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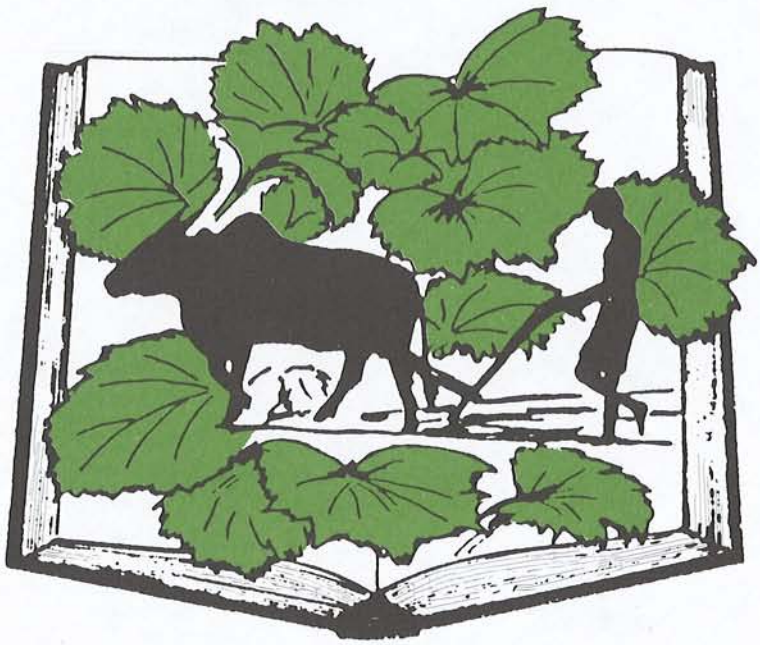
Diversity and Dynamics of Tree Species and Its Sustainability in Rural Farmland

A Case Study in Chitwan District, Central Terai of Nepal

By

Deepak Kumar Kharal

May, 2000



A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE (MANAGEMENT OF NATURAL RESOURCES AND SUSTAINABLE AGRICULTURE)

AGRICULTURAL UNIVERSITY OF NORWAY

Declaration

I, Deepak Kumar Kharal, hereby declare to the senate of the Agricultural University of Norway that this thesis on "Diversity and Dynamics of Tree Species and Its Sustainability in Rural Farmland: A Case Study in Chitwan District, Central Terai of Nepal" is a result of my own research work and it has not been submitted to any other university for award of any degree. All source of information is duly acknowledged.

Signature: .....

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Date: 03/05/2000

Approved by Main Supervisor

Signature: .....

Dr. Trygve Berg

Date: 3/5/2000

Place: Agricultural University of Norway
Ås, Norway

Abstract

The research was carried out in Birendranagar village Development Committee (VDC) of the Chitwan district, Central Terai of Nepal from August to December 1999 with the aim of analyzing the factors affecting the diversity and dynamics of tree species at farm level. A total of 98 farm households were surveyed systematically. Structured questionnaire, informal interviews and direct observation were applied for data collection.

Biodiversity of the tree species, measured in terms of species diversity index and species richness index, were 1.8 and 5.01 respectively. These values were found to be lower than in similar areas of other south Asian countries such as India, Bangladesh and Sri Lanka. Two main reasons were found responsible for lower biodiversity of tree species in the study area. Firstly, there was wide individual distribution of few tree species. Only two species dominated the total tree distribution. Secondly, there was wide distribution of households characterized by small farmland, low income, small homegarden size, small and medium sized livestock. Biodiversity was generally less in such kind of households.

Biodiversity of fodder and fruit tree species were higher than fuelwood and timber/furniture tree species. However, individual distribution of fuelwood and timber/furniture tree species occupies even more than three-forth of the total tree number. A total of 60 tree species were found in the area. An average household had about 7.7 tree species, 66.7 tree individuals, 96.9 tree per hectare and 8.9 trees per capita. The figure is consistent what others have found in other parts of the same physiographic region (Terai). But, the species number, tree number and tree density were relatively less than in the hilly farmland of the country.

The regression analysis showed very weak linear relationship between the biodiversity of the tree species (both species diversity and specie richness) and each of the socio-economic factors particularly the farm size, household size, livestock size, homegarden size, income level, fuelwood consumption, forest distance and forest visit. No single factor was able to predict the biodiversity individually. However, It was possible to observe the variation of tree species biodiversity by combination of various factors. On the other hand, analysis of variance showed significant difference of biodiversity in different farm size, homegarden size, livestock size and source of income. Reduced farm size by land fragmentation and disintegration, reduced livestock size and homegarden size, limited income and income sources may lead towards the lesser biodiversity status at farm level.

Twenty-six tree species were completely lost from the farmlands from the beginning of the settlement to date. Further, twenty species were found with very limited distribution and two of them are already under the threatened category at the national level. Only 14 new species were introduced until present. Farmers are now attracted to grow fast growing, multipurpose and easily available tree species. Economic return is the major concern for them. Such a situation may lead to the further loss of tree species from the farm. Some species such as *Shorea robusta* and *Phyllanthus emblica*, which were among the widely distributed in the beginning, are now about to be lost because of easy availability in nearby forest, slow growth rate and limited uses etc.

Acknowledgement

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Abbreviation

APP	: Agricultural Perspective Plan
APROSC	: Agricultural Projects Services Centre
CBS	: Central Bureau of Statistics
CF	: Community Forest
Ha	: Hectare
HH	: Household
FUG	: Forest User Group
HG	: Homegarden
IUCN	: International Union for Conservation of Nature and Natural Resources
ICIMOD	: International Centre for Integrated Mountain Development
Kg	: Kilogram
Ln	: Natural Log
LU	: Livestock Unit
MoF	: Ministry of Finance
MoA	: Ministry of Agriculture
MPFS	: Master Plan for Forestry Sector
NRA	: National Research Associates
Noragric	: Centre for International Environment and Development Studies
NRs	: Nepali Rupees (Nepali currency)
NLSSR	: Nepal Living Standard Survey Report
NGO	: Non-governmental Organization
Spp	: Species
UNRISD	: United Nations Research Institute for Social Development
VDC	: Village Development Committee
WECS	: Water and Energy Commission Secretariat

Conversion

1 ha = approximately 30 Katha (local unit)

1 US $ = 68.8 Nepali Rupees

Chapter 1

1. Introduction

1.1. Context of the Study:

Forest and tree resources are vital in Nepal particularly in rural areas. Among all the natural resources of the nation, forest is considered as the major one (MoF, 1998). They provide basic needs of the people. They are the primary sources of fuelwood, fodder and timber. Contribution of forest and tree resources in national economy is highly recognized. Agriculture, fishery and forestry contribute about 40 percent of the total GDP (MoF, 1998) and forestry sector alone cater for an estimated 15 percent of the GDP (MPFS, 1988). It is further important to note that fuelwood and fodder freely collected are not counted in the GDP figure. If an estimated 12 million tones of freely collected fuelwood are counted, the contribution of the forestry sector would be very high.

The importance of forest and tree resources in Nepal is far beyond what can be measured in monetary term. Their importance can be seen explicitly in the energy system of Nepal. Fuelwood alone supplies about 80 percent of the total energy requirement, 88 percent of the rural energy requirement and 98 percent of the residential sector energy requirement of the country (WECS, 1997). The role of other energy resources such as electricity, petroleum, biogas, solar energy etc. is just nominal either because they are expensive or unavailable in the rural areas. In many cases, poor and land-less people highly depend on forest and tree resources as the source of income. They collect fuelwood freely in the forest and sell to the local market.

Even the rural farming system of Nepal heavily relies on forest and tree resources for its sustainability. Agriculture is the mainstay of Nepalese economy where more than 80 percent of the economically active population is dependent (MoF, 1998). Agricultural practices, however, remains primarily subsistence oriented (APP, 1995). Rural farming

primarily depends on an integration of forest and trees, livestock and agricultural cropping. These resources are closely interrelated. Any changes in one component may have a significant effect on the others (Mahat, 1985). The role of forest and tree resources is even greater for small and marginal landholders and the land-less population, providing several benefits such as food, fuel, timber, fodder, medicine, soil and water conservation etc. Various minor forest products such as fruits, medicinal plants, honey etc were and still are the source of survival particularly in rural Nepal. Tree species have been, still are, or will be, of considerable economic and ecological importance in Nepal (Panday, 1982a).

Forest and tree resources provide the green fodder, grasses and grazing places for livestock. Farmers use agricultural residues just for sustaining livestock during the dry season. Tree fodder is the single most important sources of nutritious feed for them. Fodder form forest such as grasses and green leaf materials provides more than 40 percent of the livestock nutrition (MPFS, 1988). On the other hand, productivity of cropland highly depends on compost manure, which comes from livestock in the rural areas. Production of the manure is the biggest contribution of livestock in Nepal (Panday, 1982a). At present, livestock contributes about 31 percent of the total agricultural GDP of the country (APP, 1995). Compost manure is vital for the soil fertility in farmland. Uses of chemical fertilizer by small and medium scale farmers is rare because of economic as well as availability factors. Furthermore, Nepalese farming is not well mechanized. Cultivation is almost impossible without animal power for ploughing and for other activities such as driving cart and threshing crops etc. At the same time, rural farmers obtain nutritious food such as milk products and meat only from livestock.

Importance of forest resources is also highly realized in conservation of natural biodiversity. Forest and tree resources further play vital roles in the protection of fragile mountain ecosystems of Nepal.

1.2. Problem Statement/Justification

In Nepal, forest resources are being degraded gradually. Deforestation is the biggest environmental problem to conserve the diversity of trees as well as other plant and animal species in natural ecosystem (Mishra, 1998). Reasons for deforestation are many and complex. Some are deeply rooted in country's development patterns: rapidly increasing populations, extreme concentration of landholdings that leave hundreds of millions in search of land, slow growth of job opportunities in both city and countryside (Repetto, 1988). *Increasing numbers of people, their demand for fuelwood and timber, the maintenance of large number of livestock, and scarcity of agricultural land have mainly brought about the degradation of Nepal's forest resources. Over the last two decades, over half a million hectares of forest have been lost. The remaining accessible forests have been facing steady degradation (MPFS, 1988).* Department of Forest Research and Survey (1999) has mentioned 1.3 percent annual lost of forest during 1978/79 to 1990/91 in Terai region while forest area has decreased at an annual rate of 2.3 percent in hilly regions during 1978/79 to 1994. In the whole country, the forest area has decreased at an annual rate of 1.7 percent, whereas forest and shrub together have decreased at an annual rate of 0.5 percent during the same period.

Vast degradation of the natural forest areas has caused the significant lack of forest products in daily rural life. There are no visible substitutes for fuelwood in Nepal. Alternative energy sources are badly needed, but the combined impact of energy saving stoves and biogas systems can probably not reduce fuelwood needs by more than 15 percent during the 1986 – 2011 period (MPFS, 1988).

Settlement programme and internal migration of the population also has caused deforestation specially in the Terai region and Chitwan. The population of Terai region has increased at a faster rate than that of the hills and the mountains over census years. The figures are given in table 1.2 – 1.

Table 1.2 - 1: Population Change in Nepal

Population in Millions

Region	1971		1981		1991	
	Population	Percent	Population	Percent	Population	Percent
Mountain	1,1	9,8	1,3	8,7	1,4	7,8
Hills	6,1	52,2	7,2	47,7	8,4	45,6
Terai	4,3	38,0	6,6	43,6	8,6	46,6
Nepal	11,5	100	15,1	100	18,4	100

Source: CBS, 1999

Share of the population in Mountain and Hills has decreased during 1971 to 1991 while Population share in Terai has increased from 38 percent to 46.6 percent during the same period.

A study prepared for UNRISD (1991) has mentioned shortage of agricultural area, small size of landholding, insufficient food production, indebtedness and deteriorating environmental conditions of the hill and mountain farmers has caused for migration towards the Terai region. Plains of the Terai are more fertile than the slopes of the Hills. Plenty of the cultivable lands were still under forest due to the infestation of malaria. "The deforestation process became visible since 1950s, after the malaria eradication program was launched, especially, in the Terai and inner Terai region. There has been a continuous flow of internal migration of population from hills and mountain to Terai. Forestlands were cleared for planned resettlements and agricultural purposes. Due to fast increasing population, the forest areas have been encroached in search of more cultivable land. Similarly there was heavy dependence on forest resources for cattle feed, leaf litters for farm manuring, fuelwood, timber and such other products for industrial purposes (Kayastha and Mishra, 1998). The Rapti Valley Development Programme was the first resettlement programme of post 1950 Nepal, launched in Chitwan valley in 1956. Its objectives were to resettle the victims of natural calamities of the Hills and maintain regular food supply to Kathmandu valley by increasing agricultural production. After the implementation of this resettlement programme, a new frontier for migration to marginal peasants of the Hills was opened up (UNRISD, 1991).

Vast amount of deforestation occurred during the period of political instability. This particularly happened in 1979 and 1990 in Terai. Land is not sufficient for most of the households in Nepal and consequence was felling trees, selling logs illegally and clearing nearby forests for cultivation. Again, it is not rational to blame the poor people for the disruption of forest since poverty is the historical product of political economy in Nepal (UNRISD, 1991).

Farming systems are generally mixed, subsistence and dependent on the use of resources from the forest (Basnyat, 1995). Small farm size, continuous land fragmentation, loss of productivity, lack of irrigation facilities etc. are the general problems in rural farming system of Nepal. Forest degradation has aggravated soil erosion, drying up of mountain streams, and downstream sedimentation and flooding, as well as losses in agricultural productivity (MPFS, 1988). Average farm size declined from 1.12 ha to 0.95 ha during 1981 to 1991 period (CBS, 1991). Half of households had less than 0.5 ha of land in 1981 and still less in 1991. This means that a greater number of small farmers with holding less than 0.5 ha in 1981 were further marginalized and squeezed out of agriculture. As a result, number of landless laborers increased over a period of a decade (Basnyat, 1995).

Once the deforestation made situation critical for rural life, farmers started to increase the number of trees within the farm in various forms. The scarcity of forest products and the resultant increase in the price of wood products in the market, the regulatory policies of the forest products in the adjoining areas led to an increase in tree cultivation in the Terai (Kanel, 1995). Collecting fodder and fuelwood from the forests was becoming more and more time consuming. Farmers were becoming increasingly dependent on private trees for tree products (Thapa and Joshi, 1992). As rural population's traditional access becomes increasingly limited, forest resources are often managed through planting trees at the farm as agro-forest. In the present context of degradation of natural forest and depletion of their resources, rural farmers reaffirm traditional responsibility over the natural resources by native farming and society (Michon and Foresta, 1995). As forest degradation continues with more restricted access to the forest and with demand

exceeding the sustainable supply of forest products, the interest in tree planting has considerably increased in recent years (Das, 1999).

When the natural forests are in the verge of extinction, farmland plays significant role in the species conservation. As deforestation continues, along with the increase of population, it will be extremely difficult to conserve biodiversity in the isolated island of forest, which will be subjected to even greater pressure (Wickramasinghe, 1995). For the last few decades, the bio-diversity is in the process of severe destruction. Several species have been threatened or reached to the point of extinction (Mishra, 1998). This study finds the present status of tree species biodiversity, in terms of species diversity index and species richness index, in the farmland. No such studies have been carried out before in the farmland in Nepalese context.

Importance of farmland in biodiversity conservation is highly realized in recent years. Significant elements of biodiversity are found outside the protected area. Traditional agro-ecosystems are particularly rich sources of both biodiversity and indigenous knowledge about its management. Protected area alone is not sufficient to conserve the full range of biodiversity. Traditional agro-ecosystems are important reservoirs of genetic diversity that is not often found outside these systems (Halladay and Gilmour, 1995).

Traditional agriculture has adapted to a wide variety of local environments, producing diversity and reliable food supplies, reducing the incidence of diseases and insect problem, using labor efficiently, intensifying production with limited resources, and earning maximum returns with low levels of technology. It utilizes a very wide range of species and land races, which vary in their reaction to diseases and insect pests, and to different conditions of soil, rainfall and sunlight. It provides sustainable yields by drawing on centuries of accumulated experience by farmers who did not depends on scientific information, external inputs, capital, credit, or markets (McNeely, 1995).

Trees were always grown on farmland in every region of the country and it is still found in most of the rural farm to meet their varieties of needs from own land. In the past,

farmers were specially maintaining the trees in various traditional ways specially growing tree species in and around the farm. Farm boundary, homegarden, woodlots and homeyard are the common places for tree growing in rural farmland. It is rare to find agroforestry practice purely. *Farmers practice mixed farming systems which rely on marked extent on local resources. They try to grow multipurpose trees near their homestead, which would yield products such as fodder, fuel, bark, and nuts. Forest land is an integral part of farming systems just as much as arable land and livestock (Amatya and Newman, 1993).*

Maintaining the diversity of the species within the farm is an important aspect of traditional farming. Because farmers have different kinds of needs which are hardly meet by few species. It is assumed that greater diversity supports the security in term of goods and services derived from the variety of bio-resource. Diversity of the species may reduce the risk to the farmers if some species fails to produce due to some externalities. Diversity may provide the alternatives that are useful in critical condition. It is also important for providing the association for other bioresources. It helps in stability and resilience of the small as well as large ecological system. In case of rural farming system, diversity of tree species helps in supplying the varieties of goods and services to the farmers such as fruits, fodder, fuelwood, timber, medicine, religious value, gardening, shade and other environmental protection.

Changing tree species in rural farmland is widely noticed over a time. In the past, naturally grown tree species were mainly found in the farm and farmers were just maintaining them as it was. More recently, farming practices are being changed. Planted trees are replacing the naturally grown tree species. Large and big tree species are being replaced by small and manageable tree species. Single use tree species are being replaced by multipurpose tree species. Some fast growing tree species for timber, fuelwood and furniture are also being introduced rapidly in the farm. *Bio-diversity of the species in farming land is directly threatened by emergence of various factors in the rural farming world. Fulfilling the short term monetary needs leads to the replacement of slow growth or secondary species by fast growing and high yielding species. The same range of*

factors can affect agro-forest if they do not provide enough immediate income. This can be due to lack of inadequate marketing channels for the product (Michon and Foresta, 1995).

More recently, traditional agro-forest system that is maintaining trees in different part of the farm are being drastically changed or modified or destroyed because of many reasons such as fragmentation of land, land tenure right, socio-economic change and climatic change as well. *Landowners face certain difficulties in turning their lands over to tenant farmers. The lack of clarity and frequent changes in the land laws enacted during the past few decades (particularly land reform) have created a situation of insecurity and mistrust. This has led to labor scarcity and consequently to increased private tree farming (Subedi, Das and Messerschmidt, not dated).* Tree species with good quality are viable only so far as they can meet the farmers' needs. In this way, changes take place in the diversity and composition of tree species in rural farming system. This study will find the present status of tree species diversity, factor affecting the status of diversity and dynamics. Further, the study will find how the species are being changed or modified or destroyed in the farmland. No such types of studies have been carried out before in the area.

1.3. Objectives of the study

This thesis is developed to address the following objectives:

1. To find the existing level of biodiversity (species diversity and species richness) of the trees on rural farmland.
2. To identify the tree species, which were already lost and are threatened to be lost from the area.
3. To analyze the impact of socio-economic factors on diversity and dynamics of tree species in the area.

1.4. Hypothesis

Present study tests the following hypothesis.

1. Larger farm size encourages the higher diversity and dynamics of tree species
2. Agriculture-based households hold higher diversity and dynamics of tree species
3. Higher household Income increases the diversity and dynamics of tree species
4. Larger homegarden size have higher diversity and dynamics of tree species
5. Large livestock holding leads to the higher diversity and dynamics of tree species
6. Households living near forest hold higher diversity and lower changes of tree species
7. Higher fuelwood consumption increases the diversity and dynamics of tree species
8. Late settlers have lower species diversity and dynamics of tree species

1.5. Organization of the Thesis:

Context of the study and its rationality is described in chapter 1. Chapter 2 is about study area description. Background of the country is given briefly. General information and other characteristics of the study site are also presented in this chapter. Map of the study area is also presented. Chapter 3 deals on research methodology. It also includes the limitation of the study. Result and discussion part is described in chapter 4. This chapter starts from the general characteristics of the respondent. Other socio-economic characteristics of the area are also presented thereafter. Later part of this chapter deals the finding of the study according to objectives and discussion is made along with. Conclusion is given in chapter 5.

