Germplasm for Multipurpose Trees: Access and Utility in Small-farm Communities

Elizabeth Cromwell and Angus Brodie
with Alison Southern

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ODI Research Study

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Case Studies from Honduras, Malawi & Sri Lanka

Elizabeth Cromwell and Angus Brodie,
with Alison Southern

Overseas Development Institute

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Acronyms

AAM	ACTIONAID – Malawi
ADD	Agricultural Development Division (Malawi)
APRC	Agroforestry Project Rio Choloma (Honduras)
AP–CATIE	Agrosil vipastoral Project – CATIE (Honduras)
CATIE	Centre for Research and Training in Tropical Agriculture (Costa Rica)
CIDICCO	International Information Centre for Cover Crops (Honduras)
COHDEFOR	Honduran Forestry Corporation
CONSEFORH	Conservation and Improvement of Forest Resources Project (Honduras)
CRI	Coconut Research Institute (Sri Lanka)
CSC	Christian Services Committee (Malawi)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CTC	Ceylon Tobacco Company (Sri Lanka)
EPA	Extension Project Area (Malawi)
ESNACIFOR	Honduran National Forestry College
FRIM	Forestry Research Institute of Malawi
HASL	Hadabima Authority of Sri Lanka
ICRAF	International Centre for Research in Agroforestry (Kenya)
IFS	Institute of Fundamental Studies (Sri Lanka)
IITA	International Institute for Tropical Agriculture (Nigeria)
IRDP	Nuwara Eliya Integrated Rural Development Project (Sri Lanka)
LUPE	Land Use and Productivity Enhancement Project–USAID (Honduras)
MATF	Malawi Agroforestry Task Force
MAFEP	Malawi Agroforestry Extension Project
MAGFAD	Malawi–German Fisheries Development Project
MNRP	Management of Natural Resources Project–USAID (Honduras)
MPT	Multi-purpose tree
MPS	Multi-purpose shrub
NART	National Agroforestry Research Team (Malawi)
NFTA	Nitrogen Fixing Tree Association
NGO	Non-governmental organisation

ODA	Overseas Development Administration (UK)
ODI	Overseas Development Institute (UK)
OFI	Oxford Forestry Institute (UK)
PACO–CARE	Community Agroforestry Project–CARE (Honduras)
PMHE	Promoting Multifunctional Household Environments (Sri Lanka)
PROCONDEMA	Promotion and Training Programme for the Conservation of the Environment (Honduras)
Project MADELEÑA	Multipurpose Tree Project–CATIE (Honduras)
RDP	Rural Development Project (Malawi)
SADC–ICRAF	Southern African Development Co-ordinating Conference–ICRAF
SALT	Sloping Agricultural Land Technology
TEMG	Tea Estate Management Group (Sri Lanka)
TRI	Tea Research Institute (Sri Lanka)
UMWP	Upper Mahaweli Watershed Project (Sri Lanka)
USAID	United States Agency for International Development
VM	World Neighbors (Honduras)

Preface and Acknowledgements

This book presents the results of research into the exchange and use of multipurpose tree germplasm in farming communities in developing countries. The research was co-ordinated by the Overseas Development Institute (ODI) during 1994–1995 and funded by the Forestry Research Programme of the UK Overseas Development Administration. It is hoped that it will be of interest to researchers, aid policy-makers and government forestry officials, as well as technical specialists in forestry.

The research was implemented in response to the concerns emerging from two on-going projects: concerns relating to the effective improvement and distribution of multipurpose tree (MPT) germplasm, arising out of the work of the Forest Genetics Group at the Oxford Forestry Institute (OFI), and concerns relating to the effective organisation of germplasm supply in developing countries, emerging from ODI's seeds and biodiversity research programme. This research is very much a first attempt to identify the critical issues involved in MPT germplasm improvement and distribution and is intended to serve as a pilot project, on which subsequent research can build.

Many people and institutions have made important contributions to the research. The project grew out of concerns at both the OFI and ODI about the relevance and effectiveness of improved tree germplasm supply to resource-poor farmers. In response to these concerns, Dr Tony Simons, then of the OFI, initiated the work by approaching Elizabeth Cromwell, an Agricultural Economist and Research Fellow at ODI. She was Research Leader for the study. Angus Brodie and Alison Southern, ODI Research Associates, carried out the field work in Honduras, Malawi and Sri Lanka. Another ODI Research Associate, Anna Malos, also conducted some background research. In the writing of this book, a substantial contribution was made by Angus Brodie. Dr Jane Carter, ODI Research Fellow, also assisted. At the OFI, Alan Pottinger and Janet Stewart of the Forest Genetics Group gave a considerable amount of their time in providing helpful comments on research design and the presentation of results.

In each case study country, ODI benefited greatly from the support and assistance of local collaborating institutions. The collaborators were Ernesto Ponce, Graham Chapman, Jos Wheatley and Torsten Kowal of the ODA CONSEFORH project in Honduras; Dr Anoja Wickremasinghe at the Department of Geography at the University of Peradeniya in Sri Lanka; and Dr Jumanne Maghembe at the SADC–ICRAF agroforestry project in Malawi.

ODI also wishes to thank the staff of the many development agencies who gave up time to provide valuable information and practical help in each case study country. These include: in Honduras, Maria Lusia Martinez Garrido and Alexander Rivera (Agroforestry Project Rio Choloma), Wilberto Reyes (Agrosilvopastoral Project–CATIE), Oscar Leverón (ESNACIFOR Seed Bank), Javier Mayorga (LUPE), Carlos Ponce (PACO–CARE), Darío Enmecio Pineda (PROCONDEMA), Oscar Ochoa Mendoza (Tropical Seed), Amado Fransicso Osorto (World Neighbors); in Malawi, John Makina (Action Aid–Dowa), Martin Leach (ADDFOOD), Stephen Carr, Miguel Reabold (Christian Services Committee), Kate Wellard, Lizzie Batani and Joyce Kaezesi (Bunda College), Clare Coote and Chimuleke Munthali (FRIM), Susan Minae (ICRAF–Malawi), Trent Bunderson (Malawi Agroforestry Extension Project); and in Sri Lanka, Dr G. Wadasinghe (CARE), Drs M. de S. Liyanage and N. Fernando (CRI), D. Lakshman Nugawela (CTC), Mr G. Hemmatagama (HASL), Ajantha Paliyawardane (IRDP), Ranjith Mulleriyawa (PMHE), A. Nishanta Wickremasinghe (TEMG), Bernard Mohns, Ranjan Atygalle and Mr Warusewitana (UMWP), Professor H. Gunasena (University of Peradinya) and Dr L. Van Holm (IFS).

The views expressed in this study are those of the authors and do not necessarily reflect those of other individuals or institutions.

1
Introduction

Background to the Research

Increasing resources are being devoted to the investigation of and selection from multipurpose tree species (MPTs), with a view to providing better-performing germplasm for farming communities in developing countries. However, this improvement work is largely being carried out without direct contact with farming communities, the ultimate end users of this research effort (Simons, 1992). Information on farmers' patterns of exchange and use of tree planting material and their desired role for MPTs within the farming system has not been utilised by researchers of MPT germplasm. The need for improvement work to start with thorough investigations of the functions and characteristics of species desired by farmers, and investigations of how new germplasm can be introduced into traditional community seed systems, is increasingly recognised amongst crop breeders and agronomists (Cromwell et al., 1992; Cromwell et al., 1993).

To date, very little attention has been given to farmers' objectives in tree breeding, beyond a study funded by Winrock International (Raintree and Tailor, 1992). There is an urgent need not only to collect such information, but to disseminate it to those involved with the improvement and promotion of MPTs.

The research reported in this book was conceived with the aim of contributing to this process, by means of case studies of communities in areas where MPTs, in particular *Gliricidia sepium*, are being actively promoted. The intention is that future projects can then be designed to begin to tackle issues raised by this pilot research.

The emphasis on *Gliricidia* has been chosen because of the large amount of provenance identification and selection work that has already been done for this important MPT species (see, for example, Simons and Dunsdon, 1992). The case studies thus have the potential to illustrate well how tree germplasm is incorporated into traditional farming systems. Nonetheless, the studies are not designed to focus exclusively on uptake of *Gliricidia* but rather to reveal the broader patterns of exchange and use of existing and new tree germplasm in farming communities.

Research Hypotheses

On the basis of the background situation described above, two hypotheses were identified that the research should test:

- that the MPT germplasm that is currently available does not provide the functions and characteristics desired by farmers for such tree species;
- that the current mechanisms by which farmers obtain germplasm for MPTs are not as effective as they could be.

Objectives of the Research

Taking into account the research hypotheses, the objectives of the research were identified as being, in relation to the case study communities:

- to increase understanding of the factors influencing farmers' decisions to grow MPTs – in particular, to increase understanding of farmers' desired functions and characteristics of MPTs;
- to provide an initial assessment of the extent to which the provenances currently available to farmers provide the desired functions and characteristics – using *Gliricidia* as the main example, because of the large amount of provenance identification and selection work already done for this species;
- to increase understanding of the mechanisms by which farmers obtain germplasm for MPTs, including the importance of community mechanisms compared to external channels of supply;
- to increase understanding of the potential for improving the availability of MPTs to farmers, through external channels and through selection, multiplication and distribution of germplasm at community level.

How This Book is Organized

After this introductory chapter, Chapter 2 details the methods used to carry out the research, and the working definitions adopted for the main concepts involved in the research, such as 'multipurpose tree', 'provenance', etc.

Chapters 3 to 5 summarise the findings of the field work carried out in each of the three case study countries: Honduras, Malawi, and Sri Lanka. Each chapter describes briefly the predominant farming system, and the history of MPT improvement and promotion work in the country. The bulk of each country chapter is taken up with outlining what is known about the role of MPTs on-farm, and farmers' current sources of germplasm for MPTs. Both indigenous and introduced MPTs are considered in each case. The role of projects promoting MPTs is given due attention.

Chapter 6 then highlights the conclusions of this pilot research, which focus on various issues: the validity of the hypotheses on which the research is based; and the findings in relation to the four research objectives, both vis-à-vis each case study individually and more generally.

2
Methodology

Definition of Terms

This book uses the following nomenclature.

Multipurpose trees

We distinguish between *project MPTs* and *farmer MPTs*. *Project MPTs* are multipurpose trees as defined by scientists, i.e. those 'trees and shrubs which are deliberately kept and managed for more than one preferred use, product or service' (Nair, 1993) and are fast growing and ideally nitrogen-fixing. They include trees species such as *Gliricidia sepium*, *Leucaena leucocephala*, *Calliandra calothyrsus*, *Acacia* sp., *Azadirachta indica*, *Cassia* sp. and *Sesbania sesban*. Typical MPT products include construction timber, poles, fuelwood and fodder.

Farmer MPTs are multipurpose trees as defined by farmers. Farmers' definitions of MPTs were obtained in the research by asking farmers which trees they nurture on-farm for different purposes, and why.

The research concerned itself only with those trees growing on-farm, i.e. not with trees and tree products harvested from forests, waste or common land, etc. This included all multipurpose trees growing on farm, regardless of whether they were planted deliberately or they regenerated naturally and had been allowed to grow. Hence, farmers were questioned about the trees they 'nurture' on-farm, in preference to using the more specific terms 'plant' or 'grow'.

Germplasm

The term *germplasm* is used in this book to refer to all forms of tree planting material, i.e. including natural regeneration, wildlings, seed, seedlings, cuttings, etc.

MPT *germplasm system* describes the system for propagating, multiplying and distributing germplasm. The *formal sector* is that part of the germplasm system operated by formal organisations, be they governmental or non-governmental. The *community* or *traditional system* is that part of the germplasm system that operates spontaneously within farming communities, without outside intervention (Cromwell et al., 1992).

Species

Allaby's (1992) definition of a *species* is 'a group of organisms that resemble one another. In taxonomy, it is applied to one or more groups (populations) of individuals that can interbreed with the group but cannot exchange genes with other groups, or in other words an interbreeding group of biological organisms that is isolated reproductively from all other organisms'.

In discussing this research with tree breeders, it became apparent that this biological definition has limitations. Many species, including a number of the MPTs on which this research focuses, are capable of interbreeding (hybridisation). They may have been prevented from doing so by geographical isolation, but introductions to new areas can open up hybridisation possibilities. This is effectively acknowledged in the phylogenetic definition, which states simply that a species is the smallest unit recognisable by a unique character or combination of characters. Although this pilot research did not consider MPT hybridisation, it would be an interesting issue to cover in further research.

Provenance

Literally, this refers to the source or origin of given germplasm: it is defined by a geographical location (Greaves, 1978). The importance of provenance in forestry stems from the pattern of genetic variation between natural populations, and the fact that much forestry germplasm is still derived from these natural or semi-domesticated populations. Genetic variation is often demonstrated in characteristics that have economic, ecological, or botanical importance to tree growers.

The term is often misused and confused with terms such as *variety*. In forestry, the term variety is used where genetic differences between populations of the same species 'exhibit distinctive phenotypes' (Evans, 1992). The term *provenance* is more commonly used where variation is recognised, but not phenotypically.

Breeder

This book uses the term *breeder* to refer to any formal sector scientist involved in the collection of MPT material and selection from it, whether operating at the national level or international level.

Project

This term is used to refer to any project involved in the propagation, multiplication and distribution of MPTs to farmers. The project may be part of the government structure or a non-governmental activity.

MPT functions and characteristics

Scientists evaluate different provenances according to how well the provenances' morphological features fit into the target ecological zone; and how well these features enable the provenance to provide the economic end uses required by farmers. For ease of reference, this study calls the former group *characteristics* and the latter group *functions*. However, it is important to bear in mind that farmers may not articulate their preferences between tree species and provenances in these scientific terms.

Thus, *characteristics* include:

- ability to be directly sown;
- ability to be propagated vegetatively, eg. from cuttings;
- resistance to pest attack;
- adaptability to different soil and climatic conditions;
- low competition with crops – at root level for soil and water, and above ground for light;
- and various aspects of yield, such as speed of growth, vigorous coppicing, tolerance of browsing/lopping, and ability to produce desired products in the off-season.

Functions include:

- profuse production of good quality poles;
- fuelwood;
- fencing;
- high nitrogen fixation (to enhance soil fertility).

With respect to functions, it is important to distinguish between domestic end uses and sale off-farm. In the latter case, ability to fetch a good price may be an important function – some species may not fetch a good price in the market place, even though they yield well on-farm.

Germplasm Systems: the Influence of Forest Genetics

MPTs that have been widely distributed about the world are largely represented by narrowly-based and possibly unrepresentative domesticated material derived from unknown introductions. In contrast, systematic range-wide germplasm collection of these MPTs often demonstrate, via provenance/progeny, significant genetic variation between and within populations. This is the rationale for tree improvement projects commencing work by making extensive seed collections within a species' native range.

Genetic variation, if understood, can be utilised to the advantage of the tree grower. If misunderstood it can lead to reduced tree performance, planting failure and pest susceptibility. Tree improvement project and programmes attempt to utilise this variation to select predetermined desirable traits and thereby reduce the natural variation to a more manageable and predictable phenomenon.

Genetic diversity is important for the long-term health of populations. Many MPT introductions have consisted of one or very few individual plants, and/or germplasm of unknown genetic origin. Too few individuals may result in a narrow genetic base and lead to in-breeding problems: typically lowering of fecundity, poor growth and increased susceptibility to pests. Material of unknown genetic origin may be of an entirely unsuitable provenance, resulting in poor tree performance or even complete plantation failure. This in turn provides a poor return on investment and thus a disincentive to farmers to plant trees and to take up suitable MPT species.

Tropical trees reproduce through a wide variety of complex mechanisms. In general, however, the reproductive biology of tropical trees is characterised by being predominantly out-crossing, with the notable exception of *L. leucocephala*. Unlike common agricultural crops such as wheat and rice that reproduce readily through self-fertilisation, tropical trees depend upon cross-fertilisation for successful reproduction. Seed collected from a tropical tree genetically represents a combination of the mother tree and the surrounding individuals in a breeding population. This is in contrast to a self-fertilised seed, which represents genetically only the mother plant.

The reproductive biology of a given multipurpose tree has implications concerning how best it can be propagated, multiplied and distributed to tree growers. Production and maintenance of selected MPTs and simple on-farm multiplication of these lines may be complicated by the reproductive biology of the species. For example, for an out-breeding MPT such as *G. sepium*, selected trees will inter-breed freely with local genotypes, thereby diluting any gain achieved through selection. If the goal is to maintain the genetic integrity of the selected population, then it must be isolated by either physical or biological means.

In many ecological zones, many MPTs do not set seed and so clonal propagation, by stakes or cuttings, must be used. Where propagation is by vegetative means such as these, maintenance of genetic integrity is not a problem. However, maintenance of physical quality (freedom from fungal disease, viruses, etc.) can be. Clonal propagation over a long period, however, will limit the genetic base of the population, which may not be desirable.

The storage and distribution of MPT germplasm as seed can sometimes be problematical for the following reasons:

- Some MPTs have seed that cannot be easily stored without loss of viability.
- Some MPTs have seed that requires special pretreatment to assist the breaking of dormancy, e.g. seed coat scarification, soaking in hot water.
- Some MPTs need to form associations between their roots and nitrogen-fixing bacteria. Seed destined for environments where the necessary bacteria are scarce or absent may have to be coated with inoculum.

Research Methodology

The research was organised around three case studies, illustrating the situation of farming communities in different contexts where *G. sepium* is being actively promoted by projects for use on-farm:

- Where *G. sepium* is being distributed to farming communities within the species' native range. Honduras was chosen for this case study and the research team worked with the CONSEFORH forestry project there.
- Where *G. sepium* is being distributed to farming communities and the species is an exotic but already in long-standing use. Sri Lanka was this case study. The research team worked with the Department of Geography at the University of Peradeniya.
- Where *G. sepium* is being distributed for the first time to farming communities and the species is an exotic that has not been used before. For this case study, the research team looked at Malawi, in collaboration with the SADC–ICRAF agroforestry project at Makoka.

Before the country visits took place, the research team reviewed the available literature on patterns of multipurpose tree-growing in each of the case study areas using the ODI RDFN (Rural Development Forestry Network) library and CD ROM *(Tree CD)*. This included published literature, secondary data sources such as farming systems surveys, and research work related to MPT use and farmer preferences. Details are provided in the Select Bibliography.

Initial investigations suggested that this information for the countries concerned seemed to be relatively limited. Therefore, the major part of the country visits consisted of interviews with the different groups involved with MPT germplasm selection and distribution, to gather qualitative evidence about improvement work and germplasm distribution. These groups included breeders involved directly in provenance identification and selection; members of the Department of Forestry, including research staff, nursery staff, and extension staff at headquarters, regional and local levels; government and non-government projects working with MPTs at community level; donor staff involved in funding decisions concerning MPT work; and farmers themselves. Guideline interview schedules were used for each group of interviewees; these are attached at Appendix 1 for reference.

Time and resources did not allow the research team to carry out a large-scale sample survey of farmers. Instead, key informants were identified, in consultation with local project staff, to be representative of modal farm households with respect to holding size, land use patterns, labour availability, etc. as represented in recent census or survey data for the area. In Honduras, 26 interviews were conducted, with the help of project staff, and in Sri Lanka 13 interviews. The research team did not obtain permission to interview farmers directly in Malawi, so instead we relied on information and impressions provided by project staff and published reports such as Maghembe and Seyani (1991) and Warner (1993).

