Status of forest genetic resources conservation and management in Nepal

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Introduction

Conservation is the management of genetic resources so that they can provide the greatest sustainable yield to benefit the present generations while preserving their potential to meet the needs and aspirations of future generations (IUCN 1980). More than 70% of the people of Nepal still depend largely on forests for medicines and other products. Thus, conservation and sustainable utilization of forest genetic resources (FGR) is very important for Nepal, for the present as well as for the future.

Status of forest resources in Nepal

Nepal is a land-locked, mountainous country, located along the southern slope of the Himalayas between India and China, situated at the junction of the Indo-Malayan and Palaearctic Biogeographic Realms. Within a distance of less than 150 km, the land rises dramatically from less than 100 m asl. in the tropical Terai in the south to the highest point in the world (8848 m), on the edge of the Tibetan plateau. Nepal has an area of 147 18 km^2, of which the forest area covers 55 180 km^2, approximately 37% of the total area. According to the 1991 census, the total population of the country was 18.5 million, with an annual growth rate of 2.17%. The economy is still largely rural and agrarian.

Based on aerial photographs taken during 1992-1996, forest cover of Nepal was estimated to be 29%. In addition, 10.6% of the area was found to be degraded shrubland; thus 39.6% of the country's land is under forests (DFRS 1999).

Nepal is a small country but rich in biological diversity. It has 5400 species of vascular plants, including over 254 endemic plant species and 700 species of medicinal plants. In addition, over 175 species of mammals, 850 species of birds, 600 species of butterflies, 50 species of moths, 180 species of dragonflies, 170 species of fish, and other animals inhabit this country. With only 0.15% of the world's forest, Nepal has 2.2% of all known plants and 9.4% of all known bird species. Many valuable genetic resources are conserved in the protected areas for their potential use in the future.

Nepal has 16% of its area protected to conserve wildlife, FGR and ecosystems. However, research and management activities mostly concentrate to conserve wildlife alone. Many valuable tree species are growing inside conservation areas, but scientific studies on their identification, validation, conservation and management are yet to be initiated.

Utilization of trees

Forest trees are an integral part of rural livelihoods in Nepal (Figure 1). They dominate not only the landscape but also the way people live. Forests provide 75% of the total energy consumed in the country (fuelwood) and more than 40% of fodder for livestock is extracted from forests (MPFS 1988). Besides, they play a dynamic role in protecting the fragile mountain ecosystems and maintaining diverse and complex ecosystems of the country (Thomson 1995).

Identification of threats

Hill forests are a key resource in the Nepalese economy, providing fodder, timber and fuelwood. Their degradation has long been a concern. IDA's Forestry Sector Review of 1978 identified two major problems, which are still relevant today: the rural energy crisis and the environment deterioration caused by over-utilization of forests.

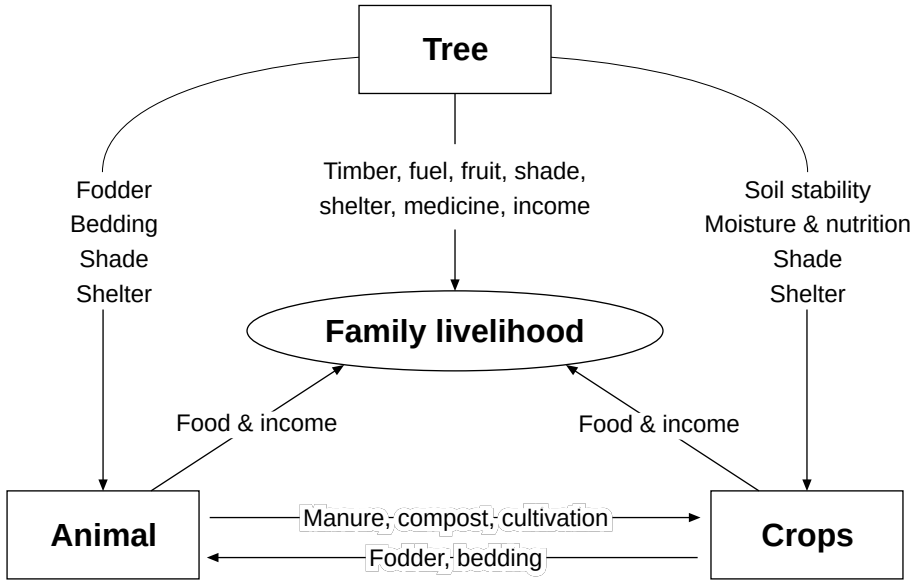

Figure 1. Nepal's tree-animal-crop farming system

Due to increasing population, there is a heavy pressure on the forest of Nepal for material needed for subsistence, such as fuelwood and fodder, as well as landuse changes. It was estimated that 10.6% of Nepal's forests degraded to shrubland in 12 years, whereas the population has been increasing at a rate of 2.1 % annually (Table 1) (DFRS 1999). Declarations on conservation of biodiversity during the Rio conference in 1992 could remain on paper alone if immediate action is not taken to stop the growth of human population.

Table 1. Forest area decline and population growth in Nepal during the last two decades (HMGN 1968, 1974, 1998a and 1998b)

	Year		
	1979	**1986**	**1998**
Forest area	43%	37.4%	29%
Population	13.7 million	15 million	21.8 million

Increase in the population, together with illegal felling and forest encroachment is the main reasons for forest degradation. If this trend continues, the condition of the forests in the country and species diversity of valuable tree species will be adversely affected.

Overexploitation of forest trees

Nepal is rich in species diversity of forest trees; physiographic and climatic variations have created habitats for various forest tree species. There are still many forest species that are not yet identified. However, many forest tree species are providing food and services to the rural communities. Due to over-exploitation, important and valuable species, such as *Dalbergia latifolia*, *D. sissoo*, *Pterocarpus marsupium, Azadirachta indica* and *Taxus baccata* are becoming rare and even under threat of extinction. All the merchantable size forest trees have been logged illegally.

Lack of forest management

From the management perspective, Nepal's forests are divided into: Government-managed forest (GMF, national forest), community forest (CF), leasehold forest (LF), religious forest (RF) and national parks and reserves (NPR, protection forest). Large parts of the forests of the Terai are categorised as GMF. Forests of 22 Terai districts are considered as productive forests. Operational Forest Management Plan (OFMP) has been developed for 18 Terai districts, but yet to be implemented.

Hill forests are managed through the Community Forestry Programme (CFP). The CFP is the highest priority programme in the forestry sector and was initiated in 1978 (MPFS 1988). The main objective of the CFP is to manage all the accessible forests through active participation of the local people. By July 2003, 12 584 forest-user groups (FUGs) have been formed to manage more than 999 951 ha of forests. There are 1 406 947 households involved in this programme. The programme is successful in protecting and rehabilitating the forests. In this programme, users have the right to protect, harvest and manage the forest after it is handed over to them. However, all the District Forest Offices (DFOs) responsible to hand over the community forests have individual approaches and understanding of community forests though there are common guidelines and regulations. Despite these guidelines and regulations, managerial decisions might be needed to suit the local environment due to the localised nature of the FUGs. Presently, the FUGs are seeking technical assistance to manage and conserve forests.

It can be concluded that any single conservation programme is not sufficient to preserve all representative species and genetic diversity. An integrated conservation programme including *in situ* and *ex situ* conservation, community forestry and domestication is urgently needed to conserve the plant genetic resources of Nepal for their sustainable use in future.