Chapter 2

2. Study Area Description

2.1. Country Background:

Nepal lies in south Asia between two highly populated countries, India and China. India covers from three-side south, east and west while China borders northern part. It is located between 26° 22' north to 30° 27' north latitude and 80° 4' east to 88° 12' east longitude covering 1,47,181 square kilometers of physical land. The country is elevated from 161 meters from mean sea level to 8,848 meters, the top of the world. Broadly, Nepal is divided into three physiographical regions and each of them extends from east to west. The low land or plain called Terai lies along the southern belt, hills in the middle part and mountain in the northern belt. Mountains with perpetual snow extend up to 8,848 meters, the highest peak of the world. Elevation of the land is basic factor to determine the climatic condition. Nepal, though not big in size, has wide range of climates differing according to variation in altitude and location. In general, the climate ranges from hot tropical in the Terai to moderate sub-tropical in the middle and to tundra in the high mountain. Vegetation type in the country is mainly determined by climatic condition of the localities.

2.2. Description of the study site:

Chitwan district is located in southern part, central Terai of Nepal. The country is politically divided into different regions. There are 5 development regions, 14 zones and 75 districts. Districts are the basic administrative unit of the government. Districts are further divided into small areas called Village Development Committee (VDC) where lower most political election is held and local governance body is elected. For the sake of convenience, VDCs are further divided into Wards from 1 to 9. Wards in the VDCs are the lowest level of address for any person, household and institution until now. Chitwan

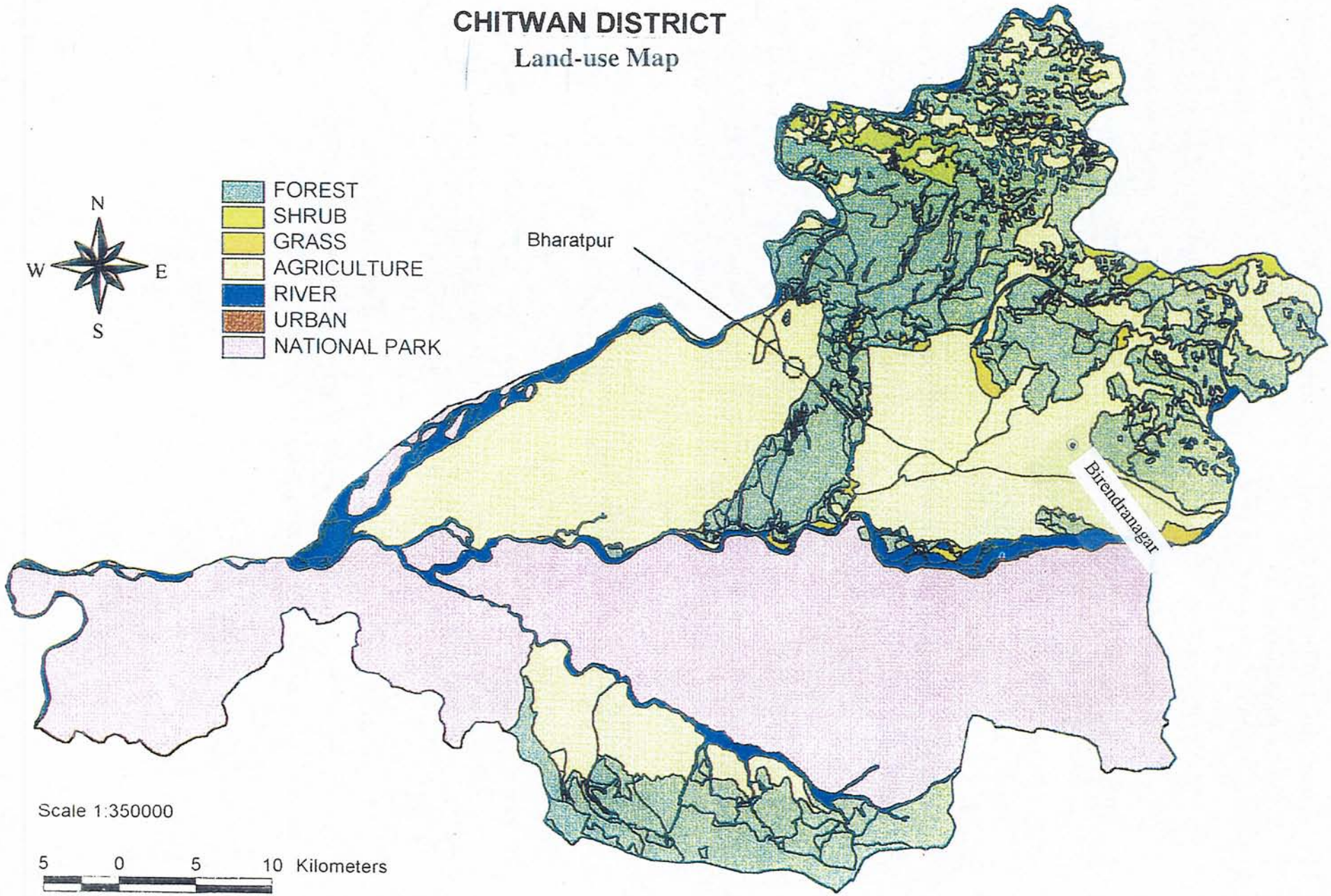
district has 36 VDCs and 2 municipalities. Birendranagar VDC from the district was taken for the research work.

Chitwan district extends from 27.27° north to 27.46° north latitude and 83.53° east to 85.27° east longitude. It covers about 2218 square kilometers, 1.49 percent of the total country's land. Southern part of the district is Indian border and other districts of the country cover rests of the sides. Outer Terai and inner Terai are there in the southern belt of the country and Chitwan lies in inner Terai belt. Inner Terai is surrounded by two hills Churia or Siwaliks in the south and Mahabharat in north.

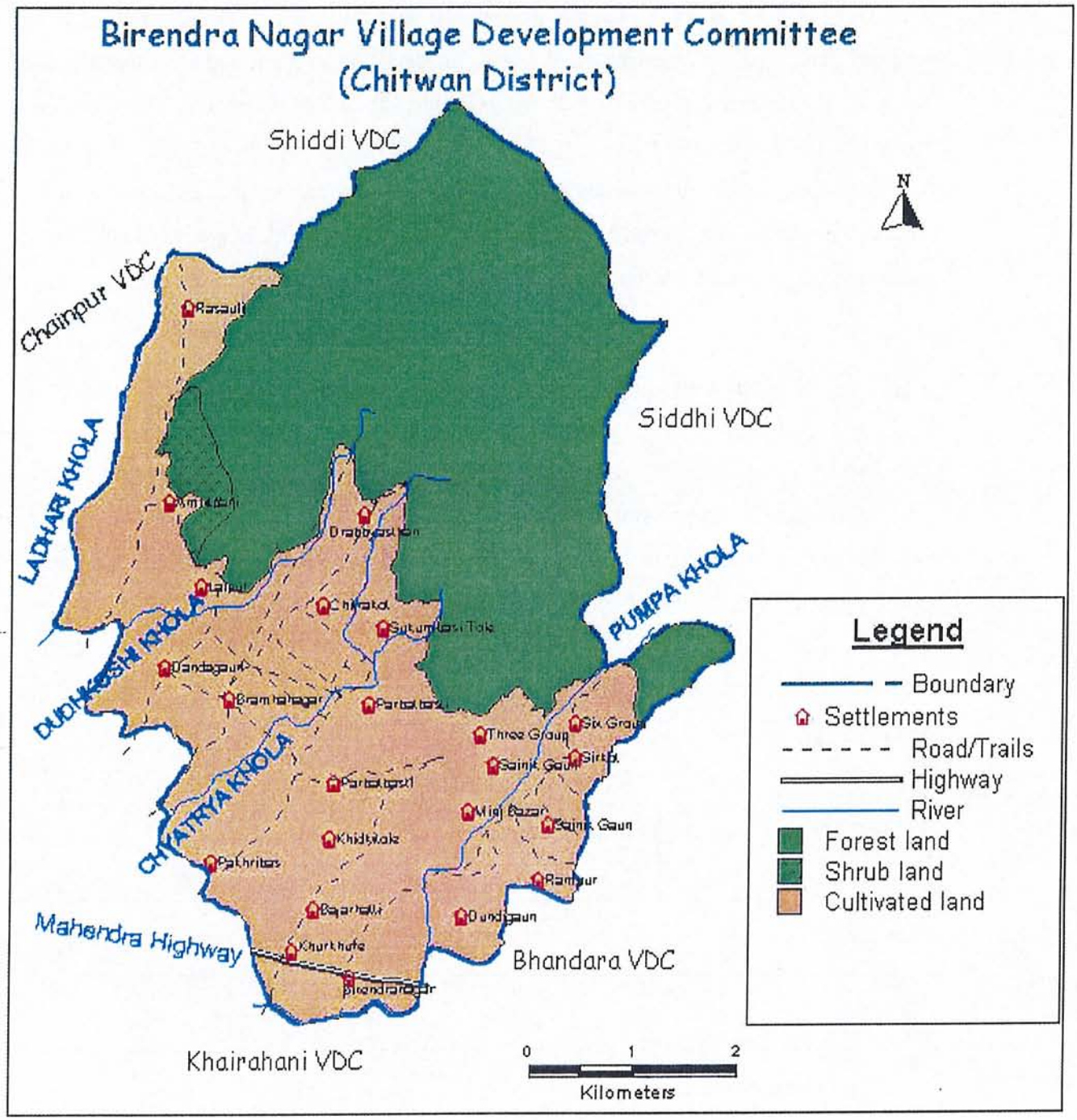
Terai is a narrow tropical belt comprising the first foothill of the Himalayas massif and extending from east to west along the southern part of t he country. It is an extension of the Gangetic plains of India, form a low flat land that has an altitude ranging from 60 meters to 310 meters. It includes most of the fertile land and dense forest area of the country. This region covers nearly 23 percent of the total area of the country and about 40 percent area of this region is under cultivation. The population of this region was 46.7 percent of the total population of the country in 1991, while in 1991 it was 43.6 of the total population of the country (NRA, 1999).

Birendranagar VDC, the study site, lies in the eastern part of the district. VDC has more irregularities in shape. Northern part of the VDC is covered by Sal (*Shorea robusta*) forest and some of its parts are already handed over to the local community as community forest. Remaining part is still under government control. Map of the Birendranagar VDC and Chitwan district are given in next page.

No written document has been found about the overall description of the VDC though very few information exist in VDC office. In fact, other socio-economic characteristics of the area are more similar with the average district figure.


CHITWAN DISTRICT
Land-use Map
N
W
E
S
FOREST
SHRUB
GRASS
AGRICULTURE
RIVER
URBAN
NATIONAL PARK
Bharatpur
Birendranagar
Scale 1:350000
5 0 5 10 Kilometers

Map of the Study Area



2.2.1. Topography

The elevation of the district ranges from 244 meters to 1945 meters. The area extends from Terai in the south to Siwalik in the middle and mid hills of Mahabharat range in northern part. About 87 percent of the total physical lands are found in Siwalik range (inner Terai) and remaining only near to 1 percent of the land lies in outer Terai attached to Indian border side. Rest about 12 percent lands locates in mid hill. Regarding Birendranagar VDC, no documentation is found about its location but general observation shows that all the cultivated land is found in Siwalik range (i.e. inner Terai) and forest area is found attached to the Mahabharat hill range in northern side.

2.2.2. Land-use Type

The district is rich in forest as well as fertile agricultural land. About 21 percent of the land is presently under cultivation and share of non-cultivated land is about 3.8 percent. Subsistence farming system is the characteristics of rural livelihood. Rural household economy heavily depends on agriculture. Share of agriculture in total GDP is about 40 percent (MoF, 1998), though contribution of other sector in national economy is gradually increasing. The comparative figure of the land-use type of VDC, district and country is given below.

Table 2.2.2 -1: Land use Type of Study Area

Figure in percentage

Region	Agriculture		Grazing	Forest	Others	Total (Sq.km)
	Cultivated	Non-cultivated				
*Nepal	20,1	6,7	11,9	42,8	18,5	147181
*Chitwan	21,3	3,8	4,7	64,8	5,1	2218
**Birendranagar	52,6			47,4		33

Source :
* : National Research Associates (1999)
** : GIS mapping

Forest area in the district covers about 65 percent of the total land, which is quite higher than the national and VDC figure. This forest area also includes the area of Royal Chitwan National Park situated in southern part along the Rapti River. Area of the Park is 932 sq. km covering wide range of wildlife habitat such as dense *Shorea robusta* forest, riverine forest and open grassland. Grazing land in the district is a bit less but no figure exists for VDC level.

2.2.3. River System

The district has three major river system; Narayani, Rapti and Lother. They are perennial in nature and flow all around the year. Some other rivers in the district are Riu and Rigdi River in south, Khageri, Kair, Budhi Rapti, Pampa, and Mardar River in center and Kalikhola, Nagdi, Panchanadi, Jugedi in northwest. These small rivers originate from foothills of the Mahabharat hill ranges, and mix either in the Rapti in south or in Narayani in northwest. Narayani River is the biggest one in the district, which flows from northern and western part. It is also the border of the district in north, northwest and western part. This is the third largest river of the country originating from the Himalayas in the north and mix with the Ganges in India. Lother River flows from east separating from another district. It mixes with the Rapti River down in the district and flows towards the west to join in the Narayani River. All the rivers system in the district ends in Narayani River.

Regarding the river system of the Birendranagar VDC, four small rivers are found originating in the foothills of Mahabharat hill range, flowing towards the south. They are seasonal and flow only some months in and after monsoon. The River system of the VDC is also given in the map of the study area. Ladhari Khola and Pampa Khola flow from west and east part respectively and remaining two Chhyatra Khola and Dudhkoshi Khola flows from center. Small rivers are generally termed as Khola. These river systems also have vital roles in rice cultivation during the monsoon season, even though they sometime create problem by cutting banks of the agricultural land.

2.2.4. Land-ownership

Number, area and fragmentation of land holdings in Chitwan district are given below.

Table 2.2.4 -1: Number, Area and Fragmentation of Landholding in Chitwan

Size of holding (ha)	Holding				Fragmentation			
	Number (%)		Area (%)		Total parcel (%)		Average parcel	
	Nepal	Chitwan	Nepal	Chitwan	Nepal	Chitwan	Nepal	Chitwan
Withoutland	1.17	0.72	0.06	0.00	0.23	0.32	0.8	0.8
<0.1	6.32	10.15	0.36	0.62	2.58	5.88	1.6	1.0
=>0.1 - <0.2	9.64	10.72	1.46	1.88	5.88	7.18	2.4	1.2
=>0.2 - <0.5	26.65	24.49	9.41	10.00	21.98	19.18	3.3	1.4
=>0.5 - <1	26.01	24.96	19.22	21.59	26.87	25.93	4.1	1.8
=>1 - <2	19.35	19.83	27.56	32.71	24.29	25.81	5.0	2.3
=>2 - <3	6.15	6.47	15.39	18.82	9.22	10.08	5.9	2.7
=>3 - <4	2.17	1.70	7.78	7.32	3.82	3.63	7.0	3.7
=>4 - <5	1.04	0.51	4.83	2.80	1.97	0.79	7.5	2.7
=>5 - <10	1.16	0.25	8.05	2.10	0.65	0.82	8.5	5.6
=>10	0.29	0.15	5.82	2.10	0.61	0.32	8.1	3.7
Total	100	100	100	100	100	100	4.0	1.8

Source : Central Bureau of Statistics (1993)
Remarks: Holdings having area under crops less than 0.01355 ha (8 Dhurs) in Terai or 0.01272 ha (4 Aanas) in Hilly and Mountainous region, but raising at least 2 productive animals or 20 poultry birds are included in the category "Without land".

Similar kind of distribution is seen in average number of holding, average area holding and average parcel holding in each category of the district and national level. Majority of the households have less than one ha of land while the households who have greater than one ha of land hold majority of the land. More than 30 percent of the land is held by big holders (having greater than 2 ha of land). Half of the total parcel number exists only in the holdings between 0,5 ha to 2 ha. Average parcel number in Chitwan is only 1.8, which is very low compared to national figure.

2.2.5. Cropping Pattern

Rice is the main food crop in the country as well as in Chitwan district. However, rice cultivation in Birendranagar VDC is less compared to Maize cultivation. Only 13 percent of the lands are irrigated and rest of the land is practiced rainfed or dry cultivation. About 26 percent of the total arable lands are irrigated in Nepal while its share is nearly double in Chitwan. About half of the country's arable land is cultivated for rice growing while its

share is abut 64 percent in Chitwan district and 40 percent in Birendranagar VDC. Area covered by the main food crops in the study site with reference to country's figure is given table 2.2.5 -1.

Table 2.2.5 -1: Area of Cultivation and Crop Type

Region	Arable land (ha)	Irrigated land	Area covered by crops (in percentage)							
			Rice	Wheat	Maize	Millet	Barley	Oilseed	Pulse	Potato
1.Nepal	2968017	26*	51	22	27	9	1	6	11	4
2 Chitwan	46814	52	64	18	59	3	3	35	3	12
2 Birdranagar	1260	13	40	16	83	0	12	79	3	Na

Source :
1 : CBS, 1997/98.
2 : District Agricultural Development Office, Chitwan, 1996
* : MoA, 1996

Share of the irrigated land in the VDC is low compared to district and national average and its result can be seen in area of rice cultivation. Maize and then Oilseed are cultivated on the largest portion of the arable land of VDC. Cultivation of Millet is not registered in statistics though its production was more in the past years and is limited to certain households in recent years. Area of the Wheat cultivation is also less, which nearly corresponds to the percentage of irrigated land in the VDC. Mustard is being now replaced by baguettes in great extent. Lentil is more common among the different kinds of pulses. It is usually grown with mustard but mustard is harvested earlier than the lentils. As the VDC has less irrigated land, the annual cropping system in the area includes Rice- Oilseeds- Maize. The major cropping system in the district is mentioned below.

Table 2.2.5 -2: Cropping System in Chitwan District

Cropping system	Number of VDC
Rice – Wheat	2
Rice – Wheat – Maize	20
Rice – Mustard – Rice	3
Rice – Oilseed – Maize	2
Rice – Wheat – Rice	1
Rice – Mustard – Maize	1
Rice – Rice – Wheat – Lentils	3
Rice – Lentils – Maize	1
Rice – Wheat- Barley	2
Rice – Maize – Millet – Oilseed	1
Maize – Millet – Oilseed	1
Maize – Millet – Lentils	2

Rice-Wheat-Maize cropping system dominates in the district. Three crops are generally grown annually though few VDC also practice two and four crops depending on the irrigation facilities and soil characteristics.

2.2.6. Climate and Weather

The district enjoys tropical to sub-tropical type of climate. Siwalik and outer Terai belt of the district has more tropical climate and mid hills of the district in the northern part enjoy sub-tropical. Climate as well and microclimate of the particular place determine the vegetation type of the district. Sal (*Shorea robusta*) forest associated with *Terminali belerica*, *Terminalia chebula*, *Terminalia tomentosa*, *Lagerstroemea parviflora Phyllanthus emblica* etc are widely distributed in the district. Riverine forests of *Bombax ceiba*, *Dalbergia sissoo*, *Acacia catechu, Trewia nudiflora* are mostly found along the river specially the Rapti River inside Royal Chitwan National Park. Grasslands with some scattered trees are also found in the district.

The average temperature ranges from 8.7 °C in December to 34.9°C in June. More pleasant weather exists between September and December. Maximum rainfall is 615 ml recorded in August while minimum rainfall is zero found in December. More than 90 percent of the total rainfall occurs during monsoon.

Chapter 3

3. Research Methodology:

3.1. Site Selection

Chitwan district, central Terai of Nepal, was selected for the research work. Chitwan district has 36 VDCs and 2 municipalities. One VDC from the district was taken for the research work and Birendranagar VDC was found appropriate. Following characteristics of the VDC decided to be selected for the research work.

1. Rural and Semi rural characteristics
2. One of the early settlement
3. Diverse community structure
4. Diverse land use type
5. Attached to the natural forest and highway

3.2. Data Collection

3.2.1. Primary data collection

3.2.1.1. Household Survey

The study was carried out in 98 households of the Birendranagar VDC. The study began in August 1999 and ended in the December of the same year. The study started from the reconnaissance survey of the study area. First, all the wards of the VDC were visited just to know the community structure, land use type, vegetation and other socio-economic condition of the area. Formal household survey was conducted and a structured questionnaire was used to get information from the households. The questionnaire is given in annex 5. Distribution of household number in each ward was obtained from the VDC office and numbers of sample households were divided accordingly.

