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**Department for International Development
Renewable Natural Resources Research Strategy**

**Natural Resources Systems Programme
Hillsides Production System
and
Forestry Research Programme**

Research Project R6881

Nepal: Agroforestry Research Strategy for the Hills

Final Technical Report

January 1998

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Preface

This Final Technical Report should be read in conjunction with the substantive final report of the project, which is available from the Systems Management Office at DFID, or from AERDD at The University of Reading:

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Abbreviations

ADB	Asian Development Bank
ADB/N	Agriculture Development Bank/Nepal
APP	Agriculture Perspective Plan
APROSC	Agricultural Projects Services Centre (Kathmandu)
CBO	Community Based Organisation
DRCFP	Dolakha Ramechhap Community Development Project
DFID	Department for International Development (formerly ODA), UK
FAIPS	Forest-Agriculture Interface Production System (of DFID, within RNRRS)
FAO	Food and Agriculture Organisation of the United Nations
FORESC	Forest Research and Survey Centre
FRD	Forest Research Division, Ministry of Forests and Soil Conservation
FUG	Forest User Group
FRP	Forest Research Programme (of DFID, within RNRRS)
HARP	Hills Agricultural Research Project
HMGN	His Majesty's Government of Nepal
HPS	Hillside Production System (of DFID, within NRSP)
IAAS	Institute of Agriculture and Animal Sciences
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	International Centre of Agroforestry Research
IFAD	International Fund for Agricultural Development
INSAN	Institute of Sustainable Agriculture, Nepal
IOF	Institute of Forestry
ITTO	International Timber Trade Organisation
LARC	Lumle Agricultural Research Centre
LIBIRD	Local Initiatives for Biodiversity Research and Development
MOA	Ministry of Agriculture
MOU	Memorandum of Understanding
MFSC	Ministry of Forests and Soil Conservation
MPFS	Master Plan for Forestry Sector
NACFP	Nepal Australia Community Forestry Project
NAF	Nepal Agroforestry Foundation
NARC	Nepal Agricultural Research Council
NFRC	National Forestry Research Committee
NRI	Natural Resources International (of UK)
NRPAD	Natural Resources Policy and Advisory Department (of DFID)
NRSP	Natural Resources Systems Programme (of DFID, within RNRRS)
NTFPs	Non-timber forest products
NUKCFP	Nepal UK Community Forestry Project
NUKFRP	Nepal UK Forestry Research Project
ODA	Overseas Development Administration (now DFID)
ODI	Overseas Development Institute
PAC	Pakhribas Agricultural Centre
PAC	Programme Advisory Committee (of DFID's RNRRS research programmes)
PSP	Plant Sciences Programme (of DFID, within RNRRS)
RNR	Renewable Natural Resources
RNRRS	Renewable Natural Resources Research Strategy (of DFID)
SEM	Socio-Economic Methodologies component (of NRSP)
SYMO	Systems Management Office (NRSP)
UMN	United Mission to Nepal
UNDP	United Nations Development Programme
WATCH	Women Acting Together for Change

Executive Summary

The purpose of the project was to prepare a strategy to guide the design and funding of research on agroforestry relating to the hills of Nepal, within the Renewable Natural Resources Research Strategy (RNRRS), in particular within the Hillside Production System of the Natural Resources Systems Programme, and the Forestry Research Programme.

Research activities comprised a review of literature on agroforestry and agroforestry research in Nepal, discussions with key informants involved in research and in rural development projects with agroforestry components, discussions with farmers in the field, and the holding of a workshop for presentation and discussion of the interim findings of the study, out of which a final draft strategy was produced.

Recent research has improved understanding of the diverse and dynamic nature of hill farming systems in Nepal and the complex problems associated with their management. However, there are also limitations. There is no overall policy framework and strategy for agroforestry research within Nepal, and therefore no systematic planning of research activities. The design of most agroforestry research projects is based on scientists' own criteria, and farmers' input to research designs, implementation and assessment of results has been limited. Overall, agroforestry research/studies to date have contributed little towards sustainable management and utilisation of resources and towards improving the livelihoods of farming communities, especially the poorer households.

An appropriate purpose for an agroforestry research strategy for Nepal would be *enhancement of the sustainability of hillside production and livelihood systems through improved agroforestry practices on both private (agricultural and non-agricultural) and public or community land.*

Proposed outputs to contribute to this purpose are:

- farmers' criteria, priorities and knowledge integrated effectively in agroforestry research,
- productive potential of farming systems sustained and increased through development of appropriate species and management options for tree-crop combinations on farm land,
- household income increased through production of high value, marketable products,
- trade-offs between agroforestry and other activities understood, and mechanisms developed to monitor socio-economic effects of agroforestry interventions, at household and community level,
- productive potential of non-agricultural private and community land increased through development of appropriate agroforestry systems and practices,
- adaptations and uptake of agroforestry systems and practices increased through increased understanding of processes of information generation and exchange.

The current purposes and outputs of DFID's various RNRRS programmes relevant to agroforestry in the hills of Nepal are expressed mostly in biophysical terms. A research strategy should take explicit account of socio-economic factors and provide options for farmers and community decisions. Improvements to institutional arrangements for research are also proposed. The norm should be that farmers are active partners in all agroforestry research, both on- and off-station, and proposals should indicate how this will be achieved.

The outputs provide a basis for a coherent, well informed research strategy which will deliver more productive and sustainable technologies and management practices. This will contribute to DFID's development goals by enabling resource-poor households to sustain their livelihoods and reducing the possibility of research outputs inadvertently disadvantaging vulnerable groups.

Background

Nepal is amongst the poorest countries in the world with a per capita annual income less than US \$200 and some 40 percent of its population (19 million) is living in absolute poverty. The economy is dominated by the agricultural sector which contributes some 52 percent of GDP and 90 percent of the employment. Agricultural production, which is dominated by small farmers (an average of less than 1 ha of land-holding), is largely based on subsistence economy, although in places agricultural activities are becoming more commercialised with increased irrigation facilities and application of commercial inputs such as inorganic fertilisers. Off-farm cash earning activities are beginning to play a key role in the household and rural economy in some parts of the rural areas.

Due to the high population growth rate (2.1% p.a.) which puts demands on natural resources that exceed regenerative capacity as well as poverty leading to short term consumption rather than long term sustainable use, the country's natural resources are degrading rapidly resulting in the depletion of biodiversity and wildlife resources and the deterioration of the overall environment.

In the context of increasing population pressure and poverty, the key issue of research in Nepal is one of sustaining and enhancing the environment (HMGN, 1995). As the agricultural sector plays a dominant role in the country's economy, any development strategy that aims to reduce poverty will need to rely heavily on agriculturally led growth based on productivity gains and increased off-farm employment.