Past and present activities in conservation, utilization and management of genetic resources

Many valuable tree species in Nepal are under threat of extinction. For better conserving these species, there is a need for a long-term commitment, strong economic base and trained manpower. In the absence of these resources, conservation of endangered and threatened forest tree species cannot move ahead as it should. It is urgent to stop the genetic depletion of forest trees to preserve future opportunities. Identification of endangered tree species, establishment of genebanks and development of appropriate propagation techniques are urgently needed to initiate conservation programme.

A practical way to preserve the valuable tree species is not only to conserve but also to utilize at the same time. Therefore, it is necessary to estimate the present status of tree species and to develop and implement a conservation and utilization programme. This would assist in supplying the needed forest products, help in carrying out management of the environment and improve the economic condition of people.

Increasing pressure on land could be minimised by making efficient use of land resources to produce more wood from the same area. In the context of forestry, it could be possibly done through a tree improvement programme (TIP), which aims to improve productivity of forests through the application of technological advances in tree breeding and propagation. In addition, TIP plays a role in conserving the genetic diversity of forest trees through the selection of plus trees from different parts of the country and establishment of a genebank.

TIP is a good option for the improvement of productivity and genetic conservation of forest trees simultaneously. The TIP in Nepal is in its infancy and is seeking a long-term commitment of the government and other assisting bodies. There are various scattered activities and coordination of these could enhance the TIP. This classical model of TIP (Figure 2) can contribute to the genetic conservation of forest trees through the establishment of a genebank and provenance trial.

Agroforestry, plantations and afforestation programme

The Department of Forest Research and Survey (DFRS) has a history of forestry research in Nepal since 1965. Forestry research has focused largely on plantation forestry. Taking note of a World Bank report in 1970 that "all the hill forests will be wiped out in 20 years time and Terai forests in 15 years", plantation forestry became the major activity of the forestry sector. Majority of the activities conducted were provenance and progeny trials. All the donors contributing in forestry sector had plantation programmes.

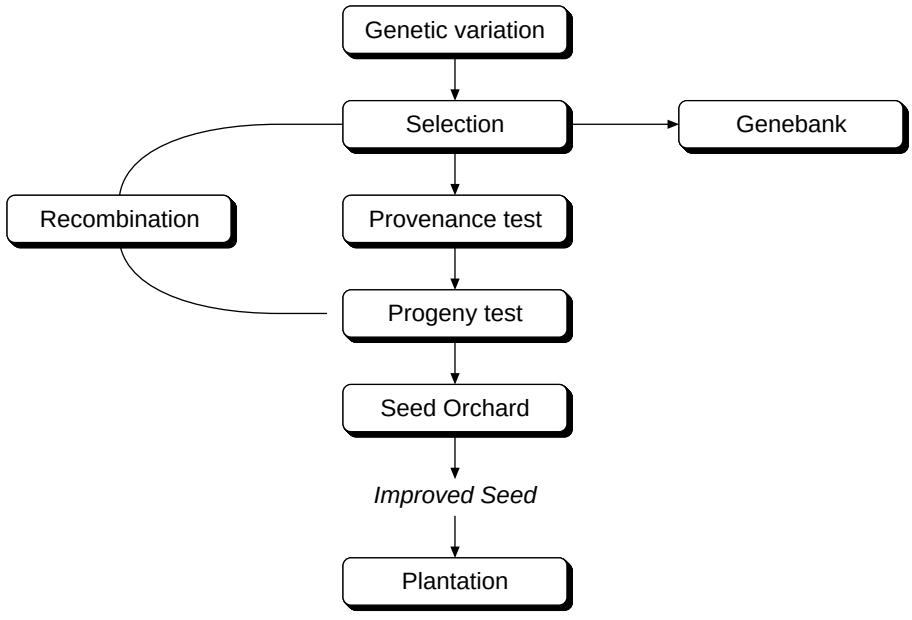

Figure 2. Classical model of a tree improvement programme

The DFRS (then Forest Survey and Research Office, later Forest Research Division) has been supported by the DFID (then ODA) to carry out research activities. Silvicultural Research Project (which was later followed by Forestry Research Projects I and II) had a main thrust on plantation research. During 1979 to 1996, a number of plantation and tree improvement studies were conducted; some 159 studies focusing on the aspects of seed, seedlings and plantations are documented in Appendix 1. There is still a substantial number of plantation and tree improvement studies, which have not been reported and are still ongoing. Appendix 2 provides a summary of the most important reports and publications in these fields.

Demand and supply of tree seed

There are two institutions active in tree domestication within the Ministry of Forest and Soil Conservation. These are the DFRS and the Tree Improvement and Silviculture Component (TISC, previously Tree Improvement Programme). There have been discussions to create an understanding between the DFRS and TISC as to which activities of tree improvement should each organization carry out to avoid duplication.

TISC is mandated to supply seed required for plantation activities in the country. TISC carries out identification, registration and management of natural seed stands of important tree species; establishment of breeding seed orchards has been initiated in different parts of the country. Detailed information on the seed stands is not available. The major goal of the programme is to conserve genetic diversity of forest trees and to supply quality seeds on a reliable basis.

The demand of farmers for fodder and fruit species in Nepal is met by many different species in small quantities from each species. Due to the scattered nature of farmers' locations, the demand could be best met through a decentralised distribution of seed carried out by farmers' associations, cooperatives and private suppliers. TISC has initiated decentralised distribution of seed through seed cooperatives. Seed cooperatives were established with the aim to collect and supply all the common seeds required for plantations. At the same time, TISC encourages and assists the cooperatives to collect and distribute more specialized seed, such as medicinal plants, important fodder trees, etc. In recent years, TISC has initiated more specialized activities in seed collecting, storage and distribution (NTFP, medicinal herbs, fodder seed, etc). Information on seed and seedling distribution by TISC is listed in Table 2 below. It can be seen that 17 166 kg of seed was distributed within a period of six years, in addition to many millions seedlings.

Table 2. Distribution of seeds and seedlings by TISC between 1992 and 1998

Species	Total seed distributed (kg)	Total no. of seedlings
Alnus nepalensis	52	1 548 000
Albizia lebbeck	802	6 416 000
Bauhinia spp.	404	469 375
Bassia butyracea	300	75 000
Choerospondias axillaris	3339	4 006 680
Cedrus deodara	48	268 800
Dalbergia latifolia	64	448 000
Dalbergia sissoo	7513	33 808 950
Eucalyptus camaldulensis	69	13 840 000
Grevillea robusta	3	15 000
Hippophae spp.	13	123 000
Juglans regia	797	15 940
Juniperus spp.	4	6300
Leucaena spp.	178	4 096 300
Michelia champaca	744	1 488 000
Pinus spp.	1874	20 581 500
Prunus cerasoides	254	304 200
Sesbania spp	14	216 000
Tectona grandis	694	346 750
Total	**17 166**	**88 073 795**

In situ conservation

In situ conservation of plant genetic resources is more effective and realistic than *ex situ*. Plant species grow and regenerate in native environment. *In situ* conservation protects the reservoir of genes for potential use in future. FGR of Nepal are preserved in national parks, and wildlife and hunting reserves. This activity started in the early 1970s aiming to conserve a representative sample of ecosystems. Currently, Nepal has eight national parks, four wildlife reserves, three conservation areas and one hunting reserve. Preserved areas cover 16.5% of total area of the country. The Department of National Parks and Wildlife Reserves is the primary agency managing these conservation areas.

These protected areas do not adequately represent all the ecosystems of the country. Most of the protected areas are located in the lowland Terai and high Himalayas. There is a major gap in the reserve system in the middle hills (500m to 3500m altitude); only 10% of the existing reserves are located in this range. The omission is significant because the middle hill zone contains 61% of Nepal's forest, out of which 57% is shrublands that are important breeding habitats for many bird species (Hunter and Yonzon 1993). Middle hill forests also consist of many valuable tree species. The potential of many forest tree species is yet to be identified, validated and scientifically managed.

