.00
Counterpart	:	None
Exptd. Output	:	Evaluation of farmer needs and interests. Report on marketing opportunities for MPTS products.

Title	:	Evaluation of indigenous MPTS
Researcher	:	Forestry Research Center
Agency	:	Faculty of Forestry, Kasetsart University
PSA No.	:	PSA89074
Date Approved	:	30.08.89
Duration	:	7 months
Amount	:	B138900.00
Counterpart	:	None
Expected Output	:	Identification of promising indigenous shrubs and lesser-known tree species for use in the Huay Hong Krai watershed. This will include identification of promising species and a review of existing knowledge of their economic uses and management. Seeds of promising species will be collected.

12.0 Literature Cited

Briscoe, C.B. 1990. Field Trials Manual for Multipurpose Tree Species. Manual No. 3. Winrock International, Arlington, VA, USA.

Burly, J. and P. Von Carlowitz. 1984. Multipurpose Tree Germplasm. Proceedings of a Planning Workshop to Discuss International Cooperation. ICRAF, Nairobi, Kenya. 198pp.

Butterfield, S., F.Ng, C. Hatch, A. Manzardo, D. Osburn, J. Palmer. 1988. Forestry/Fuelwood Research and Development (F/FRED) Project Evaluation Report. Tropical Research and Development, Inc. Gainesville, Florida. 170pp.

Dixon, R., T. Niblock and D.A. Taylor. 1989. Forestry/Fuelwood Research and Development Project: Research Networking in Asia, in *Journal of Forestry*, vol. 87, no.4.

IUFRO. 1984. Proc. IUFRO Research Planning Workshop for Asia at Kandy, Sri Lanka.

Lundgren, A. 1986. A resume of forestry research priorities in the Asia/Pacific Region. Working Paper. EAPI, East-West Center, Honolulu, Hawaii.

MacDicken, K.G. 1989. Cooperative strategies for leucaena psyllid research. In Napompeth, B. and K.G. MacDicken (eds.) Leucaena psyllid: Problems and management. Winrock International, Arlington, VA, USA. (in press).

Madamba, J. 1984. Evolution of the IUFRO MPTS Research Networks in Asia. (Annex B).

Napompeth, B., K.G. MacDicken, M. McFadden and I.N. Oka. 1987. A regional research plan for leucaena psyllid control. Multipurpose Tree Species Research Network Series, Winrock International - F/FRED, Faculty of Forestry, Kasetsart University, Bangkok. 61 pp.

Shea, K.R. and L.W. Carlson. Undated. Increasing Productivity of Multipurpose Tree Species: a Blueprint for Action. IUFRO Planning Workshop for Asia, Kandy, Sri Lanka, July 16-28, 1984. USDA Forest Service. Washington, D.C. 100pp.

Appendix 1
Research-related papers prepared with F/FRED support

Abedin Md. Z. and Md. A. Quddus. 1990. Household Fuel Availability and Homegardens in Selected Locations of Bangladesh. Co-published by FAO Regional Wood Energy Development Programme in Asia and Winrock International, Bangkok, Thailand.

Adams N. and F. B. Cady. (eds.) Modeling Growth and Yield of Multipurpose Tree Species. Multipurpose Tree Species Network Technical Series, Vol. 1.

Barrion, A.A. and C.V. Casal, 1988. Seasonal fluctuations, life history, and cytological variations of Psyllid populations in giant and native Leucaena varieties in the Philippines.

_____ 1988. Life histories of *H. cubana* in native and giant accessions of *L. leucocephala.*

Barrion, A.A. 1989. Continuation of seasonal fluctuation studies from February to July, 1989. Submitted to Leucaena Research Reports.

Bhumibhamon, S. 1988. The status of multipurpose trees in Thailand. Report No. 2. Multipurpose Tree Species Network Research Series, Winrock International, Bangkok, Thailand.

Carter, G.A. K. Paliwal, U. Pathre, R.J. Mitchell and D.H. Gjerstad. 1988. Influence of competition induced stress on spectral reflections in loblolly pine. Proceedings of Second USDA Forest Service Remote Sensing Application Conference. Remote Sensing for Resource Inventory, Planning and Monitoring. American Society of Photogrammetry and Remote Sensing.

_____ 1988. Effect of competition and leaf age on visible and infrared reflectance in pine foliage. In Bulletin Ecological Society of America 69 (2).93.

_____ In press. Effect of competition and leaf age on visible and infrared reflectance in pine foliage. In Plant, Cell and Environment.

Chalamwong, Y. Access to Production and Use of Trees by Thai Farmers. Paper No. 7. Published by Winrock International-F/FRED Project, Bangkok, Thailand.

Choldumrongkul, A.,C. Hutacharern and P. Pholwicha. 1989. Performance of multipurpose tree species toward insects and disease. Paper presented at a symposium on Recent Developments in Plantation Forestry in the Humid Tropics. UPM, Serdang, Malaysia, June.

Chuntanaparb, L. and K.G. MacDicken. 1990. Tree selection and improvement for agroforestry. In Avery, M., C. Ong. M.G.R. Cannel (eds.). Applications of Biological Research in Asian Forestry. Oxford Press-IBH, New Delhi.

Chuntanaparb, L., and R. Ranganathan. Defining tree breeding objectives for multipurpose tree species in Asia. Paper No. 10. Published by Winrock International-F/FRED Project, Bangkok, Thailand.