The hills occupy over 60 percent (9,128,500 ha.) of the total area encompassing a wide altitudinal range (300 - 4000 metres) and diverse climatic conditions, forest vegetation and agricultural practices. Rainfed farming on small land-holdings comprising series of small narrow terraces characterises most of the hills region. Much of the area is inherently unstable: land-slips and soil erosion are common, naturally occurring phenomena. Hill farming in which crops, livestock and forests and trees are intertwined, depends largely on the transfer of inputs from the surrounding forest areas through animal manure as the shortage of soil nutrients cannot be made up by applying inorganic fertilisers due to inadequate supplies, high prices and poor infrastructure.

Agroforestry research is not flagged as an explicit priority in Nepal government policy documents; however the need for support to a coherent programme of research on agroforestry issues is implicit in the current five year plan, the Agriculture Perspective Plan (APP) and the Master Plan for the Forestry Sector (MPFS).

In the eighth Five Year Plan (1992-1997), priority in agricultural research is given to rainfed crops and hill agriculture; while for forestry the main objectives include increasing the supply of forest products, increasing employment opportunities for resource poor rural households, and helping maintain soil fertility through soil conservation. The APP (1995), despite its strong focus on specific commodities for commercial production, does imply the need for research on improved pasture and fodder for livestock, incorporation of high value trees (citrus) into farming systems, and the contribution of trees / agroforestry to fertility management on crop land. MPFS (1989) focuses on natural forest management but does acknowledge the need for research encompassing "agro-silvo-pastoral studies" and the production of income-earning perennial species on farmland. On the other hand, it identifies several key constraints to improving the research effort and output, which have not been addressed in the nine years since the MPFS was drawn up. These cover human resources, institutional arrangements, financial constraints and poor facilities and equipment.

Project Purpose

Against this background, the project set out to document the current state of knowledge about agroforestry systems in the hills of Nepal and about the priorities for future research. Its purpose was to develop a strategy for RNRRS support to agroforestry research which would contribute to addressing these priorities. Although the programme purpose focuses on the physical benefits of improved agroforestry systems, in terms of stabilisation of soils and enhanced soil fertility, the study had a broader remit to consider the interactions between agroforestry systems and socio-economic and livelihood factors.

Research Activities

The research took place in three phases. First, a detailed review was carried out of published and "grey" literature covering scientific research on agroforestry, studies on local knowledge and resource management practices and strategies adopted by farmers, and development agency interventions related to agroforestry, all in the context of the hills of Nepal. (The review is presented in full in Appendix 2 of the final report of the study - Garforth and Malla (1997)). This was followed by a fieldwork phase, in which interviews were held with key informants in the UK and in Nepal - staff and senior managers from research institutes and development agencies, forestry and agroforestry specialists - and village-level discussions with farmers in two contrasting areas in the hills. In this fieldwork phase, and in the subsequent workshop, the collaboration of the Nepal Agroforestry Foundation was invaluable. The workshop - a two day event at Budol in the Kathmandu Valley - brought together 31 experienced researchers and development professionals with intimate knowledge of agricultural and agroforestry systems in Nepal to review the findings of the first two phases and to discuss their implications for future research strategy and priorities in the field of agroforestry. On the basis of the workshop outputs, a draft report and proposed strategy were prepared for consideration by HPS, FRP and SYMO.

No modification of the proposed activities and inputs was required. All planned inputs were achieved. These included a contribution to the desk research and to the workshop discussions from Dr Fergus Sinclair of University of Wales, Bangor.

Outputs

Three outputs were planned for the study:

- (1) agro-forestry practices and techniques currently used by farmers reviewed and documented
- (2) issues of concern to farmers relating to agro-forestry technology and practices identified
- (3) research strategy for agro-forestry within a systems context prepared.

For convenience, the findings are presented here under four headings: the current status of agroforestry research in the hills; priorities for future agroforestry research; constraints to agroforestry research; and the proposed strategy for RNRRS-supported agroforestry research.

Current status of agroforestry research in the hills

Studies to date have focused on the role of trees in hill farming systems, tree and forest products, tree-crop interactions, soil erosion control by trees on farms, land and tree tenure, and the impact of changes in farming and agroforestry systems. Running through much of the

literature, particularly more recent material, are two major cross-cutting themes: gender and local/indigenous knowledge.

Many different agroforestry systems and practices are documented, most of which are restricted to local areas, making generalisations difficult. Trees are commonly grown on farmland, both on *khet* and (more commonly) on terrace risers in *bari* land. Nutrient flows between trees (both on and off farm), livestock and crops are crucial to the sustainability of hill agriculture. Dependence for tree products on common rather than private land varies widely, from ten to 100 per cent. Farmers have detailed specialist knowledge about many aspects of agroforestry, including propagation techniques, shading effects on crops, and qualities and utility of different species. This knowledge is, however, unevenly distributed. Differences in local knowledge between men and women broadly reflect gender division in labour in respect of tree and forest products.

Studies on tree and forest products have focused mainly on growth and yield parameters and the factors that influence them. Recently, increasing attention has been paid to non-timber products. Research on the growth, behaviour and management of individual species has been much more common than studies on the interactions within farming systems between trees (or other perennial species) and annual crops. Farmers and scientists have different approaches to shading effects: scientists seek to minimise shading through selection of species and management regimes, while farmers have been shown to experiment with shade tolerant or responsive crops and varieties.

There is surprisingly little hard information on the soil conservation effects of specific agroforestry systems. Recent studies show that farmers have developed detailed knowledge of soils and tree-soil and crop-soil interactions pertaining to their local area and work out complex trade-offs between these elements.

Concern is expressed in recent literature about socio-economic dimensions of agroforestry interventions. Uneven distribution of land makes the planting of trees on private holdings less feasible for poorer households: unless private planting is combined with continued planting, and the protection and management of common forest resources, agroforestry programmes will have inequitable results. The distribution of benefits from agroforestry may also be skewed by gender divisions of labour and roles within households.

Increases in the amount of tree cover on private land have been noted in some areas, particularly where socio-economic changes have stimulated a market in tree and forest products or in other products dependent upon them (such as dairy produce).

Overall, however, research to date has not contributed much towards sustainable management and utilisation of resources in the hills, or towards improving the livelihoods of farming communities, especially poorer households. The literature suggests ten limitations in the research done so far which should inform plans and support for future research (see Appendix II of Garforth and Malla (1997) for a full discussion).

(1) Limited utility of research results to farmers

While scientists may have learnt much from agroforestry research, farmers have benefited little: most studies document and analyse systems and practices already well understood by the farmers who use them. At the same time, farmers' contribution to research and to the development of agroforestry practices is not fully recognised.

(2) Limited impact of research results on subsequent research

Agroforestry research has tended to be conducted in an ad hoc and isolated manner, with individual scientists and research groups following up particular interests and problems. Recommendations and findings have often not had a significant impact on the design of subsequent studies by others. This reflects the lack of an overall national, and even within institution, strategy for determining agroforestry research priorities.

(3) Bias towards tree component

Most research has focused on trees in isolation, rather than in interaction with the other components of agroforestry systems - particularly livestock and crops.

(4) Concentration on private *bari* land

Research has generally ignored the evidence that farmers are willing to plant perennial species (including fodder grasses) on *khet* as well as *bari*; and that sustainability of farming and livelihoods for many - possibly the majority - of households in the hills depends almost entirely on common forest and grazing lands.

