Abstract

Traditionally, the people of Nepal are heavily dependent on forests for the supply of fuelwood, fodder, and timber. Agricultural activities to produce food, fodder are still dominant mostly in the mountain regions of Nepal. Farmers are using forest land as an integral part in their farming system. In the Nepalese perspective agroforestry is an old age practice. Farmers are using forest land as an integral part in their farming system. Yet, the concept of agroforestry is new to the Nepalese farmers. Nontheless, the topic of “Agroforestry” is recently receiving considerable attention. This is largely due to the evidence that trees and agricultural crops can be managed simultaneously and guarantee the sustainability of agricultural system. The agroforestry systems practised by the Nepalese farmers varies according to the physiographic zones. Also, within a given physiographic zone, it varies with location. The main determinant are being the altitude and the aspect. This paper identifies the different indigenous and introduced agroforestry practices prevailing in different physiographic zones of the country, explores research and development initiatives of different institutions, and examines the opportunities of promoting agroforestry in the country.

Keywords: Agroforestry systems, Fodder trees, Livestock, Research, Development, Extension

Introduction

Nepal is a relatively small country situated between India and China with a total area of about 147,800 sq. km. In altitude, it ranges from about 70 m above sea level to 8,848 m. Topographically, the country can be divided into five roughly parallel zones from south to north. They are the Terai, the Siwaliks, the Middle Mountain, the High Mountain, and the High Himal. Over half of the population of the country lives in the hill/mountain, and most are dependent on agriculture for their livelihood (WECS 1995a).

Current land use

The total arable land in Nepal is about 2.35 million hectares. The average land holding is 0.96 ha. There are two cropping systems: one based on rice production on irrigated flat land, and the other based on the production of maize and millet on rainfed land. Livestock rearing is an integral component of farming practice in Nepal. It is the second major economic activity in rural areas accounting for 20-30% of the total annual farm income. A major part of animal production takes place on open pasture and forests specially in the high mountain physiographic zones, while a small number of livestock are fed by cut and carry of fodder and farm-residue and by-products. The pressure on forest and grassland has reached unsustainable high levels, resulting in a sharp decrease in area and productivity of these lands. This has resulted in acute shortage of feed and fodder for livestock.

Together with agriculture, forestry plays a central role in the economic and social life of the rural people. The total forested area is about 5.51 million hectares (Master Plan for the Forestry Sector 1998). Forests provide about 42% of the feed for livestock (WECS 1995b). As livestock plays a central role, mainly in the hill farming system, most farmers can be described as agrosilvopastoralists.

The direct dependence of crop production on fodder and leaf litter from forests has been analyzed by several researchers. Estimates vary significantly, but demonstrate that form 2.8 to 6.4 ha of forest/shrubland are required per ha of agricultural cropland (Robinson et al. 1987). Although most farmers have private fodder trees, and some possess private forest land, these are rarely sufficient to meet the year-round feed requirements of the increasing number of livestock.
Land use problems

Traditionally, the people of Nepal are heavily dependent on forests for the supply of fuelwood, fodder and timber. Consequently, Nepal's forests are declining in both quality and quantity. Most of the accessible forest is degraded, largely as a result of land-use practices that are not compatible with the soils, vegetation, topography, and environment of the country. Overall agricultural productivity is also very low in Nepal because of biophysical, socioeconomic, technological, institutional, and policy constraints. One of the major problems of Nepal in terms of land use development is the very heterogeneity of the agro-ecological zones.

Need for Agroforestry Technology

Nepal, like other developing countries, is currently facing several agricultural and ecological problems: exploitation of forest resources, soil degradation and loss, increasing population pressure and insecurity of land tenure. Agroforestry systems and practices hold promise for meeting these challenges. Agroforestry is a topic which has recently received considerable attention. The interest is largely due to increase agricultural productivity.