Cruz, W.D. 1988. The potential impact of biotechnology research for multipurpose tree species. Paper No. 5. Multipurpose Tree Species Network Research Series, F/FRED.

Dargantes, B. and K.G. MacDicken, In preparation. Establishment and maintenance practices for multipurpose tree species on farms and home gardens in Leyte, Philippines. To be submitted to Agroforestry Systems.

Gibson, G.L., A.R. Griffin and A.C. Matheson. Breeding Tropical Trees: Population Structure and Genetic Improvement Strategies in Clonal and Seedling Forestry. Oxford For. Inst. and Winrock International.

Haugen, C., L. Medema, and C.B. Lantican (eds). Multipurpose Tree Species Research for Small Farms: Strategies and Methods. Proceedings of an International Conference held November 20-23, 1989 in Jakarta, Indonesia.

Hoamaungkaew W., L. Medema, and L. Chuntanaparb, In preparation. Yield and financial analysis of *Azadirachta indica A. Juss*. To be submitted to Jour. of Trop. For. Science.

Hutacharern, C. and S. Choldumrongkul 1989. Survey on forest insect pests of multipurpose tree species. Jour. of Tropical Forest Sci. 2(1): 81-84.

Hutacharern, C., MacDicken, K.G., Jain, R.K., and B.G. Lockaby. 1989. Nutrition of loblolly pine on calcareous soils in western Alabama. In *Communications in Soil Science and Plant Analysis* 20 (3 & 4): 421-438.

MacDicken, K.G. 1989. Impacts of *Leucaena leucocephala* as a fallow improvement crop in shifting cultivation on the island of Mindoro. Philippines, Paper presented at IUFRO Workshop on Agroforestry, Edinburgh, Scotland, July 23-27.

MacDicken, K.G. and C.B. Mehl. 1990 Defining tree breeding objectives for multipurpose tree species in Asia. In Adams, N. (Ed.) Genetic Improvement of Multipurpose Tree Species. Winrock International, Arlington, V.A.

MacDicken, K.G., and S. Bhumibhamon. 1990. Barefoot tree breeders. In Haugen, C., E.L. Medema, and C.B. Lantican (eds.). Winrock International, Arlington, VA., U.S.A.

MacDicken, K.G., E.L. Medema, K. Awang, and S. Bhumibhamon. 1990. Experience in MPTS Network Research in Asia. Paper presented at the XIX World Congress of the International Union of Forestry Research Organizations, Montreal, Canada, August 5-11, 1990.

Maneeratana, T.. 1989. Efficacy of *Curinus coeruleus* mulsant (coleoptera: Coccinellidae) for Biological Control of Leucaena Psyllid: *Heteropsylla cubana* Crawford (Homoptera: Psyllidae) in Thailand. Thesis, Kasetsart University, Bangkok.

Mothuchelian, K., K. Paliwal, A. Gnanam and R.J. Mitchell, in press. Improving the efficiency of photosynthesis and plant productivity by plant growth regulators. In *Journal of Plant Growth Regulators*.

Naik, S.T., R. Kumar, V.M. Srinivasan and R.K. Dixon, 1988. Woody biomass production on substandard soils in India Proceedings of Southern Biomass Conference, Auburn University, pp. 9-13.

Napompeth, B. and K.G. MacDicken (Eds.). 1990. Leucaena psyllid: Problems and Management. Proceedings of an International Workshop held January 16-21, 1989 in Bogor, Indonesia

Pinyopusarerk, K., E.R. Williams, and D.J. Boland. Geographic variation in seedling morphology of *Acacia auriculiformis* A. Cunn. Ex. Benth. To be submitted to Jou. of Trop. For. Sci.

Ponce, L.B. and A. P. Bangi. 1989. Survey of farmers' current use of multipurpose tree species on small upland farms in Eastern Visayas, Philippines. Paper No. 6. Winrock International-F/FRED Project, Bangkok, Thailand.

Ranganathan R. 1990. Tree use practices in selected villages of India. Paper No.11. Winrock International-F/FRED Project, Bangkok, Thailand.

Rao, M.V., V.K. Garg, R.K. Dixon and W.D. Kelly. In press. Growth and mycorrhizal development of *Leucaena* and *Prosopis* seedlings in saline soil. In Proceedings of Asian Conference on Mycorrhizae. Madras, Tamil, India.

Tingsabadh C. and K. Phutaraporn. 1989. Socioeconomic Impacts of MPTS biotechnologies on small farmers in the Philippines, Nepal and Thailand. Paper No. 5. Winrock International-F/FRED Project, Bangkok, Thailand.

Wickramasinghe, A. 1990. The farm and village forest and land use practices: a case study in Sri Lanka. Paper No. 9. Winrock International-F/FRED Project, Bangkok, Thailand.

Winotai, A. 1989. Biological control of leucaena psyllid, *Heteropsylla cubana* crawford (Homoptera: Psyllidae), in Thailand Ph.D. Thesis. Kasetsart University, Bangkok.

Withington, D., K.G. MacDicken, C.B. Sastry and N. Adams. (Eds.) 1988. Multipurpose Tree Species for Small Farm Use. Proceedings of an International Workshop held November 2-5, 1987 in Pattaya, Thailand. Winrock International, IDRC and FAO

Yatim, G.B. 1990. Use of multipurpose tree species by Malaysia farmers. Paper No. 8. Winrock International-F/FRED Project, Bangkok, Thailand.