A major problem with *in situ* conservation is the conflict between reserves and local people. Hence, involving local communities in conservation efforts becomes important. However, interests of local people and the conservation authorities managing these areas could be different. The sources of conflicts are forest resource use, crop damage and livestock depredation (Studsord and Wegge 1995**).** Efficient management of the buffer-zone areas could be a possible solution to preserve genetic resources of conservation area.

Forest User Groups (FUGs) are formed to protect, manage and utilize the forest outside the reserve areas. Similarly, conservation groups are formed in the fringes of these areas. Projects active in these areas are providing training on income generation to these groups to uplift their economic conditions.

Ex situ conservation

Threatened and endangered species require some protective measures to maintain a genetically viable population in the wild. It is impractical to design an *in situ* conservation programme based on individual species. So, it is necessary to design a complementary *ex situ* conservation programme.

Community forestry is a viable alternative approach for *in situ* conservation of forest trees outside the protected areas. However, a major problem is the motivation of the FUGs in conservation of genetic resources. The FUGs are more interested in utilization of forest resources than in conservation of biodiversity. Occasionally there could be some conflict due to differences in motivation of the FUGs and conservationists. Hence, some level of *ex* situ conservation becomes important. This is especially true in the case of rare and endangered species and valuable species used in tree improvement programmes. The Government of Nepal has adopted a policy to hand over all the accessible forests to the local communities in lots that they are willing and able to manage. About 61% of the total forest area of Nepal is potential community forest area.

The DFRS and TISC are the two organizations under the Ministry of Forest and Soil Conservation responsible to carry out *ex situ* conservation of forest trees in the country. Their major activities include identification, registration and management of natural seed stands of important tree species and establishment of breeding seed orchards in different parts of the country. The major goal of the programme is to conserve the genetic diversity of forest trees and to supply quality seeds on a reliable basis for the success of plantation programmes.

TISC has established breeding seed orchards to conserve the genetic resources of *Dalbergia sissoo* and *D. latifolia*. Each of these orchards is expected to yield about 400 kg of seeds annually. The seed produced in the orchards should be at least 20% more productive (Thomson 1995). TISC is also promoting the identification, registration and management of local seed sources. The main aim is to make each district self-sufficient in seed supply of highly demanded species and to conserve plant genetic resources.

For the conservation of threatened and endangered species, *ex situ* conservation is more practical than *in situ*, because these species require more protective measures. This method is more costly to operate, though. In developing countries like Nepal, where poverty-related issues are more important, policy makers could rarely be convinced to finance *ex situ* conservation of plant genetic resources.

Tree improvement

The DFRS and TISC are responsible in carrying out tree improvement studies in the country. Studies carried out by these organizations focus on identification and registration of natural stands of commercially important species as well as on genetic improvement.

Major tree improvement activities conducted by TISC

Identification of seed stands

During the identification process, registration and management of natural seed stands of important tree species are done. A total of 116 seed stands of 20 different species have been surveyed in 33 districts, out of which 54 seed stands have been registered in 28 districts. The main aims of this programme are to make each district self-sufficient in seed supply of highly demanded species and to conserve genetic resources.

Establishment of breeding seed orchards

Breeding seed orchards (BSO) of *Albizia lebbeck, Azadirachta indica, Bauhinia purpurea, Choerospondias axillaris, Dalbergia latifolia, D. sissoo* and *Michelia champaca* have been established in different parts of the country. A minimum of 25 plus trees of each species were selected from the natural stands to minimize the risk of inbreeding depression. A BSO for *D. sissoo* was the first one to be established in the country; the species has been the most popular plantation species in the Terai. The BSO for *D. sissoo* is replicated in three districts, Chitwan, Sunsari and Banke districts in successive years representing three development regions, that is, East, West and Mid-west.

Major tree improvement activities conducted by DFRS

Genetic improvement of chir pine
For the genetic improvement of chir pine, the DFRS has identified 115 plus trees from eight districts and is in the process to initiate their multiplication. The DFRS is planning to establish BSOs in different parts of the country to ensure the production of quality seeds. For more information see Appendix 3.

Provenance trials
The Forest Research and Survey Centre (FORESC) has conducted a provenance test of the two most popular species of the country, namely *Dalbergia sissoo* and chir pine on different sites of the country. In addition, provenance tests of other important species, such as *Eucalyptus camaldulensis*, *Azadirachta indica, Alnus nitida, Pinus caribaea* and *Gliricidia sepium* have also been carried out.

Mass multiplication of *Eucalyptus*
The DFRS has established a clonal bank in Sunsari District in the Eastern Region for mass multiplication of *Eucalyptus camaldulensis* to meet the growing demand of FUGs and private farmers. Some 30 plus trees of *Eucalyptus* spp. have been selected in Sagarnath Forest Development Area. Scaring was conducted at the base of the selected plus trees to allow juvenile growth. Cuttings of this juvenile growth were used to establish a clone bank. Regular cuttings from the clone bank will be taken out to produce seedlings.

Domestication
Domestication of fodder, fruit, timber and fuelwood trees and growing them in marginal agricultural lands has been practised by farmers using their indigenous knowledge. In many parts of the country, farming consists of tree-crop-animal systems (Figure 1). The success of farming system depends on the contribution of these three elements and the dynamic interplay between them (Thomson 1995). Most farmers understand this very well and plant trees on their farmlands. Many tree species found in farmland are either lost or rarely found in their natural habitats. Germplasm of these tree species have been preserved in the farming system and the farmers are regularly watching and learning the dynamism of the species.

Community Forestry Programme
To date, more than 7000 FUGs have been formed and more than 999 951 ha of forests has been handed over. The programme has been successful in involving a total of 1 406 947 households in managing the forests. The programme is found to be effective to rehabilitate the forest cover and improve the forest condition. However, limitations that need to be addressed have been observed:

1. Human resources available at the Department of Forest are not sufficient to train the FUGs in the aspects of technical skills, institutional development and self-reliance.
2. Due to the increase in population, demand for forest products in many areas has grown significantly. Because of this, forest management planning has been unable to meet the increased demand, and community forests do not produce enough to fulfil the need of users. It is questionable how long the people would accept this situation, before over-extraction becomes routine.
3. Participation of women and minority groups in decision-making, together with the dominant elite needs to be improved for equitable sharing.
4. Boundary conflicts between the FUGs and equitable sharing of benefits among the users.

Institutional framework

His Majesty's Government of Nepal has developed a 20-year Master Plan for the forestry sector in 1988. It has identified conservation of ecosystems and genetic resources as a primary programme to protect special areas.

The Forestry Sector Master Plan (MPFS 1988) put people at the centre of conservation and development process. By giving adequate priority to the Community Forestry Programme and developing subsequent programmes to cover a major part of the renewable natural resources, it has empowered people for the conservation and sustainable utilization of the resources. Likewise, the Nepal Agricultural Perspective Plan (APP 1995) has realised the significant role of agrobiodiversity and also envisaged the linkages between forestry and agricultural sectors. The Tenth Five-Year Plan (2002–2007) continues the past programmes and puts emphasis on the preparation and implementation of the National Biodiversity Strategy that covers all aspects of biodiversity conservation, sustainable utilization and fair and equitable sharing of the benefits from the conservation efforts.