The field work was carried out between October and December 1994; the research team spent four weeks in each country. In-country presentations of initial results, for discussion and feed back, were made at the end of each field work period. Results were analysed between January and March 1995.

3
Honduras

Farming System

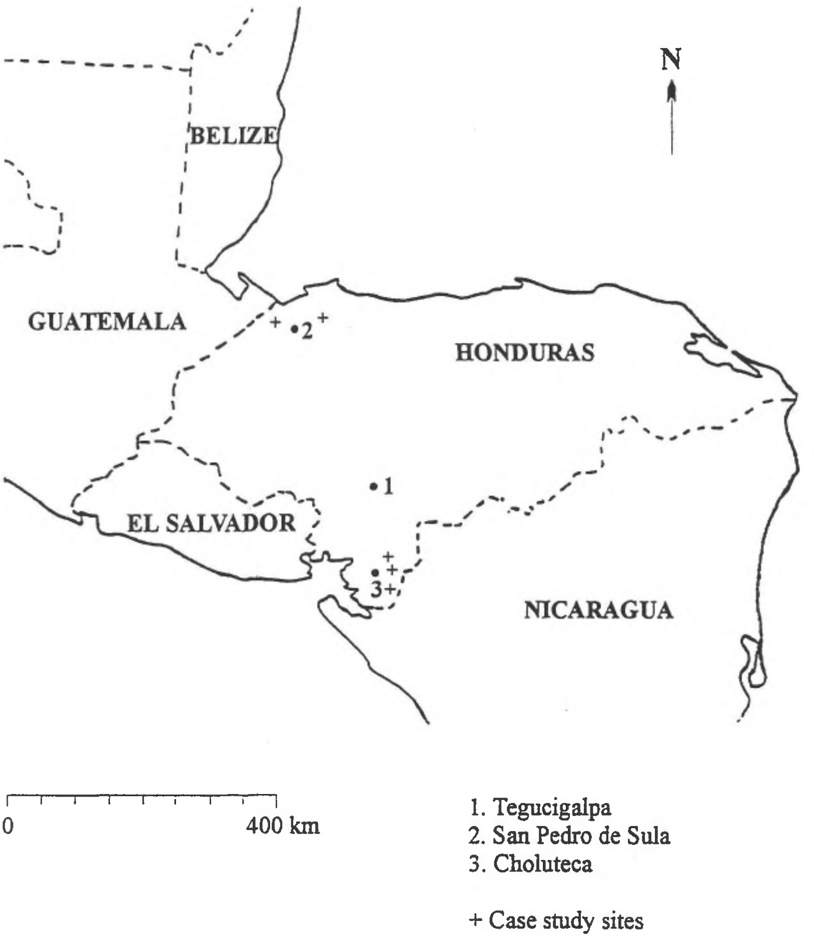
For the purpose of this research two areas in Honduras were visited; the Northern region around the city of San Pedro de Sula and the Southern region around Choluteca (see Map 3.1).

The two regions are distinct agro-ecological zones. The northern region falls within the humid tropical zone with annual rainfall of 2000–2600mm and average temperature range of 16–32°C. Rainfall is evenly distributed throughout the year, with a short dry season between the months of February and May. For the areas visited, land holding size is typically 2–5 hectares on steep (>15%) slopes. Two growing seasons per year are possible and principal food crops consist of maize, beans and sweet potato. Coffee under shade is an important cash crop. Crops are rotated, with fallow periods of 2–3 years, and fertiliser use is minimal. Farm animals include pigs and chickens; large farm ruminants are generally absent.

Choluteca falls within the dry zone that occurs along much of the Central American Pacific coast. Total annual rainfall is typically 1800–2000mm, and the region is marked by a severe dry season for 6–8 months of the year: May to October, and a mini dry season half-way through the wet season. Average annual temperatures are 28°C in October and 32°C in April. The rainfall pattern results in one principal growing season per year divided into two periods, before and after the mini dry season. All the farms included in the survey are 2–5 hectares in size and are on sloping land (>20%). Principal crops are maize, beans and sweet potato. Farm ruminants are not common.

In both regions, trees are an integral part of the farming systems; for traditional slash and burn agriculture, live fence posts, timber trees in crop fields and shade trees for coffee plantations. Honduras falls within the natural range of many internationally-known MPT species, such *Calliandra calothyrsus*, and Honduran farmers traditionally also utilise other internationally-renowned MPTs, such as *Gliricidia sepium*.

Map 3.1 Location of case study sites in Honduras



Government Policy on Forestry and Agroforestry

Honduras's present forest cover is approximately 60% of the total territorial area (112,088km^2). Forest cover is dominated by the large humid forests of Eastern Honduras; the lowland pine savannah of La Mosquitia region; and the upland pine forests in Central Honduras. These forests, particularly the latter, have influenced forest policy thinking in Honduras.

During the mid 1970s the Honduran Government created the Honduran Forestry Development Corporation (COHDEFOR), whose mandate was, and is, to regulate exploitation of the country's forest resources; encourage more environmentally appropriate agricultural land use patterns; implement reforestation schemes; and promote other forest and watershed activities. The export lumber industry was nationalised and revenue from this was used to fund COHDEFOR activities. More recently nationalisation of the forestry industries has been reversed and social forestry programmes such as the Social Forestry Scheme and the Areas of Integrated Management have declined in influence, while municipalities have gained greater control over the management of local forest resources (Utting, 1993).

Promotion of Multipurpose Trees in Honduras

MPT Promotion Projects

For this research, two projects were visited in the northern region – PACO–CARE and Agroforestry Project Rio Choloma (APRC) – and three projects were visited in the southern zone – World Neighbors (VM), PROCONDEMA, and Land Use and Productivity Enhancement Project (LUPE). A research project, Agrosilvipastoral Project–CATIE (AP–CATIE), was also visited in the south, although a visit to the project's field area was not possible. The projects were selected on the basis that they promote the use of MPTs in agroforestry systems in the context of alleviating rural poverty. The final selection was also made with time limitations in mind. Altogether, the projects serve over 30,000 farm families (LUPE 27,000; PACO–CARE 3,000; APRC 160; PROCONDEMA 78; VM 75).

Project Rationale for MPT promotion

None of the projects have carried out farm surveys focusing on farmers' MPT or tree needs. All the projects work under the assumption that MPT products and services benefit farmers and the environment in general. This assumption is based on current development thinking and development literature.

The projects that distribute MPT germplasm do so in order to contribute to their main objective of enhancing living standards by improving farming methods, leading to increased crop yields, environmental improvement and conservation. All the projects focus on agroforestry and soil conservation technologies as an approach to increasing crop yields and diversifying the cropping base. Thus MPTs are promoted as part of a system, rather than independently for the products and services they provide. Having said this, the principal functions for which projects promote MPTs are nitrogen fixation, leaf biomass and fuelwood production. The principal characteristics are fast growth, ease of establishment and, more recently, the ability to direct-seed.

Only one project, VM, did not promote the 'artificial' establishment of MPTs i.e. through planting or sowing. This project focuses on extension messages that promote management of natural regeneration of trees on farm.

MPT species promoted by projects

All the projects promote the use of MPTs within existing farming systems. All projects work with at least one traditional MPT, *G. sepium*. This MPT, although not within its native range in Northern Honduras, is well known and utilised within traditional farming systems by farmers. Otherwise, the number of promoted species is generally narrow and centred around *G. sepium* and the exotic *Leucaena leucocephala*. Other species include the indigenous *Albizia guachapele, Enterolobium cyclocarpum, Inga* sp., *Leucaena salvadorensis* and the exotics *Azadirachta indica, Eucalyptus* sp., and *Cajanus cajan*[1].

All the projects, except VM and AP–CATIE, also promote and respond to farmers' requests for 'timber' species. Fruit trees are also distributed by the projects.

Project MPT germplasm sources

PACO–CARE, APRC and LUPE get MPT seed from the Seed Bank of ESNACIFOR, the national forestry college. The principal species acquired from the Seed Bank are *G. sepium, C. cajan* and *L. leucocephala*. PACO–CARE also obtains MPT seed from a private company, Tropical Seeds. At present, PROCONDEMA and LUPE rely on making collections

[1] *Cajanus cajan* (L.) Huth or pigeon pea. This a perennial leguminous shrub.

Box 3.1 Common agroforestry technologies in Honduras

Three traditional agroforestry technologies on small farms in Honduras are:

- The establishment of *G. sepium* live fence posts with truncheons. Farmers manage the trees by pollarding, using the poles for construction and fuelwood.

- Coffee and *Inga* sp. shade trees. Farmer manage the trees for shade and mulch. *G. sepium* is also growing in popularity as a shade tree for coffee. Farmers note its beneficial mulch and improved coffee yields.

- The managing of naturally regenerated trees in crop fields. This is a widespread practice in Honduras. In the South, popular species managed for timber included *Cedrela odorata, Cordia alliodora, G. sepium* and *L. salvadorensis.*

Typical agroforestry technologies being promoted by Honduran rural development projects are:

- Contour alley cropping. The technology package normally includes: building terraces, retention walls and drainage ditches; sowing in contours; and planting MPTs in hedgerows, typically *G. sepium* or L. *leucocephala.*

- Diversification of the cropping base. This includes ginger, black pepper, cocoa, coffee and citrus production within an agroforestry intervention which normally involves contour planting, shade tree establishment and/or inter-cropping with annual crops.

from local seed sources. PROCONDEMA collects the seed by sending staff to known stands in the Choluteca area. Seed is also collected for the project by farmers, but the exact collection procedure and methodology is unclear. The material collected from different sites is not kept separately.

Previously, during the USAID-funded Management of Natural Resources project (1982–1988), LUPE bought seed from the ESNACIFOR Seed Bank. In 1989 it decided to collect seed from the trees of farmers within the programme. This was principally to save money, but also because LUPE staff felt there was already sufficient material within its project area and so this could be used, as it was already 'adapted' to the zone. Seed collection is carried out by the farmers. The exact details of the collection methods were not easily obtained, but all farmers involved mentioned that they collected seed from various trees, although no specific number was provided. Only two farmers mention selection based on phenotypic characters (see Box 3.3, pg. 27).

The projects indicate the advantage and disadvantages of using the Seed Bank source as being:

- easy access to the desired species (if the Seed Bank has it in stock);
- variable physiological quality;
- high cost;
- the long distance to the Bank's premises in Siguatepeque (in contrast, Tropical Seeds arranges door-to-door delivery in 24 hours).

According to projects, the only advantage of making local germplasm collections is the low direct cost, while the main disadvantage is given as being the diversion of staff and resources away from other project tasks.

Project awareness of germplasm source issues

Projects that acquire seed from the Seed Bank generally know its provenance, although LUPE is unsure of the provenance of any of its MPT species. The projects generally thought that the seed is not from a selected source. PROCONDEMA staff thought that the seed may have been selected, as the seed is packaged and labelled. Only one project, APRC, realised the importance of provenance selection, although APRC staff have not acted on their knowledge. The APRC project staff were unaware of any provenance performance information on project MPTs which they could utilise for making more informed MPT selection.

LUPE is unsure what germplasm of *Leucaena leucocephala*[2] had actually been distributed originally. The project admitted that it is possible the original material was a combination of variety *K-8* and a forage leucaena, possibly *L. leucocephala* var. *cunningham*, and that the seedlots had not been kept separate.

In two cases (PACO–CARE and APRC), projects distribute more than one provenance of a species. In the case of PACO–CARE this was

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[2] *Leucaena leucocephala* (Lam.) de Wit consists of two subspecies *leucocephala* and *glabrata* (Rose) S. Zárate (Stewart et al., 1992), but many varieties have also been produced for specific purposes. All promoted *L. leucocephala* are varieties of subspecies *glabrata*. The two main international tree breeding centres working with *Leucaena leucocephala* are the University of Hawaii, USA and CSIRO, Queensland, Australia.

intentional as the project recognise that a Guatemalan provenance of *G. sepium* (probably the provenance Retalhuleu) was superior to the Choluteca provenance, which is more commonly available in Honduras. The project has been unable to acquire sufficient quantities of the Guatemalan provenance, and decided to acquire both. The Guatemalan provenance is distributed to those farmer-promoters who have shown interest in receiving germplasm after seeing the *G. sepium* provenance trial at the CONSEFORH experimental station. (CONSEFORH is a forest genetics resource management project, the work of which is described in Chapter 3).

The APRC distributed two provenances of *G. sepium*, because the Seed Bank had provided two different provenances in the two consecutive years that seed had been acquired from it. One of the provenances that was sold to the project, Siguatepeque, does not appear on the Seed Bank seed list as a recognised provenance. APRC had not specified the provenance on request.

Overall, the projects are generally unaware of the importance of forest genetics in MPT promotion and use on small farms, although APRC is aware of the importance of provenance. Some projects, such as PACO–CARE and VM, have had some introduction to CONSEFORH's work, however when they organise field visits to CONSEFORH's research stations, they use them to promote the use of MPTs, rather than to demonstrate or discuss forest genetics issues with farmers.

Project MPT germplasm multiplication

Most projects acquire the quantity of seed they require at the beginning of the season and so do not store seed. Of those that do, PACO–CARE uses the facilities of the National Natural Resources Institute cold store, and LUPE stores seed of *G. sepium* and *L. leucocephala* in plastic bags in its local extension offices. In neither case are germination tests carried out, and in the case of LUPE the bags are often not labelled.

PACO–CARE is the only surveyed project involved with multiplication, in this case of *Cajanus cajan*. Multiplication of this species involves no selection of individual plants. Yields are low at present and therefore the whole harvest is utilised for seed production. This seed is redistributed to other farmers in other communities wishing to grow the species. PACO–CARE expressed an interest to CONSEFORH to establish community seed orchards of *G. sepium*, but as yet this has not happened.

The current germplasm distribution systems are determined by the projects themselves; changes within the system have been a result of changes in project policy. No project has carried out a systematic study of farmers' traditional systems for selecting, multiplying, storing and exchanging tree germplasm, although all projects are aware that MPTs are traditional within the farming system.

Project MPT evaluation systems

All the projects operate evaluation systems which include obtaining feedback from farmers, but the projects do not consider utility of MPTs in terms of functions and characteristics. PACO–CARE has an elaborate evaluation and feedback system in which farmers have to evaluate their on-farm 'improvements' according to various attributes. The other projects do not operate such a formalised system; LUPE principally uses hard data (e.g. number of farmers and areas established under agroforestry systems) as an evaluation guide.

All the projects say they need more information about the MPTs that they work with. In particular, they want information about the silviculture and the tree-crop interactions; for example, the contribution of the trees to the nutrient base of the cropping system.

MPT Seed Banks

Two institutions were named by the project interviewees as the main suppliers of MPT germplasm: ESNACIFOR Seed Bank and Tropical Seeds. Both enterprises are dedicated to selling collected and imported forest tree seed.

ESNACIFOR Seed Bank

The Seed Bank provides forest seed of known origin and known physiological quality to the market place, as well as providing training and research in forest seed management. It works with a wide range of species; for MPTs, it maintains stocks of *Albizia* sp., *Enterolobium cyclocarpum*, *Guazuma ulmifolia*, *G. sepium*, *L. leucocephala*, *L. salvadorensis* and *Mimosa tenuiflora*.

Using *G. sepium* as an example, the seed collection methodology used by the Seed Bank is as follows. The provenances collected and distributed are Comayagua, Choluteca, Otoro and Masaguara, because these were the ones identified in a provenance trial 4–5 years ago[3], and because their collection sites are easily accessible by vehicle transport. Collection within the sites is done by the Seed Bank personnel, except in

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[3] The trial the interviewee referred to was established in La Soledad and is described in Simons and Dunsdon (1992). The Honduran provenances represented in the trial were Masaguara, Guayabillas and La Garita.

the case of Choluteca, where COHDEFOR is responsible. Selection of trees involves selecting 'the best', which is defined by dominance and straightness of bole. The number of trees in the collection was not indicated. The COHDEFOR office in Choluteca described the seed collection of *G. sepium* as consisting of buying seed brought to the office by farmers, as well as staff collecting in the field, which is limited by lack of resources. Seed is then bulked and sent to the Seed Bank. It should be noted that Choluteca is a very ecologically diverse region.

Seed is sold at $40 per kg. 90% of national sales have been to the northern region to NGOs for live fence establishment. Information on provenance, seed purity and germination is provided to the purchaser, but information on seed care or treatment is not provided. The Seed Bank attributes germination failure in project nurseries to failure by projects to implement good practice; however, it does recognise the need to provide training and information about seed management and treatment in nurseries. It plans to introduce this in the near future.

The Seed Bank makes collections every year, although not all species are collected every year. A recent change in Honduras forest law has created private forests, and this has limited seed collection, now the Seed Bank has to enter into agreements with landowners to preserve seed sources.

The Seed Bank is not able to fulfil present demand because it is working at a low intensity because of a lack of resources. This is despite its increased control over its financial resources since the Government semi-privatised ESNACIFOR, and its support from the CATIE Forest Seed project (PROSEFOR).

On the more positive side, the Seed Bank believes it maintains good control over its seed collections and seed testing, to provide seed of good physiological quality. Also, its plantation and stand management work provides some incentives (*via* seed sales) to land owners and farmers to conserve forest resources both *ex situ* and *in situ*.

Tropical Seeds

Tropical Seeds is a private company trading in tropical seeds, including tree seed for *Bombacopsis quinata, Cassia siamea, Cedrela odorata, Eucalyptus camaldulensis, G. sepium, L. leucocephala, L. salvadorensis, Pinus caribaea, P. tecunumanii, Swietenia macrophylla,* and *Tectona grandis*.

Tree seed sold through the company is acquired in three ways: collections made by the company; collections made by farmer organisations in collaboration with the company; and seed brought from farmers, organisations, and other seed companies. For example, for *G.*

sepium, Tropical Seed collects seed in the provenances of Mescales, Otoro, Masaguara, and La Paz. Collections are made using the following criteria: dominant trees of good form (3 metres of clean bole, with profuse branching above 3 metres), and from natural forest (i.e. excluding hedgerow trees). The number of trees in the collection was not indicated.

Tropical Seeds also buys *G. sepium* seed from CIDICCO, which is collected by a farmer co-operative based in Cerro Verde, Choluteca. This provenance is recognised as La Garita. In addition, it imports seed from a Guatemalan supplier (provenance Retalhuleu) and the National Seed Bank in Nicaragua. These latter two provenances are distributed for research only as the supply is very limited.

To purchasers, the company provides all available information on the species and provenance, including data about the provenance (altitude, eco-zone, climate), seed test results (germination percentage, seed weight, purity, moisture), and recommendations on seed treatment, seed storage and handling. Information on provenance performance, if known, can also be provided.

The company organises delivery of any seed purchased, normally within 24 hours in Central America. Tropical Seeds has also exported *G. sepium* seed to Haiti, Hawaii and Malawi[4].

The company attempts to monitor the performance of the seed that it sells: it requests field reports from customers, and the company will provide field inspections, and management advice for a fee.