(5) Concentration on limited range of products

Most research to date has been on the management and production of fodder trees. Much less has been done on fuel, timber and non-timber products - which to many households are more important and critical. Similarly, most studies of local knowledge have focused on fodder.

(6) Limited account of the dynamics of hill farming systems

Although the dynamic nature of systems is evident from the literature, this has not generally been taken into account in research designs, nor in choice of research topics and sites. The emphasis on fodder reflects the experience of most scientists of working in remote villages with limited market activities, or the assumption that livelihoods are and will remain largely subsistence based.

(7) Farmers' criteria ignored in research design

Scientists and research professionals have tended to design research programmes and studies without consideration of farmers' criteria - for example, for the assessment of nutritive values of tree fodder and grasses, particularly in respect of combinations of feed sources. This has made it difficult to integrate the insights from research into appropriate recommendations for farmers.

(8) Limited participation in research by farmers

Farmers have had very little input into the design and implementation of field research, even where the research has been conducted on farmers' fields. There is ample evidence in the field that farmers are actively experimenting with different agroforestry practices and treatments, yet researchers have made little attempt to ally their empirical studies with those of farmers.

(9) Lack of effort to preserve agroforestry species germplasm

Several research organisations and development agencies - both national and international as well as government and non-government - are involved in promoting various indigenous and exotic agroforestry tree species at village level. There has been little effort to preserve the germplasm of these tree species used in Nepal. There seems to be no record of exotic species that are being promoted. As a result, it is difficult to judge whether the different varieties of tree species, particularly the exotics, which have performed well in one area, may also perform as well in other areas, which is already creating problems in the promotion of species or varieties which fail to live up to expectations in specific locations.

(10) Lack of systematic planning and analysis of research

In the absence of an overall policy framework and strategy, most agroforestry research and development activities have been planned and implemented in isolation from one another. There has also been geographical concentration in the central, eastern and western development regions, and at altitudes below 2000 metres. It is not clear how much of the variations in research results are a reflection of agro-ecological and farming system differences, rather than differences in research designs and procedures. Some results are too vague to be of any practical use, others are too specific to the location in which the research was done.

Priorities for agroforestry research in the hills

On the basis of the above findings, participants at the workshop identified eight priorities for future agroforestry research.

(1) Mechanisms to link farmers' and scientists' knowledge

There are two dimensions to this: (a) the need to give due weight to both farmers' and scientists' knowledge, perceptions of problems, criteria and priorities in designing research projects; and (b) the need to make use of farmers' knowledge in the conduct and interpretation of research.

Research objectives under this heading may include:

- (i) to identify "farmers' knowledge" and their problems, criteria and priorities in agroforestry
- (ii) to determine reasons why "farmers' knowledge" has not been adequately used in research
- (iii) to develop and test mechanisms by which "farmers' knowledge" could be efficiently used in research programme formulation.

Specific topics may include:

- collection, documentation and communication of farmers' knowledge in agroforestry;
- identification of gaps in farmers' knowledge in agroforestry;
- further research to fill the gaps;
- further studies on farmers' and scientists' concepts and terminologies in relation to agroforestry research;
- review of the existing methods and mechanisms used for research formulation;
- verification of available mechanisms and development of more appropriate and suitable mechanisms.

The main bio-physical and socio-economic issues to be considered here include the need for an adequate geographical and ecological coverage, differences in institutional settings and the distribution of farmers' knowledge across ethnic groups, gender, rich and poor households etc.

The approach to research will need to be both interdisciplinary and participatory in nature with focus on qualitative information with adequate representation of both geographical / ecological variation of the hills region and socio-economic aspects of the farming communities (wealth, ethnicity, gender etc.).

(2) Income generation opportunities from agroforestry enterprises, including use, processing and marketing of NTFPs

There is a need to gain better understanding about income generating activities from agroforestry and agroforestry enterprises that can provide direct benefit to the farming communities, especially the disadvantaged groups, including both utilisation of existing agroforestry systems and developing newer options for future adoption, while ensuring the diversity and sustainability of the natural resources.

The specific topics may include:

- survey and documentation of existing agroforestry activities and enterprises from which the farmers are currently deriving income;
- exploring the market opportunities for agroforestry products;
- assessment of the existing potential agroforestry innovations that could bring improvement in the current economic situation of the farming communities, especially the small land-holders and landless poor;
- designing appropriate agroforestry technologies that would help produce value-added, marketable products.

Bio-physical issues involve impact of the extraction of the mix of products (including the use of harvesting tools and techniques) on natural resources as well as on the ecosystem at large. The socio-economic issues involve the use of technology at community and / or household level, types of people and / or households involved (ethnicity, gender, landless poor, middle persons / contractors), market information (including consumption and production patterns, price and share of benefits), and processing and storing techniques.

An approach to participatory action research (with close collaboration between various related organisations and disciplines) would be required for this type of research. The research design should consider the interests, needs, criteria and priorities of different stakeholders involved in production, use, processing, marketing and benefit-sharing as well as the management of resources and technologies.

(3) Links and trade-offs (bio-physical) between tree product values, tree-crop interactions and soil erosion

There is insufficient understanding of links and trade-off between:

- tree-crop-animal interactions (competition for light, water and nutrition; nitrogen fixation and nutrient cycling - including from other land, and micro climate modification - canopy and mulch), nutritive value of tree fodder, quality of animal manure and seasonality of different farming activities;
- sophisticated farmers' knowledge on cultivation of trees and crops on *bari* and *khet* land (terrace and risers) and various product mix vis-à-vis fodder (usually constrained by effect of trees on crop yield), firewood, timber and high value NTFPs, and
- soil erosion - propensity of trees to cause soil erosion, canopy properties (e.g. *tapkan* effect), and / or propensity of trees to reduce soil erosion (root systems).

Specific research topics may involve research on growing and management of favoured fodder trees, ecological combining ability of different fodder tree species and management combinations, below-ground tree-crop interactions, effect of tree pruning on root system, crop yield responses, shade tolerance of local crop varieties, crop and tree breeding (selection), erosive impact of different tree species, developing indicators of fodder value (farmer and laboratory) of species and mixes of fodder species, farmers' knowledge about soil fertility, quantity of nutrient capture from deep soil and nitrogen fixation.

Research on these aspects will require a longer time frame with a systems approach to trials both on-station using satellite controlled experiments and on-farm participatory experiments.

(4) Links and trade-offs (socio-economic) between agroforestry activities and components (trees, crops, livestock) and other household activities

The objectives of research to address this gap may be:

- (i) to develop an understanding of existing relationships between agroforestry activities and components with other activities of the farming households,

- (ii) to assess the effect of various changes, including agroforestry technologies, on the household activities
- (iii) to develop mechanisms to monitor changes in household members' activities due to agroforestry interventions.

The specific topics may include baseline studies, farming system analysis, gender analysis at household level (labour distribution, decision making), and impact of agroforestry interventions.