Nepal signed the Convention on Biological Diversity (CBD) during the Earth Summit, 1992 and ratified it on 21 February 1994. Thus, the CBD has become the guidepost for biodiversity conservation efforts in Nepal. The World Trade Organization (WTO) through its Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement urges to register and patent biological diversity and associated property rights in order to fully obtain benefits in near future.

The Ministry of Forests and Soil Conservation in Nepal has been designated as the national focal point for the CBD. In order to successfully implement the CBD and to meet the requirements of the WTO, Nepal has initiated certain policy measures and started to implement them.

Accordingly, the National Biodiversity Steering Committee (NBSC) was formed in 1997 under the chairmanship of the Secretary, Ministry of Forest and Soil Conservation (MFSC). Representatives from various ministries (including the Ministry of Agriculture and Co-operatives, and the Ministry of Population), the National Planning Commission and NGOs (IUCN and WWF) were among the members of this committee. A National Biodiversity Unit (NBU) was formulated within the MFSC as a secretariat to the NBSC. A total of six meetings were recorded by the end of 2001.

Similarly, the Ministry of Agriculture and Co-operatives has established a National Agrobiodiversity Conservation Committee. The National Planning Commission (NPC) has also formed a National Coordination Committee for Biodiversity Conservation (NCCBC) in 2000 under the coordination of the NPC Vice-Chairman and a Biodiversity Registration Coordination Committee was formed under the coordination of the NPC Member for Agriculture. As an outcome of all these efforts, Nepal Biodiversity Strategy (NBS) has been prepared and recently approved by the government, a draft bill and policy on Access to Genetic Resources and Benefit Sharing has also been prepared and the Implementation Plan for the NBS is being prepared at the present.

National forest policy and institutional issues

As has been indicated in the previous chapters, some activities have already been initiated on biodiversity conservation. A policy has been formulated to facilitate the formulation and implementation of biodiversity conservation. However, conserving alone is not enough. There is a need for well-balanced planning to promote the concept of *use and improve*. The concept is very important in the context of this country. Nepal has successfully formed 12 584 FUGs and more are in the process. More forest area will be handed over and more households will be involved in the future. The government plans to hand over all the assessable forest if the communities demand and if they are able to manage the area. Therefore, a national forest policy should not be formulated to implement the CBD and meet requirements of the WTO alone, but it should also consider the context of development of forest management by the people of Nepal. Policy should be made to enhance the productivity of forests both qualitatively and quantitatively as circumstances demand.

Identification of national priorities

List of priority species

A seminar of the International Board for Plants Genetic Resources (currently IPGRI), held 23-25 September 1981 in Kathmandu, listed 25 tree species of Nepal as threatened and vanishing (Table 3). It was noted that a more subtle loss of biological diversity was occurring through the loss of genetic variation within species. The possible reasons may be the outright destruction of tree populations, reduction in range and fragmentation of populations into isolated units that are so small that inbreeding becomes a significant factor in survival.

Table 3. List of threatened and vanishing forest tree species of Nepal (Anon 1982)

Scientific name	Scientific name
1. *Abies pindrow*	14. *Larix griffithii*
2. *Abies smithiana*	15. *Michelia champaca*
3. *Acacia catechu*	16. *Myrica nagi*
4. *Adina cordifolia*	17. *Pinus roxburghii*
5. *Alnus nepalensis*	18. *Pinus wallichiana*
6. *Boehmeria rugulosa*	19. *Pterocarpus marsupium*
7. *Bombax ceiba*	20. *Quercus semecarpifolia*
8. *Bassia butyracea*	21. *Quercus species*
9. *Cedrela toona*	22. *Rhododendron arboreum*
10. *Choerospondias axillaris*	23. *Shorea robusta*
11. *Dalbergia latifolia*	24. *Terminalia species*
12. *Dalbergia sissoo*	25. *Tsuga dumosa*
13. *Gmelina arborea*	

In addition, some tree species from Terai, the Middle Hills and Himalayan forests were identified to be threatened and vanishing (Table 4).

Table 4. List of species identified as threatened and vanishing in Terai, Middle Hills and Himalayan forests.

	Terai	Middle hills	Himalayan forest
1	*Shorea robusta* (in danger of extinction)	*Bassia butyracea*	*Pinus wallichiana*
2	*Dalbergia latifolia* (vanishing fast)	*Pinus roxburghii*	*Tsuga dumosa*
3	*Bombax ceiba*	*Alnus nepalensis*	*Larix griffithii*
4	*Gmelina arborea*	*Choerospondias axillaris*	*Quercus semecarpifolia*
5	*Terminalia* spp.	*Pinus wallichiana*	*Abies smithiana*
6	*Michelia champaca*	*Rhododendron arboreum*	*Abies pindrow*
7	*Pterocarpus marsupium*	*Quercus* spp.	
8	*Adina cordifolia*	*Boehmeria rugulosa*	
9	*Cedrela toona*	*Myrica nagi*	
10	*Acacia catechu* (disappearing from the natural habitat)		
11	*Dalbergia sissoo*		

The first meeting of the TIP was held at the DFRS in 1992. Many professionals from different departments under the Ministry of Forest and Soil Conservation, and the Forest Tree Improvement Project (FORTIP) representative attended the meeting. This meeting listed ten nationally important forest tree species that require breeding and propagation research (Table 5).

Table 5. Ten important tree species identified at the first meeting of the Tree improvement programme in 1992

	Scientific name	Vernacular name
1	*Acacia auriculiformis*	(exotic species)
2	*Acacia nilotica*	Babul
3	*Alnus nepalensis*	Utis
4	Bamboos	Bans
5	*Dalbergia sissoo*	Sissoo
6	*Eucalyptus camaldulensis*	Masala
7	*Ficus* spp	—
8	*Pinus patula*	Patle salla
9	*Pinus roxburghii*	Khote salla
10	*Tectona grandis*	Teak, Sagawan

After the discussion it was agreed at the meeting that, to avoid duplication, each institution would carry out a specified activity. The list of species allotted for the DFRS to conduct tree breeding and propagation activities included:

- *Alnus nepalensis*
- *Eucalyptus camaldulensis*
- *Artocarpus lakoocha*
- *Pinus roxburghii*

In addition, the DRFS would also establish a potted seed orchard of *Dalbergia sissoo* from the juvenile cuttings. See Appendix 4 for more details.

Support activities

Training and capacity building

There is a need for a long-term commitment, strong economic base and trained human resources to improve the conservation and sustainable use of threatened species in Nepal. Human resources across the departments should be trained and awareness created. In the absence of these resources, conservation of endangered and threatened forest trees will not get any momentum. Along with the development of a national database on extant forest tree species, studies are needed to identify and document any unidentified tree species.

Research

The DFRS and TISC are conducting tree improvement studies of a few vanishing tree species through *in situ* and *ex situ* conservation activities. Similarly, the CFP is also contributing to the genetic conservation of forest trees. FUGs are seeking for assistance from forest technicians for better conservation and utilization. Many valuable forest tree species are preserved through domestication on private lands of the farmers.

The DFRS is actively working on *Eucalyptus* spp., *Azadirachta indica*, *Schima wallichii* and also conducts provenance tests of these species. TISC is active in establishing seed stands in the natural forests, plantations, farmlands and studying species such as *Albizia lebbeck*, *A. procera*, *Artocarpus heterophyllus*, *Azadirachta indica*, *Cassia siamea*, *Casuarina equisetifolia*, *Lagerstroemia ovalifolia*, *Schima wallichii*, *Tectona grandis* and *Terminalia chebula*.