National Forestry Research Related Activities

CONSEFORH

CONSEFORH is a forest genetics resource management project funded by the Honduras Forestry Development Corporation and British ODA. Originally, a major focus of the project was tree improvement, including a number of exotic species. Since 1987, CONSEFORH's central objective has been to contribute to forest conservation within Honduras. To fulfil this objective, it has identified priority species, established a genetic resource management programme for them and produced seed (CONSEFORH provides germplasm in seed form only), as well as compiling information on the status and silviculture of these species. All seed produced is sold commercially through the ESNACIFOR Seed Bank. In future, the Seed Bank will also manage the project's seed orchards.

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[4] The Malawian purchaser of this *G. sepium* seed was found to be the USAID-funded Malawi Agroforestry Extension Project. The provenance is probably La Garita.

CONSEFORH has not yet reached the stage of recommending practices for tree seed multiplication and seed storage.

CONSEFORH works with numerous tree species including the following indigenous tree species: *Albizia* sp. (various species), *Bombacopsis quinata, Cordia alliodora, G. sepium, L. salvadorensis* and exotic species: *Azadirachta indica, Eucalyptus* sp. (various species), and *Leucaena* sp. (various species).

The project aims to combat the perceived danger of extinction of various native species. No special problem identification studies were carried out, although more recently the project has drawn up a list of priority species and has researched Honduran project reforestation work. Collections from natural populations, and exotic introductions, have been used to establish native species trials, taxa trials, silvicultural demonstrations and some provenance/progeny trials. The exotic introductions were in response to the need to produce tree products and services from fast-growing species in order to stem the tide of deforestation and genetic erosion of native species.

The aims of the collections of indigenous species were to obtain a broad genetic base, produce seed from this *ex-situ* source and then re-introduce the germplasm into the original gene pool. This was seen as part of a process to reverse the assumed genetic erosion brought about by dysgenic selection. Neither the actual state of genetic erosion nor the extent of dysgenic selection were investigated on the ground. Tree breeding *per se* did not form part of the project.

Trees were selected from natural populations, not from 'domesticated environments' i.e. fields or hedgerows, using the following selection criteria: 50 metres minimum distance between trees, straightness of trunk, and dominance (i.e. plant vigour). The number of trees collected at any one site varied between 50 and 70. All the collections of native species were made from various sites over one provenance. The process of collection and propagation from seed also provided useful silvicultural information about these comparatively unknown species.

Conversion of progeny trials to seed orchards involves selection based on a number of criteria, including: general growth performance (interpreted as biomass production); and stability of performance across a range of sites and within a range of forestry systems. Growth and biomass production are relatively straightforward, but malleability is more difficult to evaluate in the seed orchard, especially as the project has only two test sites. Definition of these characteristics is important because the final mix of individuals in the orchard will produce the characteristics of future generations.

CONSEFORH is presently reviewing its objectives, mandate, achievements, failures and work methodology. In its experience to date, some problems have emerged. Firstly, CONSEFORH sees the main constraints to the wider use by farmers of project germplasm (and forest trees in general) as being: shortage of land and labour, farmers' lack of forestry knowledge, and the absence of incentives for tree planting in Honduras. However, all its research trials are in plantation systems and it has done no dedicated agroforestry research.

The demand for seed is assumed, rather than measured, as is the need to conserve and re-introduce germplasm. CONSEFORH's approximation to a study of seed demand was an investigation of the Seed Bank seed distribution; this reflected the supply requirements of the formal sector, not the demand from end-users.

Trees on Farms

All the interviewed farmers manage trees on their land in some form or another, rather than harvesting products from 'wild' trees growing adventitiously within the farm boundary.

According to the farmers interviewed, the most important reasons for growing trees on farm are to provide timber for house construction, poles, fuelwood, soil enhancement and fruit. Of the nine species mentioned as popular for these uses, *G. sepium* was by far the most frequently mentioned (see Table 3.1).

When farmers were asked which trees they utilise for the specific functions and characteristics on which current *G. sepium* improvement work focuses[5], the indigenous *G. sepium* and *L. salvadorensis* emerged as the most mentioned species (see Table 3.2). These two species apparently fulfil many of the functions that scientists use to define a multi-purpose tree. However, in interpreting Table 3.2 it should be noted that the current use of certain tree species does not necessarily reflect a preference for using that species for that purpose: for example, in both northern and southern Honduras farmers stressed that *Cedrela odorata* was a preferred house-building species, but other woods are used because it is now

[5] These foci were taken to be providing poles, fuelwood, fodder, fencing, and enhancing the soil, plus having fast growth, growing on any site, direct sowing, good sale value, ability to pollard, little competition with crops, and ability to coppice. However, it should be noted that current improvement work at the OFI focuses on only some of these attributes. No OFI research has been conducted on soil improvement or the marketability of products.

Table 3.1 Sample farmers' most important tree species in Honduras (sample size 26 farmers)

Tree Species	No. Farmers
Gliricidia sepium	10
Citrus spp.	3
Bombacopsis quinata	2
Cordia alliodora	2
Leucaena salvadorensis	2
Albizia guachapele	2
Byrsonima crassifolia	1
Persea americana	1
Cedrela odorata	1
no response	1

Source: ODI MPT survey 1994

The role of MPTs in farming systems

Role of traditional farmer MPTs

Farmer MPTs were identified by *function* (Table 3.2). Out of these specific functions, the mentioned trees were most valued for fuelwood, poles, fencing, and soil enhancing properties. Shade over coffee was also considered to be an important function of trees by farmers in Northern Honduras. As regards specific characteristics, farmers most valued their MPTs for fast growth, ability to grow on any site, and direct sowing. Note, however, that the concept of characteristics was difficult to discuss with farmers and much of the information was extrapolated from the interviews.

Farmers are not able to get these functions and characteristics from non-tree sources because non-tree options are not available. For example, as regards MPTs' soil-enhancing properties, farmers find chemical fertiliser is too expensive, and organic manure is scarce because cattle are not commonly kept. However, 85% of the farmers interviewed said they can get the specified functions, particularly poles and fuelwood, from off-farm trees if necessary – by purchasing locally, taking from neighbouring land or from remnant forest.

The role of project MPTs on farms

Project MPTs are those tree species being promoted for on-farm use by projects. 50% of farmers interviewed are growing project MPTs: *G. sepium*

Table 3.2: Sample farmers' tree choice according to function in Honduras (numbers indicate number of farmer responses; sample size 26)

	Northern Honduras	*Southern Honduras*	*Total*
House construction timber/ Poles			
Cordia alliodora	4	10	14
G. sepium	4	7	11
L. salvadorensis	-	7	7
Fuelwood			
G. sepium	6	7	13
Inga sp.	5	2	7
L. salvadorensis	-	6	6
Fencing			
G. sepium	7	12	19
Lysiloma sp.	-	7	7
Cordia dentata	-	5	5
Soil enhancement			
G. sepium	8	6	14
L. leucocephala	1	3	4
no answer	-	8	8

Source: ODI MPT survey, 1994

in the North; and in the South the exotics *Azadirachta indica* and *L. leucocephala* (this high adoption rate may not be typical of the farming population as a whole). However, Project MPTs do not appear in farmers' listing of their major needs for an improved standard of living. These were given as community organisation, access roads, credit, improved housing, drinking water supply, training, and improved crop seeds.

Farmers' most commonly cited reasons for planting project MPTs are for fuelwood, soil enhancement, and because they can be direct sown, and create little competition with crops. However, in the case of the exotic species (*A. indica* and *L. leucocephala*) most farmers have had these MPTs on their land for a comparatively short time (circa. 4 years), so they are still learning what functions and characteristics they offer. Farmers were particularly unsure about the uses of *A. indica*. That the reasons given are the same as for planting farmer MPTs is not surprising, considering that in Honduras most of the project MPTs are in fact indigenous species.

The bad points of *G. sepium*, a common project MPT, were listed as being: in the North, that *G. sepium* sown from seed has very slow establishment; and in the South, that *G. sepium* has to be pollarded when grown in crop fields, to prevent possible allelopathic effects[6].

Farmer sources of MPT germplasm

For farmer MPTs

At present, all the farmers obtain their trees either from natural regeneration or from their own seed/stakes (Table 3.3), rather than any off-farm sources. Farmer MPTs located within farm fields are commonly established from natural regeneration and those trees in live fences, from natural regeneration or planted as stakes or seed. Trees grown near the house that are managed for use as construction timber, poles and fuelwood are established typically from natural regeneration or sown from directly sown seed.

Stakes, in the form of 1–1.5 metre truncheons, are the most common form of traditional propagation in the North, because they are quick to establish, require low maintenance and provide a function, fencing, almost immediately. It should be noted that *G. sepium* does not set seed in the northern region, where it is thought to be outside its native range (Hughes 1987). Natural regeneration is the most common source in the southern region of Honduras, where *G. sepium* does produce seed and where stakes are not very successful.

For project MPTs

50% of the farmers interviewed grow project MPTs: nearly 25% grow *L. leucocephala*, 15% grow *G. sepium*, and 8% grow the exotic *A. indica*.

The northern projects (PACO–CARE and APRC) distribute *G. sepium* planting material in the form of seed although farmers traditionally establish this species from cuttings. The projects distribute seed to encourage the establishment of live barriers for soil conservation, through direct seeding. They promote direct seeding to achieve deeper rooting patterns and a higher density of trees in live barriers.

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[6] Farmers described a liquid that drips from *G. sepium* leaves onto the crop and causes a yellowing in the crop leaves.

Table 3.3 Farmer MPT germplasm sources in Honduras (sample size 26 farmers)

	Northern Honduras		*Southern Honduras*		*Total*	
	on-farm	*off-farm*	*on-farm*	*off-farm*	*on-farm*	*off-farm*
Natural regeneration	-	-	15	-	15	-
seed	-	1	7	-	7	1
seedling	-	-	-	-	-	-
cutting	8	-	-	-	8	-

Source: ODI MPT survey

The southern projects (PROCONDEMA and LUPE) distribute planting material as seedlings and seed. LUPE presently distributes the majority of its MPTs in seed form (although *A. indica* is distributed in seedling form). Although projects consider that seedlings provide a greater incentive to farmers, because they are easier to establish and maintain, and provide useful products in a shorter time, they are now distributing more planting material as seed, for direct seeding.

Farmers expressed preferences for both seed and seedlings, depending on the circumstances. Farmers stated that seedlings are easy to plant and maintain, and grow faster than direct seeded material. Difficulties in transporting seedlings to planting sites and the cost of the plastic containers are perceived by farmers to be prohibitive for wider on-farm use of seedlings.

Projects presently favour the distribution of seed to farmers for direct seeding or on-farm nursery production. Farmers in southern Honduras expressed interest in receiving seed rather than seedlings, as seed was easier to transport, cheaper (if it had to be bought) and provided more opportunity for farmers to control seedling production.

No project distributes inoculant. In Honduras inoculant is probably not necessary as many of the species are in their natural range and natural rhizobium is likely to be present in the soil (although the study did not verify this through a formal literature search). Also seedlings grow well and this would be unlikely in the absence of inoculant.

The number of seedlings or amount of seed distributed to each farmer was determined by individual consultation between farmer and project.

Box 3.2 Examples of the traditional tree germplasm system in Northern Honduras

- In one northern Honduran community (Congo, near San Pedro de Sula) a farmer was able to indicate the source and form of the original introduction of *G. sepium* into the community area. Seed of *G. sepium* was brought by farmers migrating from the Honduran-El Salvador border some 50 years ago. Before the arrival of the farmers, *G. sepium* had not been present in the community area.

- In another community (San Isidro in the Rio Choloma watershed), a farmer indicated that the first introduction of *G. sepium* had been in the form of truncheons from the San Pedro valley some 40 years ago. From this original introduction neighbouring farmers had taken their truncheons for fencing.

- A women farmer (Buenos Aires, near Choloma) explained that after arriving in the area and clearing the land of residual forest, *G. sepium* fences were established. The tree species was not present on their land and her husband had cut truncheons from a neighbouring farmers' trees. After the first introduction, the farmer said she had propagated the rest of the trees from original material and did not return to the neighbouring farmers' trees.

Source: ODI MPT survey, 1994

The amount of seed distributed to farmers was difficult to calculate, but the number of seedlings was between 125 and 450 trees.

All seedlings and seed are distributed to farmers free of charge, to act as an incentive for establishing the agroforestry or soil conservation techniques being promoted by the projects.

Projects generally distribute only once to each farmer. After this, two projects promote non-project sources of planting material. PACO–CARE advises farmers to obtain material from the Seed Bank or local nurseries, with farmers paying market prices but assisted in the logistics by the project (the project facilitates the request for seed and delivers the ordered seed to the farming community). LUPE encourages farmers to acquire further germplasm from their own farms, from neighbouring farms or from the natural forest.

In all cases, seedlings or seed are delivered to farmers' houses if these are close to a passable road, or to a place as near to the house as possible. Only APRC gave an indication of the distance travelled by farmers to obtain the planting material. This was 1–1½ hours maximum. Planting material is distributed to those farmers who request it. All the projects are open to all farmers within the defined project area, but is may be assumed that there is some self-selection of farmers receiving planting material: they will be the ones who are already in good contact with the project extensionists.

The mortality rate of the trees distributed is estimated by projects to be 20–40%. One project (PROCONDEMA) admitted that it had lost all trees distributed one year due to drought.

Farmer knowledge of MPT selection and multiplication

As well as distributing planting material direct to farmers, PROCONDEMA facilitates the exchange of seed between communities with which it works. PACO–CARE encourages the multiplication of *Cajanus cajan* in the project's farming communities by offering to buy the seed produced, for redistribution among other farming communities. LUPE promotes the multiplication and distribution of various MPTs by its farmer-promoters. Only one project (VM) promotes traditional systems

Box 3.3 Farmer MPT selection methods

Only two farmers select planting material and distribute it to their neighbours. Both are farmer-promoters for projects (PROCONDEMA and LUPE) and are distributing project MPTs to other farmers.

- The farmers recognise phenotypic variation within a species and select trees with desired traits. The desired traits were: straightness (*Albizia niopoides, L. leucocephala*), and heavy branching (for one type of *L. leucocephala*). Seed is then collected from those selected trees and distributed to farmers interested in planting them.

- The farmers are applying principles they have learnt in training from the project. The training related to fruit trees, but the farmers are applying this knowledge to the selection and improvement of MPTs.

- Both farmers say the results have been positive, i.e. straight trees selected have produced straight trees. In the case of *Leucaena*, the two types – 'pole type' and 'fuelwood type' – have also reproduced true, according to the farmer.

ODI MPT survey 1994

of propagating farmer MPTs: VM advocates management of naturally regenerated *G. sepium* and *L. salvadorensis* in crop fields.

However, only four farmers (equivalent to 25% of those interviewed on this issue) described phenotypic variation in trees. Two recognised interspecific variation i.e. between similar species, whilst two recognised variation within a species: in the indigenous *Albizia niopoides* and the exotic *L. leucocephala*.

MPT extension advice provided by projects

At present, most farmers receiving project planting material are given extension advice on an individual basis, because they subsequently serve to demonstrate the system within the local community. In the case of LUPE, where its promotion programme has been established longer, farmers receive extension advice from farmer-promoters. In all cases, extension advice includes time of planting, soil preparation, planting/sowing techniques, care and maintenance of seedlings, and the associated establishment of soil conservation techniques.

All the projects use farmer training and on-farm demonstrations as important components of their work, and all use the system of farmer-promoters. In all projects except APRC, these farmer-promoters receive training, implement on-farm demonstrations (i.e. using the model farm concept) and are paid part-time (10–15 days per month) to promote project technologies to neighbouring farmers. Projects provide advice on contour alley cropping, woodlots and diversification systems, and also promote tree seed transfer, although only one project (LUPE) has fully developed this methodology with *G. sepium* and *L. leucocephala*.

In interviews where farmers were asked to explain the recommendations on tree growing, all the farmers focused on establishment procedures and had difficulty articulating or remembering the recommendations. In all cases, a project extensionist had helped in the original establishment of the farmer's agroforestry system.

In follow-up interviews with project staff, staff stressed that the focus in extension work so far has been on establishment practices, with less attention to subsequent management and product utilisation; that the training process is gradual, alongside the tree growth; that many of the agroforestry technologies (such as contour alley cropping and woodlots) being introduced are foreign concepts to farmers and take time to be understood; and that, importantly, the silviculture of many MPTs is not yet well defined.

Box 3.4 Identifying project MPTs – a key requirement

In several instances in all three case study countries, farmers could not remember the name of the project MPT. For example, in Honduras some farmers could not name *A. indica*, whilst others mentioned Eucalyptus as trees of interest on their farms. When farmers were questioned on what species or type of Eucalyptus they had on their farm, all replied that it was *just* Eucalyptus. The genus *Eucalyptus* consists of over 450 species of which approximately 200 have been introduced around the world.

If a project distributes a tree species to farmers, but does not inform farmers of the full name of the species (variety, provenance), then farmers will encounter greater difficulty in acquiring more of the same from off-farm sources when the project germplasm source ceases to exist.

4
Malawi

Farming System

Malawi can be broadly divided into three agro-ecological zones: the semi-arid Rift Valley (containing Lake Malawi and the Shire Valley; 200–600 m.a.s.l.), the Highlands (1600–3000 m.a.s.l.) and the subhumid medium plateau (800–1600 m.a.s.l.) which borders the highlands (Warner, 1993). Rainfall in Malawi is unimodal (November to April). Annual rainfall is 700–1600mm, with Lower Shire Valley and the western areas of the medium plateau receiving around 700–900mm.

Malawi has a high population density with an average of 106 persons per km^2 and over 200 persons per km^2 on arable land (Bunderson, pers. comm.). The economy is dominated by the rural sector and the high population density has led to strong seasonal migration of male workers to neighbouring countries and until recently South Africa. As a result of these and other factors, women play a fundamental role in farming and in household matters.

Approximately 80% of land in Malawi is classified as under customary tenure (Warner, 1993). Smallholders are granted cultivation rights, rather than ownership, from the village headman. Village householders typically farm 0.5–1.5 ha, depending on the region. A single growing season exists, of 90–180 days. Maize is the principal food crop, with vegetables, pulses and tobacco also grown in various regions. Large ruminants, such as cattle and sheep, are found in the Shire Valley in the South but are more numerous in northern Malawi, where land pressures are less. Monocropping of maize mixtures has lead to an increasing dependency on chemical fertiliser use. In recent years withdrawal of farmer credit and rising fertiliser prices have created difficulties for resource-poor farmers: the devaluation of the Malawian kwacha in late 1994 has effectively put fertiliser prices out of reach of smallholder farmers. Considering that approximately 80% of Malawi's domestic consumption of maize is produced by smallholders, this has serious implications for national food supply and may prompt farmers to look seriously for alternatives to inorganic fertiliser (S. Carr, *pers comm.*).

Government Policy on Forestry and Agroforestry

Total forest cover is estimated at 28% of Malawi's land surface (Bunderson, pers. comm.). The greatest concentration of forest is in the northern highland region. Natural vegetation on the central plateau is miombo woodland, represented by the genera *Brachystegia* and *Jubernardia*. Approximately 75% of the overall forest cover is found on customary land, with the other 25% in forest reserves (Warner, 1993). Wood can gathered for domestic consumption under customary rights. Commercialisation of wood products requires permission and the payment of a stumpage fee to the Forestry Department. Low stumpage prices and poor payment enforcement have been interpreted as disincentives to tree growing on-farm (World Bank, 1990).