The main issue that needs to be considered here is the actual impact of agroforestry interventions on the resources and the livelihoods of household members. This includes issues relating not only to the sustainable utilisation of resources, but also to control over the resources and the sharing of benefits.

A participatory approach to research with close collaboration between scientists and professionals from concerned disciplines will be necessary.

(5) Potential of agroforestry on non-agricultural land, including private and community land

The objectives include:

- (i) to determine the potential of non-agricultural and community forest and grazing lands for agroforestry activities
- (ii) to identify and develop various suitable agroforestry options for these different types of land categories
- (iii) to identify and develop mechanisms for agroforestry systems to integrate non-agricultural land, including community land, into the overall farming systems.

Specific research topics include tree-crop interactions, selection of agroforestry tree species and crop varieties suitable for non-agricultural lands, domestication of NTFPs, and identification and development of agroforestry systems on non-agricultural lands.

The critical issues involved in this are the current approaches used to promote community forestry, land tenure and ownership of resources, decision making in resource management and benefit sharing.

A participatory approach to research, with emphasis on farmer-led experimentation and demonstration would be essential for this.

(6) Documentation of local knowledge on agroforestry systems and practices

The lack of documentation of local knowledge is one of the reasons why it is not given more weight in the design of research studies. It is a cross-cutting issue and should not be seen in isolation as a separate topic for research. Almost every aspect of agroforestry research should build on local / indigenous knowledge.

(7) Impact of agroforestry innovations on communities

There is limited understanding of ways in which agroforestry innovations / technologies adopted on individual private farmlands or community lands may affect the community as a whole. It is important to consider the overall impact of agroforestry innovations and the consequences, or the likely consequences, of such innovations on the community's resources and the members of the community.

The research may include, but not necessarily be limited to, such topics as baseline surveys, analysis of the government's various policies and institutions relating to land and other natural resource uses, mechanisms for the implementations of the policies and issues facing policy implementation, impact of the implementation of various projects such as community forestry, agroforestry, leasehold forestry etc., as well as the impact of change on the pattern and trend of the overall land and other natural resource uses (both private and community), and the impact on household and community members' general behaviour and decision making processes.

Government policies and mechanisms adopted for their implementation will need to be key issues for research.

The approach to research should be participatory and interdisciplinary in nature and should consider household and community members' interactions with natural resources in a historical perspective, in the context of government's past as well as current land and other natural resource use policies.

(8) Agroforestry information generation and exchange processes within communities

The main objective of research under this heading is to develop an understanding of ways in which indigenous / local knowledge about agroforestry is generated and distributed among rural people, both within and between farming communities, and how information from outside the community diffuses and is transformed.

Specific topics for research may include factors that trigger the community members to become engaged in agroforestry research, characteristics of community members who become engaged in agroforestry research, processes farmers use for experimentation, processes through which the results are communicated, characteristics of knowledge and information that are communicated, or not communicated, factors that contribute to the processes of knowledge being transferred, or that stop the knowledge / information from being transferred.

Each of these research topics will need to be considered in the context of both bio-physical and socio-economic issues, such as local ecology, farming systems and access to other economic opportunities, as well as ethnicity, wealth and gender. Participatory action research, in which community members' role will be critical, should be the main approach to such research. The outside team should include members with a background of research in interdisciplinary fields, including communication.

Constraints to agroforestry research

Workshop participants identified nine major constraints facing agroforestry research:

- limited institutional collaboration in policy, planning, implementation and evaluation;
- poor flow of information - nationally between professionals and research organisations, internationally, and between researchers and farmers;
- inadequate and unequal (geographical and between components) investment in agroforestry research (funds, human resources, research facilities);
- complexity and diversity within and between localities limiting the generalisability of research findings, and the consequent need to distinguish between research for specific location and research for general application;
- lack of overall national policy and strategy to assist institutions develop their own agroforestry research programmes;
- poor research-extension-training linkages;
- insufficient co-ordination of technical and socio-economic research in agroforestry research;

- agroforestry as a discipline yet to be recognised / considered for government service;
- limited monitoring of the impact of agroforestry research.

These constraints were also reflected in one way or another during the earlier discussions with key individual scientists and professionals as well as farmers in the field. We summarise them in terms of bio-physical, socio-economic and institutional issues, in the following paragraphs.

(1) Bio-physical issues

Scientists and professionals engaged in agroforestry research and development have often placed greater emphasis on bio-physical aspects of research. The bio-physical objective of agroforestry research is often interpreted as to increase and sustain the productivity of the natural resource base while maintaining its diversity. But this objective has somehow failed to provide appropriate directions, at least in Nepal, to agroforestry scientists.

Scope and boundaries Most professionals engaged in agroforestry research and development in Nepal take agroforestry to mean the planting of trees on private farm lands. For them, in order for an activity to be agroforestry, both trees and agricultural crops should be grown on the same land unit, either simultaneously or in sequence, and compete for soil moisture, nutrient and light. As both agricultural crops and trees are needed to be grown together in order for them to compete with one another, hence agroforestry takes place on private farm lands; conversely, agricultural crops are not allowed to be grown on common forest and grazing lands, hence by definition there can be no agroforestry in common forest and grazing lands.

Restricting the scope of the term to planting and/or management of perennial species on private farm lands can be too narrow a perspective as its potential contribution towards sustaining the hill farming systems, and therefore the livelihoods of the farming households - particularly small land-holders - will be limited. Given the fact that a large proportion of the farming households in the hills region are small farmers with an average land-holding of less than 0.5 ha, and their income is barely enough for six months of the year, what agroforestry on private farmland alone can do to improve the livelihoods of these poorer households is very limited, no matter how wonderful the technology may be.

Agroforestry on common forest and grazing lands could thus also be a very attractive proposition, especially for the small land-holders, the landless and those who work as tenant farmers / share croppers (e.g. introduction of improved fodder grass and legumes, and growing of high valued medicinal herbs and cash crops such as cardamom, mushrooms etc.). In any case, common forest and grazing lands have always been an integral part of the farming systems in the hills of Nepal.

We feel it is helpful to consider agroforestry more broadly to encompass the larger landscape beyond individual farmlands, where private farm lands, common forest and grazing lands, farm animals, water resource as well as farm household members, all interact with each other. In other words, the whole farming system can be considered as agroforestry. In any case there are important interactions between community forestry initiatives and on-farm tree planting activities. Initial operational (management) plans for community forests by forest user groups (FUGs) usually lead to a reduction in off-take in the early years, putting pressure on remaining national forests, and on women and children who have to collect fodder and firewood, which can be reduced by production of fodder and other products on farm (albeit often only by those who have sufficient land-holdings).

The idea of considering the whole hill farming system as agroforestry may be too broad for some for a focused research on agroforestry. But this is the reality within which households live and work. Considering the whole farming system as agroforestry means recognising the diversity of problems and constraints associated with the management of land and other natural resources in the hills region, and that the current agroforestry approaches (such as planting a few fodder trees on *bari* lands) may be based on too simplistic a view of the complex problems and opportunities facing farming communities. Any particular agroforestry research study will, of course, have a specific focus: it is important, however, that in identifying the problem and in the design of the research the research team takes account of the complex relationships within this wider understanding of agroforestry.