Regional and international collaboration

In 1995, the DFRS initiated a contractual agreement for improved research in tree improvement. Several activities were planned and executed. However, due to unfortunate situations and circumstances the project was stopped. For more details on international projects, see Appendices 1, 2 and 4. Nevertheless, the infrastructure and provenance trials are still intact and reporting is yet to be made. The DFRS therefore has a lot of potential in the field of tree improvement.

Recommendations

Establishment of national parks and reserves to represent all ecosystems

The existing network of national parks and wildlife reserves is not representative of all the different ecosystems in the country. These are concentrated in the high Himalayas and lower Terai. National parks and reserves need to be established in the Middle Mountain regions to conserve all representative ecosystems.

Tree Improvement Network

Financial assistance for the TIP should be increased and more partners for technical enhancement should be searched. The TIP should be reviewed and improved. Involvement in the programme should not be limited to the DFRS and TISC alone but be extended to Department of National Parks and Wildlife, Department of Plant Resources and other concerned institutions in the country. A coordinated Tree Improvement Network should be formed and include these institutions. Depending upon the mandate, specialised activities should be developed and implemented through this network. This network could work as a separate office with the experts from all the member institutions. Some suggested activities for the network include:

1. Identification of species diversity

More than 10 000 plant species are reported in Nepal but only 5400 plant species have been identified so far. There is a need to clearly identify and list out all rare, endangered and priority species.

2. *In situ* and *ex situ* conservation programme

In situ and *ex situ* approaches to conservation have significant roles in conserving and managing species genetic diversity. A clear policy and strategy should be developed for *in situ* and *ex situ* conservation.

3. Buffer zone management

Buffer zones in all national parks and wildlife reserves need to be managed to protect the core areas from population pressure.

4. Motivation of forest user groups

Forest users need to be motivated to conserve species and genetic diversity for their use in future generation.

5. Conservation through domestication

- Encourage farmers to domesticate and multiply rare, endangered and valuable species with appropriate technology.
- Identify other threatened species and develop technologies for domestication.
- Natural regeneration practices should be focused on Tree Improvement Programme.
- Management of community forests need to be improved as the Community Forest Operational Plan of the FUGs allow removal of single species in an operation based on use.

Since tree improvement studies are time-consuming, other priorities such as conservation of genes and biodiversity and the trend of returning to natural regeneration practices are taking over. Tree improvement research does not get the funding as it did in the past. Provenance trials established in the past under the tree improvement programme could, however, be used for *ex situ* conservation. They could function as gene reservoirs for populations that are either already extinct or are endangered in their natural habitat.

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Appendix 1

List of publications on seed, seedling, nursery and plantation research in Nepal

Year	Topic/title	Author(s)	Journal/Source
Seed scarification, storage and pre-germination treatment techniques			
1981	Provenance collection of *Alnus nepalensis* D. Don. (utis) seed	Lamichhaney, B. P.	NIFTIB 3
1981	The seed collection and propagation of oaks (*Quercus*) and chestnuts (*Castanopsis*)	Sharpe, A.L.	NIFTIB 4
1987	Pre-germination treatment of *Cassia siamea* and *Leucaena leucocephala* seed	Napier, I.	Banko Janakari 1(3)
1987	Seed storage in the nursery (*Prunus, Alnus*, and *Pinus* spp.)	Napier, I. and Robbins, A.M.J.	Banko Janakari 1(1)
1989	Limitations to the Seed Scarification on *Cinnamomum camphora*	Bruslem, D.F.R.P.	FRIC
Forest nursery research			
1980	Distribution seedlings and method of propagation of forest trees of Nepal	Lamichhaney, B. P. and Joshi, R. B.	FSRO Publication No. 3.
1981	Nursery notes- Damping off and root rots	Sharpe, A.L.	NIFTIB 3
1982	Nursery questionnaire: results of the 1980-81 survey	Sharpe, A.L.	NIFTIB 6
1984	Nursery research (1981-1984). End of assignment report	Sharpe, A.L.	SRP
1984	The use of mineral fertilizers in Nepal forest nurseries	Sharpe, A.L.	FSRO Publication No. 40
1985	The silvicultural trial unit nursery nutrition experiments 1982-1984	Westwood, S.	SRP
1986	Results of experiments conducted at Hetauda Forest Research Nursery 1984-1985	Westwood, S.	FSRO Publication No. 45
1989	Forest Seed and Nursery Practice in Nepal	Napier, I. and Robbins, A.M.J.	FRD
1989	Forest Seed and Nursery Practice in Nepal (*Nepalma ban biu tatha nursery prabidhi*)	Napier, I. and Robbins, M.	FRD
Propagation and germination techniques			
1983	Nursery growth problems		NIFTIB 9
1983	*Shorea robusta* - germination		NIFTIB 9
1982	Short Notes on Various Methods of Pre-treatment of Teak Seed	Lamichhaney, B.P.	FRIC
1982	Notes on germination of *Alnus nepalensis* (utis)	Lamichhaney, B.P.	NIFTIB 6
1982	Simple Techniques for the propagation of Stem-cuttings in Various Plants	Amatya, P.M.	FRIC
1983	The propagation of poplar and willow cuttings	Sharpe, A.L.	NIFTIB 8
1983	Seedbed protection against rodent and insect damage	Sharpe, A.L.	NIFTIB 9
1983	The production of naked root stock. A provisional recommendation	Sharpe, A.L.	FSRO Publication No. 37
1984	Optimum sowing times for important forest tree species in Nepal	Sharpe, A.L.	FSRO Publication No. 39
1984	Seedbed protection against rodent and insect damage	Sharpe, A.L.	FSRO
1988	Germination techniques for small seeded species in forest nurseries	Burslem, D.F.R.P.	FRIC
1988	Vegetative propagation of fodder trees. Preliminary research results and practical recommendations	Napier, I.	Banko Janakari 2(1)

Year	Topic/title	Author(s)	Journal/Source
1988	Initiation and development of roots in cuttings of three fodder tree species in Nepal	Parajuli, A. V.	Wolfson College, Oxford University, UK
1989	Germination techniques for small seeded species in forest nurseries in Nepal	Burslem, D.F.R.P.	Banko Janakari 2(2)
1989	Factors controlling the germination of *Grewia optiva*	Burslem, D.F.R.P.	Banko Janakari 2(2)
1989	Limitations to the use of seed scarification of *Cinnamomum camphora*	Burslem, D.F.R.P.	Banko Janakari 2(2)
1989	Germination of *Celtis australis*	Burslem, D.F.R.P.	Banko Janakari 2(2)
1990	In *Vitro* Propagation of *Ficus lacor* Buch. – Ham	Amatya, N. and Rajbhandary, S.B.	FORESC
1995	Optimum insertion times for vegetative propagation of *Ficus nerifolia* and *Saurauia napaulensis*	Thapa, H. B. and Burslem, D.F.R.P.	Banko Janakari 5(2)
1996	Optimum insertion times for vegetative propagation of *Ficus auriculata*, *Ficus semicordata* and *Artocarpus lakoocha*	Parajuli, A. V. and Flower, C.	Banko Janakari 6(1)
1996	Optimum insertion time for rooting of split and whole cuttings of *Saurauia napaulensis* and *Ficus nerifolia*	Thapa, H. B.	Banko Janakari 6(2)
Seedlings			
1976	Growth and development of chirpine seedlings in relation to nutrition, temperature and light.	Prajapati, K. P.	ANU, Canberra.
1978	Growth and development of chir pine seedlings in relation to nutrition, temperature and light.	Prajapati, K. P.	Nepal Journal of Forestry 1(4)
1987	Large plants for farmers.	Napier, I.	Banko Janakari 1(2)
1987	Early growth of some fodder trees at Hetauda and in the Kathmandu valley.	Napier, I. and Parajuli, A.V.	Banko Janakari 1(3)
1987	The optimum growing period in the nursery for six important tree species in lowland Nepal.	Westwood, S.	Banko Janakari 1(1)
1991	Large transplants (“large seedlings”) or stumps?	Paudel, H. L.	Banko Janakari 2(3)
1992	Bare rooted planting of *Alnus nepalensis* D. Don. in Nepal.	Lamichhaney, B. P.	Banko Janakari 3(2)
1996	Effect of root pruning and spacing on seedling growth of *Ficus semicordata* and *Bauhinia purpurea*	Parajuli, A. V. and Flower, C.	Banko Janakari 6(2)
1999	Yield of *Morus alba* cutting under different stool-bed regimes at Chalnakhel nursery.	Thapa, H. B.	Banko Janakari 9(1)
Seedling supply strategy and nursery management			
1993	Development of Seedling Supply Strategy to Meet the Needs of the Community and Private Forestry Program	Epstein, D.M., *et al*.	FORESC
Agroforestry and tree fodder research			
1990	A case study on Lending Policies geared to sustainable agriculture and forestry in Nepal	Amatya S M	A paper presented to FAO
1991	Raising fodder trees on the farmland: a preliminary study of farmers’ attitude	Amatya, S M	UK agroforestry discussion forum, Bangor
1992	Problems of Raising Fodder Trees: A study of Farmer’s concept	Amatya, S.M.	NFA
1993	Design of agroforestry research trial on the Terai	Amatya, S.M. and Kiff, E.	Proceedings of Regional Seminar