The aim of developing agroforestry within Nepal is to meet the present and future requirements of fuelwood, fodder, small timber and environmental protection. The single most important use of trees in Nepal, in agricultural terms, is for animal fodder. In Nepal there is an information gap between researchers, extensionists and farmers with regard to agroforestry. Literature on indigenous agroforestry systems in Nepal is scarce. Therefore, a study was carried out to make an inventory of indigenous agroforestry practices and farmers' innovation in the different agro-ecological zones and to examine agroforestry opportunities in the country.

Methodology

The study covered four physiographic zones of Nepal. Field work was done from September till November 1994 in the Terai and Mid Hills, while the High Hills and High Himal were studied during March/April 1995. A transect survey covering from Terai (160 m) to the High Mountain (above 3000 m) was carried out in the Eastern, Central and Far Western Development regions of Nepal. The survey, which lasted four months covered altogether 22 districts (Map 1). The information was collected using Rapid Rural Appraisal and Participatory Rural Appraisal methods. A semi-structured questionnaire...
survey was carried out at the household level. Under
the broad category of information specific questions
relating to agroforestry systems being practised, its
uses, limitations and opportunities were collected. To
overcome problems of local dialect and to avoid fear
which would otherwise be encountered by the local
people, local residents were hired to administer the
survey. The number and type of interviewees were
different in different districts. Participant observa-
tions were made in the field to verify, to some extent,
the answers given in the household survey. A total of
220 farmers were consulted in collecting the informa-
tion.

Results and Discussion

The result of the survey indicated that the agro-
forestry systems practised by the Nepalese farmers
vary according to the physiographic zones. The main
determining biophysical factors are altitude and
aspect. Within a physiographic zone, local variations
are significant.

Nepal's subsistence hill farmers have traditionally
practised many types of agroforestry. Hill farming
system are, in fact, based on strategies to manage
forest, pasture, and arable lands simultaneously, and
in an integrated fashion, to obtain essential items of
food, shelter, and clothing.

The result of the survey indicates that there are
two types of agroforestry systems currently in prac-
tice in Nepal. One is farm based and the other is for-
est based. Under farm based agroforestry systems the
most important were Home Gardens, Trees in
Agricultural Fields, Alley Cropping, Commercial
Crops Under Tree Shade, Intercropping with
Horticultural Trees, Intercropping with Bamboo,
Trees Around Agricultural Fields, Woodlot and
Silvofishery. Under forest based agroforestry sys-
tems the important ones were Taungya System,
Shifting Cultivation, Extraction and Production of
Non-wood Forest Products, Silvopastoral Practices
in Forests and Specific Agriculture Practices
 Associated with Forests. The brief descriptions of
each systems are as follows:-

Farm based agroforestry systems

Home Gardens

Home gardens are multi-storied agroforestry sys-
tems where the canopies are arranged to occupy dif-
ferent vertical strata. Irrespective of the physiograph-
ic zones, home gardens are common throughout the
country. The species composition, however, differs
according to the ecological zone and the socioeco-
nomic conditions of the people living there. For
example, most home gardens in the Terai generally
contain sissoo (Dalbergia sissoo) trees planted with
banana, chili, and turmeric. In the hills, villagers cul-
vitate fodder trees such as khanyu, kabro, pakhuri
(Ficus spp.) and gogan (Sauraria nepalensis). The
essence of home garden agroforestry systems is the
fulfilment of owner's subsistence needs, and the pro-
vision of aesthetic and ornamental values. There are
limitations to the adoption of this agroforestry sys-
tem by some classes of people. For example, com-
unities used to other lifestyles, such as migratory
dispersal ways of life, are not likely to adopt a
home garden system. Moreover, this system is most-
ly developed in those villages that have exhausted
their nearby accessible forest resources.