Farmers' and scientists' criteria There is a divergence between scientists' and farmers' criteria for initiating agroforestry activities in some cases. For example, agroforestry through the testing of sloping agricultural land technology (SALT) by the International Centre for Integrated Mountain Development (ICIMOD) has largely been governed by environmental goals, whereas the farmers were more motivated by production goals.

Similarly, scientists are concerned with tree-crop interactions more from the perspective of the competition for soil nutrient and water (below-ground interaction), whereas farmers are more concerned with shade effect and consequent loss of crop yield. Since trees are mostly grown on the terrace edges and risers, the below ground interaction between tree roots and crops may not be so important, at least in the hills region, although scientists point out that terraces in the hills are usually very narrow and the root systems can extend to several terraces. Nevertheless, farmers seem to be aware of the root structure of different tree species that grow on their farm lands, but they do not seem to be concerned about competition for soil nutrient and water. Instead what seems to concern the farmers more, besides the shade effect on crop yields, is the fact that some tree species' roots spread laterally and pose difficulty in ploughing/tilling the land (for example, *Ficus lacor* (*kabhro*)). Farmers use a range of criteria in deciding what and where to plant, or not plant, and these criteria need to be fully explored.

There is a general consensus among professionals that environmental concerns (including on-farm soil erosion) do not figure very much in farmers' decision making. However, analysis of the literature on local ecological knowledge, and field work conducted during this study, show that farmers do have concerns about soil erosion and its effect on crop production - for example, the impact of *tapkan* (water droplets falling from leaves) on soil and crop yield - and that these concerns influence choice and location of tree species.

There are also differences between the ways scientists interpret (and emphasise) their research results and farmers' interpretations of their problems, needs and solutions. For example, much research on nutritional value of tree fodder by scientists has emphasised crude protein, crude fibre, and more recently, digestibility and anti-nutritive factors as the most important parameters for assessing fodder quality. However, the analysis of indigenous knowledge shows that farmers classify fodder trees, for various categories of livestock, and with various seasonal and age-dependent attributes, in terms of their nutritional value (*posilo* and *kam posilo*) and as either cooling or heating (*chiso* or *obhano*), as well as fodder quality in terms of its ability to satisfy animal appetite, its palatability, its effect on animal health and milk yield and the butter-fat content of the milk (Rusten and Gold, 1991; Thapa, 1994).

Thus, individual farmers have their own objectives (and objections) which will vary with the particular circumstances of their farms and households, and involve trade-off between multiple criteria. There is scope for research that improves our understanding of their decision making criteria and processes in relation to agroforestry.

However, local knowledge is not static and farmers' objectives for tree growing and their criteria for decision making can of course change with learning and observation. For example, when farmers see the effects on crop yields of nitrogen-fixing species grown on field bunds, improvement of yields may be added to the criteria for species selection and placing of perennial species. Similarly, farmers may make decisions based on changing circumstances and opportunities. For example, with growth in market activities, there may be demand for a new tree product, whereas the demand for some of the products currently in use may not exist any longer.

(2) Socio-economic dimensions

Agroforestry cannot be treated simply in bio-physical terms, for several reasons.

Economic incentives In making decisions about new practices or modifications to existing practices, farmers respond to economic incentives (or "push" and "pull" factors): the economics (from farmers' perspectives) of agroforestry systems and technologies therefore need to be understood. This will include consideration of the opportunity costs of resources (land, labour) diverted to agroforestry practices, perceptions of risk, markets for output, and costs of inputs.

Gender Intra-household specialisation of function and labour can create severe gender imbalances in the costs and benefits from agroforestry: new practices may at the same time reduce the need for female labour to spend time trekking to forest areas for fodder and fuel, while increasing the need for on-farm labour; and if the household response to increased availability of fodder is to increase livestock holding (particularly likely if good road access stimulates a cash market for milk and cheese), the net effect for women may be to increase their daily burden while the benefits are enjoyed by men (this has been documented with respect to a dairy project in eastern Nepal, where increased household income - in the pockets of men - was accompanied by a deterioration of household nutrition (J. Denholm, pers. comm.)). A particular case of gender considerations concerns schooling for girls: any increase in the demand or requirement for female household labour leads directly to girls' being withdrawn from school.

The net effect on demand for female household labour of any agroforestry innovations must therefore be considered: the view that household labour has zero opportunity cost cannot be taken seriously.

Equity Because the opportunity cost of land differs between relatively resource rich (larger landholding, high income from non-farm sources (employment, pension)) and resource poor households, agroforestry practices can have significant equity effects. The growing of pasture and grain species for livestock fodder, for example, is not an option for households with too little land to meet their food security needs; whereas planting fodder grasses and / or trees on terrace risers may be feasible for most farmers. Equity considerations are one reason for the focus of bi-lateral projects in the forestry sector on community forestry.

Socio-economic process of experimentation Among institutions and projects which promote agroforestry, there is a strong view that we need more understanding of the socio-economic processes of experimentation, diffusion and farmer-to-farmer extension; because of the complexity of agroforestry systems in the hills, and the variation (climate, altitude, aspect, slope, availability of *khet* land, farm size, etc.) within and between agro-ecological areas, there is a strict limit on how much by way of definitive technical recommendations can come from bio-physical research; only as farmers try out, and modify, recommended practices, and share and exchange experiences and ideas, will locally adapted practices emerge.

An agroforestry research strategy will therefore need to take socio-economic issues into account, including markets, income generation, and access to common forest and grazing lands for agroforestry activities. This leads to a consideration of land tenure / ownership, and other institutional issues.

(3) Institutional issues

Agroforestry research and development in Nepal is further complicated by institutional fragmentation along disciplinary lines, particularly amongst the government (or government supported) research organisations and institutions. At present, there is no institutional arrangement, or mechanism, that would allow the formulation of an overall policy framework and strategy to guide the various institutions, organisations and individuals to plan, implement and monitor agroforestry research in a systematic way. Several institutions - government and non government, national, international and local as well as donor (bi-lateral and multi-lateral) organisations - have been involved in agroforestry activities in one way or another, and all are trying to emphasise their own interests and the disciplines that they represent.

Government (HMGN) institutions There are two main government (or government supported) research organisations and institutions, particularly relevant to agroforestry research in Nepal. One is Nepal Agriculture Research Council (NARC) under the Ministry of Agriculture (MOA) which is responsible for agriculture and livestock related research. The other is Forest Research and Survey Centre (FORESC) under the Ministry of Forest and Soil Conservation (MFSC) which is responsible for forestry related research. In addition, there are two educational institutes, Institute of Agriculture and Animal Science (IAAS) and Institute of Forestry (IOF), which operate under Tribhuvan University. The former offers BSc degrees in agriculture and veterinary science and animal health, and the latter offers a BSc degree in forestry, within which some teaching on agroforestry is given. Some faculty staff working in these institutes are engaged in research on issues relevant to agroforestry, but independently of one another.