Year	Topic/title	Author(s)	Journal/Source
1993	In the process of fodder research: Guajuma ulmifolia [in nepali]	Amatya, S.M.	Kalpabrikha 3 (31)
1993	Tree fodder establishment trials in the Middle Hills of Nepal	Amatya, S.M.	Forests, trees and people newsletter No. 22.
	Fodder trees		
1985	Trees as fodder crops	Robinson P.J.	NIFTIB 11
1989	Research needs in fodder trees	Robinson P.J. and Thompson I.S.	Proceedings of the workshop on research needs in livestock production and animal health in Nepal, Kathmandu Nepal
1990	Spotlight on species: *Ficus semicordata*	Amatya, S.M.	Farm Forestry News 4 (1):6
1990	Collecting Khanyu (*F. semicordata*) figs for seeds: a practical application	Amatya, S.M.	Proceedings of the third meeting of the working group on fodder trees, forest fodder and leaf litter
1990	Summary of results of a survey on vegetative propagation of fodder trees by farmers	Robinson P.J. and KC, S.	Proceedings of the third meeting of the working group on fodder trees, forest fodder and leaf litter
1990	Some results of the Dolakha Privat tree survey	Robinson P.J.	Proceedings of the third meeting of the working group on fodder trees, forest fodder and leaf litter
1991	Focus on Oak Forest	Mathema, P.	Banko Jankari 3(1)
1991	*Ficus semicordata:* a multipurpose tree species for the lower hills of Nepal	Amatya, S.M.	Proceedings of Multipurpose tree species in Asia and Pacific, Los Banos, Philippines
1992	Spot light on species *Sapindus mukorassii*	Amatya, S M	Farm Forestry News 6(2)
1993	Agroforestry in Nepal: Research and practices	Amatya S.M. and Newman, S.	Agroforestry systems 21(3)
1994	Agroforestry Systems and Practice in Nepal	Amatya, S.M.	Department of Forest
1994	Intra specific variation in *Ficus semicordata* in Nepal	Amatya S.M.	Banko Janakari 4(2)
	Planning fodder management		
1983	Farm Fodder trees in Nepal: patterns of ownership and use	Hawkins, T.	NIFITIB 9
1986	Provisional guide to site-species matching for Nepal	Teare J.A. and Howell, J.H.	FSRO Soil Technical Note No 8

Year	Topic/title	Author(s)	Journal/Source
1986	Fodder Tree Research in Nepal: A brief review of past work and future needs	Robinson P.J.	Proceedings First Farming Systems Workshop
1986	Investigations of tree use in Farm: An example from the Tamang Community at Gairigaon	Thompson, I.S., Robinson P.J. and Shakya R.	Proceedings Third Farming Systems Workshop
1987	Proceedings of the First Meeting of the Working Group on fodder trees, forest fodder and leaf litter	Robinson, P.J.	FRIC Occasional Paper No 3/87
1988	Proceeding of the second meeting of the working group on fodder, fodder trees, forest fodder and leaf litter	Robinson, P.J.	FRIC Occasional Paper 2/88
1988	FRP activities related to fodder trees and forest fodder	Robinson, P.J.	In FRIC Occasional Paper 2/88
1988	Fodder tree survey in South Lalitpur	Upton, P. and Robinson, P.J.	In FRIC Occasional Paper 2/88
1989	Fodder trees research needs	Robinson, P.J. and Thompson, I.S.	Proceeding of 2nd NARSC, FSRDD
1990	Effect of Altitude, Aspect and Season on the Use of Fodder Tree Species in South Lalitpur District	Upton, P.	Banko Jankari 2(2)
1991	Country-wide survey of farmer's knowledge and perception about tree fodder – 1990	Upadhyay, L. R.	FRD Occasional Paper No 1/91
1991	Fodder trees and their lopping cycle in Nepal.	Amatya, S.M.	Janmabhumi Press
1991	Grazing impact on forest resource	Amatya, S.M.	NFA 6 (2)
1991	Tree crop interaction	Robinson, P.J., Amatya, S.M. and Philip, M.S.	Fifth Farming systems working Group meeting
1992	Use of tree fodder in Jhapa and Sunsari Districts in the eastern Terai	Upadhyay, L.R.	Banko Jankari 3(3)
1993	Regional Seminar on fodder trees, forest fodder and leaf litter	Mathema, P. (ed)	DFRS
1993	Study on fodder tree establishment in Central Hill Region	Amatya, S.M.	Kalpabriksha Vol 2 No 21
1993	Study on growth rate of *Acacia catechu*	Amatya, S.M.	Kalpabriksha Vol 3 No 25
1994	Growth and Production Figures for *Leucaena leucocephala* and *Ficus nerifolia* Grown on Terrace Riser	Amatya, S.M. and Kiff, E.	Banko Janakari. 4(2)
1996	Financial returns in the Nepali agroforestry Models	Amatya, S.M.	Banko Jankari 6(2)
	Managing fodder trees		
1984	Fodder Tree Seedling Survival Rate	Hopkins, C.C.G.	FRIC
1987	Evaluation for multipurpose tree growth, yield and value: issues in methodology	Robinson P.J. and Thompson I.S.	Multipurpose Tree species for small farm use workshop November 1987