Trees in Agricultural Fields

Due to hilly topography, the majority of agricul-
tural fields, particularly irrigated rice fields, are ter-
raced. Farmers do not grow trees in irrigated paddy
fields. They do, however, grow trees on rainfed ter-
races or on degraded lands. The predominant tree
species are Ficus spp., D. sissoo, Bauhinia spp.,
Acacia catechu, Artocarpus lakoocha, Cassia
saamea and Albizia lebbeck in the Terai region and
Bauhinia spp. Albizia procera, Alnus nepalensis in
the hills. The number of trees per farm varies with an
average of 15 in the Koshi hills (Abell 1981) to 53 in
western Nepal (Fonzen and Oberholzer 1984). All
the trees are multipurpose species used for fodder,
fuelwood, timber and small cottage industries (for
example, leaf plates of Bauhinia). Fuelwood is the
most important use. Despite the very small holdings,
farmers retain these multipurpose trees deliberately,
even foregoing losses in crop productions. The tree
also serve as an emergency cash bank (Tuladhar

Alley Cropping

In this system fast growing, nitrogen fixing
shrubs are planted as hedgerows, while food crops
are inter-planted between these hedgerows. The sys-
tem provides wood and green foliage for fodder or
green manure for food crops. Small trees or shrubs
are planted and pruned frequently to prevent them
from producing too much shade. Trees are grown in
relatively compact rows (between 2 to 4 m wide,
never more than 6 m apart). Crops are grown in the alleys between the tree rows. Mainly farmers in the middle and high mountain physiographic zones of Nepal have adopted this system. Some species that are being used as alley cropping were *Indigofera* and *Leucaena leucocephala*.

**Commercial Crops Under Tree Shade**

In this system, agricultural cash crops such as tea and coffee are grown along with tree crops. Planting of tea along with the crops is most prevalent in the Terai regions of eastern Nepal. There, tea is traditionally grown under the shade of one or two strata of tree canopies. Tea plants are grown mostly under *Siris* (*Paraserianthes* spp.). In the eastern part of the middle mountain physiographic zone, farmers plant cardamom (*Amomum subulatum*) under *Utis* (*Alrius tzepalensis*) trees. Utis trees are nitrogen-fixing and also provide fuelwood and small timber. Normally, farmers grow cardamom on marginal lands, near water hole land in gullies. Ginger and turmeric are planted in the Terai regions under tree canopies (*Eucalyptus, Dalbergia sissoo* and *Cassia siamea*) where there is less possibility of growing other crops because of the shading effect.

**Intercropping with Horticulture Trees**

This type of agroforestry is more prevalent in the Terai than other regions of the country. Orchards of mango (*Mangifera indica*) and litchi trees in the Terai are intercropped with agriculture crops. The spacing varies from 5 to 6 m between mango trees, but with litchi trees it could be less 3 to 4 m depending on the land availability. As this system demands more land area, farmers having less land find difficulty in practising this system.

**Cultivation of annual crops with bamboo**

This type of cultivation is mainly practised by farmers in the Terai and middle hills of Nepal. In this system, different varieties of bamboo are planted along with food crops such as wheat, maize, and paddy. Bamboo has many uses and is an integral part of rural life. Some species also provide edibles to human beings.

**Trees around Agricultural Fields**

One common agrosilviculture strategy employed by farmers is the planting and protecting of trees on cropland. Fodder, fruit, and timber trees are commonly found scattered throughout fields, especially on rainfed lands. Farmers usually plant trees along the borders of agricultural land and fallow and waste lands. This practice has become increasingly common in many parts of Nepal as the gap between fodder demand and supply widens (Denholm 1991). So far, only 5% of the bond boundary is utilized. There appears to be great scope for utilizing this land resource (Tuladhar 1991). However, neither an economic analysis of this practice nor studies on the impacts of tree on crop yields are available.

**Woodlot**

The main purpose of having a woodlot is to protect agricultural fields from soil erosion, prevent water springs from drying up, prevent land slips and land slides, and maintain stream flows. The management of these areas is vested with the communities in the villages.