Table 3.2.1.1 -1: Distribution of Sample Size

Ward no.	1.Total HH#	Weighted value	Sampled HH#	Interval of HH between two sample	Average sample percent
1	388	0,200	19	20	5
2	202	0,104	10	20	5
3	200	0,103	10	20	5
4	151	0,078	8	20	5
5	151	0,078	8	20	5
6	78	0,040	4	20	5
7	108	0,055	5	20	5
8	345	0,178	18	20	5
9	309	0,159	16	20	5
Total	1932	1,000	98		

Source :
1 = CBS (1994)

All nine wards of the VDC were represented during the survey. The total sample size was divided in each ward according to their population size. Selecting appropriate sampling technique is a difficult job specially when numerous factors are to be considered. For this study, stratified random walk sampling technique was carried out to select the particular household for questionnaire survey. A first household in the ward was taken randomly and others were selected after a specified interval of households. Interval of the household was calculated by dividing the total number of household in the ward with sampled number of household in the ward. Interval of the two-sampled household was 20. Thus, every 21st household in all wards of the study area was interviewed. This sampling technique simply distributes the sampled unit evenly within the whole area.

Before conducting the formal questionnaire survey, the questionnaire was pre-tested in five households and some modifications were adopted according to the findings. Most of the questions were designed in tabulated form and quantitative data/information were taken for study purpose. Ranking and scoring were done in cases when quantitative data was found to be difficult to obtain.

Categorization of the households was made after data collection. First, selected households were visited and all the necessary information was gathered from them. The questionnaire was completed directly through the interviews with the household member.

Mostly the household heads were asked for the information though some women (mostly wife of household head) and old members joined in the discussion. Some problems were found with female respondents because few were just married and new for the place. Therefore, most attention was given to the household head and elder persons. Children were also present in the discussion in few households.

3.2.1.2. Direct Observation

During the household survey, direct observation was also made to know the existing situation of the tree species holding, their distribution, growing pattern, homegarden size, land use pattern etc. All the tree species and their number of individuals were counted regardless of their age in each sampled household. Past situation of the species holding was obtained from the questionnaire survey.

3.2.1.3. Informal Survey

In addition to the household survey and direct observation, informal discussion was also made with the local representatives, VDC representatives and VDC staffs. Staff of the District Forest Office, District Agricultural Development Office and Office of the District Development Committee. Informal survey was conducted mainly for the verification of the data obtained from the household level so that their views can either be supported or rejected. Executive member of the Dudhkoshi Community Forest and Amritdharapani Community Forest were also visited and interviewed to know the past and existing situation of forest in nearby settlement areas. Some experts in the concerned area specially from Institute of Forestry and Department of Forest Research and Survey were also visited and discussed about the matter.

Some key informants were also visited and discussed. It was necessary mainly for getting information regarding the history of the area, settlement programme, and changes in forest and vegetation type, changes of weather and climate and changes in cropping

pattern during the cultivation period. Particularly the early settlers were selected as key informants so that all the biophysical and socio economic changes in the area are obtained clearly. Their views were also considered for comparison purpose.

Few group discussions were also conducted in local level. Problems and constrains in the area, suggestions and recommendations for the future improvement were taken during the group discussion.

3.3. Data Calculation

3.3.1. Species Diversity Index

The main objective of the study was to find the level of species diversity and species richness in household as well as whole VDC level. Distribution of tree species and their individuals are the basic variables to calculate the species diversity index. Each tree species type and their number of individuals are found for each household. Then species diversity index for an average household and total study area was calculated by using the specific method as mentioned below.

Shannon and Weaver (1949) have derived the formula to find the level of species diversity of an area. An index is used to measure the species diversity

$H` = - \sum Pi * LN Pi$

Where,

H` = species diversity index

Pi = n/N (proportion of the individual tree of a species with total number of individual Trees of all species in the community).

Values of the Shannon diversity index for real communities are often found to fall between 1.0 and 6.0. The maximum diversity of a sample is Hmax when all species are equally abundant (Stilling, 1996).

3.3.2. Species Richness Index

Species richness of the total study area and an average household were also calculated by using a method derived by Margalef (1969). It is simply a ratio of total number of species and total number of individuals with some modifications. It gives more priority to the number of species rather than number of individuals.

$R = (S-1)/ \text{Ln } N$

Where,

R = Species richness index

S = Total number of species

N = Total number of individuals

Here, increase by a few numbers of individuals within species changes the index more than the large number of individuals within a species.

3.3.3. Livestock Number

Households in the study area have three kinds of livestock; cows, buffaloes and goats. Chicken and duck were not considered here for the calculation of livestock number. Heads of each category were counted during the data collection and they were converted into the standard unit called Livestock Unit later on. Livestock Unit is calculated by using the conversion factors as mentioned below.

Table 3.3.3 -1: Livestock Conversion Factor

Livestock type	Conversion factor
Cow	1.0
Buffalo	1.5
Goat	0.6

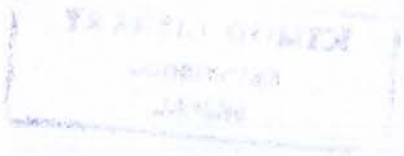
3.3.4. Household income

It was one of the difficult parts to get real information from the household. Farmers do not give exact figure about their income for various reasons. Sometime it is also difficult to calculate just immediately after asking question and sometimes they intentionally hide the facts. Rich households generally think that they could be taxed more while poor farmers think that they will be assisted and subsidized by outsiders may be from government, bank, donor agencies and NGOs etc. Therefore, both categories of the households generally show less figures than exactly one.

For this study, households were not asked to mention the income in monetary term directly. Since the crop production is the major source of income, total production from the farmland were taken separately and converted it into monetary term later on just my multiplying it with local market prices. Income from the tree products of the farm is derived by another way. Since the fuelwood and fodder are not monetized yet in local level, income from these resources were derived by shadow pricing. Value of a unit of fuelwood and fodder were considered the cost of a labor for a day. Income from the fruits was not so reliable because it is also not fully monetized yet. Fruits are mostly consumed by themselves and sale in local market is rare. Income from fruits was calculated by rough estimation. Production of milk and meat was considered to calculate the income from livestock. Total production was multiplied by local market price and then income was found.

Income from labor was derived by multiplying the total number of days to be labored in a year and price of the labor per day. It was also difficult because farmers do not remember the exact number of days that they spent for laboring. Here labor income also includes the salary from temporary job and income from share tenancy.

Income from other sources such as business, service, pension etc. was calculated just by asking them in absolute monetary term. All the income was taken in local currency.



3.4. Data Analysis

Data were analyzed using different statistical tools in different computer programs. Excel, Access and Minitab programs were particularly used. Raw data and information from the completed questionnaire were first entered into the Excel program in database form. Some necessary calculations were completed within this program. Qualitative form of data and information were also coded and entered for analysis. During data entering, each of the sampled households was put in row and each characteristics of the household was mentioned in column. Once the basic calculation and modification were completed, variables were categorized according to needs. Data were sorted and filtered for categorization. The main aim of categorization was comparing their average impact on diversity and dynamics of tree specie. Once the data were filtered, all other information corresponding to the concerned category were copied and brought to Minitab (A statistical programme) for analysis.

Descriptive characteristics such as number of observation, mean, median, standard deviation, standard error, cofficient of variance, maximum and minimum value were found for each variable. Similar types of information were also obtained for each category of the variables. Regression and correlation tools were used to find the linear relationship among the variables and between species diversity and other socio-economic variables. Furthermore, ANOVA was applied to find the impact of variables on species diversity and specie richness. Impact of the variables on tree density, tree per capita, average species holding, average tree holding etc were also found by ANOVA test.

3.5. Secondary Data Collection

Some baseline information of the study area was obtained from VDC office, Office of the District Development Committee, Chitwan; District Office of the Statistics, Chitwan; and Central Bureau of Statistics. Other information was taken from District Forest Office, District Agricultural Development Office, District Livestock Development Office of the Chitwan district. Institute of Agriculture and Animal Science and Institute of Forestry

were also visited for secondary source of information. In addition to this, some research organization such as Nepal Agricultural Research Council (NARC), APROSC, Department of Forest Research and Survey, International Centre for Integrated Mountain Development (ICIMOD), IUCN were also visited for secondary data.

3.6. Limitation of the study

This study provides the status of biodiversity in the rural farmland of Nepal. The study was completed within some limitations, which are as follows:

1. The major limitation of the study was that it could not cover all the cross-sectional characteristics and activities of the sampled households. Only few important socio economic variables were observed for the study.
2. The study was completed in a specific area with small sample size within a short period. Therefore, the result obtained may not be equally applicable to all other part of the country.
3. The socio-economic data and information were heavily reliance on sincerity of the farmers, their memory and knowledge.
4. Household head were not present in some households during the survey. Data and information of such households heavily depends on knowledge, memory and sincerity of other member of the household.
5. Women were not represented well during the questionnaire survey.
6. Farmers were reluctant to give exact figure of the income.

Chapter 4

4. Result and Discussion

4.1. General Characteristics of Respondents

The distribution of sample household of the study area according to gender, age group, caste and education level is presented in table 4.1-1. The total number of male respondent was more than double compared to female respondent, even though no discrimination was made with any sex. It is because of male dominating characteristics in most of internal and external affairs of the household. Male heads about 90 percent of the households. Generally female become the household head when the senior male either has passed away or has gone outside for job. Female-headed households are quite uncommon in the area as well as in the whole country. Nepal Living Standard Survey Report (1996) shows that females head about 14 percent of the households and this ratio is almost constant for both the rural and urban areas. The 1991 population census also revealed 13 percent female-headed household.

Table 4.1 -1: General Characteristics of Respondent in the Study Area

Category		Number of Respondent	Percentage
By sex			
	Male	66	67.3
	Female	32	32.6
By age group			
	<= 30 years	06	06.1
	> 30 to <=50 years	44	44.9
	> 50 years	41	41.8
By caste			
	Brahmin	40	40.8
	Chhetri	10	10.2
	Others	39	39.8
	Lower caste	03	03.0
By education			
	Illiterate	49	50.0
	Primary/secondary education	38	38.7
	SLC	06	06.1
	University level	05	05.1

Source : Field study (1999)

Share of male and female population was 47.5 and 52.5 percent respectively and this figure differs a bit than the national average as found by CBS (1991) in population census. Percentage of male population was 49.86 for national, 49.55 for Chitwan district and 49.4 for the study area in 1991. National figure remained same until 1996 as shown by Nepal Living Standard Survey Report 1996.

According to age, about 45 percent respondents belong to middle-aged group (greater than 30 years and less or equal to 50 years). About 42 percent were older aged, over 50 years. Respondents below 30 years were just few because older members of the household were taken deliberately in the discussion during household survey. It was essential to discuss with older one to get more information about the past.

Average household size was about 6.38 (male = 3.03 and female = 3.35), which is a bit higher than the national average (i.e., 5.6 in 1991 and 5.7 in 1996) as mentioned in NLSS Report 1996 and district average (i.e., 5.4 in 1991). Medium sized household (member with greater than 5 and less or equal to 8) is predominantly found in the area representing about 45 percent of the total number of household. Big family (with greater than 8 member) was found in less number, only about 16 percent. Small family size represents about 37 percent of the total. In the past, until 20 years ago, joint family systems were widely found in the country where grandfather/grandmother to grandchild live together in the same household and survive in the same economic conditions. However, the system is changing gradually towards the nuclear family where husband /wife and their children lives together. There are several factors to determine the size of family such as social, economical, political, literacy and even international factors too.

Exactly half of the respondents were illiterate. NLSS has also found similar result in 1996. According to them, about 56 percent population never attended school in the past. Only five percent of the respondents were university level in the study area.

By caste, about 41 percent were Brahmin (Upper caste under Hindu system) followed by other caste group, Chhetri and lower caste respectively. Other caste group particularly

includes the Magar, Gurung, Tamang, Newar and Tharu in the area. No discrimination has been made to conduct household survey considering any background of the household. According to the VDC source, only about 33 percent of the population belong to Brahmin caste while other caste group represents more than half of the population. Brahmins were represented fairly in high level just by coincidence. The general characteristics of the households by caste are mentioned in table 4.1 – 2.

Table 4.1 - 2: Selected Household Characteristics by Caste in the Study Area

Variables	Caste				Average	Stdev	SE mean	CV
	Brahmin	Chhetri	Others	Lower				
Duration of living (year)	18.1	22.5	24.2	12.3	20.8	10.4	1,05	0.50
HH size (number)	6.5	6.0	6.2	7.6	6.3	2.3	0.2	0.36
Farm size (katha)1	20.9	20.0	21.7	10.3	20.8	20.2	2.0	0.97
Parcel number	2.1	1.9	1.7	1.6	1.9	1.1	0.1	0.58
Homegarden size (katha)	0.9	1.3	0.5	0.5	0.8	1.0	0.1	1.26
HH income (NRs)2	56971	65355	58355	33750	57667	43127	4357	0.74
Livestock size (LU) 3	5.0	3.2	3.9	3.9	4.4	2.9	0.3	0.67
Forest distance (minute)	31.2	14.7	34.5	16.6	30.4	26.5	2.6	0.87
Fwood coll. Time (hours)	4.4	3.0	4.3	3.3	4.1	1.7	0.1	0.40
Forest visit (days)	21.6	15.5	22.3	23.3	21.3	31.7	3.2	1.48
Fwood cons. (kgs)	1695	1725	1762	2450	1748	668.8	67.6	0.38

Stdev = Standard deviation, SE = Standard Error, CV = Coefficient of Variance
Source : Field study (1999)
Note :
1 : 1 ha = 30 katha
2 : 1 US $ = 68.80 NRs
3 : Please see in methodology chapter for livestock unit

Other caste category includes Magar, Gurung, Tamang and Newar particularly. They have settled in the area earlier than others have. In fact, they were the main settlers at the beginning in the area but their population ratio is less in recent years mainly because of hill migrants of other caste group. They were mostly retired soldiers of either the British or the Indian army service. Gorkha soldiers from Nepal became famous when they fought for the British government during the first and Second World War. Their income, therefore, mostly comes from army pension. Household size and farm sizes were fairly distributed in three categories except lower caste. High variation is observed in farm size distribution ranging from 1 Katha (0.03 ha) to 135 Katha (4.5 ha). Lower caste is most deprived group in the Nepalese society. Their average farm size and average income is

very low than average of other caste categories. May be the late settlement could have caused less farm size. Price of land is higher in recent years than past so that it is costly to buy large farm size by many late settlers. Fuelwood consumption between the lower caste group and other categories is high. Lower caste consume high amount may be because of running small cottage industry based on fuelwood. *Kami or Bishwakarma (Black-smith)* people within the Lower caste are supposed to make different tools such as axe, cutting blade, ploughing blade and other iron works in their own household. It consumes lot of fuelwood and charcoal during the processing. It might have caused high level of fuelwood consumption in their household.

4.2. History of Settlement in the Area

No written document has been found on earlier existence of Birendranagar VDC, the study area. Even the VDC office does not have enough information about itself. Therefore, early settlers were used as the source of information. Key information has been taken from them particularly on settlement in the area and socioeconomic changes over time. First settlement in the area was established nearly 40 years ago in 1960, shortly after when Rapti Valley Development Programme was launched in Chitwan district in 1956. It was the first resettlement programme in Nepal. Its objectives were to resettle the victims of natural calamities of the Hills and maintain regular food supply to Kathmandu valley by increasing agricultural production (UNRISD, 1991). The programme was started after eradication of malaria from the region. The history of deforestation in Terai region starts since then.

Many hill migrants including considerable number of retired soldiers came into the Chitwan district to settle permanently under the Rapti Valley Development programme. UNRISD (1991) has mentioned shortage of agricultural area, small size of landholding, insufficient food production, indebtedness and deteriorating environmental conditions of the hill and mountain farmers has caused for migration towards the Terai region. Plains of the Terai were much fertile than the slopes of the Hills. Plenty of the cultivable lands were still under forest due to the infestation of malaria. There has been a contiguous flow

of internal migration of population from hills and mountain to terai. Forestlands were cleared for planned resettlements and agricultural purposes.

Present study area was also under the resettlement programme. However, the settlement was started shortly after 1956. At the beginning, much of the lands were cleared for settlement along and around the Rapti River, south and western part of the Chitwan district. Shortly after, government thought to create wildlife-protected area in south of Rapti River and it is still there with the name of Royal Chitwan National Park. This park is now famous internationally for its biodiversity and productivity. It is also listed as World Heritage Site. Once the government decided to establish wildlife protected area is south to Rapti River, hill migrants specially the retired soldier had to leave the land again and present study area named Birendranagar VDC was found suitable for their resettlement.

Dirgha Singh Tamang, 84, one of the respondent and key informant, was active in management of the resettlement programme for the hill migrants specially the retired soldier. According to him, a team, including him was formed to find an appropriate place to resettle the households who were living in the southern part of the district in Rapti Valley. Finally they found Birendranagar VDC, present study area, appropriate for settlement permanently. Right there, it was full of dense forest with much wildlife. The government provided 45 Katha (1.5 ha.) of land for each household. The land was full of tree resources including commercially valuable trees such as *Shorea robusta, Acacia catechu, Dalbergia latifolia, Pterocarpus marsupium, Michalia champaca* etc. Settlers were not allowed to use any of the commercial wood as mentioned above. Some contractors were working there to collect logs from such trees. Finally, all valuable trees were cut down and taken outside to the Timber Corporation of Nepal (TCN). A few number of trees and their species were left in the farmland, most of them were either non-valuable or degraded.

Since then, many changes have occurred in the area. Not all of the early setters are there nowadays. More hill migrants have arrived there to settle permanently. Chitwan is

considered one of the most productive areas in the country. Some early settlers have left the place. In fact, immigration and emigration is a continuous process taking place everywhere. The early settlers are either being replaced partly or wholly by outsiders. Table 4.2 -1 shows the distribution of households by settlement period and other characteristics of the household by settlement period are given in table 4.2 – 2.

Table 4.2 -1: Distribution of Households by Settlement period

Category of settlers	Scale (in years)	Number of households	Percentage
Late settlers	<=5	08	08.1
Middle settlers	>5 - <=10	13	13.3
Early settlers	>10 -<=20	31	31.6
Early settlers	>20 -<=30	22	22.4
Early settlers	>30	24	24.5

Source: Field survey (1999)

Above table reveals that migration is less in recent years than the past. May be area is saturated having maximum number of household and population to support them.

Table 4.2 - 2: The Selected Characteristics of Households by Settlement Period

Variables	Category of settlers		
	Late settlers	Middle settlers	Early settlers
Settlement period (year)	3.2	8.4	24.7
Household size (number)	5.2	6.9	6.4
Farm size (katha)	6.6	22.4	22.0
Parcel number	1.5	1.7	1.9
Home garden (katha)	0.2	0.8	0.9
Household income (NRs)	31278	48346	61982
Livestock size (LU)	2.3	4.8	4.5
Forest distance (minute)	22.5	33.4	30.7
Fwood collection time (hrs)	3.1	4.4	4.2
Forest visit (days)	13.3	17.3	22.8
Fwood consumption (kgs)	1069	2077	1763

Source: Field study (1999)
Note :
Late settlers = living less or equal to 5 years
Middle settlers = Living more than 5 years but less or equal to 10 years
Early settlers = Living more than 10 years to time of settlement

Settlers were grouped into three categories for comparison purpose. Average farm size for the late settlers is very low compared to other two categories. Price of the land might have affected the size since price of the land usually rises as the time goes ahead. Average size of the farm is also decreasing over time. Parcel number does not deviate much across the different groups. But, High variation is observed in household income of the each category, lowest in the late settlers and highest in early settlers. Early settlers could have more sources of income than middle and late settlers. Pension is an important income source for early settlers and they have large farm size. Further, livestock is another source of income in rural Nepal, which is also found in higher number among early settlers. Late settlers are residing near to forest than others. May be the price of the farmland influence settlement area. The settlement exists between East-West highway in south and forestland in north. This East-West highway mostly determines the price of the farmland in Chitwan district. Price of farmland is less in near to forest area while it increases as the distance between farmland and highway decreases. Another reason may be that late settlers want to secure more in terms of fuel, fodder and timber at the beginning that might have caused to settle them near to forest. But it is somehow confusing that the average number of forest visit is lower for late settlers and higher for middle and early settlers. Their requirement may be less than others. Both average household size and average livestock size is less in late settlers compared to others. As explained above, their farm size is small so that they cannot spend more time only for collecting forest products. Instead, they need to work more may be in outside farm for income. Fuelwood consumption level of the late settlers also proves this fact because it is nearly half of the middle and early settlers.