In 1976 the Forestry Department initiated National Tree Planting Day. The goal was to establish woodlots, and by 1985 over 16 million seedlings had been distributed. Farmers can obtain seedlings from Government Forestry Department nurseries in exchange for beer bottle caps, sponsored by the national brewery Carlsberg. Species are typically *Eucalyptus camaldulensis*, *Cassia siamea* and *Gmelina arborea*. In 1994, National Tree Planting Day – normally a public holiday on 22 December – was cancelled because of the lack of rains and complaints from Forestry Department civil servants that, for them, the day was not a holiday.

Malawi's current stated policy on agroforestry is to 'undertake a programme of research in the areas of silviculture, including species suitable for agro-forestry, watershed management...and, given the land constraints and the relative value of alternative crops, smallholders will be encouraged to embark on agroforestry' (Office of President and Cabinet, 1987). These policies are implemented through the National Agroforestry Research Team, based at the Chitezde Agricultural Research Station, and the Agricultural Development Divisions (ADDs).[7]

Promotion of Multipurpose Trees in Malawi

Work on MPTs for Malawian conditions was started in the early 1980s by the University of Malawi's Bunda College of Agriculture, the Forestry Research Institute of Malawi (FRIM) and the National Agroforestry

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[7] For the purposes of delivering government agricultural development services, Malawi is divided into eight area-based Agricultural Development Divisions (ADDs).

Research Team (NART) (FRIM, 1897; Chiyenda and Materechera, 1987; Saka et al., 1991).

Initial interest was in alley cropping with *Leucaena leucocephala,* although more recently the focus on this species has waned because the species has not adapted well to Malawi's nutrient-poor and acidic soils, is eaten by goats during the dry season, and is attacked by termites and the psyllid *Heteropsylla cubana.*

Attention is currently focused on *Sesbania sesban, Gliricidia sepium* and *Tephrosia vogelii. C. spectabilis* is the favoured species with some extension projects simply because it is the only one with sufficient seed available, but the research organisations are cautious about promoting it because the nitrogen content in the leaves is high and the species is not known to fix atmospheric nitrogen[8] (i.e. implying that it depletes soil nutrient levels). There are no records of its first introduction to Malawi; it is now planted around houses for wood and shade, and it is also used widely as an ornamental tree for street planting.

The major agroforestry and soil and water conservation systems that are being promoted in Malawi are: realignment of marker ridges, contour alley cropping, and systematic interplanting of trees in crop fields, especially with *Faidherbia albida.*

MPT Promotion Projects

For this study, five projects were visited (see Map 4.1): the EC-funded ADDFOOD, the USAID-funded Malawi Agroforestry Extension Project (MAFEP), ICRAF-Malawi (based at Chitezde Agricultural Research Station), the NGOs Christian Services Committee (CSC), and ACTIONAID Malawi–Dowa (AAM). These are all projects with significant involvement in the promotion and distribution of MPTs; they were identified through consultations with representatives of the SADC–ICRAF Agroforestry Project and FRIM. However, the degree of emphasis on 'promotion' of MPTs, compared to their 'evaluation', varies between projects. For example, MAFEP does not wish to be seen as actively promoting particular MPTs; rather, it works with farm families to evaluate alternative species. This distinction should be remembered when reading this section. Most of the projects selected, particularly

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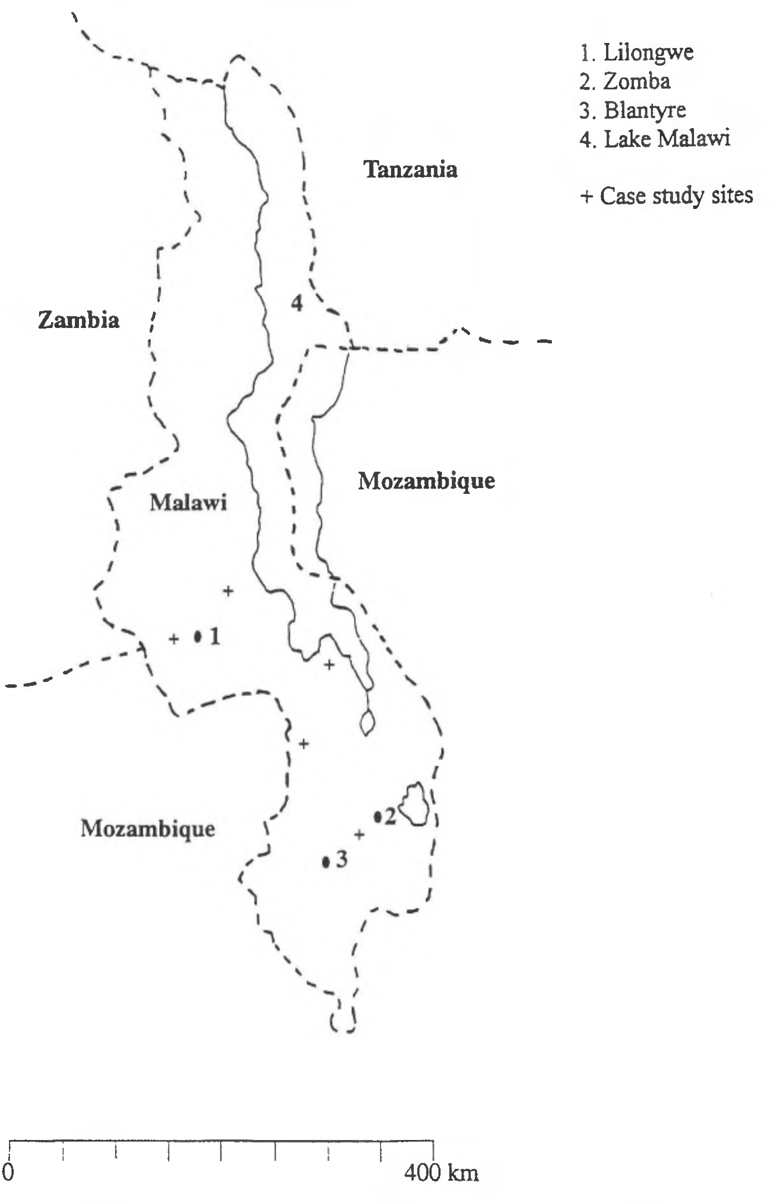
[8] *Cassia spectabilis* originates from Central America and is widely used about the tropical world as an ornamental. The genus *Cassia* is not known to nodulate or to be associated with nitrogen fixing rhizobium. There are no recorded experiences of *C. spectabilis* being used as an MPT in alley cropping in Malawi, although it has been reported in improved fallow and mulching agroforestry interventions (Egi and Kaliangire, 1988).

Map 4.1: Location of case study sites in Malawi



Box 4.1 The alley cropping debate in Malawi

The validity of alley cropping systems is hotly debated in Malawi at present, with extension/rural development projects in favour and research organisations more cautious. The outcome of this debate will have significant implications, not least for MPT germplasm demand and supply.

Alley cropping is being promoted by its protagonists (principally ADDFOOD) in the absence of any better alternatives for dealing with Malawi's serious land degradation problem. (Bunderson *et al.*, 1993).

The research organisations (FRIM and ICRAF) and various individuals maintain that alley cropping in Eastern Africa has not shown sustainable benefits (i.e. in terms of maize yields) in the medium to long term, and that promotion of MPT species, other than the widely tested *L. leucocephala*, is irresponsible, especially if the species do not fix atmospheric nitrogen.

The general agroforestry literature is conflicting in its opinions on the benefits of alley cropping in Eastern Africa (Lal, 1989; Maclean *et al*,. 1992; Wendt, 1993). ICRAF, which represents the forefront of agroforestry research, held alley cropping in high esteem for many years and actively promoted it. Today ICRAF has moved away from identifying itself with the promotion of alley cropping for Eastern Africa and is presently working on alternatives, such as improved fallow systems (S.Minae, *pers. comm.*) and MPT inter-cropping with maize (J. Maghembe, *pers. comm.*).

Any large shifts in agroforestry technology promotion – be it planting arrangement, silviculture or species focus – have a significant impact on MPT germplasm improvement, multiplication, and distribution because these are long term activities. Resources dedicated today to MPT germplasm multiplication will not bear fruit for up to 5 years; in that time, the demand for the MPT species may have altered or fallen and thus in retrospect those limited resources could have been better used elsewhere.

ADDFOOD, have large promotional programmes operating through Ministry of Agriculture ADDs and their corresponding Rural Development Projects (RDPs) and Extension Planning Areas (EPAs). Altogether, the projects work with just under 20,000 farm families (AAM 8,000; ADDFOOD 10,000; and MAFEP 450).

Project rationale for MPT promotion

All the projects work with MPTs as part of agroforestry and soil and water conservation technologies, based on the following rationale:

- Malawi has high rural population densities;
- average land holdings are typically only 0.5–1.5ha per household;
- most cultivated land is under continuous cropping of predominately maize mixtures, with low use of inorganic or organic fertiliser;
- soil erosion and declining soil fertility are perceived to be the major limiting factors to increasing maize yields.

Agroforestry and soil and water conservation systems are seen as appropriate low-cost technologies for addressing the problems of soil erosion and low soil fertility, and hence helping to alleviate rural poverty and malnutrition.

Within these systems, the projects view the principal advantageous function of the MPTs they promote as being the provision of leaf biomass, as a nutrient supply for soil fertility restoration. The projects view functions such as fuelwood, poles and fodder as secondary. All the MPTs being promoted are leguminous plants, but not all fix atmospheric nitrogen. Important MPT characteristics according to the projects are: fast growth, ease of establishment, suitability to low fertility and acidic soil conditions, drought tolerance and ability to coppice.

MPT species promoted by projects

The projects principally promote, or have promoted, the exotics *L. leucocephala, C. spectabilis* and *G. sepium.*

All the projects work with indigenous trees – *Faidherbia albida* and *Sesbania sesban* – as well as exotic ones. *F. albida* is a leguminous tree noted for its soil-enhancing properties and beneficial impact on maize production (Saka et al., 1994). Its leaf fall coincides with the first rains and it produces biomass during the dry season. Most projects started extension work with *F. albida* 2–3 years ago. All promote the systematic planting of the species in cultivated fields. Known locally as *msangu*, the species is much appreciated by farmers, who actively protect young seedlings in cropped fields (Maghembe and Seyani, 1991). Its major disadvantages are its slow growth in situations of less than ideal propagation; the large variability in growth performance between individual trees, including progeny; and the poor establishment from direct seeding and seedlings. Variability in growth rates is most pronounced in the first 4–5 years: the differences diminish after 10–15 years (S. Carr, *pers. comm.*).

Generally, the projects visited knew little of the silviculture of *F. albida*, although some research is now being carried out. For example, Chris Masamba of FRIM is currently working on *F. albida* for his doctorate at the University of London (Wye College).

All the projects visited used NART's work to guide their initial species selection. The ICRAF–Malawi Agroforestry Project also carried out a Diagnosis and Design survey (Minae, 1986) to determine its research priorities. The other projects (AAM, ADDFOOD, CSC and MAFEP) have not carried out formal surveys to identify farmers' needs and the relative value of working with MPTs. However, AAM, CSC and MAFEP carry out informal problem identification exercises with farmers and promoters. These events are used to orient and evaluate project operations.

FRIM and SADC–ICRAF have both carried out ethnobotanical studies of trees on farms in Malawi (Lowe et al,. 1995, Coote et al., 1993a, 1993b, Maghembe and Seyani, 1991).

Project MPT germplasm sources

All the projects could state their supply source of the MPT material that they are distributing, but this did not equate to an awareness and appreciation of its genetic quality. AAM and CSC did not know the provenance of the MPTs that they are distributing. In the other cases, project staff were aware of the provenance they distributed but did not relate this to forest genetic issues.

G. sepium is acquired from FRIM and project collections. FRIM's seed comes from two provenance trials, a seed stand at Makhange, and a 2 year old seed orchard of the provenance Retalhuleu[9]. These represent introductions made over 40 years ago (origin unknown), an introduction about 25 years ago at Makhanga (origin also unknown), and the latest introductions made by FRIM for provenance trials and the establishment of a seed stand. *G. sepium* material presently being distributed is of mixed origin. MAFEP imported *G. sepium* seed (provenance La Garita) two years ago from Honduras via the company Tropical Seeds, but this material has not been sown or distributed yet. The MAFEP project leader decided not to distribute the imported seed until it had passed all phytosanitory tests and the project had sourced information on the performance of species[10].

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[9] The Retalhuleu germplasm was provided to FRIM by OFI.

[10] This is in response to pressure from FRIM not to release the seed to farmers. Instead, MAFEP will probably distribute seed to the National Agroforestry Research Team, FRIM and some of its own farmers to trial the performance of the provenance.

Box 4.2 Estimating demand for MPT seed in Malawi

The current high demand for MPT seed is possibly the result of three factors:

- all projects are convinced that agroforestry interventions are positive low-cost sustainable technologies for increasing crop yields;
- projects tend to promote direct seeding, which requires approximately 4 times as much seed as establishment via. seedlings;
- one project (ADDFOOD in Zomba RDP) suggested that it acquires and distributes more seed than is actually sown or required in any one year and the excess seed is subsequently stored.

L. leucocephala is acquired from FRIM and from local collections made by the projects. ADDFOOD and MAFEP have also established seed stands for this species. *C. spectabilis* is collected locally by all the projects except AAM, which buys material from FRIM. Projects stated that there is no shortage of material for this species, but all had encountered low germination rates. *T. vogelii* is acquired from two sources: the parastatal Smallholder Coffee Authority, and the Ministry of Agriculture's Bvumbwe Agricultural Research Station in the Lower Shire Valley.*S. sesban* is acquired from SADC–ICRAF at Makoka Agricultural Research Station. *F. albida* is acquired by local collections by all projects, except AAM who get material from FRIM.

For most species, the projects know that the material has not been selected. The original importation of *L. leucocephala* was probably selected material, var. *cunningham* (MAFEP) or K-8 (ADDFOOD). *C. spectabilis* is material of unknown original origin. *T. vogelii* probably originates from selected material. *S. sesban* is not selected material. *F. albida* is also not selected seed.

CSC and ADDFOOD make indiscriminate local collections of MPT planting material, and the germplasm they subsequently distribute to project farmers is from more than one source. Whether these sources represent more than one provenance is unclear. AAM also distributes more than one provenance of each MPT; the project was unaware of the issues relating to provenance variation. MAFEP and ADDFOOD distribute germplasm of *G. sepium* from more than one source. MAFEP stores and distributes the different sources separately. ADDFOOD does not maintain the same degree of supervision of storage and distribution and so mixing of germplasm sources may occur.

Project demand for MPT germplasm

According to the projects, the main disadvantage of the seed sources currently used is the limited supplies of material available for the most popular MPTs – particularly *G. sepium*, which is seen as the replacement for *L. leucocephala* in Malawi. Projects state that the Seed Bank at FRIM – the only authorised tree seed supplier in Malawi – cannot keep pace with projects' requirements, and the quality of the seed supplied is variable and often poor. MAFEP considers that the current shortage of MPT seed is the critical limitation on expansion of extension programmes working with MPT and agroforestry systems in Malawi. According to one estimate[11] some 400 tonnes of MPT seed is needed over the next 5 years, simply to serve 10% of the rural population. If this quantity of seed was represented by *G. sepium* alone, the required seed production area would approximately be 650ha, assuming *G. sepium* was planted at 2m x 4m and produced around 150kgs per ha.

Project MPT germplasm multiplication methods

Only two projects – ADDFOOD and MAFEP – multiply seed themselves, in addition to procuring supplies locally or from formal seed sources. Both projects are establishing seed stands on farmers' and EPA land.

ADDFOOD, which calculates its seed requirement to be 5 tonnes per year[12], has established seed stands on farmers' land and EPA demonstration plots. The project has established five seed stands of *L. leucocephala* and intended to establish up to 95 plots of *G. sepium* in the year following the ODI MPT survey. It is using two provenances of *G. sepium*: Retalhuleu which is being distributed to farmers; and seed from the Makhanga site in the Lower Shire, which is being distributed separately to the EPAs. Half a kilogram of seed is given to each farmer (approximately 2,500 trees for 0.25ha) to be sown directly, and 400 seedlings to each EPA. Planting density is 1m x 1m; the plots will probably be thinned.

MAFEP plans to establish seed stands for *G. sepium* of similar design to ADDFOOD's (the design protocol was provided by OFI). However, the project considers that its need for seed will be so great that a more efficient system will be required: hence its suggestion that private sector participation in MPT seed supply be encouraged.

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[11] T. Bunderson, *pers. comm.*

[12] This represents 0.5kg of seed per household, sufficient for 1/4 ha of alley cropping per household per year.

ADDFOOD and MAFEP both store seed. In the case of ADDFOOD, storage is done by the RDPs or EPAs. Seed is stored in hessian sacks; germination tests are carried out prior to sowing. Until 1993, MAFEP stored all its seed in a private cold store (it has approximately 2 tonnes of seed in stock). However, this facility has now been withdrawn. Seed is stored in plastic bags. Germination tests are carried out prior to sowing. Seed collected by the project is stored separately by year and location area.

The mortality rate of the trees distributed and planted ranged between 40–70% (this range is for seedlings planted out). No project has measured mortality with direct seeding techniques. All the projects indicated that the survival of seedlings sown in drought years was seriously affected, as was the survival of trees of one to three years of age. In drought years mortality can reach 100%.

MAFEP

MAFEP is primarily concerned with evaluating agroforestry technologies; however it does also collect MPT seed locally because FRIM is not able to meet all its needs. The project does not generally make the seed it collects available to other projects, although is has provided some seed to both ADDFOOD and CSC.

MAFEP's collection procedure selects on the basis of form (although this is not very rigorous); heavy fruit/seed production; and avoiding isolated trees. Farmers help with collection. Seed that is collected locally is packaged separately for each site and year. Seed is not mixed or bulked. About 500kg of seed is collected per year. The disadvantage of local collection is that species choice and genetic quality are related to zone. The project overcomes this to some extent by transferring seed from one area to another.

In addition to local collection, MAFEP intends to establish *G. sepium* (Retalhuleu provenance) seed stands with seed from FRIM.

Project MPT evaluation systems

All the projects have carried out general project evaluation exercises, which vary from evaluation workshops, to adoption surveys and yield studies. Within these surveys, farmers are given some opportunity to express their opinions of the functions and characteristics of the project MPTs on their farms, but in most cases the trees are still too young for their eventual functions and characteristics to be clear to farmers.

However, no project has formally evaluated its germplasm distribution system and obtained the views of farmers, nor have projects collected any information about traditional systems for selecting, multiplying, storing and exchanging tree germplasm. The current distribution systems were decided by the projects in all cases, although there has been adaptation and modification of the systems following informal consultations between farmers, promoters and project staff.

National Forestry Research Activities relating to MPTs

Four institutions were named by the project interviewees as the main suppliers of MPT germplasm: Forestry Research Institute of Malawi (FRIM); Malawi Agroforestry Extension Project (MAFEP); NART at Chitedze Agricultural Research Station; and the Smallholder Coffee Authority. Only the first two institutions were visited; they are the largest suppliers of MPT planting material in Malawi at present.