There is no clear mandate for agroforestry research within HMGN institutions. NARC has a pastures and fodder division within its National Animal Science Research Institute which is doing trials on species and varieties of annual and perennial fodder, while FORESC established a fodder working group which it has now promoted to become a fodder and agroforestry working group.

The DFID-supported LARC and PAC (two of the very few research centres that have, over the last two decades or so, been attempting to integrate various components of the hill farming systems in their work) now come under the auspices of NARC and are expected to be fully merged with NARC in 1998. Both centres have established agroforestry research teams, comprising scientists from various relevant disciplines. LARC recently has been given a mandate from NARC to carry out agroforestry research relevant to the 11 hill districts of the Western Development Region, and is in the process of negotiating a Memorandum of Understanding (MOU) with NARC and FORESC for carrying out agroforestry related research in the selected districts. LARC is expecting a similar MOU at the national level between NARC and FORESC next year. However, it is uncertain how these moves by NARC will actually resolve issues which are more fundamental to agroforestry research, in particular the role / place of forestry expertise. NARC has no forestry expertise and currently requires a BSc degree in agriculture as a prerequisite for professional staff positions. On the other hand, NARC has approved the formation of the multi-disciplinary agroforestry research team at LARC which will be responsible for carrying out agroforestry research in Western Development Region.

FORESC sees agroforestry as falling within its national mandate for forestry research. It seriously lacks agriculture, horticulture, animal science and socio-economics expertise among its staff. One requires a BSc forestry degree as a prerequisite qualification to join FORESC as a professional staff member. Discussions with senior FORESC officials indicate that its priority for research lies with natural forest management, because this will directly benefit over 60 percent of the population who rely on forest produce from these areas, and agroforestry second. This is understandable given the fact that its primary mandate is to focus on forestry research, not agroforestry.

Bi-lateral and multi-lateral projects There has been substantial bi-lateral and multi-lateral activity in community forestry, agriculture and soil conservation, with different projects supported by different donors working in slightly different ways in their "own" districts, but all within the context of HMGN policies (e.g. Agriculture Perspective Plan and Master Plan for Forestry Sector). Activities (such as formation of forest user groups (FUGs), hand over of management of community forests, distribution of tree and grass seedlings for planting on common and private lands as measures for soil conservation etc.) have been planned and implemented as part of the community forestry and soil conservation strategy, and are all in collaboration with Forest and Soil Conservation Department staff at the national and district levels. These projects support work on agroforestry to some extent (more extension and training and, to a lesser extent, research) for different reasons. Most community forestry projects see agroforestry as an essential complement to community forestry.

Bi-lateral projects have no research capacity of their own in agroforestry and rely on others for technical information; but some of them are able to fund others to do research if needed. For example, NACFP is currently commissioning some studies from NAF.

Hills Agricultural Research Project - HARP - is a major new bilateral (DFID-supported) project, designed to assist the transition towards full incorporation of LARC and PAC within NARC in 1998. HARP is assisting in designing the restructuring of both LARC and PAC to enable them to be proactive in seeking external research funds (including bidding for funds from HARP and other donor institutions) in a competitive environment.

National and International Non-Government Organisations (NNGOs and INGOs) In recent years, the NGO sector has been emerging rapidly and donor interest in it is increasing. Some of the NNGOs, e.g. NAF, and INGOs, e.g. CARE, have been active in agroforestry development and promotion. This, together with the lack of commitment to agroforestry research by government research organisations as well as the less secure funding situation for the hill agricultural research centres (LARC and PAC), is leading to a movement of qualified staff from these centres to the NGO sector. With the incorporation of expertise in the interdisciplinary field from these centres, the NGO sector has now strengthened its position for agroforestry activities. However, as with bi-lateral and multi-lateral projects, most NNGOs and INGOs are more concerned with extension and development activities than research.

A few National and INGOs are involved in small-scale research on agroforestry. NAF has been (and still is) doing research funded by Ford Foundation and Nepal Australia Community Forestry Project (NACFP). NAF's research findings on lopping height and practices on farmland are now incorporated into their extension activities in other hill districts. A Nepal UK Forestry Research Project (NUKFRP) study recently completed with NAF is now being written up.

CARE/Nepal has no provision for agroforestry research, but uses participatory action research as part of its field activities (e.g. participatory varietal selection) and has recently conducted a

study of farmer experimentation over several years within a CARE/Nepal project area (Bala Ram Thapa, pers. comm., 1997).

Local NGOs, Community Based Organisations (CBOs), and Forest User Groups (FUGs)

During the field work for this study, we were able to observe a number of local NGOs', community-based organisations' (CBOs) and forest user groups' (FUGs) agroforestry related activities which are often, but not always, supported by national and international NGOs and bi-lateral projects. Some of the CBOs and FUGs seem to be actively involved in agroforestry experimentation both on farmers' fields and in communal lands. Compared to the research programmes and activities planned and implemented by government research organisations like NARC and FORESC, CBOs' and FUGs' experimentation appeared to be more village focused, participatory, and oriented to farmers' needs and problems, although not as rigorous in terms of the experimental design. There is a lot of potential for involving these local organisations for co-ordinating agroforestry research in the field.

(4) Training and skills of scientists and professionals

Another constraint critical to agroforestry research in Nepal is the general lack of understanding and skills required for agroforestry research by scientists and professionals.

As indicated earlier, there has now been a move towards forming agroforestry and other interdisciplinary research working groups (NARC, FORESC, LARC, PAC) drawing people from relevant disciplines. However while the formation of working groups is a positive step, most of these individual professionals have background and training on disciplinary grounds and lack the experience and skills needed for interdisciplinary agroforestry research. There is limited provision within the country for such training, perhaps due mainly to the fact that the various institutions and organisations have traditionally been set-up on disciplinary lines.

(5) RNRRS structures and procedures

Agroforestry cuts across the boundaries of many of the 11 programmes which constitute DFID's Renewable Natural Resources Research Strategy (RNRRS). There is a danger of potential projects based on interdisciplinary research being sidelined in favour of those designed on conventional, disciplinary lines when decisions for funding are made. In addition, the various purposes and outputs included in the programme logical frameworks to guide the development of research proposals currently emphasise the bio-physical aspects of research. There is little explicit provision within the disciplinary programmes for consideration of either socio-economic or institutional aspects of research in natural resource management. This is critical, especially when the RNRRS (and DFID generally) includes poverty alleviation and economic sustainability within its purpose and goals.

An RNRRS agroforestry research strategy for the hills of Nepal should therefore be robust enough to guide project design and funding decisions in all those programmes and production systems which include Nepal as a focus or target country. DFID, through the Natural Resources Policy and Advisory Department (NRPAD), also needs to ensure that procedures are in place to allow maximum synergy and complementarity between the different programmes and production systems.