4.3. Distribution of Farmland

The farm size of the households varies greatly from 0,033 to 4.5 hectares with mean 0,7 and standard deviation 0,67. Table 4.3-1 depicts the distribution of households in farm size categories.

Table 4.3 - 1: Distribution of Households by Farm Size

Categories	Scale (ha.)	Average	Number of HH	Percentage of HH
Small farm	<=0,5	0.25	47	47.9
Medium farm	>0,5 - <=1,5	0.86	42	42.8
Big farm	>1,5	2.25	09	09.1
Total average		0.7		

Source: Field study (1999)

Average farm size is gradually decreasing in Nepal. In 1961, it was about 1.11 ha and it became about 0.97 ha in 1971. Then figure reached up to 1.13 ha in 1981. But Population census 1991 found 0.96 ha average farm size in the country. It is only about 0.7 ha in the study area, a bit lower than national average but close to district average (0.8 ha) of 1991. Ojha et.al. (1994) has also found 0.65 ha of average farm size in Birendranagar area. CBS (1996) has found 40 percent small farmers (operating less than 0.5 ha of land) and 13 percent large farms (with 2 ha and more land) in the country. Current finding also does not deviate much from this figure. It is mainly because of large distribution of small farmers. Some other characteristics associated with different farm size are given in table 4.3 -2.

Table 4.3 - 2: General Characteristics of Households by Farm Size

Variables	Category of farmland		
	Small	Medium	Large
Settlement period (year)	16.7	24.2	26.3
Household size (number)	5.4	7.0	8.7
Farm size (katha)	7.5	25.7	67.5
Parcel number	1.6	1.9	3.2
Home garden (katha)	0.3	1.0	2.4
Household income (NRs)	43076	59664	119494
Livestock size (LU)	3.0	5.2	6.9
Forest distance (minute)	31.9	28.3	30.7
Fwood collection time (hrs)	4.2	4.0	4.3
Forest visit (days)	23.9	19.0	21.1
Fwood consumption (kgs)	1471	1972	2133

Source: Field study (1999)

Large farm holders are early settlers in the area. Early settlers, who arrived in the place at the very beginning, were granted the land from the government and some others could have bought much land in very low price. But recent years, price of the land is high that primarily have caused to hold less farm size in the late settlers. Household size, parcel number and home garden size increases as the size of the farm increases. Size of the home garden almost depends on size of the total farmland. Household income and livestock size is also different in each farm size. Household income of the rural household mostly comes from the on-farm activities mainly from agricultural crops. Hence, income generally increases as the farm size increases and situation is also same for livestock holding. May be small farmers do not have enough resources to support large herd size. Big variation is found in fuelwood consumption. Large family size, large herd size might have caused to consume more fuelwood by big farmers.

4.4. Land fragmentation

The number of parcels in total operated area by a household gives an indication of land fragmentation. A parcel is generally defined as a piece of land physically separated from other land belonging to the area operated by a household. A parcel may consist of one or more adjacent plots or fields. Land fragmentation has occurred in most agricultural land of Nepal since the beginning of cultivation. Various factors determine the level of land fragmentation among which socio-economic is the most important. In Nepal, no policy measure exists at all to either reduce or stop the land fragmentation in the agriculture land. Law inherits land by the sons no matter how small the farm size is. Holding farm is some sort of prestige in rural society. Big landholders generally have strong hold in social activities. No individuals, therefore, want to lose the land that is inherited even until the land less size. Average parcel number in the area is about 1.91, which is quite low as compared to national average. Distribution of the household with different parcel number is presented in table 4.4 - 1 below.

Table 4.4 - 1: Distribution of Households by Parcel Number

Categorys	Scale (ha.)	Average	Number of HH	Percentage of HH
Single parcel	1	01	45	48.9
Double parcel	2	02	32	32.6
Greater than 2 parcels	>2	3.7	21	21.4
Total average		1.9		

Source: Field study (1999)

Number of parcels in the area varies from 1 to 5 with mean 1.91. This figure does not deviate much from the district average (1.8 in 1991), though national average is 4 in 1991 and 3.8 in 1996 as shown by CBS (1996). Nearly half of the total numbers of households have only one parcel indicating less fragmentation of the land. Table 4.4 – 2 depict the changes of parcel number in the study area.

Table 4.4 - 2: Average Parcel Number in the Study Area

Time Series	In Small farm	In Medium farm	In Big farm	Total Average
At beginning *	0.6	1.5	2.0	1.2
10 years ago	0.8	1.8	2.5	1.6
5 years ago	1.4	1.9	3.2	1.8
At present	1.6	1.9	3.2	1.9

Source: Field Study (1999)

* : Period between 10 years ago to time of settlement

Parcel number increases as the size of the farm increases. Decreasing trend of average farm size is also observed over time. The trend shows the further decrease of parcel number in the future too. Big farm with single parcel is rare in the area unless some policy measure is adopted. Other characteristics associated with the different parcel number are mentioned below.

Table 4.4 - 3: Selected Characteristics of Household by Parcel Number

Variables	Number of parcel		
	Single	Double	> Two
Settlement period (year)	19.9	20.3	23.3
Household size (number)	6.0	6.1	7.3
Farm size (katha)	15.7	19.7	33.5
Parcel number	1.0	2.0	3.7
Home garden (katha)	0.6	0.8	1.2
Household income (NRs)	48411	60782	72752
Livestock size (LU)	3.8	4.7	5.1
Forest distance (minute)	30.6	24.3	39.1
Fwood collection time (hrs)	4.1	4.1	4.5
Forest visit (days)	25.7	15.6	20.7
Fwood consumption (kgs)	1657	1777	1900

Source: Field study (1999)

Higher number of parcel generally indicates the large farm size, high income, and large livestock size in the area.

4.5. Livestock Holding

Livestock is an integral part of the rural farming system in Nepal. In fact, it has a great influence on sustainability of the rural livelihood. A good interrelationship exists among livestock, agricultural crops, household income and sustainability. The majority of the farmers keep livestock in rural areas. Average number of livestock units (see chapter 3) per household is only 4.4 comprising 0,9 buffalo, 1.5 cattle and 1.8 goats. It varies from 0 to 10.8 livestock units. The figure is low than the national average herd size of cattle, buffalo and goat, which were 3.3, 2.2 and 4.5 respectively. Distribution of the households with different livestock size is mentioned in table 4.5-1.

Table 4.5 - 1: Distribution of Households by Livestock Size

Categories	Scale (LU)	Average	Number of HH	Percentage of HH
Small livestock holding	<=2	0.7	23	23.4
Medium livestock holding	>2 - <=5	3.4	38	38.7
Large livestock holding	>5	7.6	37	37.7
Total average		4.4		

Source : Field study (1999)

The average size of the herd is small and further decreasing in the area. A comparative figure is given below in table 4.5-2.

Table 4.5 -2: Average Livestock Holding in Nepal

Unit in number

Livestock type	Field study (1999)	1. District average (1991)	2. National average (1991)	3. National average (1996)
Cattle	0.9	3.2	3.5	3.3
Buffalo	1.5	2.9	2.3	2.2
Goat	1.8	3.4	3.9	4.1
Total Livestock Unit	4.4	9.7	9.7	9.0

Source : Field study (1999)
Note:
1. CBS (1999), Nepal
2. CBS (1999), Nepal
3. CBS (1996), Nepal

Average livestock size is lower compared to the national and district average. It may be because of problem related to other socioeconomic factors in the study area. Livestock rearing needs large amount of resources such as fodder, concentrated feed and agricultural residues etc. Nearly half of the total numbers of households are small farmers who produce limited amount of resources from own farm, which further cannot support large herd size. Green fodder is another important source on which livestock depends. Furthermore, they might not have more time to spend just for livestock rearing because they mostly depend on off-farm income. Holding improved breeds of livestock might have replaced large herd of local breed.

Grazing is another problem in the area. It is very difficult to hold large herd only in stall-feeding. Grazing provides livestock feeding in daytime, which could ease to hold large herd even by the small farmers. Grazing opportunities are further affected by the availability of household labor. In recent time, no household member can sacrifice his/her time just for following animals. May be the opportunity cost of grazing animals is higher so that it is less economical. Table 4.5-3 exhibits the percent of farmers practicing different level of stall-feeding in the area.

Table 4.5. - 3: Percentage of Household Practicing Stall-feeding in Different Settlement Period

Time series	Average month of stall feeding	Percent of farmers practicing stall feeding in month			
		<2	=>2-<6	=>6 - <10	=>10
At beginning	03.5	9.0	53.2	14.2	23.3
10 yrs ago	08.1	7.7	05.5	17.7	68.8
5 yrs ago	10.7	8.1	01.0	10.2	89.9
At present	11.0	0.1	00.0	08.1	91.8

Source: Field study (1999)

Feeding practice of the livestock is changed significantly. Average month of stall-feeding is increased from about 4 months to 11 months at present. More than 90 percent of the total households practice about 11 months of stall-feeding.

As mentioned earlier, about 19 and 29 percent of the households depends on labor for primary and secondary source of income respectively. They need to be involved more in off-farm activities and this situation is not easy to combine with holding a large herd in the household. The selected characteristics of the households with different livestock holding are presented in table 4.5-4.

Table 4.5 - 4: Selected Characteristics of the Households by Livestock Size

Variables	Category of livestock size		
	Small	Medium	Large
Settlement period (year)	18.7	19.0	24.0
Household size (number)	4.7	6.2	7.5
Farm size (katha)	12.5	14.8	32.2
Parcel number	1.6	1.9	2.1
Home garden size (katha)	0.4	0.6	1.3
Household income (NRs)	53048	48919	69522
Forest distance (min)	36.3	23.0	34.2
Fwood coll. Time (hrs)	4.3	3.8	4.5
Forest visit (days)	16.3	24.0	21.7
Fwood consumption (kgs)	1363	1756	1978

Source: Field study (1999)

Large farm size supports higher livestock number. As discussed earlier, livestock requires more resources such as space, labor, agricultural production etc., which is mostly found in large farm size in the area. Household income is not influenced much from the livestock holding may be due to small herds. Livestock feeding preparation for milking cows, buffaloes and oxen could have influenced higher fuelwood consumption in large livestock holdings.

Some more facts have been found to explain the lower number of livestock in the area. Herd size is gradually reducing and further decrease seems to be occurred in future as shown by the current trend. In recent years, ox ploughing is being replaced by tractor. Household distribution using different ploughing techniques is given in table 4.5 - 5 below.

Table 4.5 - 5: Percent of households using different ploughing system

Level of use	Percent of Households Using	
	Ox ploughing	Tractor
Very high	1.0	41.8
High	11.2	26.5
Medium	11.2	10.2
Low	67.3	12.2

Source: Field study (1999)

Use of the system is measured by ranking in four levels. Very high level refers the complete use of the system. Another system is not used at all. Low level refers the occasional use of the system just to supplement other one. About 9 percent of the households do not use any kind of ploughing. Having small size of land, they grow little or no for main crops. Farmers themselves cultivate manually. If the current situation continues, traditional ploughing system will be limited only to few households after some year. CBS (1999) shows that about 1.3 percent of the total households uses tractor for cultivation. It is difficult to use tractor in the Hills and Mountains because of terracing, while it can plough most of the Terai land. Holding Oxen all around the year is not cost effective currently since they need feeding every day. It is laborious and time consuming too. It is, therefore, cheaper to use tractor.

Various resources are used for livestock feeding among which crop residues are the most important. Other resources are tree fodder, surface grasses, concentrated feed etc. Dynamics of socioeconomic and biophysical condition also influence the level of use of resources. Use of crop residues and concentrated feeds has increased for livestock feeding. A good relationship exists between the use of crop residues and the practice of stall-feeding. Crop residues provide the basic and important feeding resources for livestock. Residues from paddy are mostly used for livestock feeding and other residues such as maize, mustard and wheat are also used to some extent. Level of use of tree fodder and surface grasses has decreased in recent years. Table 4.5-6 presents the percent of households using different level of crop residues in the area.

Table 4.5 - 6: Percent of Household Using Feeding Resources for Livestock

Level of use	Percent of households using resources			
	Crop residues	Tree fodder	Surface grasses	Concentrated feed
Very high	83.6	0.0	1.0	0,0
High	3.0	5.1	24.4	1.0
Medium	2.0	37.7	29.6	30.6
Low	1.0	46.9	34.7	53.0

Source : Field survey (1999)

Note : Level of use is compared with the settlement period

Here too, level of use is measured by ranking that ranges from very high level to low level. Use of resources at the settlement time is taken as reference for comparison. Crop residues are used for livestock feeding and others are used in specific seasons and occasions because of availability as well as price factor. About 90 percent of the households keep livestock and they use all types of feeding resources in different proportions. Using concentrated feed is costly and its use in most cases is not economic.

4.6. Household income and sources

Agriculture is the main source of income on which about half of the households depends as primary source of survival. Agriculture is the backbone of national economy that supports 80 percent of the economically active population and 40 percent of the total GDP (MoF, 1998). Table 4.6-1 presents the distribution of households by income sources.

Table 4.6 - 1: Percent of Households by Income Sources

Unit in percentage

Source of Income	As a primary source	As a secondary source	As a tertiary source
Agriculture	46.9	44.9	3.0
Labor	19.4	28.5	12.2
Business	6.1	8.1	1.0
Pension	17.3	5.1	0.0
Service	10.2	2.0	1.0
Cottage industry	0.0	1.0	0.0

Source: Field study (1999)

Agriculture is not sufficient as source of income for survival. In fact, Nepalese agriculture is subsistence based. Nearly one fifth of all the households depend on labor as the primary source of income and another 29 percent depend on the same sources as second most important source. Here, income from labor includes wages from daily labor, salary from temporary job and income from share tenants. Nepal Living Standard Survey Report (1996) has mentioned 61 percent income from on-farm and share of non-farm income and other income is 22 percent and 16 percent respectively. On-farm income includes income form agricultural crops, livestock, non-crops goods, and land rental. Off-farm income includes income from labor, regular job, pension, business and commerce, cottage industry etc. Here, income from value of owner occupied housing, annual earning from deposits in saving account, fixed account, treasury bill, stocks and shares, employee provident fund, pensions and commission frees or royalties are avoided because of complexity. Average income of the household from various resources is presented in figure 4.6 –1.

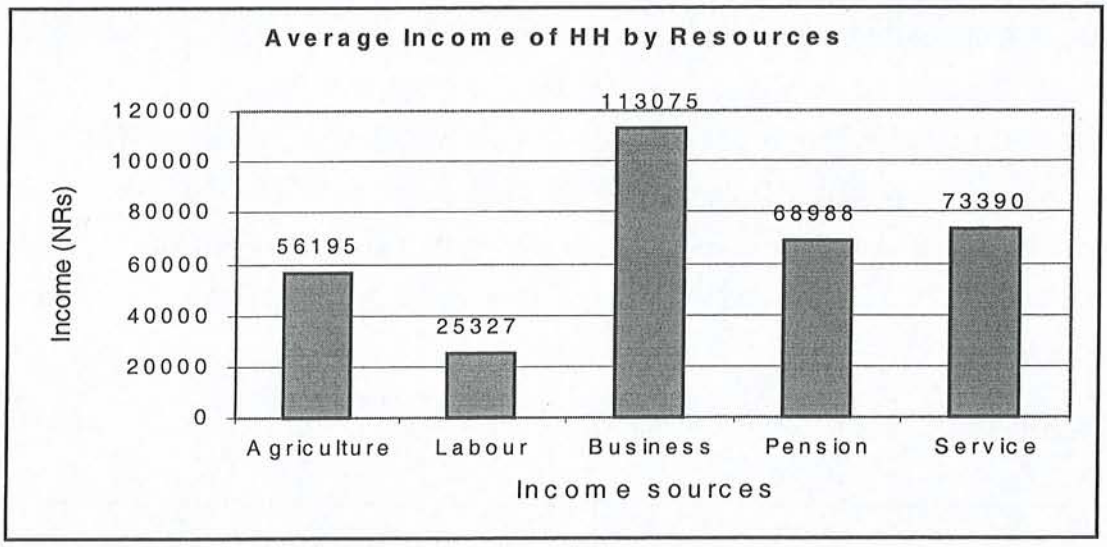


Figure 4.6 – 1: Average Household Income by Primary Source of Survival

Retired soldiers are among the early settlers and their pension is the third largest source income in the area. Young male members of the other caste category prefer to join in army service giving more priority to the British army, Indian army and Nepalese army

respectively. The system still exists in the area. Income from service includes the regular job in governmental, non-governmental and private organization. Few households depend on business as their main source of income. Business oriented household are mainly involved in small grocery, clothing shop, stationery shop, machinery shop etc. Average income of the household by various sources is given below.

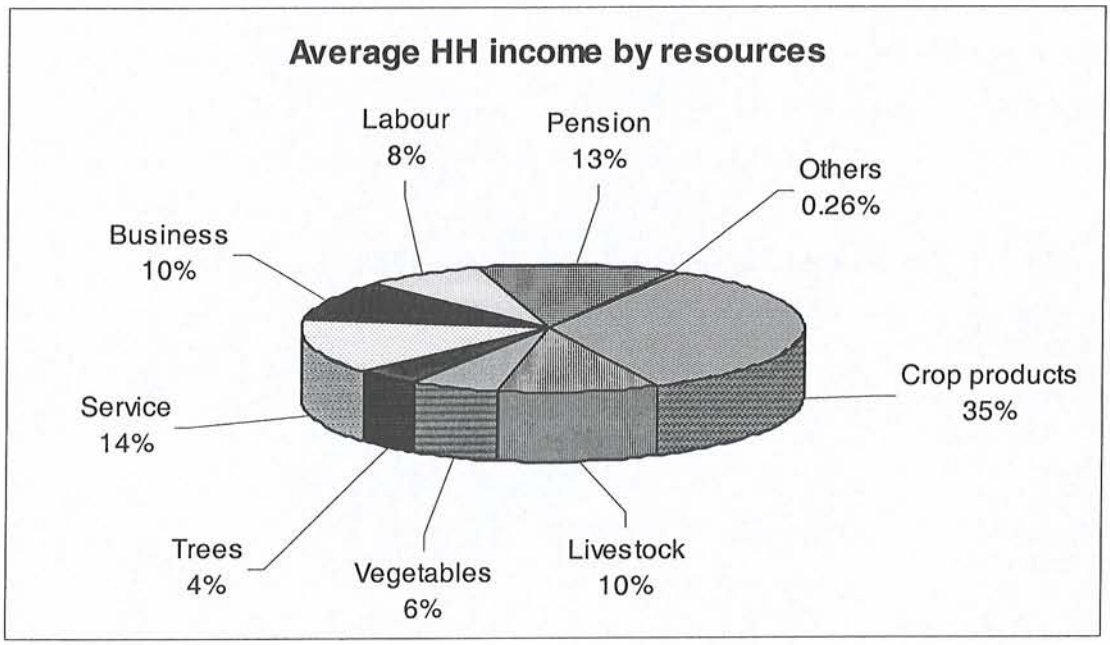


Figure 4.6 - 2: Average Household Income by Resources

High variation is observed in annual household income. It varies from NRs.14150 to NRs.273000 with 57668 as mean and 43127 standard deviation. More than half of the total income is derived from on-farm production. Labor contributes about 8 percent of the total income, though about one fifth of the households depend on it. For comparison, households are divided into three categories and their distribution is given in table 4.6 – 2.

Table 4.6 - 2: Distribution of Households by Income Level

	Number of household in different income group		
	Low income (<=50000)	Medium income (>50000-<=100000)	High income (>100000)
Number of household	57	33	8
Percent of household	58	34	8

Source: Field study (1999)

It reveals the economic situation of the households in the area. Majorities of the households are surviving in low economic condition while the proportion of high-income groups is less. Other selected characteristics of the different income households are presented below in table 4.6 – 3.