Year	Topic/title	Author(s)	Journal/Source
1989	Variation of *Ficus semicordata* Buch. Ham. Ex. Smith *sensu lato* – Its Taxonomy, Distribution and Use as a fodder tree in Nepal	Amatya, S.M.	Oxford University
1993	Tools and Techniques used in Agroforestry: an overview		NFA VII (2)
1994	Management Options for *Ficus subincisa*	Amatya, S.M., Bowen, M.R. and Harvey, S.	FORESC
1984	Trees as Fodder Crops	Mathema, P.	FORESC
Plantation and plantation management research			
	Selecting species		
1982	Provenance variation of *Alnus nepalensis*	Lamichaney, B. P.	Unpublished
1983	*Pinus caribaea*: Early provenance trial results	Joshi, M. R.	NIFITIB 9
1985	Variation of *Alnus nepalensis* D. Don. in Nepal. Summer trial at Pakhribas (Dhankuta)	Lamichhaney, B. P.	NIFITIB 11.
1987	Choice of species for afforestation in the mountains of Nepal	Howell, J. H.	Banko Janakari 1(3):7-14
1988	The Species Site Requirements for Nepal	Howell, J.H.	FRSO
1989	Six Nepal Provenance of *Dalbergia sissoo* Roxb	Neil, P.E.	FRIC
1989	Preliminary provenance testing of *Dalbergia sissoo*	Neil, P.	Banko Janakari 2(2):113-114
1989	Eucalyptus, or other exotics, or indigenous species?	Neil, P.	Banko Janakari 2(2):109-112
1990	Preliminary results from trials of exotic acacias	Neil, P.	Banko Janakari 2(3):213-219
1990	Some promising early species results from the Bhabar Terai	Neil, P.	Banko Janakari 2(3):279-280
1990	*Gliricidia sepium* provenance testing in Nepal	Neil, P.	Banko Janakari 2(4):399-402
1990	*Indigofera teysmannii* – a species for the Terai and Bhabar Terai	Neil, P.	Banko Janakari 2(4):403-405
1990	*Leucaena leucocephala* variety trial in Nepal	Shakya, R.	Nitrogen Fixing Tree Research Reports 11:84-85
1990	*Dalbergia sissoo* provenance testing in Nepal	Neil, P.	Nitrogen Fixing Tree Research Reports 8:130-132
1991	Preliminary results of broadleaved species in the Middle Hills of Nepal	Shakya, R.	Banko Janakari 3(1)
1992	Provenance trial of *Gliricidia sepium* in Dhankuta District	Sherpa, S.L.; Joshi, L. and Shakya, R.	Banko Janakari 3(3)
1997	Appropriate Tree Species for Plantation in Waterlogged Sites in Terai Region Of Nepal	DFRS	DFRS
2001	Preliminary findings on provenance trial of *Azadirachta indica* in western Terai, Nepal	Thapa, H. B.	Banko Janakari 11(1):39-43
	Plantation research		
1976	Planting tropical pines in Nepal	Amatya, D. B.	FRSO Publication No. 27
1980	Silvicultural Trials Unit. Research Report. Planting Programme –1980 Report	FSRO	
1981	Silvicultural Trials Unit. Research Report. Planting Programme –1981 Report	FSRO	
1982	*Eucalyptus* species for energy production	Amatya, S.M.	Tribhuwan University
1982	Silvicultural Trials Unit. Research Report. Planting Programme –1982	FSRO	FRIC

Year	Topic/title	Author(s)	Journal/Source
1983	Silvicultural Trials Unit 1983. Planting Programmes Report	FSRO	
1983	The potential role of *Leucaena leucocephala* in forestry in Nepal	Hawkins, T.	NIFITIB 8
1985	An interim report on tree species trials in Resource Conservation and Utilisation Project (RCUP) area	Joshi, R. B.	Unpublished report.
1985	Tistung Trial Sites. Silvicultural Trials	FSRO	
1985	Planting Summary. Silvicultural Trials Unit	FSRO	
1986	Adabhar trial research results	Hawkins, T.	
1987	Forestry Research Compendium – to 1986	Hudson, J. M.	FRIC Occasional Paper No. 1/87.
1987	Forestry Research in Nepal up to 1986	Hudson, J. M.	Banko Janakari 1(2):3-14
1987	New Forestry Research in Nepal, 1987	Hudson, J. M	FRIC Occasional Paper No. 1/88.
1989	New Forestry Research in Nepal -1988	FRD	Unpublished
1989	Research Experience with pines in Nepal	Neil, P.	Banko Janakari 2(2):103-107
1990	Early performance of *Paulownia* species	Neil, P.	Banko Janakari 2(3):220-222
1990	Establishment techniques for broadleaved tree species in the middle hills of the central region of Nepal	Shakya, R.	Unpublished
1990	Research trends and the forestry research database for Nepal	Neil, P.	FRIC Occasional Paper 1/90.
1990	Plantation establishment pattern for community forestry plantation in the Bhabar Terai	Shakya, R.	Banko Janakari 2(4):407-409
1990	Experience with Australian acacias in Nepal	Neil, P.	Nitrogen Fixing Tree Research Reports.
1990	Possible techniques for raising and planting sandalwood in Nepal.	Neil, P.	Banko Janakari 2(3):223-228
1991	A role for *Pinus maximinoi* and *Pinus greggii* in Nepal's afforestation efforts.	Neil, P.	Commonwealth Forestry Review 70 (40):191-200
1994	Effect of Application of Compost, Fertilizer and Plastic Mulching on the establishment and growth of *Prunus cerasoides*, *Ficus auriculata, Ficus semicordata* var. *montana Amatya,* and *Ficus nerifolia*	Suwal, M.R., Shrestha, R.K. and Thapa, H.B.	Lumle Agricultural Centre
1994	Manual of afforestation in Nepal (two volumes)	Jackson, J. K.	FRD
1994	Forest Research in Nepal - Contribution towards environment conservation	Joshi R.B. and Amatya, S.M.	Regional Conference on Environment and Biodiversity
	Growth and productivity of plantations		
1982	Some preliminary estimate of the productivity of plantation grown *Tectona grandis* and *Dalbergia sissoo* at Sagarnath, Nepal	Joshi, M.R	FRSO Publication No. 35
1992	A comparison of growth rates and development of some fuel wood tree species in the eastern Terai of Nepal	Thapa, H.B.	Unpublished

Year	Topic/title	Author(s)	Journal/Source
1994	Growth performance of *Dalbergia sissoo* as fuel wood species in lowland of Nepal	Joshi, R.B.	Banko Janakari 4(2):154-156
1997	Early growth performance of some tree species on waterlogged sites in Nepal's Terai	Joshi, R.B.; Thapa, H.B. and Oli, B.N.	Banko Janakari 7(1):10-14
1997	Growth performance of *Dalbergia sissoo* provenances of Nepal and Pakistan	Joshi, R.B. and Thapa, H.B.	Banko Janakari 7(2): 27-31
1998	Growth of five fast growing tree species in the Terai of Eastern Region of Nepal	Thapa, H.B.	Banko Janakari 8(2): 14-22
1998	Early selection in tree breeding programme: a review	Dinesh Karki and S.J. Lee	Banko Jankari 8(2)
2001	Growth and fuel wood production of *Cassia siamea* and *Eucalyptus camaldulensis* under short rotation in the eastern Terai of Nepal	Thapa, H.B. and Subedi, N.	Banko Janakari 11 (2): 34-41
	Plantation management		
1982	Some preliminary indicators from research for forest management guidance in the hills of central Nepal	Joshi, M.R. and Wyatt-Smith, J.	NFTIB. 7
1982	Planting with naked-root stock (preliminary results)	Joshi, M.R.	NFTIB. 7
1987	A greater role for broadleaved species in the mid-hills	Shakya, R. and Thompson, I.	Banko Janakari 1(2): 18-20
1987	Tree planting and natural succession at Pipal Chaur, Sankhu	Thapa, H.B. and Budhathoki, S.K.	Banko Janakari 1(3): 15-16
1987	Early thinning and pruning yields from *Pinus patula*	Thapa, H.B.	Banko Janakari 1(3): 17-20
1988	Invasion of pine plantation by broadleaved species	Thompson, I.	Banko Janakari 2(1): 66-67
	Species/Plantation Silviculture Research		
1982	*Pinus patula*	Neville, G.A.	FRIC
1988	Eucalypt provenience research in Nepal	Neil, P.E.	IUFRO meeting, Pattya, Thailand
1989	Variation of *Ficus semicordata* Buch. Ham. Ex. Smith *sensu lato* – Its Taxonomy, Distribution and Use as a fodder tree in Nepal	Amatya, S.M.	Oxford University
1989	*Ficus semicordata* Buch. Ham. Ex Sm. and Its Taxonomy	Amatya, S.M.	FRSD
1990	Notes on *Acrocarpus fraxinifolius*	Neil, P.	Banko Janakari 2(4): 391-393
1992	Notes on carob tree (*Ceratonia siliqua*)	Amatya S.M.	Banko Janakari 3(4)
1992	Sissoo	Mathema, P.	FORESC
1993	*Dalbergia sissoo*: A Compilation of Papers Published in Nepal	Forest Research Division	FORESC
1995	*Alnus nepalensis* D. Don. (A detailed study).	Lamichhaney, B.P.	FORESC Monograph 1/95.
1998	Neem: Parichaya Tatha Ek Prarambhik Adhyayanko Natija (Neem: Introduction and results of one preliminary study)	Thapa, H.B.	Abhiyan 1(2):12-18. Balkot Development Society. September 1998.
1998	Teak	Thapa, H.B.	FORESC
1993	Ritha: A cash earning tree	Amatya S.M. and Chapa D.R.	Nepal Journal of Forestry 21 (3)
	Special research		
	Economics of conventional and taungya fuelwood plantations	Hawkins T., Hocking D.	