**Silvofishery**

This system where tree crops are grown in conjunction with fish farming is currently gaining momentum in the Terai where *sissoo* trees (*D. sissoo*) are being planted on the terrace risers of fish ponds, along with bananas, pineapples and papayas. In some cases ducks and pigs are also included in the system. The main reason for taking up this practice were to fulfill the requirements of each sub sector, such as, extracts from ducks and pigs are considered to be good food for fish, and utilization of available resources by planting trees for fuel, fodder and small poles, near the boundaries, thereby protecting water resources.

**Forest-Based Agroforestry**

**Taungya System**

This system is practised only in the Terai region. One of the main objectives of this system is to encourage farmers to grow agricultural crops between trees. The experience has shown that growth of trees in intercropping areas is 3-4 times better than in areas where intercropping has not been practised.

**Shifting cultivation**

This system is practised in the middle mountain physiographic zones of Nepal, mainly in the eastern region, often on very steep slopes. Rotation cycles have decreased to less than five years in many places, preventing oak regeneration and resulting in a
replacement by bamboo and *Eupatorium*, an invasive weed (Shrestha 1989).

**Extraction and Production on Non-wood Forest Products**

In Nepal, fodder is a major non-wood forest product. Non-wood forest products in Nepal can be categorized by end-use into one of four groups: (a) subsistence: medicinal, food stuff, construction materials (b) village based enterprises: bamboo, loka and allo (c) raw materials for industries, and (d) jaributi: raw materials for pharmaceutical industries.

Both men and women of rural Nepal are engaged in the collection of aromatic and medicinal plants. Rural households use the income from this activity to purchase clothes, salt, food, and other essentials (Rawal 1995).

**Silvopastoral Practices in Forests**

As animal husbandry is an important component of farming systems in Nepal, silvopastoral practices are common throughout the country. Animals are allowed to graze in old plantations, subalpine and alpine pastures.

In the middle and high mountain physiographic zones, where farmers do not get the opportunity to graze their livestock in large-scale plantations, farmers often graze their livestock on communal lands. These lands also serve as a fodder bank or future reserve when green feeding material becomes scare, especially in the winter. There are three main features of silvopastoral practices in Nepal: (a) increasing small holders' income by producing meat/milk (b) contributing organic matter to the agricultural fields, and (c) reducing weed growth in community, government, and private plantations by allowing hand cutting of ground grass.

**Specific Agriculture Practices associated with Forests**

A new agroforestry practice was introduced in the Terai under the Terai Community Forestry Development Project. Under this system, sissoo tree (*Dalbergia sissoo*) and other fast growing exotic species such as *Cassia siamea*, *Indigofera* are planted without sacrificing the remnants of high sal forest (*Shorea robusta*) and its associate trees. Agricultural crops integrated in the system include maize, mustard, and occasionally tobacco. This system has been found to be feasible by most of the farmers. This system does not allow regeneration of the tree species, as the land are being cultivated continuously for planting agricultural crops.

**Research and development**

There are 13 organizations in the country involved in developing agroforestry Table 1.