Table 4.6. - 3: The Selected Characteristics of Households by Income Level

Variables	Income group		
	Low income	Medium income	High income
Settlement period (year)	18.3	24.0	25.3
HH size (number)	5.9	6.7	8.0
Farm size (katha)	12.7	27.2	52.6
Parcel number	1.6	2.1	3.0
HG size (katha)	0.5	1.3	1.3
HH income (NRs)	34680	69065	174425
Livestock size (LU)	3.8	4.9	6.4
Forest distance (minute)	32.2	27.1	31.2
Fuelwood coll. Time (hrs)	4.3	3.8	4.8
Forest visit (days)	24.6	17.8	12.5
Fuelwood cons. (kgs)	1610	1868	2231

Source: Field study (1999)

Income influences many aspects of the household. Household sizes, farm size, parcel number, livestock holding, forests visit and fuelwood consumption is influenced by the household income of the area. High-income households have big families. It is obvious that they can afford more facilities for the members. Household income and farm sizes are closely related in rural Nepal. Income increases as the farm size increases. Lower income household cannot produce enough resources in their own farm. On the other hand, they cannot afford alternative sources of energy such as kerosene, biogas plant, LPG, electricity etc. to substitute the fuelwood.

4.7. Forest Resources

No written document of the area has been found on the database of natural resources. GIS tool was applied to prepare a map of the study area, which shows about 15.72 sq.km (48 %) of the land covered by forest. Few shrub and grassland are also included in the forest. Almost all of the households use nearby forest resource for fuelwood, fodder and timber. It further supports by providing stone, sand, soil and even the source of drinking water. As mentioned before, small and medium farm sized households dominates the overall population. They do not have sufficient size of farmland to produce enough resources at a time. Cereal crops are highly prioritized in rural farming system. However, trees are also grown in different form. The importance of forest resources is greater particularly for small and medium farmers. It is difficult to survive without forest.

In the past, until 4 years ago, the government managed the forest through the district forest office. Protection from the users was main tools for forest management. There was no local participation in forest management activities. Locals were taken as outsiders. As a result, local users attempted to exploit the forest resources as much as they could. Some wanted to secure their timber requirement while some others were involved in illegal supply of logs. Households were allowed to collect fuel wood from dead and fallen trees, and collection of fodder was legal. Farmers' main concerns were timber and fuel wood. They were also using other products such as fruits, seeds, soil, water, honey etc from the forest. Further, hunting was, and still is, strictly prohibited without license. Gradually, the population has increased and hill migrants have come to the area. The forest is degrading rapidly. Gyan Prasad Sapkota, 63, said that extreme exploitation occurred during the referendum in 1979 to 1980. The same level of forest exploitation took place during the changes of political system in 1990.

In 1993, the new government changed the forest policy making it more flexible to involve the local users in forest management activities. New Forest Act 1993 and Forest Regulation 1995 came into existence, according to which the government has taken an ambitious plan to hand over about 61 percent of the total forest area to the local

communities as community forest. Users themselves control all the management activities of the community forest. Since then, many degraded forest areas have been handed over specially in Hills and Siwaliks region. Figure of the community forest in the country is presented table 4.7 - 1.

Table 4.7 - 1: Status of Community Forestry in Nepal

Physiographich region	Total area (Ha.)	Number of FUG	No. HH benefited	Number of district with CF	Total number of district in region
Hills/mountain	547718	8721	840102	53	55
Terai	86470	615	136772	20	20
Chitwan District	4742	8	5092	Na	Na

Source : Department of Forest (1999)

The New Forest policy has also been implemented in Chitwan district, Central Terai of Nepal. Some degraded forest areas have already been handed over to the local communities and some areas are under consideration. Three community forests of the Birendranagar VDC are registered in the district forest office, among which one was already handed over to the community in 1997. Amritdharapani community forest is now fully managed by local users. Dudhkoshi and Bagdevi Community Forests are in the process and are being managed by the communities since the registration has been completed.

The quality status of the forest is measured for different settlement period. Farmers were asked to assess the level of forest quality in rank. Ranking is further supported by other variables such as time of resource collection, average forest visit etc. Table 4.7– 2 exhibits the dimensions of forest status in the area.

Table 4.7 - 2: Forest Quality Assessment of the Area

Time series	Av. Time to reach forest (in minutes)	Av. Time to collect a unit of fuel wood (In hours)	Av.time to collect a unit of fodder (In hours)	Av.days to visit forest per year	Level of use of fuel wood	Quality of the forest
At beginning	21.7	1.6	1.4	134.8	1.1	1.2
10 yrs before	29.5	2.7	2.4	84.4	2.1	2.4
5 yrs before	30.7	3.8	3.4	49.5	2.9	3.4
At present	31.0	4.4	3.8	23.5	3.2	3.5

Source : Field survey (1999)

Ranking that ranges from very high level to low level assesses forest quality and use of fuel wood. 1 indicates the very high level and 4 indicate low level. Beginning of the settlement is taken as the reference for comparison. Farmers in the area believe that quality of the forest has been decreasing since the beginning and will further decrease if some interventions are not made. Increased time for resource collection further indicates the degradation of forest quality over time. Significant change in forest visits may be due to unavailability of resources in time. The selected characteristics of the households relating to forest visit are presented table 4.7 - 3.

Table 4.7 - 3: Selected Characteristics of the Households by Number of Forest Visit

Variables	Category of forest visit in days		
	<= 15	>15 to <=30	>30
Settlement period (year)	21.1	19.7	23.8
HH size (number)	6.2	6.4	7.0
Farm size (katha)	20.3	22.4	17.0
Parcel number	1.9	1.8	2.1
HG size (katha)	0.9	0.7	0.5
HH income (NRs)	62009	53726	41443
Livestock size (LU)	4.0	4.8	4.8
Forest distance (minute)	34.3	20.1	47.9
Fuelwood coll. Time (hour)	4.1	4.1	4.6
Fuelwood consumption (kg)	1673	1853	1843
Forest visit (days)	10.0	25.0	92.0

Source :Field survey (1999)

Household income has great influence on forest visit. Low-income group highly depends on forest resources. Fuelwood is the main item for which households visit forest frequently. Distribution of households using fuelwood and other energy resources for cooking purpose is presented in figure below.

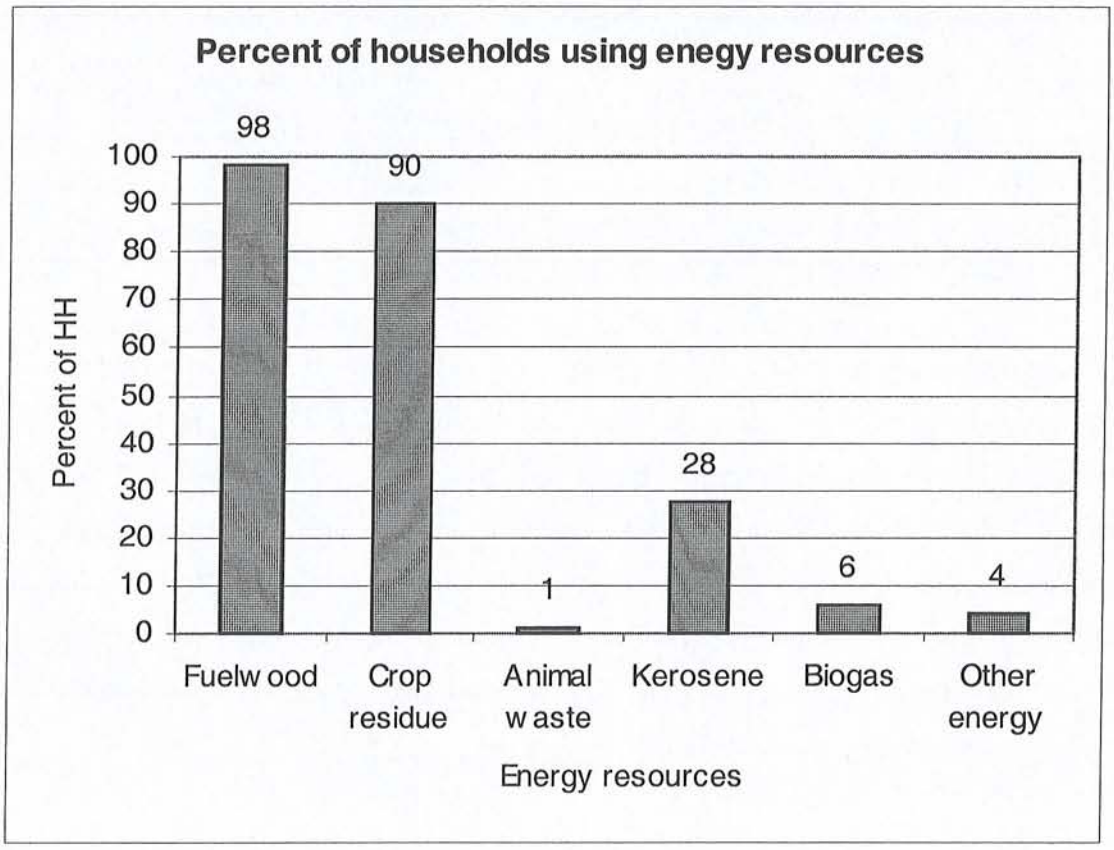


Figure 4.7 -1: Percent of Households Using Energy Resources

Note : Energy use for cooking purpose only

Fuel wood is the primary source of energy in most part of the country. As reported by the NLSS Report 1996, wood is used by about 65 percent of the households for cooking purpose in Nepal. Same report has mentioned dung and other litters like leaves, thatch, straw and stalks as the second most source of energy that are used by 25 percent of the households. The percentage households using LPG is negligible, below one percent. Nearly 5 percent of the households use kerosene for cooking. The use of other fuels (including electricity, coal, charcoal and biogas) is also very low (CBS, 1996).

WECS (1997) has found that fuelwood supplies about 80 percent of the total energy requirement of the country. About 91 percent of this energy is consumed in residential sector and contribution of fuelwood in this sector is almost 99 percent.

Level of use of fuelwood depends on various factors, among which socioeconomic is the most important. Availability and price of the other form of energy such as kerosene, LPG, electricity, biogas etc. is fairly suited for rural poor. However, use of such energy form is increased in recent years in the area. Community itself controls forest and households are not allowed to collect fuel wood and timber unless public announcement is made according to the management plan of the Community Forest. Few households have biogas plant, which can be used for both cooking and lighting.

Pressure on the forest resources has decreased in recent years. Following factors might have caused the reduction of the high pressure on forest resources.

1. Decreased forest visit
2. Decreased level of fuel wood consumption
3. Increased the level of other energy resources
4. Changed forest policy (Implementation of Community Forest)
5. Reduced livestock size per holding

A discussion with the member of Dudhkoshi and Amritdharapani Community Forest was made to know the existing situation of forest resources. According to them situation is recovering rapidly, even though the area was badly degraded earlier. Improvement is also found in direct observation.

4.7.1. Fuel wood Consumption:

Fuel wood consumption varies from zero to 3600 kg with mean 1748 kg and 668 kg standard deviation. Households were divided into three categories for comparison purpose. The selected characteristics of the household using various level of fuelwood are presented in table 4.7.1 – 1.

Table 4.7.1 - 1: General Characteristics of Households by Fuelwood Consumption Level

Variables	Category of fuel wood use (kg)			Remarks
	Low (<=1500)	Medium (>1500-<=2250)	High (>2250)	
Settlement period (year)	19.1	20.8	23.9	
HH size (number)	5.3	6.4	8.1	
Farm size (katha)	12.6	22.6	32.3	
Parcel number	1.6	2.0	2.1	
HG size (katha)	0.7	0.8	1.1	
HH income (Nrs)	50564	54304	77700	
Livestock size	3.3	5.1	5.0	
Forest distance (min.)	39.2	24.8	25.4	30 Katha= 1 Ha. 68.50 Nrs = $1
Forest visit (days)	21.9	20.5	22.0	
Fwood coll. Time (hrs)	4.5	4.1	3.7	
Fwood consumption (kg)	1062	1920	2662	

Source: Field study (1999)

Increasing household size, farmsize, livestock size and income supports for higher level of fuelwood consumption in the area.

4.8. Agricultural Cropping System and Area:

Cereal dominates the cropping pattern in Nepal. Rice is the most common and important crop in the country and maize comes in the second position. Wheat cultivation is gaining popularity in recent years. Millet and barley are common in the mountains and the hills. Lentil and soybeans are common legumes grown. Mustard is the prominent among oilseed crops. Potato is the major crop of the mountain and the hills. Winter and summer vegetables are grown in the hill and the Terai. Majority of the household cultivates paddy, though only about 13 percent of the cultivated land are irrigated in the area and other depends on monsoon. The area is mostly dry and rainfed. Lack of irrigation is the single most reason for cultivating wheat by less number of households. Percent of the households cultivating selected crops is given in figure 4.8 -1.

Few households cultivate millet compared to regional and national level. The area is not self-sufficient in food, though majority of the households cultivates main cereal crops. Number of households buying main cereal crop is more than number of households

selling crops. 60 percent of Nepal's population has to spend more than two-thirds of their household budget for food alone. More than 80 percent of the food supply consists of cereals in Nepal (Bohle and Adhikari, 1998). Table 4.8 – 1 shows Percentage of the households selling and buying different crop product in the area.

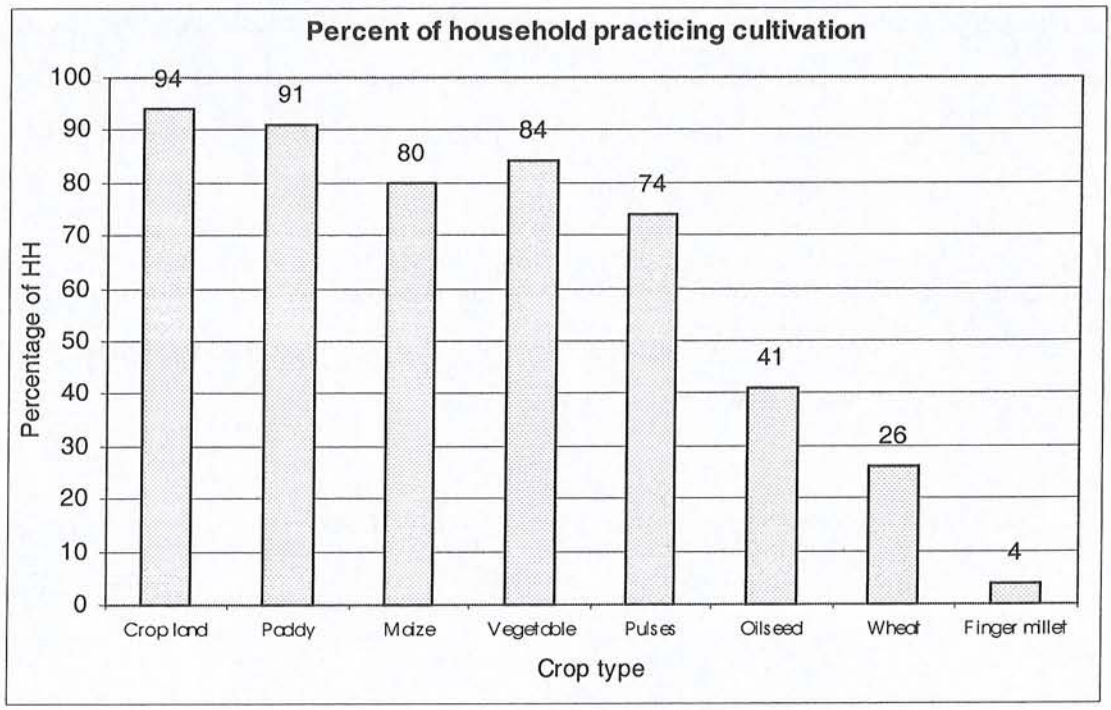


Figure 4.8 - 1: Distribution of Households by Crop Type

Table 4.8 - 1: Percentage of Households Buying and Selling Crops

Unit in percentage

Household	Crop type						
	Paddy	Maize	Wheat	Finger millet	Mustard	Lentils	Vege
Selling crop	18	6	3	0	0	5	8
Buying crop	45	41	37	1	90	58	44
Neither selling nor buying	37	51	16	5	10	31	42
Not using	0	2	44	94	0	6	6

Source: Field study (1999)

Nearly half of the total numbers of households are small landholders with less than 0,5 ha of farmland. This size is, in fact, not sufficient to produce enough food for average household. Therefore, a large portion of the population buys food items mainly cereal in

the area. As explained earlier, only about 47 percent of the total households are agricultural based and similar portion of the households depends on it as secondary source of income. Rest of all primarily depends on non-agricultural income sources. Only few households are self-sufficient from their own products.

Finger millet is limited to certain households and many others do not even use it. All households use rice and mustard. Rice is the basic and major foodstuff while mustard is the complementary food items. Households usually do not buy mustard seed directly but buy in the form of edible oil from the market.

Households have mentioned loss of productivity as the main problem in agricultural practice. Farmers believe that productivity of the farmland has decreased significantly in the area as shown by table 4.8 – 2.

Table 4.8 - 2: Households' Perception on Productivity of Land

Unit in ranking

Time series	Productivity of Crop type						
	Paddy	Maize	Wheat	Finger millet	Mustard	Lentils	Veg.
At beginning	1.9	1.1	1.9	2.1	1.1	1.8	1.9
10 yrs ago	2.1	2.1	2.5	2.5	2.5	2.6	2.6
5 yrs ago	2.4	3.4	2.7	3.4	3.7	3.0	3.0
At present	2.5	3.9	2.8	3.7	3.8	3.2	3.1

Source : Field study (1999)
Note : Productivity is measured in ranking ranging from 1 to 4.
1 = Very high, 2 = High, 3 = Medium, 4 = Low

Comparison of the productivity is made with reference to the productivity at the beginning. Farmers believe that productivity of each crop type is decreased over time. It is severe in maize and mustard. Nature is dynamics. The situation is changing everywhere and so is in the study area. Households reported the following factors responsible for lost of productivity in the farm.

1. Intensive utilization of farmland.
2. Lack of composting and organic materials.

3. Lack of knowledge on use of chemical fertilizer etc.
4. Changes in weather and climate
5. Lack of soil moisture

Inverse relation has been found in utilization of organic manure and chemical fertilizer in the study site. It is almost true also in the national level. In reality, once the compost and organic matter is not sufficient, farmers use high level of chemical fertilizer as well as herbicide and pesticide to maintain the same level of productivity. Livestock as well as forest and tree resources are the major source of compost manure and organic matter. Agricultural crop residues can also be used as compost and organic matter, but its use is limited for this purpose. Farmers have mentioned following factors for lack of compost and organic matters in the farmland.

1. Decreased livestock number
2. Decreased forest and tree resources (quality and quantity)
3. Decreased agricultural production
4. Decreased homegarden size etc.

Distribution of the households using different level of agricultural input is given in table 4.8 – 3.

Table 4.8 - 3: Percentage of HH Using Various Agricultural Inputs

Level of use	Percent of households using agricultural inputs			
	Organic manure	Chemical fertilizer	Insecticide/pesticide	Improved seed
Very high	0.0	2.0	0.0	0.0
High	18.3	43.8	2.0	5.1
Medium	28.5	38.7	5.1	20.4
Low	51.0	6.1	37.7	20.4

Source : Field study (1999)

Use of agricultural inputs is measured in ranking that ranges from very high to low level. Use of inputs at the time of settlement is taken as the basis for comparison. Although

almost all of the households use organic manure, half of them use in low level as compared to the time of settlement while majority of the households use chemical fertilizer in high to medium level. Continuation of the current situation will lead to the further loss of productivity in the future too. Price as well as their availability factor mainly determines the level of use insecticide/pesticide and improved seed. Use of insecticide/pesticide is sometime risky. Many illiterate farmers even do not know the proper use.

4.9. Home Garden (HG) System

It is a kind of traditional agroforestry practice in the rural farming system. It is a multi-layered and multi species system. At ground level, vegetables and other herbaceous crops are grown. The tallest tree occupies the upper most layers and some fruit trees are found in middle story. This system in the farmland preserves immense species diversity in household level. Nevertheless, species diversity and plant density vary from place to place according to ecological and socioeconomic factors. This system is well developed where the people have exhausted their nearby accessible forest resources in the past (Amatya, 1995). Homegarden system still exists in the area. Distribution of households with various sizes of the homegarden is given in table 4.9 - 1.