FRIM

Since its establishment in 1966, FRIM has carried out a broad spectrum of forestry research, including investigations in silviculture, agroforestry, community forestry and tree improvement. FRIM's main focus in tree improvement has been industrial exotic softwoods and hardwoods, particularly members of the genus *Pinus* and *Eucalyptus*. Agroforestry or non-industrial species are more recent additions to the programme.

The MPTs on which FRIM works are given in Table 4.1. The species choice was determined as follows:

- for exotics, by the utility of the species for conditions in Malawi, based on a review of the available literature;
- for indigenous and naturalised species, by the utility of the species on-farm, based on existing working knowledge;
- that all selected species should not only provide useful products and services for on-farm use, but also have beneficial growing characteristics – such as plasticity across sites and resistance to termite attack.

FRIM's Agroforestry Unit started work on *G. sepium* in Malawi in the mid-1980s under the World Bank-funded Fuelwood and Polewood Research Project for the Rural Population of Malawi. The project focused on species trials and silvicultural aspects of the selected tree species. More recently, MPT provenance trials, seed stands and seed orchards have been established by the Tree Improvement Unit. On the whole, FRIM's tree improvement programmes follow classical industrial tree breeding strategy: individual tree selection through stages of mass selection, progeny evaluation and seed orchard roguing, with overall

Table 4.1 FRIM Tree Improvement Species

FRIM	*Species*	*Research Phase*	*Seed Source*
Industrial exotic hardwoods	*Eucalyptus camaldulensis*	SSO	SSO
	E. tereticornis	SSO	SSO
Non-industrial exotics	*Gliricidia sepium*	PT, SS	PT
	Azadirachta indica		
	Gmelina aborea	PT	PT
	Cassia siamea	PT	ST
Non-industrial indigenous	*Faidherbia albida*		ST, NT
	Uapaca kirkiana	+T	NT

Key : SSO = seedling seed orchard, PT = provenance trial, SS = seed stand, +T = plus tree (a tree recommended for production or breeding orchard use following grading), ST = selected trees, NT = non-selected trees.

Source : adapted from Barnes, 1993

strategy objective of providing improved growing stock for medium-large scale timber plantations. FRIM's MPT tree improvement programme has largely followed this strategy, with some modifications.

FRIM established two provenance trials of *G. sepium* with material provided by OFI, at Phirilongwe and Naungu (Ngulube and Mwabumba, 1994). At Naungu, 24 provenances were established. After two years' growth, survival, height, basal diameter, number of stems, number of branches, branch thickness, dry weight and basic wood density were assessed. Above ground biomass was measured in terms of foliage and wood (stem, branches and twigs) production. Pod length, number of seeds/pod, seed dimensions and seed viability were also assessed for seed production purposes.

The best overall provenances, based on combined characters, were: Managua, Volcanachitan, Retalhuleu, Masaguara and Guayabillas. The best performing provenance in terms of overall biomass production was Managua from Nicaragua. Other provenances high in foliage biomass production – but low in wood biomass – were: Vado Hondo, Playa Azul, El Roblar, Belen Rivas and La Garita.

FRIM's Seed Bank

FRIM operates a Seed Bank which collects, imports, processes, stores and sells seed. Most of the sales are of seed for exotic industrial softwoods and hardwoods, but demand for MPTs has grown in recent years. All FRIM's seed is sold through this seed bank, which is located at the Institute's headquarters in Zomba. There has been a lack of co-ordination between the Seed Bank and the Tree Improvement Unit, which has led to information blockages. Changes are in progress, following the recent restructuring of FRIM's activities (C. Coote, *pers. comm.*).

Box 4.3 FRIM's main concerns relating to MPT seed supply and usage in Malawi

- Through its MPT provenance tests, FRIM has been able to identify those provenances that seem to be the most promising and this information has been published, but it says the projects do not use it or are not aware of it.

- At present FRIM cannot meet the demand for seed for agroforestry species, particularly *G. sepium.* FRIM considers a larger seed orchard to be the only solution to its supply problems and is in the process of developing one for *G. sepium.* However, as noted earlier, the projects are not confident that this will work and they believe other alternatives, such as on-farm seed stands, local collections and importation of seed from other countries should also be investigated. This is taking place.

- Projects are using alternative seed sources, both imports and local collections. FRIM is concerned that the genetic quality is either unknown or poor, possibly leading to poor growth performance, so providing a disincentive to farmers to plant trees. In addition, the widespread distribution of inferior germplasm will dilute the impact of any introduced (superior) material.

Source: FRIM staff

The Seed Bank's seed collections for the major MPTs (*G. sepium, L. leucocephala, C. spectabilis, F. albida* and *Sesbania sesban*) are of a general nature. There is no selection of ideotype trees; the only selection criterion is the avoidance of diseased trees. The number of trees making a collection was only specified in *F. albida.*

G. sepium is collected from 4 sites. The sites are collected separately and no bulking occurs. Makhanga, in the Lower Shire valley, was established some 10–15 years ago. It has around 1,500 trees; it has not been thinned from its original planting density of 1.5 x 2 metres. An average of 25–30kg seed is collected each year from this site. Phirilongwe and Naungu represent the two provenance trials. In the past seed has been collected across the sites, so the provenances have been mixed. Today FRIM collects only from the best provenances, although progeny are still of mixed provenance origin. About 20kg and 60kg are collected per year from these two sites respectively. The seed collectors were unsure of the origin of the Kachulu site[13]. Only 15kg is collected per year. Current actual demand for *G. sepium* seed from the Seed Bank is approximately 400kg per year, compared to the total collection of around 125kg.

L. leucocephala is collected from 2 sites, Phirilongwe and Naungu. Up to 60kg and 20kg has been collected per year from these sites. FRIM also buys seed from the Malawi–German Fisheries Development (MAGFAD) project. Demand for the species is low, at 40kg per year, due to *L. leucocephala's* susceptibility to termite and psyllid attack and its unsuitability to Malawi's acidic soil conditions.

C. spectabilis is collected from sites in 4 towns: Zomba, Karonga, Lilongwe and Kasungu. All the sites represent street plantings in built-up areas and therefore the genotype is very dubious.

F. albida is collected from 7 sites. Four of the sites contain 4–6 selected trees from which the entire site collection is made. Selection criteria are: tree form, branching habit, large extensive crowns, and heavy fruit production. A single tree will yield up to 50kg of seed in any one year.

Sesbania sesban is collected from 2 sites of unknown origin.

All collected seed is tested. A sample of each seed lot is tested for purity, germination, weight and moisture and seed is re-tested every 6 months whilst in store. The test results are provided to seed buyers.

The Seed Bank also advises projects that are initiating on-farm seed production. For example, FRIM recently provided both ADDFOOD and MAFEP with *G. sepium* seed of the provenance Retalhuleu for the establishment of seed stands on farmers' land. The Seed Bank also trains farmers in seed collection techniques and is experimenting with this strategy for its own future seed collections.

Trees on Farms

No farmer interviews were carried out on a formal, structured basis in Malawi as government permission for this was not obtained. The

[13] The Kachulu site probably consists of the Retalhuleu provenance.

following sections were compiled from information derived from interviews with project personnel, field visits with projects, and literature.

The role of MPTs in the farming system

Role of traditional farmer MPTs

The most important reasons given by Malawian farmers for growing trees on-farm are soil enhancement, fuelwood, timber and fruit production – mainly for domestic use. As regards characteristics, trees on-farm are most valued if they do not compete with crops and they grow fast. Farmers rate *F. albida* as an important on-farm tree; other valued species include *Mangifera* sp., *Gmelina arborea, Bauhinia thonningii, Brachystegia spiciformis* and *Ficus natalensis* (Maghembe and Seyani, 1991).

The ODI research team found it difficult to determine if farmers attribute one or more specific functions to particular tree species on their farms. However, ethnobotanical studies carried out in Malawi (Lowe et al., 1995; Coote et al., 1993a, 1993b; Maghembe and Seyani, 1991) suggest that there are a large number of indigenous tree species that have multiple uses and there exists wide regional variation in what trees farmers use for specific functions.

Fuelwood and poles are often acquired off-farm: from neighbouring farms, the community forest, and the protected forest. Poles and building timber are also bought in town. However, for soil enhancement, there are few other sources open to farmers: cash or credit with which to buy chemical fertiliser is in short supply, particularly since the ending of the farmer club credit system in 1994; and there are insufficient livestock to provide organic manure.

The role of project MPTs on farms

Farmers that had planted a project MPT had done so because they had heard from the project that the MPT provided 'fertiliser' to the soil and improved crop yields. All had starting growing project MPTs within the last five years.

According to farmers, the project MPTs were susceptible to termite attack (particularly *L. leucocephala*); and to browsing by goats; had no effect on soil fertility; and were not drought tolerant. One farmer who had not planted a project MPT gave as his reason that he was not convinced that its presence in the field improved soil fertility and maize yields. He stated that his neighbour had still to apply fertiliser to his maize crop even after having planted the local project MPT, *L. leucocephala.* Some farmers in the ADDFOOD and MAFEP programmes who had planted project MPTs still receive chemical fertiliser. Recent research by IITA indicates that some fertiliser application is necessary to maintain crop yields in alley cropping (Whittome, 1994).

Farmer sources of MPT germplasm

For farmer MPTs

Farmers do nurture some of their tree species rather than simply harvesting naturally-occurring trees, particularly for the functions of soil enhancement and pole production. However, harvesting naturally-occurring trees for fuelwood does occur. Overall, the main source of germplasm for farmer MPTs appears to be natural regeneration, followed by seed and seedlings; this is supported by Maghembe and Seyani (1991). Cuttings do not appear to be a significant source. Excluding natural regeneration, farmer MPT planting material is also obtained from other farmers, Forestry Department nurseries, and projects.

Farmers acquire seedlings at Forestry Department nurseries either for cash or through exchanging beer bottle tops. This latter scheme, promoted by Carlsberg Breweries, has jeopardised the economics of seedling distribution as the value of the brewery sponsorship has been eroded by inflation and no longer contributes sufficiently to Forestry Department costs.

When farmers decide to plant trees on their land, they generally obtain from 5 to 500 seedlings. One farmer explained that he had transported 500 plants by foot from the Forestry Department nursery to his farm, a distance of around 1.5km, on two separate occasions, in 1960 and 1985.

A number of the farmers in the project areas demonstrate considerable knowledge of and ingenuity in propagating trees on-farm (see Box 4.4).

For project MPTs

Farmers growing project MPTs – *L. leucocephala, G. sepium* and *F. albida* – had obtained the planting material from one of the projects or from government extension staff.

Two to three years ago, projects initially distributed seedlings produced in communal/group nurseries. Seedlings were distributed primarily to create a clear visual impact, and because this was the form recommended by NART. AAM still follows this system: it distributes seed to group nurseries, where seedlings are propagated. The project indicated that direct seeding has not been successful, as farmers do not have sufficient labour to plant MPT seed at the same time as crop seed. Late sowing of MPT seed leads to establishment failure.

The other projects now distribute planting material in the form of seed. ADDFOOD distributes seed for establishment by direct seeding, while

Box 4.4 On-farm farmer tree propagation in Malawi

Examples from the project areas include:

- One farmer produces about 500 seedlings per year of *E. camaldulensis* in his own nursery for his own pole and fuelwood needs. The nursery is located in a garden in a moisture-retaining valley bottom (dimba) and the seedlings are planted out in the dimba garden area. Seed for planting is collected from one tree in the dimba garden. The high number of seedlings produced is an attempt to combat high losses due to termites: the farmer has successfully established only a dozen trees in two years of planting 500 trees per year. The farmer receives assistance from the local EPA extensionist in nursery preparation, but not in any other aspects of seedling production.

- Another farmer left one tree of *G. arborea* to mature in a hedgerow and collected seed from it. He planted the seed in a nursery in a dimba garden and planted out the resulting seedlings. No one has given him any instructions, except for the ICRAF extensionist who responded to his request for advice about seed treatment. So far the results have been good, but it is only the second year of his experiment. He is producing the trees because he wants more *G. arborea* on his land for fuelwood.

- A third farmer propagates *Melia* sp. for pole production. He collected seed from one tree on land belonging to the local mission, which he has direct seeded. He was taught about the value of the tree and how to propagate it by his parents.

Source: ODI MPT survey, 1994

CSC and MAFEP distribute seed and containers, leaving farmers to choose whether to create individual nurseries for producing seedlings or to direct seed. Direct seeding is now the favoured practice for establishment because it is perceived by projects to be low-cost, an easy technique to transfer to farmers and to be sustainable, in the sense that farmers can maintain the system themselves.

The change in policy, from seedlings to direct seeding, has been decided unilaterally by the projects; problems with seedling establishment may have contributed. One RDP within the ADDFOOD programme indicated problems were due to poor farmer establishment practices; farmers removed seedlings from their containers completely and planted the seedlings as if they were 'bare-root' seedlings. Farmers explained to the extension officer of the RDP that they had done this because it was easier to transport the seedlings, without their containers, to the field. However, other farmers, when asked, expressed a preference for seedlings as these are easier to establish than direct seed.

The quantity of planting material distributed to farmers varies between projects. AAM lets farmers determine the number of seedlings they want, although a typical quantity is 50–100 seedlings per farmer per year. ADDFOOD distributes 0.5kg of seed per farmer (sufficient for approximately 0.15–0.20ha of alleys), on the basis that this is a realistic area for a farmer to establish in any one year, and on the basis of seed availability. The quantity of seed distributed by CSC – enough for up to 20 trees per species per farmer – is limited by the quantity of seed that it can acquire and by the fact that CSC focuses on the distribution of *F. albida* germplasm, for which fewer trees are required per ha (it distributes other species – *G. sepium*, *Sesbania sesban* and *C. spectabilis* – on an experimental basis only). MAFEP does not distribute a set quantity: the amount is determined by the farmers. The farmers in the ICRAF–Malawi on-farm trial programme received between 250 and 500 seedlings.

AAM, ADDFOOD and CSC do not inoculate, or distribute inoculant with the seed distributed to farmers. Simon Carr, formally head of CSC, considers that poor performance of *G. sepium* may be in part a result of absence of inoculant in the soil in Malawi. MAFEP inoculates seed of one species only, *L. leucocephala*, prior to its distribution. FRIM does not distribute any inoculant for the leguminous MPT species that it sells from the Seed Bank.

All the projects distribute germplasm directly to farmers. ADDFOOD does so via the government RDPs, EPAs and extension agents. AAM and CSC distribute planting material through their respective promoters. Farmers do not have to travel far to acquire MPT planting material, although they have to transport the material from the community distribution point to their fields.

Up to now, none of the projects have given farmers instructions as to how they can obtain further supplies of planting material after the initial distribution. Farmers could receive project MPT germplasm for more than one year if they so desired.

All the projects distribute planting material free of charge, in the belief that this provides an incentive for farmers to establish agroforestry systems. AAM and MAFEP also distribute containers free of charge, whilst CSC heavily subsidies the price it charges.

The type of farmers targeted as recipients of MPTs by the projects are resource-poor smallholder farmers (modal land holdings 0.5–1.0 ha). Women have been targeted by one project (CSC); the other projects state

Box 4.5 The uptake of project MPTs by farmers

The uptake of project MPTs by farmers has been higher than expected. Possible explanations include:

- Malawian farmers' increasing concern about soil fertility – MPTs offer an alternative source of fertiliser (this is the principal message of most extension projects).
- The flexibility of some projects (AAM Malawi, CSC and MAFEP) in their approach, which has included responding to farmers' species preferences (e.g. the addition of poles and fuelwood species to the MPT programme).
- The projects' requirement that farmers take up the agroforestry technology in order to receive other project benefits, such as credit (AAM and ICRAF–Malawi) or food donations (ADDFOOD).

that they are aware of women's role in the farming system. MAFEP tries to persuade all farmers in a selected water catchment to try the MPT technologies, but it also supports individual farmers outside these selected catchment areas if they express a wish to experiment with the project's agroforestry systems.

MPT extension advice provided by projects

The projects maintain that all farmers in the project programmes receive extension advice on soil preparation, planting, seed treatment, direct seeding, management of the trees and pruning. All the projects base their recommendations on the MAFEP and NART recommendations for agroforestry practice in Malawi, which take the form of a menu of options based on currently available information. Modifications will be made as new research results appear. Farmers who had received MPTs from the government extensionists had not received any advice from them on recommended practices.

5
Sri Lanka

Farming System

Sri Lanka can be divided broadly into three agro-ecological zones. Rainfall is monsoonal and ranges from well over 2000mm/yr in the wet zone to 700mm/yr in the dry zone. It averages some 1,000–1,200mm/yr in the intermediate zone. The annual temperature range is 17–30°C, and the main daily temperature for Kandy, the hill capital, is 24°C.

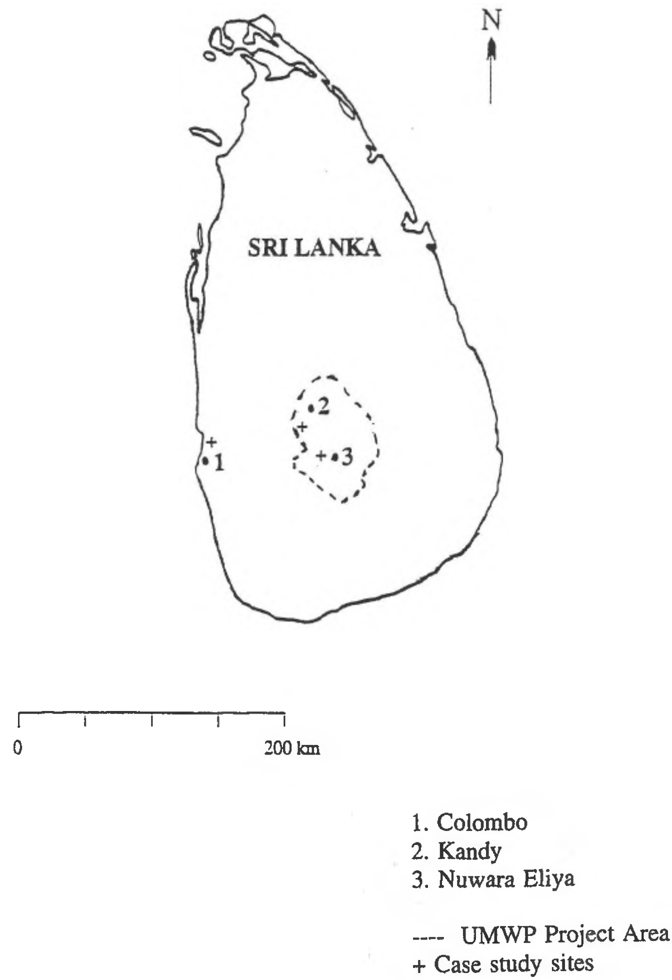
The research survey was conducted amongst farmers in Kandy and Nuwara Eliya districts in the central and southern hill country of Sri Lanka (400–2,000 m.a.s.l.) (Map 5.1). This area was selected because much of the project MPT work in Sri Lanka is being conducted in conjunction with colonisation schemes established on degraded uplands following the evacuation of parts of the Upper Mahaweli river valley for dam and reservoir construction in the late 1970s. The ODI research team consulted farmers in the wet and intermediate zones.