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<thead>
<tr>
<th>Table 1. Organizations involved in Agroforestry activities</th>
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<tr>
<td>1 Care - Nepal</td>
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<td>2 Department of Forest Research and Survey</td>
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<td>3 Herbal Crops Development and Extension Programme, Ministry of Forests and Soil Conservation.</td>
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<tr>
<td>4 Institute for Sustainable Agriculture</td>
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<td>5 Lumle Regional Agricultural Research Centre, National Agricultural Research Council, Ministry of Agriculture</td>
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<td>6 Nepal Agroforestry Foundation</td>
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<td>7 Pakhribas Agricultural Centre, National Agricultural Research Council, Ministry of Agriculture.</td>
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<td>8 Pulpa Development Programme</td>
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<td>9 Sagarnath Forestry Development Project, Ministry of Forests and Soil Conservation.</td>
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<td>10 Tribhuvan University, International Development Research Centre, Institute of Forestry, Institute of Animal Science.</td>
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<tr>
<td>11 United Mission to Nepal</td>
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<td>12 Watershed Management Project, Department of Soil Conservation</td>
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<td>13 Winrock International</td>
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Most of these organizations are trying to introduce fodder trees in new sites. Some have focused on studies on growth rates, yield of fodder species, and the effects that various tree-spacing have on crop yields. A system combining trees with herbaceous species is also being studied in the Terai and high hills. Bamboo growing techniques are emerging as viable land use options in the Terai. Some institutions are trying to rehabilitate degraded land through Sloping Agriculture Land Technology. Some are examining the economics of fuelwood versus food grain production. Various exotic grass species have been tested on farm in different agroecological regions. Most of the introduced species have problems with regard to seed production and propagation (Pande 1992). Improved grass varieties have been developed under high-intensity management (with
fertilizers and proper grazing intensities) practices. Expecting these species to thrive under low inputs and existing high grazing pressure does not seem realistic. It may be more appropriate to identify local pasture species, as well as tree and shrub species, for pasture improvement. Considering the severity of the problems related to food and fuelwood shortage in Nepal, and the vast diversity of agroecological conditions, the present research efforts made to address farming system problems have been inadequate. Systematic agroforestry is a relatively new approach, as such, agroforestry research has not received proper attention. There is tremendous potential for agroforestry research and development in Nepal. Research in agroforestry can gain a proper footing only after a detailed analysis of different agroecological zones and socioeconomic conditions of the populations is undertaken and appropriate measure of effectiveness are selected for each case.

**Education and training**

Three types of organizations are actively involved in agroforestry training and extension in Nepal: government agencies, universities, and non-governmental organizations (both local and international).

**Extension services**

Extension services are provided by the concerned governmental and non-governmental agencies working on agroforestry. Besides this, several local and international NGOs are actively engaged in agroforestry extension programs. To cite two examples, Lumle and Pakhribas Agricultural Centres conduct integrated on-farm and on-station research and provide extension services to local villagers. The concerned institutes of Tribhuvan University have active agroforestry extension programmes.

**Credit facilities**

Credit facilities for agriculture development are available through the Agricultural Development Bank. But there are no credit schemes specifically designed for agroforestry development in Nepal.

**Seed/seedlings availability**

Local farmers unable to obtain their favourite tree seeds and seedlings from forest nurseries and concerned offices. They raise the seeds on their own and plant the wildings on their farm land as and when available. Often the seeds are not from good sources and hence do not give desirable end product. Seeds and seedings should be made available to interested farmers by concerned agencies. Whosoever makes the collection of seeds, it is always preferable to collect from local sources. The seed should have vigour and should posses good germination capacity.

**Opportunities for agroforestry**

There is a growing evidence that in some circumstances, agroforestry is more profitable than forestry alone, and may have a number of social advantages for the farmer and from the nation’s view point. The principle of agroforestry could also be applied well in the development Non-Timber Forest Products.

Nepal’s forest policies are noted for their progressive aim to turn over the management of the nationalized forest land to local communities. There are ample opportunities for the development of agroforestry in Nepal.

It has been estimated that about 61 percent of the total forest areas could come under community forestry. There is ample scope for putting into practice different types of agroforestry systems in these areas. Moreover, agroforestry can be practised gainfully in leasehold forest areas. The potential for developing different types of agroforestry system in private areas is enormous, if market opportunities are also developed.

**Limitations of the study**

This study was carried out with an intention of exploring the exiting agroforestry systems in the country. Therefore, as far as practicable, maximum number of districts were included in the study. This in itself put a limitation on the presentation of the study. As for example, details concerning the differences between the ethnic groups in practising the agroforestry systems could not be included. However, these have been dealt with in Amatya and Newman (1993). Similarly, the overview of hill farming system have been discussed by Goldsmith (1981) and Upraity et al (1989). Studies which could lead to further details on these aspects of the problem could not be undertaken.

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References