Table 4.9 -1: Percentage of Household by Homegarden size

Settlement period	Household with HG system	HH with small HG (<= 1 katha)	HH with medium HG (>1 - <=2 katha)	HH with large HG (> 2 katha)	Average size of HG (Katha)
At beginning	64.9	11.6	18.1	35.0	1.35
10 years before	60.0	23.3	22.2	14.4	0.98
5 years before	51.0	21.4	20.4	09.1	0.85
At present	50.0	13.2	28.5	08.1	0.85

Source : Field study (1999)

Half of the households still have homegarden in the farming system and percentage of households with this system is continuously decreasing over time. Average size of the

homegarden is 0.84 katha (0.02 ha) ranging from zero to 5 katha (0.16 ha) with 1.06 standard deviation. Soemarwoto (1987) found exactly the same figure in West Java of Indonesia. If the current situation continues in the study area, this system will be limited in few households may be only in large landholders. Size of the farmland as well as other socioeconomic factors determines the existence and size of the homegarden.

4.10. Biodiversity of Tree species in Rural Farmland

Both species richness index and species diversity index were calculated to assess the status of the biodiversity for the study area. Tree species were categorized in different types based on their use. Shannon Index (H`) and Margalef (1969) have been used to find Species diversity index and species richness index respectively. Species diversity and species richness of the area is presented in table 4.10 – 1.

Table 4.10 - 1: Species Diversity and Species Richness of the Area

	Descriptive information on tree biodiversity						
	Total	Average/HH	Minimum	Maximum	Std	SE	CV
Species Diversity	1.80	1.35	0	3.07	0.75	0.07	0.55
Species Richness	5.01	2.00	0	6.32	1.24	0.12	0.62
Number of species	60.0	7.7	0	30.0	5.69	0.57	0.74
Number of trees	128864	66.7	0	1514	183.2	18.5	2.74

Std = Standard Deviation, SE = Standard Eror, CV = Coefficient of Variance
Source: Field study (1999)

Species diversity index is 1.8, which is very low as compared to the similar areas of other south Asian countries particularly the Bangladesh, India and Sri Lanka. Bashar (1999) has found 3.24 Shanon diversity index only of fruit species in Bangladeshi homegarden. Sellathurai (1997) has mentioned 3.93 Shanon diversity index in Sri Lanka. Wide individual distribution of few tree species was the main reason for lower biodiversity. Nearby natural forest supports the farmers to great extent that might not encourage them to grow large number of trees in the farm. A total of 60 tree species are found in all sampled households. Similar result was found in the farmland of the eastern Terai. Das (1999) has recorded more than 60 species as grown by farmers on their farmland in eastern Terai of Nepal. Carter (1992) recorded 101 tree species in a study conducted in middle hills of Nepal. Rusten (1989) found 127 tree species in the same elevation. It simply reveals that farmland in the hilly region conserve more tree species than the Terai. Hilly farming system is more fragile and sensitive than that of Terai. Hill settlers may need more resources and diversity for security in terms of fodder, fuelwood and land

protection. Forest and tree products can be replaced by alternative sources in case of Terai but it is difficult in most part of the hill because of poor transportation and less income. Average tree number is somewhat consistent with the figure mentioned by Karki (1988). He estimated that smallholders planted and maintained an average of 60 trees on land holdings averaging 1.1 ha.

Average species per household is 7,7 with a range from zero to 30 with 5,69 standard deviation. Multiplying average tree holding with total number of household in the area derives total tree number for the whole area. Tree species have been categorized in different type based on their use and their diversity index is further calculated in table 4.10-2 below.

Table 4.10 - 2: Diversity and Species Richness of Tree Species Type

	Species type				
	Fruit	Fodder	Timber/ Furniture	Fuel wood	Other
Diversity index	0.20	0.37	0.31	0.20	0.05
Species richness	2.87	4.40	0.12	0.47	1.43
Number of species	19.0	29.0	7.0	9.0	7.0
	(2.6)	(4.9)	(0.5)	(1.4)	(0.3)
Trees per HH	5.4	23.3	38.9	51.7	0.6

Source: Field study (1999)
Note : 1. Figure in bracket gives the average number per household
: 2. Only the principle use of tree species was considered for categorization.

Tree species are categorized based on their prime use. In practice, almost of the tree species can be used for fuelwood purpose though fuelwood may not be the main use. Diversity and species richness of all type of species is lower even than the average. Both diversity and richness is higher in fodder species compared to others. Species richness is directly proportional to the species number and inversely proportional to the tree number. Several socioeconomic factors mainly determine the level of diversity and species richness particularly at household level. Species diversity is less important in fuel wood and timber/furniture species. Household concerns are amount, not the diversity in terms of fuelwood and timber requirement while diversity is prime consideration in fodder and fruit species. May be the singletree species can meet the fuel wood requirement of a

household. Fuelwood and timber/furniture can be stored after harvest and used later on. Fuel wood can be collected whenever needed.

Unlike fuel wood and timber/furniture trees, species richness is important for fodder and fruit trees. Productivity and taste are the prime consideration in case of fruit trees while harvesting season is minded in fodder trees. Varieties of fruit species satisfy man with different taste in different season. Furthermore, not all fruit trees produce good number of fruits and seeds every year and their diversity may compensate such variation. Higher diversity might reduce the risk of production failure of single species. Fruits are also the sources of income in critical situation. It can be sold in the market though it is uncommon in the rural context. Sometime, it can be a matter of pride for household if they please the relatives, visitors, or higher status person serving fruits. Fruit trees are also highly used for shading purpose since the temperature goes up to 35 degree Celsius during summer. Fruits are mostly planted in nearby home either in the home garden or in the home yard. Some fruit trees such as *Artocarpus heterophyllus, Morus alba* etc are multipurpose and serve varieties of products at a time. All these factors may explain why rural farmland holds higher fruit species richness.

Rural people also think a lot about fodder trees. Different fodder trees are harvested in different seasons. Large number of fodder tree species supports the livestock feeding longer. Green tree fodder is the nutritious feed for stall-fed livestock. Higher diversity of these tree species might supply the fodder resources all the year. Sustainability of the rural farming system depends on proper combination of agricultural crop, livestock and tree/forest resources in Nepal. Distribution of the household having various tree species type is presented in figure 4.10 – 1.

The figure in the chart signifies the importance of species diversity in fodder and fruit trees in rural farmland. Individual number of tree of each species type has different distribution, which is presented in figure 4.10 – 2.

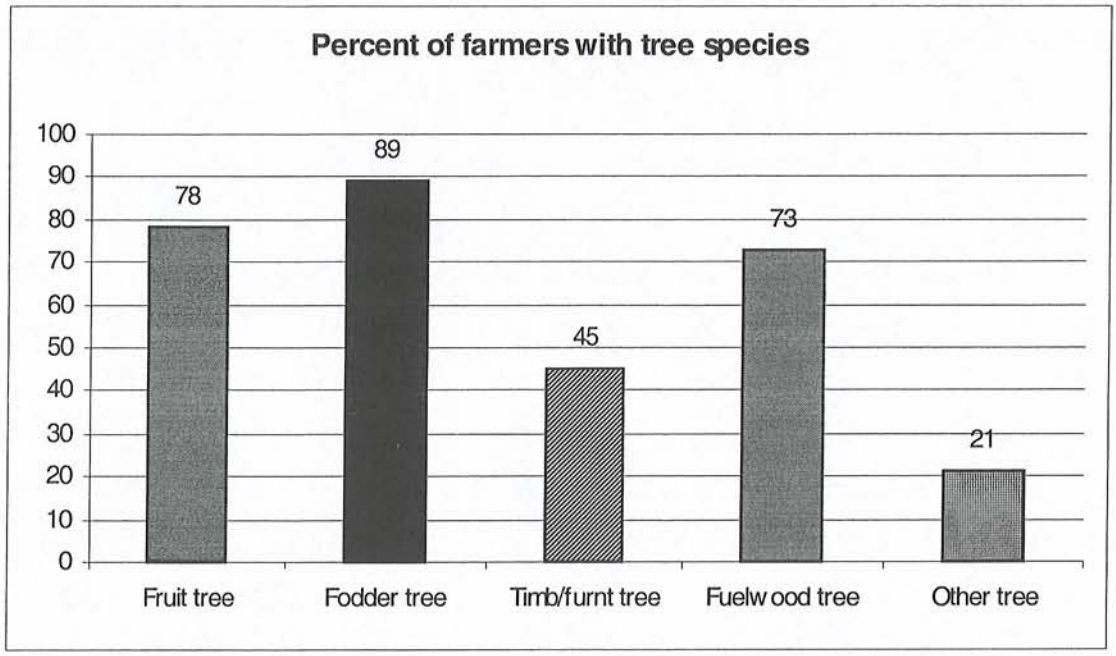


Figure 4.10 - 1: Percentage of Households by Tree Species Type

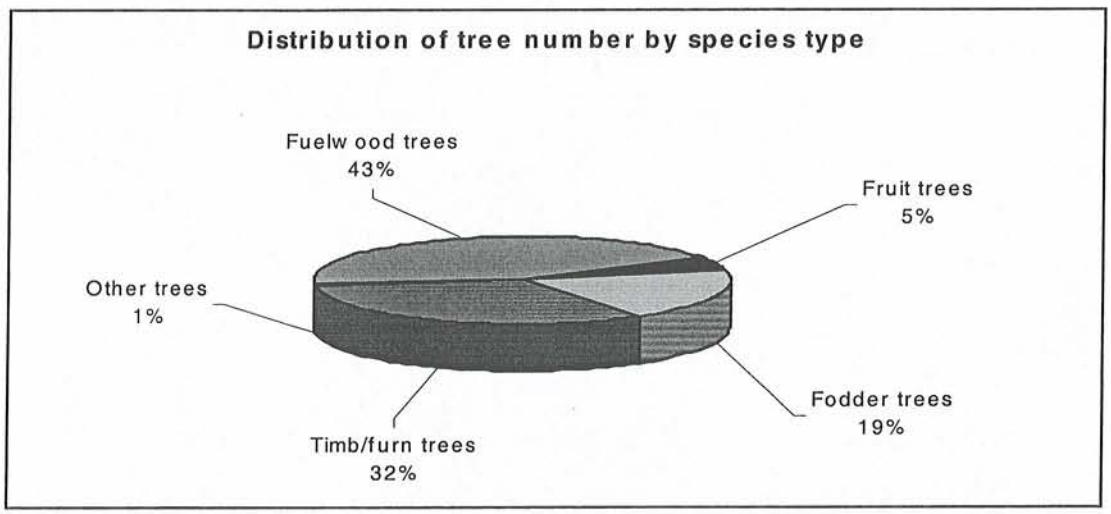


Figure 4.10—2: Distribution of Individual Tree Number by Species Type

Despite the low number of species, fuel wood trees are more common than others. There is no single species that is only used for fuelwood.

4.10.1. Pattern of Tree Growing in Rural Farmland

Farmers have to manage their farmland to maximize production for greater benefit. As stated earlier, the majority of the households have small and medium sized farmland, which alone cannot support the requirement of the whole family. Food mainly from the cereal crop is not the only matter to be considered for survival. Fuel wood, fodder, timber, fruits etc. are also equally important. Farmers also need vegetables to complement main food items. They need to allocate the farmland to grow many products at a time. It is even further difficult if the farm size is smaller. Still, about half of the households have homegarden system in their farm, even though its size is continuously decreasing over time. Homegarden plays vital role to conserve large number of species in household and farm level. Table 4.10.1-1 exhibits the general pattern of tree growing in the study area.

Table 4.10.1 -1: Tree Growing Pattern in the Farmland

Pattern of growing	Percent of farmers with system	Average species number	Average tree number	Share of total trees (percent)
Home garden	51.0	3.1	07.7	11.5
Farm boundary	74.5	2.8	15.3	22.9
Scattered planting	29.6	0.6	01.3	01.9
Woodlot	12.2	0.8	41.7	62.5
Home yard	20.4	0.4	00.6	01.0

Source: Field study (1999)

Only few households have a woodlot but average tree number and share of the trees is significantly higher in this system. Woodlot is the place where trees are grown in the farmland. Once the land is not suitable for agricultural purpose, farmers use such land unit for tree growing in Nepal. Largest portion of the households maintains trees in farm boundary. Limited number of trees can be seen in middle scattered here and there in the farm. Intensified uses of land and mechanized ploughing have caused fewer trees in the middle. Highest number of tree species is found in home garden and lowest is recorded in home yard. Common tree growing patterns are presented in photos.

Pattern of Tree Growing in the Study Area

Photo 1: Structure and Composition of Tree Growing in Homegarden

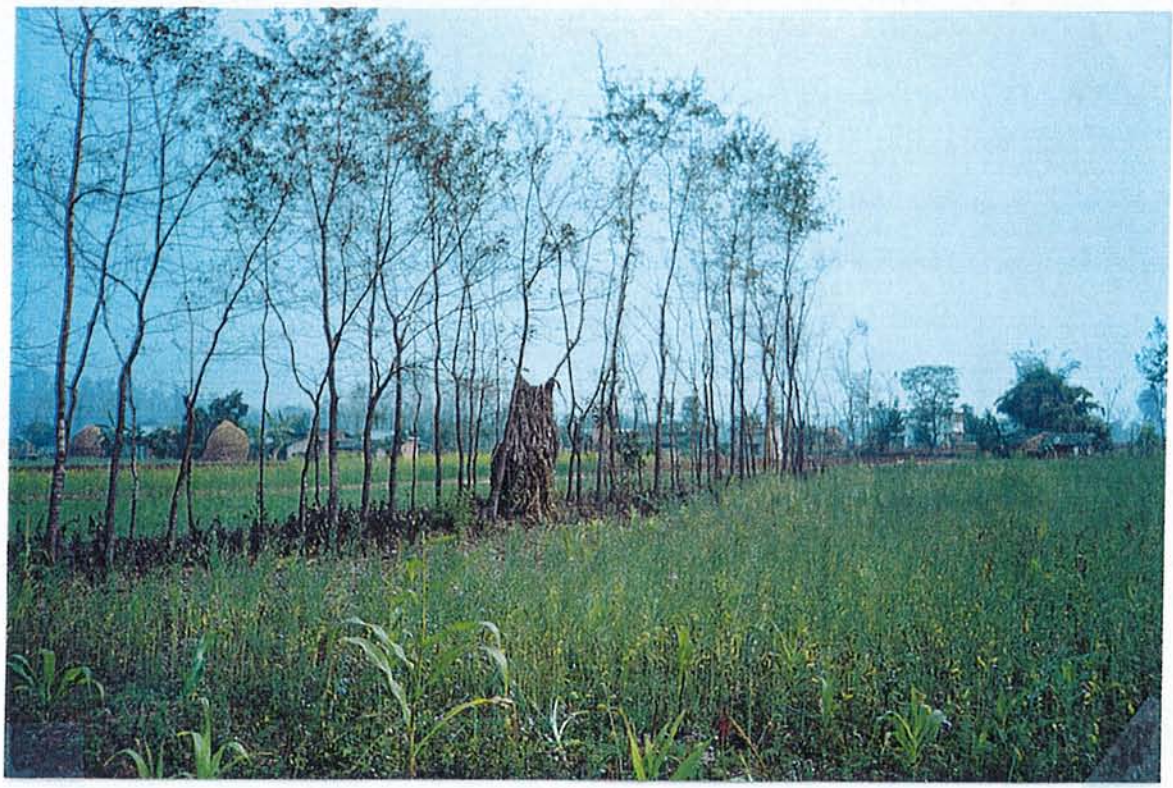


Photo 2: Farm Boundary as the Most Common Place for Tree Growing

4.11. Socio-economic Impact on Farm Biodiversity

Several factors determine the status of biodiversity in various levels. Household and/or farmland are the smallest unit of biodiversity management. Other level of the management could be a watershed/catchment area, natural landscape/seascape, topographical, physiographic and ecological region etc. Some factors are crucial for species diversity management and others may affect less. Socioeconomic factors are the most important to be minded in farm and/or household biodiversity management. Species diversity, size, shape and plant density also vary from place to place depending on cultural, ecological and socio-economic factors (Soemarwoto, 1987). Tree planting and use were found to be correlated with socio-economic factors such as ethnic group, economic level and farm size (Karki and Karki, 1988).

Biodiversity = f (FS, I, FD, LS, FC, HGS, HHS, PN, SP, SD, FV etc.)

Where,

FS : Farm size
I : Income level
FD : Forest distance
LS : Livestock size
FC : Fuel wood consumption
HGS : Home garden size
HHS : Household size
PN : Parcel number
SP : Settlement period
SD : Source of income
FV : Forest visits (frequency)

Single factor hardly determines the level of biodiversity completely. However, it is also true that some factors could influence more than others. Impact of the socioeconomic factors in tree species diversity of farmland is analyzed and presented hereafter.

4.11.1. Impact of Farm size on Biodiversity:

It has generally been shown that large areas support more species (Stilling, 1996) but the situation may different place to place. Smaller farm size might compel the farmers to have densely planted land. To find the impacts of farm size in tree species diversity, farm was categorized in three groups; small, medium and large. Then distribution of farm size in each group were analyzed and compared. The result is presented in table 4.11.1.1-1.

Table 4.11.1 - 1: Impact of Farm Size on Biodiversity

Category of farm	Scale (katha)	N	Av. Farm size	Spp diversity index	Spp richness index	Av. Spp per HH	Av. Tree per HH	Tree/ha	Tree/cap
Small	<=15	47	7.5	1.12	1.55	5.1	23.6	116.0	4.0
Medium	>15-<=45	42	25.7	1.54	2.27	9.1	57.2	64.2	8.8
Large	>45	9	67.5	1.63	2.97	14.3	336.0	149.3	35.2
Average			20.8	1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.016	0.001	0.000	0.000	0.166	0.000
Result				S	S	S	S	NS	S

Av. = Average, Spp = Species, HH = Household, ha = hectare, cap = capita
Source: Field study (1999)
Note :
S = Significant
NS = Not significant

Both species diversity index and species richness index are significant among the categories of the farm size. Since the farmers' priority is agricultural crops, small farm size may not be sufficient to grow large number of trees and species in the same unit of land, even though tree density is higher in such farm. Panday (1987b) reports that the farm size holdings are small for afforestation plots and that there is no income incentive for tree planting as there is no timber market. However, no strong relationship exists between the species diversity and farm size ($r^2 = 0.028$, $n = 98$). It implies that farm size

alone is not the powerful determinant of the species diversity. Anyway further fragmentation and disintegration of land might affect species diversity to some extent in rural Nepal. Further analysis is presented in table 4.11.1 – 2 about the impact of farm size on species holding.

Table 4.11.1 - 2: Number of Trees and Tree Species by Farm Size

Category of farm	Fruit spp	Fruit tree	Tim/furn spp	Tim/furn tree	Fodder spp	Fodder tree	Fwood spp	Fwood trees
Small	1.7	3.0	0.3	10.1	3.4	11.4	1.9	16.2
Medium	3.0	6.0	0.5	18.8	5.8	21.8	1.5	28.3
Large	4.6	11.9	0.9	170.2	7.5	64.0	2.0	213.8
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.1
P-value	0.000	0.00	0.001	0.000	0.000	0.000	0.020	0.000
Result	S	S	S	S	S	S	S	S

Spp = Species, Tim = Timber, Furn = Furniture, Fwood = Fuelwood
Source :Field study (1999)
Note :
S = Significant

Average holding of each tree species type and their individual number is highly significant according to farm size. Both species number and their individual number increase continuously towards the larger farm size. Not all farmers are in a position, legally or practically, to invest in trees. Poor farmers with little holdings, and those who depend mostly or solely on their work as tenants on the lands of other owners, fall in to this category (Subedi et.al., not dated). Large farm size is important for large number of species conservation.

4.11.2. Impact of Homegarden Size on Tree Biodiversity

Homegarden is a kind of traditional agroforestry. As explained earlier, this system still exists in the area and picture is presented in photo. It is the complexity of multiple plant species. Continuous changes of socioeconomic and other biophysical factors have also affected the some dimension of homegarden. It is now important to know if the system has any impact on species conservation. Size of the homegarden is divided into three

categories and analysis is completed for the comparison. The result is presented in table 4.11.2 – 1.