The traditional Sri Lankan farming system is based on the cultivation of rice paddy on imperfectly drained soils, in conjunction with mixed cropping on freer drained soils. Nineteenth century colonialists introduced plantation farming of tea, coffee, cocoa and rubber to the hill country, and these cash crops still play an important role in smallholder farming. Tobacco is an important smallholder cash crop in the intermediate zone.

Farmers evacuated from land flooded for reservoir development were resettled by the State on land which is marginal for economic production of tea. Land allocations were often on severe slopes (>20%) which had become degraded due to previous poor cultivation practices and concurrent erosion. New settlers were advised to grow cash crops such as coffee and pepper as well as subsistence crops. Paddy rice did not form part of the farming system in the allocated lands in the uplands. As part of the resettlement package, MPTs were introduced as part of a soil conservation strategy. Thus farmers perceive MPT hedgerows as a means of rehabilitating degraded land for tea cultivation.

Land holdings are typically between 0.25–1.0 ha in the settlement areas. Established farms support a variety of crops including tea, pepper, banana, mango, coconut and jak (*Artocarpus heterophyllus*). Plots that have been colonised more recently are planted with seasonal vegetables such as beans for rapid income generation.

Map 5.1: Location of case study sites in Sri Lanka



Outside the settlement areas, MPTs have been introduced for soil conservation in tea, tobacco and vegetables, and soil amelioration in coconut and seasonal crops, such as pulses.

Cattle and goats are present, but not on all farms. Some cattle are stall-fed but most are grazed on tethers both on and off-farm. Draft buffalo are maintained by some small farmers growing paddy.

Government Policy on Forestry and Agroforestry

The Sri Lanka Forestry Department does not currently have an MPT programme. Government forestry sector policy is in the process of being reviewed. According to a draft revised policy statement, the state 'will promote sustainable agriculture, animal husbandry, and agro-forestry systems in rainfed areas' (Forestry Department, 1994). Strategies for achieving this include:

- improving security of land and tree tenure;
- providing tax remissions;
- soft loans;
- provision of high quality planting material at cost or subsidised prices;
- removal of disincentives for tree growing;
- relaxation of restrictions on felling and transport;
- provision of technical assistance.

Specific objectives that relate to agroforestry include:

- the promotion of tree growing on homesteads and other private farmlands, in recognition of the importance of tree growing on non-forest land;
- the promotion of private tree growing in buffer zones and environmentally sensitive areas;
- encouraging most national needs for forest-based products to be met from domestic sources.

In addition, appropriate government, university and other research organisations will be encouraged to carry out and promote research and provide extension services to increase the productivity of existing agroforestry systems, 'paying special attention to multipurpose trees and conservation farming methods' (ibid, p.5).

Promotion of Multipurpose Trees in Sri Lanka

MPT Promotion Projects

Seven organisations promoting MPTs were interviewed for this study: five are development projects and two are commercial companies (see Table 5.1).

The projects visited have a wide range of objectives and aims, although soil conservation and improving agricultural incomes of resource-poor farmers are central themes to all of them. UMWP activities are implemented directly with farmers and more widely through the provision of training and resources to more than 25 implementing agencies, e.g. Hadabima Authority of Sri Lanka (HASL), Ceylon Tobacco Company Ltd (CTC) and the Tea Estate Management Group (TEMG). The projects serve over 4,000 families (UMWP 3,600; PMHE 600) and cover an area greater than 3,000km^2 (UMWP 3,000km^2; HASL 14km^2; CTC 35km^2; TEMG 35km^2).

One company (TEMG) does not target small farmers specifically, but sees a future role in assistance to tea smallholders. TEMG manages tea, rubber and other plantation crops within the area visited and also assists UMWP in seed multiplication.

Table 5.1 Projects interviewed for the survey

Project	*NGO/GO/IO*	*Activity*
Upper Mahaweli Watershed Project (UMWP)	bilateral	development
Hadabima Authority of Sri Lanka (HASL)	GO	development
Nuwara Eliya Integrated Rural Development Project (IRDP)	bilateral	development
Promoting Multi-functional Household Environments (PMHE)	NGO	development
CARE	NGO	development
Ceylon Tobacco Company Ltd (CTC)	independent	commerce
Aitken-Spence Tea Estate Management Group (TEMG)	independent	commerce

NGO=Nongovernmental Organisation, GO=Government Organisation, IO=Independent Organisation.

Project rationale for MPT promotion

The projects visited are promoting MPTs as part of an agroforestry system, Sloping Agricultural Land Technology (SALT), the use of which has been pioneered by UMWP. Project MPTs are established as contoured hedgerows as a means of conserving the soil and improving soil organic matter, with green manure, so that a range of crops can be grown. Projects promote the use of *G. sepium* primarily as part of the SALT package (see Box 5.1).

Other functions for which MPTs are promoted are micro-climate enhancement (PMHE), shading of tea (CARE, TEMG), and soil nutrient improvement in tea (TEMG) and coconut (CRI) plantations. The UMWP also promotes the integration of livestock on farms with MPT hedges to provide dry season fodder.

Box 5.1 Sloping Agricultural Land Techonology (SALT) in Sri Lanka

SALT, originally developed in the Philippines (Tacio, 1991), is a set of technologies that involves the planting of MPTs as contour hedgerows in cultivated land, to conserve soil and generate leaf mulch or fodder.

In Sri Lanka, SALT is principally targeted at tobacco small-holders, and families who were moved from areas affected by hydro-electric dam and reservoir construction and who were resettled in colonisation schemes on degraded lands (Nuberg and Evans, 1993).

SALT involves close planting of MPT cuttings in two rows on the contour to form hedgerows as a means of biological erosion control on sloping lands. Hedgerows require regular pruning for maintenance and these loppings can be used for leaf mulch to maintain soil fertility and to reduce soil erosion.

SALT is also applied on much flatter land (<5% slope) in the dry zone where the hedgerows act as windbreaks and increase micro-climate humidity, and the leaf mulch improves rainwater infiltration and soil fertility.

As SALT technology has developed into various forms based on components of crop, livestock and fuelwood systems, it has become important to include species other than *G. sepium* in order to cater for other functions and characteristics e.g. fruits and timber. Two projects (PMHE, IRDP) are testing mixed species hedgerows, to avoid the risks of complete hedgerow failure due to drought or pest attack.

G. sepium is the principal, although not the only, project MPT. This is because it is widely available (it was first introduced in the late eighteenth century) and is multi-functional in terms of providing shade, fodder, fuelwood, green manure and fast-growth within SALT. *G. sepium* has been promoted in both annual and perennial cropping systems in all three agro-ecological zones of Sri Lanka (wet, dry and intermediate) to improve soil organic matter content and soil moisture.

Other MPTs are being tested for their performance in specific agro-ecological conditions (see Box 5.2) but none is widely available to farmers as yet. On the whole, projects perceive that *G. sepium* is the most appropriate species to use at the present time. UMWP staff stated that introduction of different provenances to field situations was of a lesser priority than performance evaluations of different species under various agro-ecological conditions.

MPT species promoted by projects

Projects in Sri Lanka promote a selection of MPTs. Of these, the naturalised *Gliricidia sepium* is the most widely promoted, because it is widely available and grows in a range of agro-ecological zones. Exotic species include: *Acacia auriculiformis, Alnus acuminata, Alnus nepalensis, Calliandra calothyrsus, Casuarina cunninghamiana, Crotalaria* sp., *Flemingia congesta, Inga edulis, Leucaena leucocephala* and *Cassia spectabilis*. Projects also promote a number of indigenous species including *Erythrina lithosperma,* and the exotic multi-purpose shrubs *Desmodium rensonii* and *Tephrosia vogelii.*

G. sepium has been promoted in preference to *L. leucocephala* because of the latter's psyllid problems and because *G. sepium* is already widely available in Sri Lanka.

Interest in establishing species such as *C. calothyrsus, F. congesta* and *D. rensonii* from seed has come about because *G. sepium* performance is reduced at altitudes over 1,500 metres. *G. sepium* seed is not widely available and trees established with cuttings suffer during the dry season due to poor root development. *C. calothyrsus* is being promoted as an alternative species to *G. sepium* over 1,500 metres, and is reported to perform well up to 1,800 metres (Stewart, *pers. comm*). The UMWP recently imported 400kg of *C. calothyrsus* seed (of unknown genetic quality) from Indonesia (Simons, *pers. comm.*).

Acacia auriculiformis and *Tephrosia vogelii* have been tested with disappointing results (UMWP). Other species under test are *Alnus nepalensis, Alnus acuminata* and *Casuarina cunninghamiana*. The naturalised Mexican sunflower, *Tithonia diversifolia,* has been promoted as a

Box 5.2 An example of a project MPT species evaluation in Sri Lanka

PMHE ranks the MPTs it is testing in the dry zone as follows:

- *Flemingia congesta* is the preferred MPT as its loppings decay most slowly and are therefore valuable as a mulch. However, it is susceptible to drought and a grain borer which defoliates the tree in the dry season.

- *Gliricidia sepium* is the next preferred MPT species. However, it does not self-seed easily and parrots eat the pods.

- *Desmodium rensonii* is ranked third. It is very drought resistant but it is susceptible to blister beetle, which affects seeding by attacking the flowers. It also harbours yellow mosaic virus which harms various food crops, and is intolerant of water logging.

- *Leucaena leucocephala* is ranked last. It is intolerant of water logging, susceptible to psyllid attack, and it does not tolerate acid soils.

Source: R.Mulleriyaawa, PMHE, *pers comm.*

hedgerow plant by UMWP and PMHE, although many farmers regard this plant as a common crop weed.

Project MPT germplasm sources

Promotion of SALT by UMWP has created a demand for germplasm amongst other projects. Projects obtain *G. sepium* as cuttings from material which is generally readily available to farmers locally or can be transported from further afield with project assistance. *G. sepium* seed is not generally available due to a number of factors (poor seed set; fungal attack in humid areas; pod shattering; bird predation in dry areas). The lack of seed has not been an issue with farmers since cuttings are a convenient form of planting material for establishing hedges quickly, particularly when these attract incentive payments (CTC, UMWP). Projects do not dictate any tree selection criteria when cuttings are collected.

Although there are provenance trials for *G. sepium* in Sri Lanka, the selected material from these trials is multiplied up only for research establishments' use, and at the time of the ODI MPT survey UMWP anticipated that their own provenance samples of *G. sepium* and *C.*

calothyrsus would not be available for testing in the field for a further eighteen months. Projects would have to be very dissatisfied with the locally available *G. sepium* before they would go to the expense of purchasing commercial seed; there is no evidence that they are dissatisfied at present.

Projects source seed for species other than *G. sepium* from UMWP and may continue to use UMWP as a supplier. UMWP now gives priority for seed distribution to those projects who want seed for multiplication to establish their own seed stands.

UMWP estimate that only about 10% of SALT hedgerows have been established from introduced seed. UMWP has experienced problems acquiring selected seed of *F. congesta* and *D. rensonii*. However, selected material for other species has been obtained from OFI (*C. calothyrsus, Acacia angustissima*), CSIRO (*Acacia auriculiformis*) and NFTA (*C. calothyrsus, L. leucocephala*).

Whilst many of the projects are experimenting with a range of MPT material, none of the germplasm that is distributed to farmers is from selected provenances. Non-selected MPT planting material is available commercially and has been purchased periodically by UMWP, but other projects stated that prices were too high for germplasm to be obtained in this way. Additionally, projects are concerned about the quality and timeliness of arrival of imported seed.

Projects are aware that germplasm from UMWP is not from selected sources. Staff are also aware that their knowledge of technical forest genetic issues, such as tree selection, maintenance of genetic integrity and provenance variation, is limited. If different *G. sepium* provenances were available, UMWP stated that cuttings banks could be established but that distribution of this improved germplasm would be bulky and difficult to regulate. There would also be a need to make farmers aware of the issues involved where improved germplasm could cross-pollinate with local landraces.

Project demand for MPT germplasm

The amount of seed requested from UMWP has increased over the years, due to the promotion of SALT by the project. Demand for UMWP MPTs has been high in the private sector (CTC, TEMG) but uptake has been less strong amongst the government extension services (e.g. Tea Smallholder Development Authority, Silk Authority, Department of Export Agriculture) since these agencies are crop-oriented and lack resources for additional tree-orientated activities. In general, a demand has not yet been created amongst farmers for many species of project MPTs, except in small areas where projects have had a high input.

Some projects (PMHE, CTC, HASL) state that their work with MPTs is constrained by the limited availability of planting material, particularly of seeds. IRDP required improved material. There was a requirement for more technical information (UMWP, IRDP, TEMG). UMWP expressed a wish for a number of species for provenance testing. There was also recognition of a need for collaboration between tree improvement programmes and projects. UMWP stated that the distribution of MPT planting material in Sri Lanka needed to be streamlined and commercialised in order that demand could be met.

Project MPT germplasm multiplication methods

Some projects (UMWP, PMHE, CTC, TEMG) are attempting to multiply seed, e.g. *C. calothyrsus*, and *F. congesta*, on a small scale on project land. TEMG have co-operated with UMWP on seed multiplication by providing land and management for seed stands, and by packaging seed for UMWP.

UMWP and IRDP have seed multiplication schemes with local farmers. Projects distribute seed of *C. calothyrsus*, *D. rensonii* and *F. congesta* to farmers to establish as seed stands. UMWP asks farmers to harvest seed which has reached at least 75% maturity. This is then sun dried and cleaned at the collection point. Specific mother trees are not identified for seed collection. UMWP buy the collected seed from the farmers; this scheme has certainly encouraged uptake of *C. calothyrsus* as an alternative to *G. sepium*. UMWP records show that in 1994 about 50kg of *C. calothyrsus* was collected by farmers from their seed stands and individual trees in SALT hedgerows, and 20kg of *D. rensonii* seed and 250kg of *F. congesta* was collected from project seed stands. Locally-collected seed is brought to a cold store in hessian bags, where it is cleaned, weighed and sealed in plastic bags. Seed labelling appears to be a problem: many packets are not dated and others are marked with non-permanent markers. There are no records of germination tests being carried out. *F. congesta* and *D. rensonii* seed produced by UMWP in 1993 was reported as having poor viability. Problems with germination were attributed to nursery staff failing to carry out pre-germination treatments to break dormancy. UMWP recognises that its seed collection methods are not rigorous. However, staff state that *C. calothyrsus* provenances will be kept in isolation for seed production.

IRDP also collects sun-dried seed from contact farmers, paying their labour costs and encouraging them to sell material raised in their own nurseries to neighbouring farmers. IRDP farmers select seed from those mother trees with the 'best performance' although this is not clearly defined. IRDP contact farmers store seed in a traditional way i.e. seed is sun-dried on mats and then put into polythene bags with insect repellent leaves such as lemon grass. The bags are stored in the ceiling space above the kitchen fire.

In most cases the mortality of *G. sepium* cuttings appears to be low, although there is some evidence of the need to improve knowledge of cutting selection (stage of growth, thickness, length) and planting (depth), in order to optimise hedgerow establishment.

Project MPT evaluation systems

In 1978/88 UMWP carried out baseline surveys and community workshops to determine farmers' needs. Farmers' concern about declining yields was interpreted as a need for soil conservation. As Sri Lankan farmers already use live fences, and practise lopping and mulching, the SALT hedgerow technique was considered to be an appropriate technology to promote. UMWP staff also carried out an informal survey in 1991 to assess farmers' needs for particular tree species and to detail those species available locally.

More recently, PHME has surveyed farmers about the importance of trees in the farming system and IRDP has assessed the availability of local planting material. Other than this, projects have not formally elicited farmers' opinions on the introduction of MPTs to cultivated land.

No project had formalised procedures for evaluating MPTs under farm conditions. Farmers receiving planting material from UMWP nurseries are required to register so that follow-up is possible. However, there is no formal system for obtaining feedback. Neither does IRDP operate formal feedback systems; instead it obtains feedback in the field from contact farmers, on whom it relies to follow up other farmers in each local group. Project staff felt that MPT work was constrained by a lack of field staff.

MPT germplasm suppliers

UMWP is the main supplier of MPT planting material to its implementing agencies, and to other projects. UMWP has obtained seed in a number of ways: from SALT workshops at Mindanao, Philippines; commercial purchases of non-selected material; local seed collections; and from overseas institutions such as OFI, NFTA and CSIRO.

According to UMWP, the distribution system currently used by its agencies succeeds in supplying healthy germplasm to farmers, and the establishment of local nurseries has cut down on transport costs. At the time of the ODI survey, UMWP was making plans to export MPT seed. UMWP argues that Sri Lanka has a range of agro-ecological zones in which MPT seed could be produced and states that Sri Lanka already has a suitable infrastructure for seed production, marketing and distribution. It is not clear whether the project will be targeting a known demand outside Sri Lanka but exploiting overseas markets will require particular attention to seed selection, handling, storage and certification.

National Forestry Research Activities relating to MPTs

The function and performance of MPTs in different farming systems is being evaluated by a number of institutions in Sri Lanka. Those consulted for this study were: the Faculty of Agriculture, University of Peradeniya (UP); the Coconut Research Institute; the Tea Research Institute; and the Institute of Fundamental Studies.

The University of Peradeniya, through a link project with OFI, has established a number of provenance trials for various MPT species: *Azadirachta indica, C. calothyrsus, Casuarina esquisetifolia, G. sepium* and *L. diversifolia* complex to name but a few. This programme started in 1989, although the University initiated some work with *Acacia* and *Leucaena* in 1986. The University also hosts the annual regional MPT workshop, in which staff from UMWP and academic institutions participate.

None of the research projects provide or distribute germplasm to projects promoting MPTs for on-farm use.

Trees on Farms

Farmers in Sri Lanka have a long tradition of integrating crops and trees. Traditional and introduced agroforestry systems include shifting or *chena* cultivation, taungya system[14], Kandyan forest gardens, alley cropping, and intercropping of coconut and shade trees in tea, coffee and cocoa (Nanayakkara, 1993). Traditional agroforestry species found on-farm include *Artocarpus heterophyllus, Cocos nucifera, Mangifera indica* and *Gliricidia sepium*. *G. sepium* was introduced to Sri Lanka in the late 1700's, as a shade tree in tea estates, and it is now viewed by many farmers as indigenous. The first recorded introductions were made from Trinidad,

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[14] A system developed in the late nineteenth century, whereby farmers maintain at the same time permanent crop fields in the villages and small-scale plantations of teak and bamboo in the forests.

purportedly from seed of one tree (Hughes, 1987). Local landraces are likely to have a narrow genetic base (Simons and Stewart, 1994).

Farmers visited for this survey identified tea (*Camellia sinensis*) as the most important tree on-farm as it provides a saleable crop. Other important trees on-farm are *Artocarpus heterophyllus*, *Cocos nucifera*, and *Musa* sp. for their fruit and timber (depending on the species). Project MPTs (principally *C. calothyrsus*) are considered important for their seed crop.

The Role of Multipurpose Trees in the Farming System

Role of traditional farmer MPTs

Farmers perceive that most tree species have a number of functions and that any tree could be described as multipurpose. However farmers state that provision of a saleable end product is an important requirement for trees grown on-farm.

The tree species most frequently mentioned by farmers as having multiple functions was *G. sepium*, principally for its use as fencing, fuelwood, fodder, leaf mulch, poles, shade and as a support host for black pepper.