Appendix 2

Summary of major publications and reports in forestry research

Subject area of documentation	No. of documents
1. Soil survey and analytical laboratory research	**65**
Supporting soil management	13
Supporting planning of plantation activities	22
Supporting plantation management	18
Other soil activities	12
2. Seed, seedling and nursery techniques research	**45**
Seed scarification, storage and pre-germination treatment techniques	5
Forest nursery research	9
Propagation and germination techniques	21
Seedlings	9
Seedling supply strategy and nursery management	1
3. Agroforestry and tree fodder research	**30**
Agroforestry and fodder research	5
Fodder trees	7
Planning fodder management	14
Managing fodder trees	4
4. Plantation and plantation management research	**66**
Selecting species	18
Plantation research	24
Growth and productivity of plantations	8
Plantation management	6
Species/plantation silviculture research	10
5. Bamboo research	**13**
Growth research	1
Utilization research	2
Bamboo ecology and distribution	3
Propagation	3
Special research in Bamboo	4
6. Natural forest silviculture and management research	**14**
Growth studies	2
Regeneration management	1
Research on techniques of natural forest management	9
Soil conservation	2
7. Researching techniques of quantification and qualifying forests	**24**
Developing mensuration tools	12
Biomass and volume relations	3
Site Index research	1
Measuring trees and forests	8
8. Researching tree and forest health	**28**
Nursery	4
Plantations	15
Bamboo	1
Natural forests	4
Causal elements in Nepal	4
9. Forest policy and plans	**3**
10. Extension techniques research	**17**
11. Special research	**11**
12. Forest products research	**4**
13. Community/participatory and private forestry studies	**18**
14. Non-timber forest products research	**10**
Silvicultural considerations	1
Survey and inventory techniques	3
Management plans for NTFP management	1
Marketing	1
Special studies	4
TOTAL	**359**

Appendix 3

Provenance trial of chir pine (Pinus roxburghii) and its scope in Nepal

Chir pine (*Pinus roxburghii*) is an important native conifer tree species in Nepal. It has dominated the coniferous forests of the country, which comprise 17% of the total forest area. There has been a great interest during the 1980s in chir pine plantation because of the high survival rate and ease of establishment of the species. In 1981 and 1982, 57% of all trees planted by the Community Forestry Development Project were chir pine. It was considered a suitable pioneer species for the rehabilitation of severely degraded exposed sites of the hill.

Community forestry is a major activity in the hills of Nepal. It mainly focuses on the fulfilment of immediate needs of farmers for fuelwood and fodder. Since pine needles have no use as fodder and is also less preferred by the local people for fuelwood, chir pine plantations have generated considerable debate among the public. Thus, forestry personnel have been compelled to start planting more socially acceptable broadleaf tree species on degraded sites regardless of their ecological adaptability. The consequence is a large-scale mortality in many community forestry plantations such as in Sindhu Palchowk and Kavre Palanchowk districts of Nepal.

Chir pine is used for various purposes. It is serving as a major construction timber in hilly areas and even in cities like Kathmandu it is the best alternative construction timber. It is also widely used for making furniture. There are hundreds of furniture factories operating in Nepal, many of which are unable to operate at full capacity due to the shortage of raw materials. Similarly, two plywood mills have been operating at 52% capacity due to the shortage of raw material. Sustainable management of the chir pine forests could contribute to the alleviation of these shortages. In addition, resin from chir pine trees is used to manufacture turpentine, rosin and other products. In many inaccessible forest patches of the country, where timber production is not practicable, chir pine forest could be used solely for resin collection. HMG, ADB and FINNIDA estimated in 1988 that the requirements of existing rosin and turpentine industries would be 6600 metric tonnes by 2010–2011.

Chir pine has a potential to uplift the rural economy through the establishment of industries and opportunities employment. Chir pine-based industries could be a viable option to mitigate the domestic demand and earn foreign currency by exporting required products to international markets.

The Forest Research and Survey Centre (FORESC) has established a chir pine provenance trial in Syanja district. Eight provenances of Nepal are being tested.

Appendix 4

DFRS/FORTIP collaboration (Dinesh Karki 1997, unpublished)

What is FORTIP?

FORTIP is the abbreviated title of the UNDP/FAO Regional Project on "Improved Productivity of Man-Made Forests through Application of Technological Advances in Tree Breeding and Propagation". It is one of the leading UNDP/FAO supported forestry programmes in the Asia and Pacific region aimed at improving forest productivity through genetic enhancement of forest trees.

Tree improvement programme and FORTIP's support to Nepal

The first meeting of Tree Improvement Programme was held at DFRS in 1992. Together with the FORTIP representative Mr N.Q. Zabala, many forestry professionals from different departments attended the meeting. The meeting listed ten important forest tree species in Nepal for tree breeding and propagation research (for results, see Table 5).

As regards the aspects of national tree breeding and propagation, TISC and the DFRS discussed and agreed on the activities that each agency would undertake. The main goal of this meeting/discussion was to avoid duplication of work and reinforce each other's efforts. On that basis, the DFRS had a mandate to conduct tree breeding and propagation activity on four species (*Alnus nepalensis, Eucalyptus camaldulensis, Artocarpus lakoocha* and *Pinus roxburghii).*

In addition, the DFRS has initiated the establishment of a potted seed orchard for *D. sissoo* and *Eucalyptus camaldulensis* from juvenile cuttings. The construction of a greenhouse at Butwal was initiated in 1995 with financial support from FORTIP. This was a three-year cooperation between the DFRS and FORTIP, which provided financial and technical assistance. However, the DFRS did not receive further financial support from FORTIP after one year, as a result, construction of the greenhouse at Butwal has been halted.

With the existing greenhouse facilities, basic research such as germination and propagation tests are conducted. However, for the establishment of a potted seed orchard it would be necessary to construct and improve the conditions of this greenhouse. Basic requirements of the Butwal greenhouse at present are glass covering all around the greenhouse and installation and maintenance of a water supply system. Another important need is the establishment of a humidity and temperature control system.