Many research projects funded under RNRRS naturally involve collaboration between UK institutions and bi-lateral development projects within the UK-Nepal aid programme. Concern has been expressed that the process of preparing proposals in response to Programme and Production System "calls" does not allow sufficient time (or resources) for effective collaboration at the design stage: a bi-lateral project which itself is the outcome of a long process of dialogue between UK and HMGN partners may find itself having to make decisions

quickly about a collaborative RNRRS proposal without time to consult widely with Nepalese partners, which may be perceived later by Nepalese (bi-lateral) project partners as a rather "top-down" way of doing things.

This danger is reduced to the extent that programme goals, purposes and outputs have been determined in collaboration with in-country stakeholders, but there remains a possibility of the RNRRS project decision process creating some misunderstanding between UK and Nepalese partners in bi-lateral projects. Proposal writers, PAC members and Programme Managers (PMs) / Production System Leaders (PSLs) also need to recognise the real costs incurred by in-country Nepal-UK projects (staff time, vehicle use, etc.) which have not been anticipated in existing project budgets and log-frames.

DFID / RNRRS recognises this as a problem area. DFID is mainly constrained by the competitive process within RNRRS programmes and by the requirements of project cycle management. Efforts are, however, being made to avoid difficulties arising in practice.

A proposed strategy for RNRRS-supported agroforestry research for the hills of Nepal

(1) Research objectives (purpose)

The overall objective of agroforestry interventions, and therefore of research to support agroforestry interventions, is to improve the livelihood of rural communities through contributing to the productivity and sustainability of their farming systems. The specific objectives may be as diverse as:

- improved soil fertility and increased crop production
- sustainable utilisation of natural resources, including forests and trees
- increased availability of fodder, fuelwood, timber and other various non timber forest products
- income generation
- environmental protection and soil conservation.

Taking into account the current (mid-1997) logical frameworks for relevant programmes and production systems within RNRRS, an appropriate purpose for an agroforestry research strategy for the hills of Nepal would be:

sustainability of hillside production and livelihood systems enhanced through improved agroforestry practices on both private (agricultural and non-agricultural) and public or community land.

In this context, 'sustainability' includes environmental, social and economic sustainability, and the recognition that sustainability depends, inter alia, on RNR users' having a range and diversity of options from which to select and adapt.

Under FRP, it is a requirement that research funded under the programme will be of relevance to at least two countries. Given the location-specific nature of much agroforestry knowledge and practice, it will be necessary to identify those research outputs which can realistically be addressed by undertaking activities in another country as well as Nepal.

It is also important that a research strategy should:

- take explicit account of socio-economic factors (including gender issues, equity, labour supply, and changing markets for livestock, crop and tree products)

- be geared towards providing options for farmer and community decisions: the assumption that agroforestry intervention is an appropriate - or the only appropriate - way forward for farmers in a specific situation should not be taken for granted
- encompass production on both private and community (including FUG managed forest) land, in view of the interactions and possible trade-offs between them.

(2) Proposed outputs and research topics

To contribute to the above purpose, the following outputs are proposed. Further discussion on these and how they might be addressed can be found in the section on research priorities above.

(i) Farmers' criteria, priorities and knowledge integrated effectively in agroforestry research

This output refers not only to the need for fuller and more systematic documentation of farmers' knowledge, but also to the recognition that the specification of research problems and the design of research studies will be much more appropriate if they take account of farmers' knowledge and their criteria for evaluating research findings and technologies. Research will therefore be needed to develop and test new procedures, research designs and protocols which incorporate farmer knowledge and their active involvement in research. This could be done within FAIPS and HPS, with possible support from SEM which is already funding research on farmer-participatory methodologies and on the incorporation of local knowledge in RNR research (though not in Nepal).

(ii) Productive potential of farming systems sustained and increased through development of appropriate species and management options for tree-crop combinations on private farm land¹

One of the most widespread agroforestry practices in the mid-hills is the growing of perennial species, mostly (but not exclusively) for winter fodder, on crop terrace risers on *bari* land. There are some interesting location-specific examples of trees on *khet* land, but the value of the rice crop and the complications of growing trees in irrigated and inundated conditions are likely to remain barriers to farmers' incorporating more trees. Nevertheless, the fact that farmers in some situations find it an appropriate option to grow (or protect) trees on *khet* land suggests that research is needed to help them overcome the above constraints.

Trees on terrace risers are tolerated in association with crops on *bari* land, despite their competitive effects on crops, because farmers value tree fodder as a dietary supplement for livestock at key times in the dry season, when green fodder is not available from other sources. Firewood and timber are secondary products which may be obtained from fodder trees as well as from other trees growing on uncultivated farmland (in gullies, for example).

There is some evidence that (a) farmers do not have as many trees of some species as they would like because they are difficult to propagate, and (b) farmers would like more trees on farm but do not increase the number or size because of their competitive effect on crops. Farmers have key gaps in knowledge relating to below-ground interactions and specifically the effect of tree pruning on the competitive ability of different tree species and hence appropriate management strategies to optimise fodder supply while controlling competition with crops. Recent research outside Nepal suggests that ecological combining ability of trees with crops varies markedly with tree species and that only some species respond appropriately to silvicultural management. Furthermore, attributes of tree root systems that confer advantages for intercropping appear to be heritable (Dasanayake, 1996).

¹ The following four paragraphs are based on a communication from Dr Fergus Sinclair, of University of Wales, Bangor.

Integrated research is therefore needed on:

- tree fodder (and other product) value
- tree-crop interactions
- effects of trees on long-term soil fertility and soil erosion

which will inform participatory tree and crop breeding programmes and result in appropriate species and management options.

Biophysical research could be jointly supported by FRP and PSP (with PSP extending its current support for farmer participatory variety-selection to annual crops grown in agroforestry systems - for example to identify shade tolerant varieties). System interactions would be more suited to HPS and FAIPS support.

(iii) Household income increased through production of high value, marketable products

Research under this output would improve our understanding about income generating activities from agroforestry and agroforestry enterprises that can provide direct benefit to the farming communities, especially the disadvantaged groups, including both utilisation of existing agroforestry systems and developing newer options for future adoption, while ensuring the diversity and sustainability of the natural resources. Specific research topics could include:

- survey and documentation of existing agroforestry activities and enterprises from which the farmers are currently deriving income;
- exploring the market opportunities for agroforestry products;
- assessment of the existing potential agroforestry innovations that could bring improvement in the current economic situation of the farming communities, especially the small land-holders and landless poor;
- designing appropriate agroforestry technologies that would help produce value-added, marketable products.

An appropriate approach to such studies would be participatory action research, in which options are selected, tested, refined and evaluated by the various stakeholders.

As shown above, farmers in some situations are already realising market opportunities for agroforestry practices - including growing more fodder on-farm to enable them to increase milk production to meet market demands, and the sale of firewood from farmland. Growing of cardamom under *Alnus nepalensis* (a nitrogen-fixing pioneer tree with a high and sparse canopy) is common, especially in the eastern mid-hills. Other systems involving both understorey products and trees are being considered by farmers and their development could be enhanced by village-level domestication. This will require integrated research on targeted species with market potential. Research on both appropriate marketing channels and institutions as well as the cultivation of the species is required, and while emphasis will be on yield of the high value product, concern for associative attributes may still be necessary depending on how different species are to be integrated on-farm. Ownership of domesticated NTFPs, whether in the farm or forest, may require specific attention.