Farmers consulted for this study vocalised their preferences for different trees solely in terms of the functions they fulfilled; growth characteristics were infrequently commented upon. Neither the naturalised *G. sepium* nor the exotic *C. calothyrsus* are seen by farmers as truly 'multipurpose', principally because neither has a saleable end product.

The role of Project MPTs on farm

Farmers establish project MPTs on their farm principally (but not exclusively) for one of two reasons: for the establishment of hedgerows under SALT; or for the establishment of seed stands for seed production.

G. sepium is commonly promoted by projects as the MPT to establish in hedgerows for SALT. The central function of the MPT in this case is for soil conservation and leaf mulch. When questioned about its role in the farming system, interviewees repeated what they had been taught, viz. that the MPT is 'good for the soil', i.e. the trees fix nitrogen. Few had been shown any scientific evidence for this claim or appreciated nodulation.

Farmers mentioned other functions of project MPTs in SALT as being fuelwood and fodder, but suggested the latter is not exploited. Farmers who collect fuelwood from their SALT hedgerows let the hedges grow tall to provide poles: this conflicts with correct maintenance of SALT[15]. Some farmers also express preferences for other fuelwood species. As regards fodder, many families in the areas surveyed do not have livestock so this function is not important[16]. In fact, farmers suggest that the presence of *G. sepium* or other fodder trees on-farm act merely as an attraction to the wandering livestock of other farmers and, therefore, as a disincentive for planting this species.

There was some evidence that SALT hedgerows are perceived as a means of colonising and rehabilitating land so that tea can be re-established in order to earn regular income (the irony being that it was poor management of tea that brought about land degradation in the first place). Most farmers with small land holdings want an economic product from the trees they grow on-farm, but present project MPTs do not provide this. UMWP and IRDP have recognised this and are now looking to improve the economic performance of SALT hedgerows by using them to support crops such as wingbean (IRDP) and high-value spices such as vanilla (UMWP).

No farmers visited had increased the area of hedgerows on their farms once the project incentive payment scheme (see p.64) was withdrawn. As hedgerows need time to establish and require regular maintenance in order to be effective barriers to soil erosion, many farmers appear to need further evidence of the long-term benefits of SALT before embarking on further hedgerow planting.

Given the recent introduction of SALT, it is perhaps not surprising that interviewees found it difficult to articulate an evaluation of the available project MPTs in terms of functions and characteristics: at the most, hedgerows have been on-farm for 4 years, so farmers have had little real evidence of improvements in soil fertility and moisture relations as yet. Since regular lopping of hedgerows is a necessary component of SALT, some characteristics of individual trees, such as branching habit, early maturity, etc., will not in any case be apparent to farmers.

Farmers also managed project MPTs, namely *C. calothyrsus*, on-farm for seed production. Projects provide farmers with a secure market for the

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[15] Correct maintenance of SALT requires frequent lopping to reduce shading and to provide material for beating up gaps within hedges. Domestic requirements for fuel may also conflict with the long-term application of mulches to the soil.

[16] For those households that do have livestock, Fledderman (1992) has stated that dependence upon off-farm fodder resources, particularly grasses, is high and that these are only insufficient during the dry months, when tree leaves replace grass in the livestock diet.

seed produced, although the life span of the projects is limited. Farmers recognise that project MPTs grown for seed also fulfil other functions such as fuelwood, fodder and soil enhancement.

During the study some social concerns were apparent which have implications for the uptake of project MPTs, and for farmers' overall self-reliance in the long term (see Box 5.3).

Sources of MPT germplasm

For farmer MPTs

For species where the end-product is important, e.g. fruit, seedlings are raised from fruits consumed domestically. For *Artocarpus heterophyllus*, farmers have selected material as seeds or wildlings from their preferred variety and have found that it does not breed true[17].

Wildlings of other species are collected from neighbours, relatives or forest areas but these often face high mortality rates, as a result of the selection of over-sized seedlings which are less likely to survive uprooting and transportation. Settlers also return to their former villages and bring back species which may not be appropriate for the agro-ecological zone in the settlement areas.

For *G. sepium*, farmers frequently obtain cuttings from locally available material both on- and off-farm. There exists some exchange of material between neighbours, but there is little evidence of community mechanisms of germplasm supply and exchange. One thing that may contribute to this is the fact that colonisation programmes have disrupted traditional social organisation by displacing people and introducing families from different social backgrounds and areas into new communities. Thus the settlement schemes with which some projects (UMWP, HASL, PMHE) are working are a special case; dissociated from family ties and social norms, the new communities lack traditional leaders and social cohesion. Clearly, this has implications for the neighbourly relations upon which traditional systems of tree germplasm exchange depend.

In general, local non-selected *G. sepium* material appears to be performing satisfactorily under a variety of agro-ecological conditions. There is no evidence that farmers have knowledge of different provenances of the local *G. sepium* landrace and, since propagation

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[17] *Artocarpus heterophyllus* is monoecious and although self pollination is possible, via flies, self fertilisation is prevented by self-incompatibility. Therefore the genotype of any progeny will be represented 50% by the mother genes and 50% by the unknown father. Therefore the likelihood of progeny 'breeding true' is small.

Box 5.3 Social issues influencing the uptake of project MPTs by farmers in Sri Lanka

- Regardless of previous occupation, settlers are allocated land on the basis that they will be earning their income from agriculture. In practice, many settlers had not had previous experience of farming, a nd the poor quality of the allocated land has worked against the effo rts of those settlers with an agricultural background.

- Whilst homesteads and agricultural crops are being established, settle rs need to generate income off-farm, from paid labour or small business. This practice tends to persist after crops have become established, as returns to agriculture are poor and fall even lower on ce the farm has been allocated second priority in terms of time, input s and management.

- Many settlers were previously landless or otherwise resource-poor, particularly in terms of assets and education. Their priority, therefore, is for short-term economic gain, and efforts directed at long-term land conservation with no visible economic gain in the short-term are of lower priority.

- Farmers' interest in maintaining project MPTs for long-term soil conservation is limited as many leave their land fallow during the off-season, regardless of the wind and rain erosion that may result;

- The practice of letting livestock browse at will during the off-season means that, where MPTs are planted, immature hedges run the risk of being destroyed by browsing livestock;

- Landlords can see an economic advantage in establishing SALT on th eir land cheaply by using lessee-labour rather than hired labour. Therefore lessees who have planted SALT hedgerows at the behest of CTC run the risk of losing their improved land to the landlord on expiry of their short-term lease.

appears to be almost entirely through cuttings from a narrow genetic base, genetic variation is likely to be extremely limited. Farmers do appear to recognise genetic variation and select for it in *Artocarpus heterophyllus* (Wickramasinghe, 1992), but this study did not identify any examples of farmer tree selection for desired characteristics.

For project MPTs

Farmers growing project MPTs under SALT or for seed production obtain germplasm via projects in the form of cuttings (*G. sepium*), seed (*F. congesta*) and seedlings (*C. calothyrsus, C. spectabilis*). Projects distribute both seed and seedlings, but favour direct seeding of SALT hedgerows in dry or windy areas, or where shallow-rooted cuttings compete with seasonal crops. One project (IRDP) claims that farmers express no preference as to the form of germplasm distributed. Provision of seed reduces project costs in terms of nursery care, but farmers are generally not familiar with raising MPTs from seedlings, nor with direct sowing methods of establishing SALT hedgerows.

The amount of germplasm farmers receive varies between projects. UMWP distributes around 250 seedlings of *C. calothyrsus* per farmer for seed production.

Projects supply MPT and other germplasm free of charge to farmers in target communities, with the aim of rehabilitating the land and providing income-generating trees as a package to colonise land in settlement areas. In addition, UMWP, CTC and HASL make incentive payments to farmers to establish SALT hedgerows on their land. In the past UMWP distributed all germplasm free to its implementing agencies, but it is now asking them to pay. None of the projects visited distribute inoculant. UMWP considers inoculant is not the answer to enhancing nitrogen fixation as there are doubts as to the effectiveness of nitrogen fixation in the acidic soils of the project area.

Where projects are actively implementing their programmes, local offices that distribute germplasm are set up to service the target communities. In general, these are within a few kilometres of all target farmers. However, where local offices have closed down after a fixed period of implementation activities (HASL), farmers complain that they then have no means of accessing germplasm and advice. One project (IRDP) stated that their programme of targeting farmer groups through a number of contact farmers was the only feasible means of distributing germplasm. IRDP instructs its contact farmers on how to propagate the material they receive and distribute it on to other farmers.

Projects supply *G. sepium* cuttings to farmers establishing SALT when there are no locally available sources of cuttings. One project (CTC) relies on farmers making their own cuttings and, if material is transported to the farm, costs are deducted from the farmer's incentive payment.

UMWP has a central tree nursery at Lewella which can supply over 50 different species of tree as seedlings. There are also six local nurseries established in the UMWP areas which supply farmers with seeds and seedlings. Local nurseries have been established on the private land of individuals who are interested in utilising and multiplying trees. UMWP hopes that an internal market for MPT germplasm will develop, as support from the Mahaweli authorities cannot be guaranteed after 1997. UMWP estimates that the project's nurseries produce more than 400,000 seedlings annually, but only three field officers are assigned to co-ordinate nursery and agricultural activities.

UMWP has trained other agencies to start their own nurseries but has been disappointed by the lack of action on their part as yet. UMWP is in the process of producing seed handling leaflets for each species, targeted at seed multipliers and nurseries. In addition, extension leaflets are being translated into Sinhala for farmers.

None of the projects visited have formally collected any information on farmers' traditional ways of collecting and multiplying tree germplasm. Staff made the point that in relatively new settlements there is no traditional distribution system as such, although germplasm does get introduced to farms from forest areas or neighbours' plots.

One project (PMHE) has studied propagation practices amongst settlers in the dry zone (Wilson, 1993). The project states that farmers collect wildlings from the forest and bring germplasm from their former villages, and that there is some exchange of material between neighbours.

MPT extension advice provided by projects

Amongst the UMWP agencies, the extension system is fairly informal, excepting CTC who have succeeded in establishing SALT hedgerows on 3,000 ha out of the target area of 3,500ha. This would appear to be due to the company's incentive payment system and management style. UMWP have experienced difficulties in getting small farmers to follow extension recommendations, partly because many settler farmers are only part-time and do not have a full commitment to soil conservation.

6
Conclusions

The overall research findings reveal that of the two study hypotheses, one remains uncertain, whilst the other was proven. The hypothesis that the MPT germplasm that is currently available does not provide the functions and characteristics desired by farmers for such tree species was neither proven nor refuted by our research. The hypothesis that the current mechanisms by which farmers obtain germplasm for MPTs are not as effective as they could be was confirmed. Four main problem areas emerged:

- MPT planting material is often distributed in a form that is not familiar to farmers (for example, as seeds in areas where farmers traditionally use seedlings) and farmers often have little practical knowledge of artificial tree establishment using cultivated seedlings as other methods, such as use of natural regeneration or transplanting of wildlings, are more traditional:
- farmers are often not told about how they can get further supplies of MPT planting material, after the initial distribution;
- farmers are often not clear about how to manage the planting material once they receive it;
- and few projects have investigated whether or not there is potential for distributing MPT planting material through farmers' traditional channels for collecting and multiplying tree germplasm.

The rest of the discussion in this chapter deals with the findings concerning the four research objectives.

Factors Influencing Farmers' Decisions to Grow MPTs

This pilot research considers twenty-six projects and research organisations contacted during case studies in three countries in which MPT germplasm management was examined. The research, supported with additional information gathered from thirty-nine farmer interviews, demonstrates clearly that projects and research organisations promoting MPTs have done little to investigate farmer genetic resource management in relation to trees on-farm, while at the same time they have promoted the use of various MPTs for on-farm use.

Farmers' own choices in tree species and management are determined by their needs and resource constraints: farm/family labour profiles; local species diversity; access to off-farm tree resources; availability of non-tree product alternatives. Simplified assessment of farmer tree usage will not reflect all farmer needs. Similarly, farmers' present day tree species profile may not necessarily reflect their tree species preferences. Farmer tree needs and use are site-specific and at present projects have not addressed this issue completely.

Access to off-farm tree sources is also important in determining tree management on-farm, and is highly site-specific. In the case study countries, non-tree alternatives for soil enhancement may not be available to farmers due to the absence of sufficient number of large farm animals and the relatively high cost of fertiliser.

Farmers nurture and manage trees on-farm to fulfil a range of aims: timber, fruit, fuelwood, fencing and shade. However, the research found that farmers do not conceptualise trees in terms of functions and characteristics in the way that researchers do. More in-depth research is needed to determine what tree attributes farmers appreciate, especially if MPTs are to be improved for particular functions or characteristics.

Trees on-farm are typically managed by farmers to obtain a combination of end products. Projects need to consider how to balance the promotion of MPTs for single and multiple functions. Although a single function such as soil enhancement is important because there are limited substitutes, its promotion as the sole function of an MPT may well conflict with farmers' own tree-growing objectives.

Projects urgently need to re-consider the present selection of tree species being promoted primarily for soil enhancement. In the apparent absence of rigorous international evidence that these species can provide a significant difference to crop yields on farm, continued promotion of them must also be questioned.

Extent to Which the Available Project MPTs Provide the Functions and Characteristics Desired by Farmers

The research finding that most projects have not carried out surveys to investigate farmers' on-farm tree needs is disturbing. Some projects have conducted participatory *problem* identification exercises with farmers, where declining soil fertility was identified as a major problem facing farmers. However, the identification of appropriate *solutions* has been project-led.

Although trees are not of the highest priority for improving standards of living, farmers are adopting project MPTs and the agroforestry systems that projects promote. The research suggests that farmers are adopting project MPTs for a variety of reasons including the following:

- Effective extension messages encouraging farmers to take up MPTs and agroforestry systems.
- Farmer trust in outside interventions. Since most projects have been promoting MPTs for a relatively short period (up to 4 years), farmers have not had the opportunity to observe first-hand the effects of MPTs before they take them up.
- Incentives such as food, cash, employment, credit and training. Incentives are not always perceived by projects as influencing rates of technology adoption. However, it seems likely that they do.
- Some project MPTs meet the same needs as other trees traditionally grown on-farm. They may fill a niche where there are limited local tree germplasm sources, limited natural forest, or particular difficulties in propagating or growing locally desired tree species.

MPTs are established in a range of agroforestry and forestry systems. Where MPTs are promoted for alley cropping, there is a need to assess the role of MPTs in soil amelioration more objectively. The promotion of alley cropping is largely justified by simplistic problem-solution identification, with the solution hinging on the soil-enhancing abilities of the MPT. Although the appropriateness of alley cropping is currently being debated in research and project circles (see Box 4.1; Whittome, 1994; Carter, 1995; Sanchez, 1995), farmers are wholly unaware of this questioning of the technology. This should be addressed urgently.

The research also suggests that more attention is needed on certain specific issues related to the promotion of project MPTs, including the following:

- does farmer on-farm management of agroforestry systems provide the predicted yield benefits?
- what MPT species are appropriate for acid soils?
- what are the effects of non-nodulating MPTs on soil nitrogen?
- can present agroforestry systems contribute simultaneously to environmental conservation at the macro community level, whilst also providing tangible benefits to individual farmers?

Mechanisms by Which Farmers Obtain MPT Germplasm

An important research finding, supported by observations in other countries (Shanks and Carter, 1994), is that farmers do not commonly propagate their on-farm trees using seed. Natural regeneration is far more commonly used. The implication for projects promoting propagation methods other than those traditionally used is that they need to examine thoroughly the technological and social issues relating to any technology introduction. As the research illustrates, few projects dedicate resources to this type of investigation.

The study reveals only limited evidence of active local seed suppliers. In all cases farmers appear to have considerable knowledge of and ingenuity in propagating some species of trees on-farm. The presence of this knowledge, however, should not lead to the assumption that local knowledge exists or is applicable to project MPT propagation or multiplication.

In all cases projects decide the form in which MPTs are distributed (seed, seedling or cutting) without farmer consultation. Farmers were only consulted (to some extent) on species choice and the number of trees to be supplied.

Distributing MPT germplasm free of charge is used as an incentive for farmers to establish agroforestry systems. This raises doubts as to whether farmers will be willing to pay for MPT germplasm in the future. If they are not, projects may need to consider how best to distribute and multiply MPT germplasm to farmers on a long term basis. One way may be to investigate, work with and improve whatever systems farmers currently operate (see section on potential for organising the selection, multiplication and distribution of improved provenances of MPTs at community level, below).

The research found MPT germplasm supply to be very limited. Projects note that MPT seed from the formal sector is expensive in comparison to locally-collected germplasm. For these reasons, projects obtain MPT germplasm through local collections and, where this is not possible, through MPT germplasm suppliers, typically national seed banks.

On the whole, locally collected MPT germplasm is:

- of unknown genetic quality;
- collected with weak protocols;
- selected on 'timber tree ideotype' criteria.

MPT germplasm from selected and improved sources is in extremely limited supply. This is a result of:

- inadequate local seed stands;
- low demand, stemming from limited recognition by projects of the value of quality germplasm, and therefore unwillingness to pay the necessary premium for such seed.

At present, what material is available is used for germplasm multiplication and agroforestry research.

Projects that distribute MPT germplasm to farmers are often unaware of the genetic quality, and the provenance that they are distributing. Even when germplasm suppliers and projects have the necessary information they do not pass it on to farmers. Not only is this potentially wasteful of scarce resources, it also makes it very difficult to assess germplasm performance in the field for future acquisitions.

It is disturbing to find that projects and MPT germplasm suppliers can carry out germplasm acquisition and distribution in such an inappropriate manner. The research indicates that the principal cause is inadequate knowledge or appreciation amongst the field staff, technicians and administrators of these rural development projects that are promoting MPTs of the basic principles of genetic variation, and the importance of maintaining seed source records. Given the advances in recent years in understanding the importance of genetic variation, it is disappointing to find that these messages have not reached the field.

Potential for Organising the Selection, Multiplication and Distribution of Improved Provenances of MPTs at Community Level

In general, farmers are known to have a knowledge of genetic variation in plants, particularly economic crops (de Boef et al., 1994). The 3 case studies for our research recorded only a low level of farmer knowledge of genetic variation of trees on-farm, but this may well be more a result of the necessarily limited number of farmer interviews than farmers' lack of knowledge *per se*.

The research shows that the predominant method used by farmers for obtaining trees on-farm is through natural regeneration and farmer propagation from on-farm resources. Farmers infrequently acquire tree germplasm off-farm. Farmers' patterns of tree germplasm acquisition suggest that demand for any project promoted MPT will be higher in the short term than in the long term.

Ideally, community-based germplasm supply has the potential to provide farmers with MPT germplasm on a sustainable, self-reliant basis. Community-based schemes have potentially low costs and the scope for considerable local participation. Such schemes can provide farmers with the opportunity to observe MPT growth and performance and to receive project training. The schemes can also enable projects to distribute appropriate quantities of germplasm to target farmers as cheaply as possible.

Community-based germplasm supplies of project MPTs are 'introduced' technologies and, therefore, their level of sophistication and appropriateness will need to be assessed in social and technical terms. Field work suggests the need to consider the following:

- the most appropriate method of organisation, taking into account the differing reproductive biology of individual MPT species;
- the development of simple design protocols for germplasm multiplication and distribution;
- storage ability and need for seed treatment and inoculation;
- access to MPT germplasm will need to take into account *socio-economic* issues such as the economic value of the MPT germplasm, the community organisational structure, land and tree tenure, etc.