Table 4.11.2 - 1: Impact of Homegarden Size on Tree Biodiversity

HG size	Scale (katha)	N	Av HG size	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Small	<=1	62	0.17	1.12	1.52	5.0	26.0	73.7	4.0
Medium	>1-<=2	28	1.62	1.70	2.55	10.6	122.0	126.8	14.9
Large	>2	08	3.31	1.89	3.71	18.2	188.0	171.5	25.8
Average			0.84	1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.00	0.00	0.00	0.01	0.11	0.001
Result				S	S	S	S	NS	S

Source: Field study (1999)
Note:
1 ha. = 30 katha (local unit)
S = Significant
NS = Not significant

Home garden size significantly affects tree species diversity, species richness, average species holding and average tree holding in the area, even though no strong relationship exist between homegarden size and species diversity ($r^2 = 0.19$, n = 98). Complete loss of the system and reduction in size will lead to the loss of tree species diversity unless other socioeconomic factors are changed.

Table 4.11.2 – 2: Number of Trees and Tree Species by HG Size

HG category	Fruit spp	Fruit tree	Tim/fur spp	Tim/furn tree	Fodder spp	Fodder tree	Fwood spp	Fwood trees
Small	1.5	2.3	0.3	13.0	3.4	11.1	1.1	19.0
Medium	4.1	8.7	0.6	70.0	6.5	44.6	1.9	100.1
Large	6.1	6.1	1.1	130.8	11.6	43.0	2.0	136.5
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.1
P-value	0.000	0.000	0.000	0.026	0.000	0.009	0.001	0.040
Result	S	S	S	S	S	S	S	S

Source : Field study (1999)
Note :
S = Significant

Table 4.11.2 – 2 shows that average holding of each species type is significantly different among the categories. Species number increases as the homegarden size increases.

4.11.3. Impact of Caste on Biodiversity:

Nepal, the only Hindu country in the world, has caste system. People/households are categorized in four major caste groups. It is based on hierarchical system. Brahmin caste is considered as the highest one followed by Chhetri. Other caste groups are referred as Baishya. Lower caste is also referred as untouchable. Many ethnic groups in the country belong to other caste comprising more than half of the total population. Different castes follow different cultures, traditions and concepts in general. But, Brahmin and Chhetri follows same sort of religion, culture and tradition. Caste alone does not determine all the system of the household but it also depends on interaction with other caste and group. Cultures and traditions of the people vary place to place even within the same religious group. Hinduism and Buddhism are the two major religious groups comprising about 94 percent of the total population in Nepal.

Table 4.11.3 - 1: Impact of Caste System in Biodiversity

Caste	N	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/capita
Brahmin	46	1.38	1.99	7.8	70.2	105.5	10.4
Chhetri	10	1.47	2.46	10.5	43.3	61.5	6.8
Other	39	1.25	1.81	6.8	72.7	100.2	8.2
Lower caste	3	1.72	2.64	7.0	12.0	39.0	2.1
Average		1.35	2.00	7.7	66.7	96.9	8.9
P-value		0.642	0.383	0.341	0.924	0.783	0.857
Result		NS	NS	NS	NS	NS	NS

Source : Field study (1999)
Note :
NS = Not significant

The survey does not reveal any impact of caste on species diversity, species richness, species number and tree numbers of the households. Tree species are, in fact, equally important for all. Small farm size, small home garden size and less income of the lower caste households could have influenced to hold less number of trees, less tree density and less tree per capita in their farm.

Table 4.11.3 - 2: Number of Trees and Tree Species by Caste

Caste	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Brahmin	3.0	6.1	0.5	43.8	4.7	21.6	1.5	56.3
Chhetri	3.3	8.9	0.7	11.9	7.0	24.9	1.6	15.7
Other	2.0	4.0	0.4	43.1	4.7	26.0	1.2	59.5
Lower	2.0	2.3	0.6	0.7	4.6	8.6	1.0	2.0
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.19	0.06	0.49	0.875	0.44	0.94	0.45	0.85
Result	NS	NS	NS	NS	NS	NS	NS	NS

Source : Field study (1999)
Note :
NS = Not significant

Even the distributions of species number and tree number are not influenced by caste. However, here too, lower caste possesses less number of trees and tree species than others. In reality, this group is the most deprived one in the Nepalese society. They are excluded in many social activities. Traditionally, they are supposed to depend on other caste member for their survival, even though concept is gradually changing towards the improvements.

4.11.4. Impact of Income Sources on Tree Biodiversity

Agriculture is the primary source of income for about half of the households in the area. Remaining half of the households depends on labor, pension, service and business for their income. It is necessary to know if the income sources of the households have impact on species diversity. Agriculture- based households might adopt different strategy than the others. Table 4.11.4 – 1 shows how the income sources affects on species diversity and species richness in the area. As shown in table below, species diversity and richness also depend on income sources. Highest species richness and highest tree number is found in agriculture-based households. This is because of high dependence on forest and tree resources, livestock and agricultural crops for their livelihood. Business-based households may focus on less intensive farming, cash cropping, may be renting land etc.

Table 4.11.4 - 1: Impact of Income Sources on Biodiversity

Category of Income source	N	Species Diversity index	Species richness index	Av spp holding	Av tree holding	Tree/ha	Tree/capita
Agriculture	46	1.56	2.38	9.6	106.4	112.3	15.3
Labor	19	0.96	1.36	4.7	37.0	209.3	37.5
Business	6	1.68	2.44	8.6	30.1	30.6	5.1
Pension	17	1.11	1.55	5.3	19.3	38.5	7.3
Service	10	1.32	1.85	7.7	42.8	63.0	8.6
Average		1.35	2.00	7.7	66.7	96.9	8.9
P-value		0.02	0.01	0.007	0.38	0.04	0.17
Result		S	S	S	NS	S	NS

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Labor-based households have lowest species diversity and lowest species richness. This is because of their small farm size, small home garden size and less income. These three factors mostly determine the species diversity in the rural farm. As mentioned before, small farm size does not support large number of trees and tree species though highest tree density exists in such type particularly in labor based households.

Table 4.11.4 - 2: Number of Trees and Tree Species by Income Source

Sources	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Agriculture	3.1	6.7	0.6	67.6	6.3	32.8	1.7	86.2
Labor	1.6	3.1	0.2	20.6	3.4	14.7	1.1	29.2
Business	3.8	6.1	0.3	5.1	5.1	20.3	1.3	16.5
Pension	1.9	3.6	0.5	5.7	3.1	10.5	1.0	11.8
Service	2.8	6.7	0.6	17.9	4.5	19.2	1.5	25.1
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.05	0.11	0.12	0.42	0.01	0.549	0.22	0.47
Result	S	NS	NS	NS	S	NS	NS	NS

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

4.11.5. Impact of Settlement Period on Biodiversity

The first settlements were established nearly 40 years ago in 1960. Since then, many changes have taken place in the area. Not only the early settlers are there. Internal immigration and emigration process took place during the period. Actually, it happens everywhere. Chitwan district was and still is the dream of many hilly residents. Huge mass of the population arrived in Chitwan from the hilly districts in late 1950s, after eradication of malaria. Chitwan still receives many hill migrants. But out migration is also taking place. Based on settlement period, households are divided into mainly three categories; early settlers, medium settlers and late settlers. The study tests whether the species diversity and species richness in the farm is influenced by settlement period. Table 4.11.5- 1 shows the result of the analysis.

Table 4.11.5 - 1: Impact of Settlement Period on Biodiversity

Category of Settlers	Scale (Year)	N	Average year	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Late settlers	<=5	8	3.25	0.89	1.19	4.1	17.2	99.1	3.0
Med. Settlers	>5-<=10	13	8.46	1.21	1.83	7.3	123.7	150.7	15.7
Early settlers	>10	77	24.74	1.42	2.10	8.1	62.2	87.5	8.4
Average				1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.14	0.12	0.16	0.39	0.40	0.31
Result				NS	NS	NS	NS	NS	NS

Source : Field study (1999)
Note :
NS = Not significant

The current data shows that the species diversity and species richness increases as the duration of living increase, but the difference is not significant among the categories. Even the linear relationship between living time and species diversity is very weak. Late settlers might not have sufficient time to grow and maintain large number of trees. They are still new for the area. But old settlers know quite more about their surrounding and environment. They have crossed the experimental stage to select the best and suited species in the farm while new settlers must start from the beginning. When a household decides to sell the farmland partially or wholly, they exploit the resources from the farm as much as possible before leaving it, which might be the possible reason to have less number of trees and species in late settlers' farm. New settlers generally start the farm

from nothing. Further analysis is completed to find the impact of settlement period in average holding of different tree species type.

Table 4.11.5 - 2: Number of Trees and Tree Species by Settlement period

Category of Settlers	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Late settlers	1.4	2.4	0.2	5.6	3.0	10.6	1.0	11.3
Med. Settlers	2.5	6.0	0.7	93.2	4.8	26.5	1.3	107.2
Early settlers	2.8	5.7	0.5	33.2	5.2	24.1	1.5	46.6
Average	2.6	5.4	0.5	38.9	5.0	23.3	1.4	51.7
P-value	0.26	0.29	0.23	0.27	1.35	0.769	0.48	0.40
Result	NS	NS	NS	NS	NS	NS	NS	NS

Source : Field study (1999)
Note :
NS = Not significant

Table 4.10.5 –2 demonstrates that average holding of tree species and their number are not significant among the different settlers, though some differences is observed in absolute figure. Specially the average holding of tree numbers in late settlers is low compared to medium and late settlers. It reveals that frequent change of land and place for settlement purpose is not good for conservation of biodiversity in rural farm level.

4.11.6. Impact of Household Income on Biodiversity

Income of a household is comprised of agricultural production, tree products, labor, rented land or houses, pension, business, service etc. High-income households could have different status in the society than lower one. Farm level management could be different in different income household. Their farming practices and strategy could be different. For comparison, households are divided into three categories; low-income groups, middle-income group and high-income group. Analysis is completed to know the impact of household income on species diversity and species richness of the farm and result is presented below.

Table 4.11.6 - 1: Impact of Household Income on Biodiversity

Income group	Scale (000 NRs)	N	Average income	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Low	<=50	57	34680	1.26	1.74	6.0	25.7	100.7	4.2
Medium	>50-100	33	69065	1.53	2.37	10.1	110.0	93.8	14.6
High	>100	8	174425	1.26	2.18	9.6	179.3	81.7	19.0
Average			57667	1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.25	0.059	0.002	0.019	0.941	0.016
Result				NS	NS	S	S	NS	S

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Difference in the species diversity, species richness and tree density are not significant among the categories of the income group. Income level of the households alone does not determine the species diversity ($r^2 = 0.004$, n = 98). However, significant differences are observed in average holding of trees and tree species. Lowest number exists in low-income households. Larger farm size might have supported higher number of trees and tree species in medium and high-income household. Distribution of other tree species type across the different income group is also presented in table 4.11.6 –2.

Table 4.11.6 - 2: Number of Trees and Tree Species by Household Income

Income group	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Low income	1.9	3.8	0.3	9.1	4.2	13.9	1.1	15.4
Medium income	3.6	7.7	0.7	62.6	6.0	40.9	1.7	87.7
High income	3.6	7.7	1.0	153.6	6.1	20.3	2.3	162.5
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.001	0.004	0.000	0.009	0.086	0.071	0.002	0.025
Result	S	S	S	S	NS	NS	S	S

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Only the number of fodder trees and fodder species aren't significant among the categories of the households, though absolute figure is still lower in low income and

higher in medium and high income group. Greater household income generally supports higher level of species diversity in farm level.

4.11.7. Impact of Livestock Size on Biodiversity

Livestock is vital for livelihood and sustainability of the rural part. It is the main source of fertilizer for agricultural soil fertility. It also produces the nutritious food for rural people. It is also a source of income as well as drought power for ploughing and driving cart etc. But, at the same time, they need lot of resources for their survival. It is more time consuming and laborious too. Farmers hardly manage to hold large number of livestock particularly in recent years. Tree fodder, crop residues, surface grasses, concentrated feed are use for their feeding. Higher number of livestock needs large quantity of fodder and large number of trees as well. Great relation exists between trees and livestock holding in rural farming. Table 4.11.7-1 explains how livestock holing in household level influences the species diversity, species richness etc.

Table 4.11.7 - 1: Impact of Livestock Holding on Biodiversity

Livestock size	Scale (LU)	N	Average livestock	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Small	<=2	23	0.7	0.8	1.2	4.2	41.1	83.6	6.9
Medium	>2-5	38	3.4	1.5	2.1	7.5	27.0	95.4	4.4
Large	>5	37	7.6	1.4	2.3	10.0	123.4	106.6	14.8
Average			4.4	1.3	2.0	7.7	66.7	96.9	8.9
P-value				0.001	0.001	0.000	0.05	0.857	0.062
Result				S	S	S	S	NS	NS

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Livestock has great influence on species diversity, species richness, tree number and tree species number in rural households of Nepal. Large livestock size supports large number of trees as well as species holding, which ultimately increases level of species diversity in the farm. But, livestock is also not a powerful determinant for tree biodiversity ($r^2 = 0.06$, $n = 98$). Large herds of livestock are found in higher income household and large farm

holders. Table 4.11.7-2 further shows the impact of livestock size on various species holding.

Table 4.11.7 - 2: Number of Trees and Tree Species by Livestock Size

Livestock size	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Small	1.7	2.8	0.2	30.4	2.3	8.0	1.1	34.7
Medium	2.4	4.5	0.5	6.4	4.9	17.0	1.4	13.9
Large	3.4	8.0	0.6	77.5	6.6	31.2	1.6	101.2
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.008	0.001	0.058	0.077	0.000	0.050	0.156	0.078
Result	S	S	NS	NS	S	S	NS	NS

Source : Field study (1999)
Note :
S : Significant
NS : Not significant

The data further clears that higher number of species as well as their number can be conserved in the farmland if the households maintain large livestock size. Decreasing trend of livestock size in study area reveals the possible loss of tree species and trees from the farmland.

4.11.8. Impact of Forest Distance on Biodiversity of Farmland

Forest is the main source of tree species in many part of the world. Forest resources primarily support the rural lives since the beginning of the settlement. Forest and tree resources provide food, energy, fodder, timber, environment and other values to the people. Forest is also the main source of trees in the farmland, which comes either in the seed or in seeding form. Few other tree species specially fruits and ornamentals are derived from outside forest, though their wild relatives may still exist in wilderness. Being a main source of tree species in farmland, forest distance may have some impact on diversity of tree species and their number in the farmland. Analysis has been completed and presented below to find the impact of forest distance on diversity of tree species in the study area.

Table 4.11.8 – 1: Impact of Forest Distance on Biodiversity

Category of distance	Scale (min)	N	Average (min)	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Near	<=15	41	9.9	1.40	2.00	7.3	25.8	75.9	4.3
Middle	>15-45	40	31.5	1.38	2.05	7.9	70.5	79.6	10.0
Far	>45	17	77.0	1.15	1.82	8.0	156.3	188.1	17.6
Average			30.4	1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.48	0.80	0.84	0.045	0.027	0.055
Result				NS	NS	NS	S	S	NS

Source : Field study (1999)
Note :
S : Significant
NS : Not significant

Difference is not significant in species diversity and species richness of the mentioned categories. The linear relationship is also weak between species diversity and forest distance (r^2 = 0.01, n = 98). Number of tree holding and tree density in distanced household is far higher compared to other two categories. Trees per capita also increase as the forest distance increases. Generally households near to the forest need not be worried much about having large number of tree in the farm. They do not need to spend much time and effort to collect it from forest, but it is quite difficult for households who live far from the forest. Almost a whole day is lost just to collect a unit of fuel wood or fodder, which might not be economic or safe compared with growing trees in the farm. Carrying a big unit of fodder or fuel wood from a long distance sometimes create health problem. It could be health hazard and it might cost even more than growing trees in the farm. These factors might be the possible reason to hold large number of trees on their farm. Impact of forest distance in other species holding is further discussed below.

Table 4.11.8 - 2: Number of Trees and Tree Species by Forest Distance

Category of distance	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Near	2.2	4.4	0.4	4.5	5.1	17.3	1.1	11.2
Middle	3.1	6.5	0.5	45.2	4.7	20.2	1.5	56.4
Far	2.6	5.4	0.5	107.1	5.1	43.9	1.7	138.6
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.214	0.261	0.871	0.032	0.90	0.20	0.162	0.036
Result	NS	NS	NS	S	NS	NS	NS	S

Source : Field study (1999)
Note :

S = Significant
NS = Not significant

It can be interpreted from the fact that longer distance from forest could encourage people to plant large number of trees as well as tree species in the farm, as long as households depends on trees for fuel wood and fodder.

4.11.9. Impact of Resource Collection Time on Biodiversity

A test is made to find the effect of resource collection time on farm biodiversity in the study area. Resource collection time is different from that of the forest distance. Forest distance just shows the time to reach the forest where resources are found. But resource collection time includes all the time needed for going to the forest, searching for resources, collecting it and making appropriate size, then coming back to home with some rest on the way. It can be three to six time higher than the forest distance. Table 4.11.9-1 shows the impact of resource collection time on household biodiversity in rural Nepal.

Table 4.11.9 - 1: Impact of Resource Collection Time on Biodiversity

Category of time	Scale (hour)	N	Average (hour)	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Short	<=3	28	2.0	1.5	2.2	8.6	30.5	74.2	5.1
Medium	>3-5	48	4.4	1.2	1.8	6.2	44.5	71.9	6.3
Long	>5	22	6.3	1.2	2.1	9.7	161.2	180.1	19.0
Average			4.1	1.3	2.0	7.7	66.7	96.9	8.9
P-value				0.291	0.364	0.03	0.02	0.015	0.015
Result				NS	NS	S	S	S	S

Source : Field study (1999)
Note :
S : Significant
NS : Not significant

Resource collection time has impact that is no more significant on species diversity and species richness of the tree species in the area. Since the linear relationship is weak (r^2 = 0.03, n = 98), fuelwood consumption time alone cannot predict much about the species diversity. But, households living far from the forest have large number of trees, tree

density and tree per capita compared to others. It refers that increasing resource collection time might initiate people to plant large number of trees and tree species in the given condition. Further test is completed to know the impact of resource collection time in distribution of other tree species at farm level.

Table 4.11.9 - 2: Number of Trees and Tree Species by Resource Collection Time

Category	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Short	2.6	5.7	0.5	5.7	5.9	20.5	1.5	14.1
Medium	2.3	4.5	0.4	24.7	3.7	16.0	1.1	33.5
Long	3.3	7.3	0.6	112.1	6.4	42.7	1.9	139.5
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.237	0.162	0.203	0.014	0.013	0.134	0.030	0.021
Result	NS	NS	NS	S	S	NS	S	S

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

The households living far from the forest focus particularly the fodder, fuelwood and timber/furniture tree species for which farmers have to visit forest frequently.

4.11.10. Impact of Number of Forest Visit on Biodiversity

Number of forest visit is another factor to be minded that could influence on species diversity in farm level. Just forest distance and resource collection time are not sufficient unless forest visit is considered. Forest visit is measured in number of days here. Within the same category of forest distance and resource collection time, one household may visit forest more frequently than others and the result could be different in this situation. Households visit the forest according to their needs and sufficiency. To find the impact of forest visit on species diversity, ANOVA is completed and result is shown below.

Table 4.11.10 - 1: Impact of Forest Visit on Biodiversity

Forest visit	Scale (days)	N	Av. Visit	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Few visit	<=15	57	10.4	1.27	1.88	7.6	62.7	100.0	9.3
Fair no. of visit	>15-<=30	34	25.0	1.46	2.11	7.4	38.1	68.0	4.9
High no. of visit	>30	7	92.1	1.46	2.28	9.1	237.9	211.4	25.1
Average			21.3	1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.449	0.576	0.779	0.023	0.081	0.045
Result				NS	NS	NS	S	NS	S

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Number of forest visit does not influence much on species diversity, species richness and species number of the households. Difference is not significant among the categories. The relationship is weak between the number of forest visit and species diversity ($r^2 = 0.001$, $n = 98$). Here, it is difficult to explain why the households visiting forest more have larger number of trees in their farm. Another test is also completed to find whether forest visits further has influence on average holding of varieties of tree species. Result is given below on table 4.11.10-2.

Table 4.11.10 - 2: Number of Trees and Tree Species by Forest Visit

Forest visit	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Few visit	2.7	5.7	0.5	37.6	4.7	20.6	1.5	48.6
Fair no. of visit	2.3	4.9	0.4	17.9	5.1	16.3	1.2	23.4
High no. of visit	3.0	5.4	0.4	151.3	6.4	79.3	1.5	215.0
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.649	0.817	0.858	0.064	0.575	0.011	0.593	0.026
Result	NS	NS	NS	NS	NS	S	NS	S

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Number of fuelwood trees and fodder trees are significantly high in higher forest visit households. Highest diversity exists in fodder species and lower is found in timber/furniture species.