There is scope for biophysical research conducted in Nepal and other countries on the performance of species with market potential under different conditions, funded under FRP. Associative attributes and socio-economic analysis of the potential contribution to household income and rural livelihoods would be more appropriate to HPS.

(iv) Trade-off between agroforestry and other activities understood, and mechanisms developed to monitor socio-economic effects of agroforestry interventions, at household and community level

This output recognises that agroforestry interventions cannot be considered in isolation. Research will improve our understanding of the complex bio-physical and socio-economic interactions not only within agroforestry systems, but within the wider livelihood systems in which rural households allocate their resources. A major issue here is the impact of agroforestry interventions on the resources and livelihoods of households, and the inter- and intra-household distribution of the costs and benefits.

Although both biophysical and socio-economic questions need to be addressed, it is important that these are not dealt with in isolation. On the biophysical side, the following priority research topics are identified:

- optimum management of favoured fodder trees (HPS)
- ecological combining ability of different fodder tree species and management combinations (FRP)
- below-ground tree-crop interactions (FRP)
- effect of tree pruning on root system (FRP)
- crop yield responses to management of the tree component (HPS)
- shade tolerance of local crop varieties (HPS)
- crop and tree selection and breeding (FRP, PSP)
- erosive impact of different tree species. (HPS)

On the socio-economic side, priority topics are:

- developing indicators of fodder value (farmer and laboratory) of species and mixes of fodder species (HPS)
- understanding farmers' knowledge about soil fertility, quantity of nutrient capture from deep soil and nitrogen fixation (HPS, SEM)
- decision making and trade-offs at household level between land/labour uses, and between enterprises (HPS, SEM)
- gender and socio-economic analysis of the impacts of agroforestry interventions (HPS, drawing on outputs from SEM)
- comparative analysis (between countries) of the influence of government policy on agroforestry activities at community and household level (FRP).

(v) Productive potential of non-agricultural private and community land increased through development of appropriate agroforestry systems and practices

If agroforestry is to have a significant impact on the productivity and sustainability of small scale farms and on the livelihoods of resource poor households, research must encompass the potential of non-agricultural land. Research topics should include:

- tree-crop interactions in community forest (HPS)
- selection of agroforestry tree species and crop varieties suitable for non-agricultural lands (HPS)
- domestication of NTFPs (FRP, HPS)
- identification and development of agroforestry systems and practices appropriate to non-agricultural lands (HPS).

(vi) Adaptation and uptake of agroforestry systems and practices increased through increased understanding of processes of information generation and exchange in relation to agroforestry

Many farmers are actively experimenting with the integration of trees and other perennial species on their farmland (species evaluation, comparison of silvicultural and management

practices); and some FUGs and communities are trying new ways of increasing the productivity of forest and non-forest common access land. Improved understanding of what they are doing and trying to achieve, and of the processes involved, will enable researchers to develop new procedures for on-farm and farmer-participatory research which will increase farmer "ownership" and the likelihood that outputs will be rapidly communicated within the rural social system.

It was suggested earlier that research is needed on factors that trigger community members to become engaged in agroforestry research, characteristics of community members who become engaged in agroforestry research, processes which farmers use for experimentation, processes through which the results are communicated, characteristics of knowledge and information that are communicated, or not communicated, and factors that contribute to the processes of knowledge being transferred, or that stop the knowledge and information from being transferred.

This issue is of concern not only in Nepal - and not only in relation to forestry and agroforestry. It could therefore be taken up by FRP in association with SEM.

(3) Cross-cutting issues

There are several sets of issues which all agroforestry research should take into account and incorporate. These include the *socio-economic dimensions* of agroforestry systems and interventions. Even in research which is essentially bio-physical, it is important that the results are subject to economic and social analysis. At the simplest level, for example, the farm, household and community level economics of any proposed agroforestry innovations must be analysed, including risk analysis. Research proposals should indicate how this will be done.

Similarly, it has been shown above that agroforestry interventions and changes can have significant *equity and gender* effects. All research proposals should include explicit gender and equity analysis of the problem or issues to be addressed by the research, in order to identify potential gender and equity implications of the expected outputs, and to indicate how gender and equity issues are taken into account in research design.

Institutional issues include land and tree tenure and their effects on individual and collective decision making in relation to agroforestry practices and natural resource management.

In view of the importance of local knowledge, both as a means of identifying researchable gaps and constraints and in ensuring that research objectives and designs take account of farmers' criteria for judgement and decision, all research proposals should include a review of what is known about local knowledge in relation to the topic/issue/problem to be addressed by the research, or incorporate the preparation of such a review into the proposed research.

(4) Institutional arrangements for agroforestry research

Having appropriate institutional arrangements in place is a major determinant of successful achievement of research objectives. DFID/RNRRS strategy for addressing the institutional issues should be at two different levels. The first relates to the lack of appropriate institutional arrangements for planning and implementing agroforestry research within Nepal. There is an urgent need for the establishment of a close link between the two major research institutions, NARC and FORESC, responsible for agricultural and forestry research programme. A task force comprising representatives of NARC, FORESC, IOF, IAAS, some key bilateral and multilateral projects and NGOs would be an appropriate mechanism to work out the solution. DFID could promote this idea and assist in its implementation, perhaps through HARP.

Pending such a solution, In the mean time, a modest amount of funding could be allowed for research by NGOs.

The other level is related to the mechanisms through which DFID/RNRRS makes funds available for agroforestry research. We suggest:

- after the acceptance of concept notes, adequate time, and a modest amount of funding, be allowed for discussions with potential in-country collaborators and for their participation in developing a full research proposal
- local NGOs and CBOs be considered appropriate research partners, particularly in the management of off-station research
- all proposals should indicate that collaboration is in place to cover adequately all the biophysical and socio-economic disciplines relevant to the research.

(5) Farmer participation in research

The norm should be that farmers are active partners in all agroforestry research, both off- and on-station, and proposals should indicate how this will be achieved. Research should also take account of farmers' own experiments and seek both to learn from and to enhance farmers' experimental procedures. SEM is due to publish "Best Practice Guidelines" shortly on farmer participatory research within RNRRS programmes.

Contribution of outputs

The outputs presented above will contribute to DFID's developmental goals through their effect on funding decisions within relevant RNRRS Programmes. The contribution is an indirect one and depends on the implementation of the above recommendations in the development of a systems-based research strategy which gives due weight to socio-economic issues and incorporates farmers and their priorities and knowledge. The outputs provide a basis for a coherent research strategy which can deliver more productive and sustainable technologies and management practices.

The intended users of the outputs are, principally, RNRRS Programme Managers, developers of research proposals, and DFID advisers. They will be made available through the distribution of this Final Technical Report and the substantive research report (Garforth and Malla, 1997), and discussion of them at relevant Programme Advisory Committees. Distribution will be done by HPS Production System Leader.