The research found that most project community-based ventures presently being carried out are in response to the present shortfall in MPT supply, rather than as part of a clear strategy to establish community-centred, sustainable tree seed supplies.

The research suggests that community-based germplasm supply will only fulfil a short-to-medium term niche in providing farmers with a source of germplasm for a particular species. Once farmers have the necessary germplasm on-farm, the source may become redundant (although there may be a demand for other introduced species). For this reason, projects establishing community-based schemes must consider the choice of genotype very carefully. Some improved/selected genotypes may provide specialist benefits, while other genotypes may provide more diverse attributes. Whatever the germplasm used, selection must be based on a thorough investigation of farmers' needs and the role of the targeted MPT in the farming system.

Key research implications

- A high priority should be placed by projects on investigating local on-farm tree needs as perceived by farmers. Without such information, researchers, germplasm suppliers and projects will continue to supply germplasm to meet assumed needs – which do not necessarily match actual needs.
- Solutions to farmer-identified problems, such as the use of MPTs to address declining soil fertility, should be analyzed and assessed in a more participatory and objective manner, so as to include farmers, projects and researchers.
- The limited implementation in the field of current knowledge about MPT genetic resource management should be addressed urgently. One mechanism for this would be the establishment of a support and training programme for project technical staff. This initiative could be led by a number of international forest genetic research organisations.
- Projects implementing community-based germplasm supplies need to re-think the rationale behind their present schemes, which in many cases appear to be short-term responses to project-determined goals. There is a need for a clear seed supply strategy. Important issues that community-based germplasm supply should consider include the nature of existing indigenous systems, the costs and benefits to the community of existing and potential germplasm supply systems, and the sustainability of those systems.

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Appendix 1

Checklist for MPT Project Interviews[18]

(For the main MPT dealt with by the project)

1. *Project Profile*

Name — Funder
Name of interviewee — Job title, location
Project aim
Project activities (main ones)
Target area
Target groups and no. of house holds (hh)
Date started working with MPTs
Summary of MPT activities
List of MPTs being used (species, provenance) and their major characteristics and functions (if not already known to you)

2. *Rationale For Distributing MPTs*

Why does the project distribute exotic MPTs rather than mpts? * Is it on the basis of detailed farmer surveys done to establish the species that would be most useful to farmers in terms of providing them with the *functions* and *characteristics* they need (explain these terms)? If so, detail no. of farmers surveyed, type of farmers (representative?), what questions asked (on ecology only, or also on function?), was survey conducted by project or was secondary information used?

- Or, is it on the *assumption* that MPTs would be useful? If so, is the assumption that MPTs will be useful to individual farmers, or that MPTs will be useful to the area in broad terms e.g. to stem environmental degradation.
- Or, is it because they were offered MPT planting material by an outside source? (if so, detail how this happened)

(If farmer survey results indicate that the MPTs currently available are *not* useful, present these results and get project's reaction).

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[18] MPT refers to project MPTs, mpt refers to farmer MPTs.

3. *Seed Sources*

Is the original source of the MPT seed distributed by the project known? (Name)

- If imported, there should be a Certificate of Origin detailing species, origin, date of collection, germination rate, seed treatment.
- If local, the seed should have been dried, cleaned, treated with insecticide, and labelled with species, provenance, collection date and name of collector.

If known, note name and location of breeder in sufficient detail to locate and interview them (whether in-country or international). If not known, try to get sufficient details to be able to work backwards to breeder (e.g. get name of government official who sent seed to project and ask them from whom they got seed, etc.).

Does the project know whether the material has been selected or not? (i.e. taken from elite trees or superior genotypes)

Advantages and disadvantages of current seed sources, according to the project.

4. *Seed Multiplication & Storage*

Does the project multiply source seed in a way that preserves genetic integrity? (Are they aware of the need to do this?)

- Collecting seed from a single mother tree kept in isolation, or taking cuttings, does preserve integrity.
- Collecting seed from stands of trees grown using seed from different sources does not preserve integrity.

(If used) In the project's opinion, what is the lifespan of community seed orchards/nurseries? Give reasons.

How much planting material can the project multiply up per year?

How does the project store seed?

- Germination tests should be carried out before storage. Seed should be put into labelled bags in cold room or well-ventilated place, in the shade, in sacks or drums.

5. *Seed Distribution System*

Does the project distribute planting material of numerous different provenances or only one?

- If MPTs are to be planted singly on farms, should distribute seed from one provenance only.
- If MPTs are to be grown in stands, hedges, etc., should distribute seed from many provenances, in order to preserve genetic diversity.

In what *form* does the project distribute planting material (seed, seedlings, cuttings, etc.)? Why?
(If farmer survey results indicate preference for an alternative form, present results and get project's reaction)

If the project distributes cuttings, rather than seed/seedlings, do they take any steps to avoid dangerous levels of genetic uniformity building up in MPTs in local area (which increases susceptibility to disease, etc.)? If so, give details.

Does the project have any formalised system for preserving the physical quality of the planting material as it is distributed?

(If needed) Does the project distribute inoculant with planting material?

What pack size/minimum no. of seedlings/cuttings and why?

What price? (Probe in detail if not sold for money e.g. for food-for-seed, etc.)
Does this cover the project costs of sourcing, multiplying, storing and distributing? If not, give details.

From where is planting material distributed? (no. and type of locations e.g. project HQ, local-level nurseries, local markets, government extension agents, contact farmers/farmer groups, etc.) (a sketch-map may help)

How far on average do farmers have to travel to obtain planting material?

Does the project give farmers instructions about how to get further planting material? If so, what? (To come back to project, to use only cuttings from initial handout, to save seed from initial handout)

How was the current distribution system decided upon? (were farmers' views taken into account?)

Why does the project not make greater use of traditional distribution systems?
(If farmer survey results suggest the traditional distribution system apparently has some clear advantage over the project system, present the results and get the project's reaction)

What extension advice does the project provide to farmers receiving MPTs?

- Should include time of planting, site preparation, care of seedlings, how to plant, soil protection and shading.

How much planting material has been distributed so far?

Is uptake of MPTs as high as expected? Why?

What type of farmers were intended to be the main recipients, and have been so in practice? (men, women, village leaders, better-resourced, poor)

Advantages and disadvantages of current distribution system, according to the project.

6. MPTs & Traditional Seed Systems

If the project has done any work with indigenous mpts, get details. Especially concerning project's view of advantages and disadvantages of species and available planting material, compared to exotic MPTs.

Why did the project start working with mpts? Current scope? Future plans?

Try to get detail on the selection and multiplication systems used. Does the project follow 'good practice' (as per Sections 3 and 4 above)?

Has the project collected any information about farmers' traditional systems for selecting, multiplying, storing and exchanging tree planting material (whether indigenous or exotic)? Get details, especially concerning project's view of advantages and disadvantages of traditional exchange systems.

7. Farmer Participation & Feed-back

Does the project have formalised systems for getting feedback from farmers on a) utility of current MPTs in terms of function and characteristics and b) utility of current distribution systems (ease of access, price, etc.)?

If so, describe (what forum: at nursery, at field days, other (specify); what staff member; system for using information thus obtained)
(If farmer survey results indicate that there are problems with a) or b), present these results and get project's reaction).

What is mortality rate of trees distributed? (try to get rough estimate if not known exactly)

8. Looking to the Future

Future plans
What does the project most need help with in strengthening its MPT work? (for example, better seed sources, help with designing more appropriate distribution system, more technical information to pass onto farmers, etc.)

With regard to its MPT activities, does the project get all the help it needs from the suppliers of its source seed, from the government farm forestry agencies, from the project funders? (give detail)

Anything else the project wishes to tell us?

Checklist for MPT Germplasm Suppliers and MPT Research Project Interviews

(For those MPTs mentioned in project interviews)

1. *Profile*

Name
Job title, location
List of MPTs working with (species, provenance)
Why did you become involved in MPT selection? (interested in trying to make better selections available, superiors requested it, funding available, high status activity, other)

2. *Provenance Selection*

For the MPT with which you are involved, rank the *functions* and *characteristics* for which you are selecting, in order of importance (establish whether yield and/or ideotype and/or economic end-use rank highly).

What is your rationale for this ranking? (Is it based on discussions with farmers? If so, give details of how these discussions were conducted: when, where, how many and what type of farmers, who asked the questions)
(If farmer survey results indicate that *functions* and *characteristics* other than those listed by the breeder are important to farmers, present these results and get breeder's reaction)

Describe the field methods used to select between provenances. Were farmers involved in the selection process? If yes, give details. If not, why not?

Do you think that it is important to maintain genetic diversity in the material selected, or that it is acceptable to use selection methods that narrow the genetic base?
(If farmer survey results indicate that the opposite is preferred by farmers, present these results and get the breeder's reaction).

(If breeder believes narrow genetic base is necessary but project interviews indicate that projects are distributing more than one provenance, present these results and get the breeder's reaction).

Do you think there should be greater collaboration between breeders working on the same species? If so, in your opinion why does this not happen and how could it be encouraged?

Why do you not work on indigenous mpts?

3. *Recommended Practices*

Describe the practices you would recommend for multiplying and storing seed at project level.

Do you think it is better, in terms of preserving the genetic integrity of provenances, for material to be distributed to farmers in the form of seed, seedlings, or cuttings?

Why?

If cuttings, do you believe there is a risk of creating dangerous levels of genetic uniformity in the trees grown on-farm? If not, why not.

Describe the on-farm cultivation practices you would recommend that farmers use to get best results from your material.

Have you tested how your material performs if these practices are not followed exactly? (This can be important: for example, for improved varieties of maize, each day's delay in planting reduces final yields by 3%)

Have you discussed your recommended seed multiplication, seed storage, and on-farm cultivation practices with projects?
If so, in what forum? (international conference, regional meeting, in the field with individual projects, other)

(If farmer and/or project interview results indicate that any of the above recommendations are unrealistic or unused, present these results and get the breeder's reaction)

4. *Blockages*

Do you think that there is a big demand for the currently available MPT selections?

How do you know? (assumption, discussions with project, farmer survey, other)
(If farmer and/or project interviews indicate otherwise, present these results and get breeder's reaction)

If project interviews indicate that there is a shortage of planting material to distribute, present these results and ask breeder what can be done, in her/his opinion, to overcome this. In particular, ask whether s/he considers that farmers could be used to multiply up material. If not, why not.
(If farmer survey results indicate that farmers have a considerable amount of expertise in selection, multiplication, storage, and exchange, present these results and get breeder's reaction)

[Any further questions arising out of farmer and/or project interviews] Especially, anything that the projects feel the breeders should be providing help with (as per Section 8 of Project Interviews).

What are the main problems hampering your own work?

In your opinion, what are the main problems hampering wider use of MPTs by farmers?

Anything else the breeder wishes to tell us.

Checklist for Farmer Interviews

(For the main mpt and MPT)

1. *Socio-economic Profile*

Interview no. Village

Relationship to hh head Sex Age

[plus any other details that define socio-economic status in local context e.g. credit recipient, holding size, etc.]

Needs for better standard of living

Tree ranking
1.
2.
3.

(Take note of the *functions* MPTs are designed to fulfil (poles, fuelwood, fodder, fencing, soil fertility). Ask farmers which trees they nurture for each of these functions. Identify the 3 species which fulfil the largest number of these functions)

2. *Factors Influencing Farmers' Decisions to Grow mpts*

(To be asked for mpt species ranked first above)

Does farmer nurture the species rather than harvest naturally-occurring trees?

Desired *functions* of the species (poles, fuelwood, fodder, fencing, soil fertility, other (specify)) (specify whether mainly for domestic consumption or mainly for sale in each case)

Desired *characteristics* of the species (good survival, can be direct sown, fast-growing, vigorous coppicing, tolerant of browsing/lopping, does not compete with crops, grows under different soil and climate conditions, produces in off-season, fetches good price, other (specify))

Why not get these *functions/characteristics* from non-trees (e.g. from crops for fodder, from dung for fuelwood)?

Why not get these *functions/characteristics* from trees growing off-farm?

Does farmer distinguish between provenances (for example, by giving different names to different forms of the same tree)? If yes, does s/he think having a lot of different provenances is useful (why?), or not important?

3. *Value of MPTs*

Have you heard of [name main MPT available locally using local name or project name]? From where did you hear about it (government, project, relative, neighbour, local trader, other (specify))?
(If no, skip rest of this Section)

Have you planted any on your land? How much (no. of seedlings or area as appropriate)?

Why?

List good points of the MPT (note what farmer says but also categorise into *functions* and *characteristics* as given above).

List bad points of the MPT (ditto).

Why have you not planted any on your land? (note what farmer says but also categorise into provenance (*functions, characteristics*), *form*, quantities, quality, access, price, advice).

If yield is mentioned as an important *characteristic*, by either farmers who have planted or those who have not, find out what incremental yield the MPT must have over mpts for the farmer to plant it (if given in local measurements, get conversion rate).

Would you like to plant other MPTs or mpts, besides those you have (other species or provenances)? Name. Why?

Feedback check on value of MPTs
(To cross-check with projects' answers concerning participation and bottom-up approach in provenance selection)

Repeat bad points raised by farmer above.

Has farmer told these bad points to anyone?

Who? (government, relative, neighbour, local trader, project (specify exact member of staff (job title) and location))

When? (time, location e.g. market, field day)

What happened? (any positive action?)

Have you asked for other MPTs or mpts besides those currently available? What happened?

4. *Sources of Planting Material: mpts*

(To be asked for mpt species ranked first above)

Where did the trees of this species that are growing on your land come from (give all sources if more than one):

a. grew up by themselves (blown by wind, carried by birds/animals, seed that fell from existing trees)
b. planted by farmer (from somewhere else on their land, from public land/wild land [use local name])
c. obtained from someone else (government, relative, neighbour, local market, project (specify incl. precise location e.g. which nursery), other (specify))

(In all cases, specify quantity from this source and year obtained. For b. and c., specify *form* in which planted (seed, seedling, cutting). For c., specify means by which obtained (cash, gift, swop, barter, other (specify) [for swop and barter, specify what swopped/bartered for and quantity])

Which source does farmer prefer and why? (note what farmer says but also categorise into provenance (*functions, characteristics*), *form*, quantities, quality, access, price, advice).
If preferred source is not major source, find out why. (ditto)

Why did farmer use other sources besides the preferred one? (go through each source listed) (ditto)
If farmer used a. and b. only, or used a. and b. more than c., find out why (separately for a. and b.) (ditto)

5. Sources of Planting Material: MPTS

(Ask only those farmers growing project MPTs)

Source of MPT (list all sources if more than one) (government, relative, neighbour, local market, project (specify incl. precise location e.g. which nursery), other (specify)).

(Specify quantity from this source and year obtained. Specify *form* in which planted (seed, seedling, cutting). Specify means by which obtained (cash, gift, swop, barter, other (specify) [for swop and barter, specify what swopped/bartered for and quantity])

Which source does farmer prefer and why? (note what farmer says but also categorise into provenance (*functions, characteristics*), *form*, quantities, quality, access, price, advice)
If preferred source is not major source, find out why. (ditto)

Why did farmer use other sources besides the preferred one? (go through each source listed) (ditto)

In farmer's opinion, what would need to be done to encourage farmer to get MPTs from relatives, neighbours or local markets rather than from government or project?

Would farmer be interested in having a community seed orchard/nursery? If not, why not? If yes, how could the costs of it be met? Who would do the work? For how many years would it be useful?

Feedback check on sources of planting material: MPTs
(To cross-check with projects' answers)

Repeat any bad points about project sources of MPTs raised by farmer.

Has farmer told these bad points to anyone?

Who? (government, relative, neighbour, local trader, project (specify exact member of staff (job title) and location))

When? (time, location e.g. market, field day)

What happened? (any positive action?)

6. *Potential for Improving Availability of MPTs*

(Formal sector sources (project) and distribution issues were dealt with in the previous Section. This Section deals only with selection and multiplication issues w.r.t. community sources)

(Ask only those farmers growing MPTs *plus* any farmers mentioned by them as having specialist MPT multiplication and selection knowledge)

In this Section, emphasise you are referring only to MPTs [use local name or project name], not to all mpts.

Local knowledge of selection and nurturing
Have you ever tried to take cuttings/grow seedlings (as locally appropriate) from MPTs already growing on your own or someone else's land?

Why did you try to do this?

Describe what you did (selection and nurturing). In particular, find out whether farmer identifies superior mother trees and, if so, on what factors choice is based (tree size/shape, location, foliage, healthiness of branches and trunk, presence of flowers and seeds, other (specify)).

Who told you what to do? (government, relative, neighbour, local trader, project (specify))

Were the results good or bad? (identify whether farmer distinguishes between genetic and physiological quality and give detail if they do)

If not asked in Section 2 above, find out whether farmer distinguishes between provenances of trees (for example, by giving different names to different forms of the same tree)?

Knowledge of recommended practices
Are you aware that there are recommended practices for selecting and nurturing MPTs? (If no, skip rest of this sub-Section)

Describe how you are supposed to select, plant and nurture MPTs (site, planting season, spacing, shade, fertiliser)

I expect you don't find it possible to follow all these recommendations, do you?

Go through each recommendation and find out whether farmer does and if not, why not.

Role of project nursery workers/ extension staff
Who told you what are the recommended practices for MPTs?

What happens to trees if you don't follow all these recommendations? (press for an exhaustive list)

(If didn't mention project)
Are you aware that there are project staff [use local name] who can give you advice on planting and nurturing MPTs? (If no, skip rest of this sub-Section)

When did you last see them?

Where? (on-farm, at community meeting, at project (specify). What did you discuss?

Local experts
Is there anyone in your community who is particularly successful in selecting and nurturing MPTs?

Get name and location in sufficient detail to locate and interview them.

ODI Research Studies

Germplasm for Multipurpose Trees: Access and Utility in Small-Farm Communities

Elizabeth Cromwell and Angus Brodie, with Alison Southern

Increasing resources are being devoted by international and national research institutes to collecting germplasm from multipurpose tree species (MPTs), and selecting from it to provide better MPT germplasm for developing countries. But to date little work has been done to find out what role small-farm communities – the ultimate end users of the research – want MPTs to play within the farming system, what attributes MPTs need to have in order to be useful to farmers, and how better MPT germplasm can best be disseminated to them.

In this book the authors report on the situation in communities in three different countries where MPTs are being actively promoted: Honduras, where many MPT species are within their native range; Malawi, where a number of exotic MPTs have been recently introduced; and Sri Lanka, where some exotic MPTs such as *Gliricidia sepium* have been in use for a long time.

The authors describe how 'improved' MPT germplasm is incorporated into existing farming systems, and the broad patterns of exchange and use of indigenous and new tree germplasm within the case study communities. A number of problems are highlighted; the aim is that these findings will provoke further research in this area so that the relevance of current MPT improvement work to small-farm communities can be further enhanced.

Elizabeth Cromwell is an agricultural economist and a Research Fellow at ODI. Angus Brodie and Alison Southern are agro-foresters with extensive experience in Central America and Sri Lanka respectively.

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