4.11.11. Impact of Fuel wood Consumption on Biodiversity

As mentioned before, fuel wood is the main source of energy in rural Nepal. About 88 percent of the rural energy comes form fuel wood (WECS, 1997). Large portion of the fuel wood is used for just cooking food. Forest and farmland both are the sources of fuel wood in rural areas. Rural livelihood is difficult without fuel wood, which is directly derived from trees and forest. It is generally thought that fuelwood need of the households may encourage the people to plant large number of trees in the farmland since the forest is less accessible in the recent years. Higher number of trees in farmland may secure the household energy requirement. Comparison scenario of the species diversity in different fuel wood consumption level is presented in table 4.11.11-1

Table 4.11.11 - 1: Impact of Fuelwood Consumption on Biodiversity

Cons. level	Scale (00 KG)	N	Av. cons	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Low	<=15	37	1062	1.21	1.74	6.2	30.8	103.8	5.4
Fair	>15-<=22,5	41	1920	1.31	1.96	8.0	103.7	114.4	13.2
High	>22,5	20	2662	1.67	2.52	9.6	57.3	48.2	6.6
Average			1748	1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.082	0.073	0.094	0.208	0.28	0.187
Result				NS	NS	NS	NS	NS	NS

Source : Field study (1999)
Note :
NS = Not significant

Fuelwood consumption alone does not influence much in species diversity of the farmland, though little difference is found among the categories. Even the linear relationship between fuelwood consumption and species diversity is not strong (r^2 = 0.051, n = 98). Further analysis is made and presented below in table 4.10.11-2. Although the difference is not significant, large number of trees and species are generally found in high fuelwood consumption level. As a result, high fuelwood consumption may be problem in other areas, but it encourages farmers to maintain large number of trees and tree species in the farmland. Fuelwood substitution practices may reduce the species and tree holding particularly in the farm.

Table 4.11.11 - 2: Number of Trees and Tree Species by Fuelwood Consumption

Consumption level	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Low	2.3	4.3	0.3	14.9	3.8	12.4	1.1	19.9
Fair	2.6	5.9	0.5	64.5	5.2	34.0	1.4	86.0
High	3.0	6.4	0.7	31.0	6.4	21.4	1.8	40.5
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.530	0.341	0.044	0.275	0.068	0.188	0.097	0.231
Result	NS	NS	S	NS	NS	NS	NS	NS

Source : Field study (1999)
Note :
S : Significant
NS : Not significant

4.11.12. Impact of Parcel Number on Biodiversity

Parcel is the physical separation of land for the same landholder (owner). For comparison, households have been divided into three categories; having single parcel, having double parcel and having more than double parcel number. Each farmer is entitled to have single parcel at least. Some households have more than one parcel for various purposes. Sometimes it is not possible to find the land in appropriate size in one place. In such case, farmers have to buy more than single piece of land. Sometime single parcel might not be useful to grow varieties of crop. It is still quite unknown how the parcel numbers affect in species diversity at farm level. Table 4.11.12 - 1 gives the result of analysis made to find if the parcel number has impact on species diversity.

Table 4.11.12 - 1: Impact of Parcel Number on Biodiversity

Parcel number	Scale (00 KG)	N	Average Parcel	Spp diversity index	Spp richness index	Average spp holding	Average tree holding	Tree/ha	Tree/cap
Single	<=1	45	1	1.25	1.78	6.6	43.5	122.6	6.4
Double	>1-<=2	32	2	1.42	2.05	7.4	41.0	64.8	7.0
> Double	>2	21	3.4	1.45	2.36	10.2	155.5	90.5	17.1
Average				1.35	2.00	7.7	66.7	96.9	8.9
P-value				0.48	0.20	0.063	0.042	0.271	0.094
Result				NS	NS	NS	S	NS	NS

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Species diversity and species richness are not significantly difference among the categories of the parcel number, though value increases as the parcel number increases in general. Only the little difference exists among them. The linear relationship between parcel number and species diversity is very weak (r^2 = 0.016, n = 98). Average tree number is significantly different among them. Higher parcel number has supported large number of trees in the farm. Tree density is also much higher in higher parcel number. To find the impact of parcel number in specific tree species holding, further analysis is done and presented in table 4.11.12-2.

Table 4.11.12 - 2: Number of Trees and Tree Species by Parcel Number

Parcel number	Fruit spp	Fruit tree	Tim/fur spp	Tim/fur tree	Fodder spp	Fodder tree	Fwood spp	Fwood tree
Single	2.3	4.8	0.4	20.8	4.3	19.4	1.3	31.6
Double	2.7	5.3	0.4	20.5	4.5	15.8	1.2	27.7
> Double	3.0	6.9	0.7	105.6	6.9	43.0	1.8	131.5
Average	2.6	5.4	0.5	38.9	4.9	23.3	1.4	51.7
P-value	0.442	0.381	0.145	0.042	0.048	0.144	0.228	0.056
Result	NS	NS	NS	S	S	NS	NS	NS

Source : Field study (1999)
Note :
S = Significant
NS = Not significant

Higher parcel number could encourages the farmers to have large number of trees and tree species in the farm, if the size of the farm is large.

4.12. Dynamics of Tree Species in Rural Farmland:

Nothing remains static in this universe and certainly not the tree species. Changes occur sometime because of ecological processes and sometimes by human interference. Forest is the main source of tree species in the farmland, even though many of them are already domesticated. Over a long period, many changes occurred in species composition, species structure and species type. Useful and economical tree species are generally preferred by farmers and other species might be lost particularly from farmers' land. Economic benefit either in the monetary term or in other indirect form is the major driving force to determine the species type to be held by the farmers in their farmland. This study tries to find out whether the species are changing or not. List of tree species found in different time series is presented in annex. Table 4.12 - 1 shows the list of widely distributed tree species of the area in different period.

Table 4.12 - 1: Widely Distributed Tree Species in the Area

Widely distributed species at present	Percent of households with species holding				
	At present	5 yrs ago	10 yrs ago	At beginning	Widely distributed species at settled time
Melia azedarach	60 (1)	29 (4)	3 (10)	0 (48)	*Shorea robusta*
Mangifera indica	60 (2)	50 (16)	41 (26)	13 (44)	*Terminalia belerica*
Artocarpus heterophyllus	44 (38)	39 (37)	28 (32)	5 (44)	*Garuga pinnata*
Dalbergia sissoo	43 (5)	36 (5)	9 (7)	3 (38)	*Terminalia tomentosa*
Psidium guyava	39 (29)	30 (29)	16 (28)	9 (35)	*Gmelina arborea*
Garuga pinnata	38 (0)	37 (13)	32 (13)	44 (35)	*Ficus religiosa*
Dendroclamus spp	35 (0)	37 (0)	22 (1)	18 (34)	*Dillenia pentagyna*
Leucaena leucocephala	33 (1)	21 (0)	6 (3)	1 (32)	*Phyllanthus emblica*
Prunus persica	31 (3)	15 (3)	6 (7)	0 (32)	*Stereopermum tetragonum*
Gmelina arborea	29 (17)	28 (17)	28 (21)	35 (31)	*Ficus glomerata*

Source : Field study (1999)
Note : Figure for the species of settled time is given in bracket

Table shows the list of top 10 tree species distributed in highest number of households at present time and at beginning. *Melia azedarach* and *Mangifera indica* are found in majority of the households at present. Both of them are multipurpose. *Artocarpus heterophyllus*, fruit tree, is held by about 44 percent of the total household but its distribution was less at the beginning of the settlement. Similar percent of the household holds *Dalbergia sissoo* in their farm. Two species namely the *Dalbergia sissoo* and *Melia*

azedarach dominate the whole distribution of tree numbers. They cover about three-forth of the total tree number. Both of them are primarily used for timber/furniture and fuelwood purpose. *Dalbergia sissoo* alone represents more than half of the total tree numbers. *Melia azedarach* is further used for fodder particularly for goat. Karki and Karki (1988) found similar result in the Chitwan and Rupandehi district, central Terai of Nepal. They have mentioned that among the 20 tree species prevalent in the two districts, *D. sissoo* was more widely grown than any other native or exotic tree, representing 50 percent of the total number of trees planted. Das (1999) has also found the *Mangifera indica, Artocarpus heterophyllus, Dalbergia sissoo and Psidium guyava* as the most widely distributed tree species on the farmland in eastern Terai of Nepal.

At the beginning of the settlement, *Shorea robusta* was distributed in highest number of households followed by *Terminalia belerica, Garuga pinnata, Terminalia tomentosa* etc respectively. *Terminalia tomentosa and Terminalia belerica* are the close associates of the *Shoea robusta* forest. *Garuga pinnata* and *Gmelina arborea* are still exist in large number of households comparatively.

Among the widely distributed tree species at present, 40 percent are fruits and their presence was less at the time of settlement. There was only one fruit species named *Phyllanthus emblica* at the beginning and rests were other types. More than half of the widely distributed species are fodder categories and its abundance was about 80 percent at the beginning. Regarding timber/furniture trees, it also occupies 40 percent of the top 10 having same position as beginning. Tree species that are principally used for fuelwood purpose is also about 40 percent. Because of the multiple uses of some tree species, they are counted in all types separately so that sum does not become 100 percent.

All trees can be used as fuelwood. Farmers usually do not plant fuelwood species separately, even though few species are recognized as the best one.

Garuga pinnata and *Gmelina arborea* are one of the widely distributed tree species of the farmland found in both time. Both of them are good fodder. *Garuga pinnata* is easily

propagated by vegetative means, which may be reasons why it is so common. Further, it is branchy and produces lot of fodder in a year. It is also not so big so even women and children can lop it. *Gmelina arborea* is good for fodder, fuelwood and furniture as well. It also does not have negative interaction with crop in high level. Their roots also do not compete with crops because of deep root system.

One species was completely lost from the area, which was widely distributed at beginning. *Dillenia pentagyna* is now confined only in the nearby forest. Distribution of tree species type in different period is mentioned below:

Table 4.12 - 2: Distribution of Tree Species Type by Time

Time series	Distribution of tree species					
	Fruit (%)	Tim/furn (%)	Fodder (%)	Fuelwood (%)	Other (%)	Total spp number
At present	32	12	58	15	12	60
5 yrs before	22	15	54	18	12	72
10 yrs before	27	17	52	18	6	71
At beginning	16	17	61	17	9	69

Source : Field study (1999)

A total of 60 tree species were recorded in the study area. The highest number of tree species was found around 5 years ago. After then, species number started to decline. Some tree species with few numbers were already there in the farm when early settlers were granted land for permanent settlement. All of them were naturally grown and found scattered all over the farm.

Chet Bahadur Kunwar, 86, one of the respondents, said that he spent about two years just for clearing the land by felling and burning unnecessary trees. There was no question of timber and fuelwood problem at the very beginning. Most early settlers felled down and burnt even important tree species just to clear the land for cultivation. Scattered trees in the farm were making problem in crop cultivation because they provide the resting-place for birds and monkey in one hand and in other hand, they shade the crops more. He further added that trees at the beginning were giant in size. There are no such trees even

in the forest any longer. He further said that the tree species were mostly left in home garden, home yard and farm boundary few years later. Tree species are being changed since the beginning. Fruits and other valuable tree species are replacing non-valuable one. Old and giant tree species are being replaced by new and small tree species. Fast growing tree species are being planted in the farm. The farmers are selecting more economical tree species.

Establishment of two brick industries in the VDC have caused too much to be lost large number of trees as well as species specially from ward number 6, 7, 8 and 9. It is now easy to sell trees from the farm. Brick industry consumes lot of woods. They buy any kind of trees regardless of quality. They just need the amount of wood to burn the brick. Since then, some households have sold trees for money. Continuation of this situation might reduce the species diversity and species richness of the area.

The diversity of fruit species is increased over time in the farm while diversity of other species type is decreased. Changes of the fodder species diversity is not big while tremendous changes have been observed in timber/furniture species.

During the period of cultivation, some tree species are completely lost from the farmland and some new species are introduced. It is estimated that the process will go on continuously in the future too. Rate of changes may be different in different period depending on the socio-economic and ecological factors. The table 4.12 - 3 shows the figure of lost and introduced tree species in the farmland.

Table 4.12 - 3: Analysis of Species Lost and Introduced in the Area

Category of spp.	Average	Minimum	Maximum	Std.
Lost	6,02	0	24	7,13
Introduced	6,03	0	21	4,64
P – value	0,991			
Result	Highly insignificant			

Source : Field study (1999)

Average lost and average introduced tree species in the farm is almost equal with somewhat different level of standard deviation. New species generally replace the old one. Characteristics of the tree species mainly determine their existence in the farm. For example, trees were giant at the beginning while they are small and manageable at present. Table 4.12-4 shows the list of lost tree species from the farmland area.

Table 4.12 - 4: List of Lost Tree Species from the Area

S. N.	Local Name	Scientific Name	% of HH with Spp till 5 yrs back	% of HH with Spp till 10 yrs back	% of HH with Spp at beginning
1	Bodhdhayero	*Lagerstroemia parviflora*	0.0	2.2	19.5
2	Dar	*Boehmeria regulosa*	0.0	0.0	2.6
3	Dudhilo	*Ficus nemoralis*	1.0	0.0	1.3
4	Karang	*Pongamia pinnata*	4.1	3.3	11.7
5	Karma	*Adina cordifolia*	0.0	1.1	10.4
6	Khari	*Celtis australis*	0.0	0.0	1.3
7	Koiralo	*Bauhinia veriegata*	0.0	0.0	1.3
8	Kumbhi		0.0	0.0	1.3
9	Patke	*Gaultharia hookaris*	1.0	0.0	5.2
10	Palans	*Butea monosperma*	0.0	4.4	27.3
11	Kusum	*Schleichera trijuga*	1.0	2.2	13.0
12	Lampate	*Duabanga grandiflora*	1.0.	1.1	1.3
13	Latikath	*Cornus oblonga*	0.0	0.0	2.6
14	Rudhilo		0.0	0.0	1.3
15	Sandan	*Ougenia dalbergoides*	2.1	1.1	1.3
16	Singane		4.1	3.3	5.2
17	Siris	*Albezia spp*	0.0	8.9	2.6
18	Tantari	*Dillenia pentagyna*	0.0	1.1	33.8
19	Valayo	*Rhus wallichii*	0.0	2.2	18.2
20	Teak	*Tectona grandis*	1.0	0.0	0.0
21	Rabar		1.0	0.0	0.0
22	Phaledo	*Erithrina arborescens*	1.0	1.1	0.0
23	Masala	*Eucalyptus spp*	3.1	3.3	0.0
24	Kalkiphool	*Callistemon viminalis*	1.0	0.0	0.0
25	Ashok	*Saraca indica*	1.0	0.0	0.0
26	Pakhuri	*Ficus glaberrima*	0.0	1.1	2.6

Source : Field study (1999)

Since the beginning of the settlement, 14 new tree species have been introduced in the farm while 26 other species have completely been lost from the area. Maximum number of lost species and introduced species by a household was 24 and 21 respectively. Among the introduced tree species, more than half were fruits followed by fodder species and

timber/furniture species respectively. On the other hand, fruit species, fodder species and timber/furniture species were lost by 12, 41 and 41 percent respectively.

Less number of fruit tree species were lost compared to others. In total, the number of lost and introduced tree species are almost in balance though timber/furniture tree species were lost about 41 percent and only 7 such kind of tree species were introduced in the farm. Farmers managed to hold all the fruit species until 10 years back. Instead, 50 percent new fruit species have been introduced. More fodder species were lost than their introduction until then. In addition, the situation was almost same for timber/furniture tree species. There was almost balance between the lost and introduced tree species in total until the 10 years back. Nevertheless, large numbers of tree species were introduced until 5 years ago. Situation in the farmland changed afterward. From 5 years back to now, more species were lost compared to introduction of new species in the area. If the trend continues, further loss of tree species is expected from the farm. May be few species will be introduced to substitute the lost one.

4.12.1. Socio-economic Impact on Species Dynamics

Socio-economic factors might not alone determine the species changes but it is the significant one in rural farmland situation. Farmers' decisions mainly determine which species to be retained and which one to be cleared from their farm. Some ecological factors may affect to some extent for species change. Here, the study explores the impact of socio-economic factors on species dynamics in rural farmland and table 4.12.1-1 summarizes and presents the situation.

Farm size, homegarden size, household size, income level, livestock size and settlement period have significant impact in species dynamics. Number of species lost and species introduced is different in each category of these factors. Level of species changes continuously increases as the farm size increases and so is income level and homegarden size. Although the impact of level of fuel wood consumption is not significant, the trend shows that higher changes occurred in high consumption level and lower changes

occurred in lower consumption level. The situation is also similar for level of forest visit. Business oriented household have introduced more tree species than others followed by agriculture based, service based, pension based and labor based household respectively. Lowest species change occurred in labor-based household-farm. Caste does not have any significant impact on species changes though loss of species is lowest in lower caste. As the settlement period increases level of species changes also increases. Long duration of living allows farmers to change the species composition frequently. Generally, the late settlers should spend some years just to introduce the species in the farm.

Table 4.12.1 - 1: Impact of Socio-economic Factors on Species Change

Variables	Categories of variables	Average of species lost	Average of species introduced
Farm size	Small – Medium – Large	3,36 – 8,00 – 8,22 (P = 0,001)	3,89 – 7,00 – 10,44 (P = 0,000)
Homegarden	Small – Medium – Large	4,80 – 7,18 – 11,50 (P = 0,026)	3,72 – 8,96 – 13,62 (P = 0,000)
HH size	Small – Medium – Big	4,94 – 10,37 –5,34 (P = 0,026)	4,44 – 7,81 – 6,65 (P = 0,023)
Livestock size	Small – Medium – Large	3,82 – 4,73 – 8,70 (P = 0,012)	3,56 – 5,50 – 8,10 (P = 0,000)
Fwood cons.	Low – Medium – High	4,56 – 5,87 – 9,00 (P = 0,080)	4,51 – 6,31 – 8,20 (P = 0,013)
Forest visit	Less – Fair – High	5,59 – 5,91 – 10,00 (P = 0,307)	6,38 – 5,23 – 7,00 (P = 0,445)
Forest distance	Near – Fair – Far	5,51 – 6,40 – 6,35 (P = 0,839)	5,04 – 6,67 – 6,88 (P = 0,205)
Fwood coll.time	Quick – Fair – Late	5,67 – 5,95 – 6,59 (P = 0,903)	6,17 – 5,25 – 7,54 (P = 0,155)
Income level	Low – Medium – High	4,51 – 9,12 – 6,50 (P = 0,005)	4,34 – 8,09 – 8,87 (P = 0,000)
Income source	1 – 2 – 3 – 4 – 5	7,64 – 2,73 – 5,66 – 4,82 – 6,90 (P = 0,127)	7,47 - 3,42 - 7,66 -4,05 - 6,70 (P = 0,004)
Caste	Brahmin – Chhetri – Others – Lower	4,52 – 8,60 – 7,48 – 1,33 (P=0,097)	6,21 – 8,30 – 5,15 – 7,00 (P=0,265)
Settlement time	Early – Middle – Late	7,31 – 1,76 – 0,50 (P = 0,002)	6,51 – 6,07 – 1,25 (P = 0,008)

Source : Field study (1999)
Note :
Income sources: 1= Agriculture 2= Labour 3= business 4= pension 5= Service

4.12.2. Risk of Species Loss and Sustainability

Distribution of species and their individual number determine the possible loss or extinction of species from the area. Widely distributed species are less vulnerable to be lost or extinct from the area. In reverse, less distributed species are threatened to be lost from the area. If species is distributed either in large number of household farms or in large number of individual in the area, there are said to be widely distributed. They are comparatively safe for not to be lost. Once the species is found either in limited number of households or in limited number of individual, they are referred as threatened species to be lost. There is high risk with these species. They can be lost from the area in near future. Here, list of threatened species is made based on their distribution in number of-farm and number of individual. Table below lists the species name, which are threatened to be lost from the farmland area.

Table 4.12.2 - 1: Threatened Tree Species in the Area

Species Name	% Of HH reporting at present	# Of individuals at present	% Of HH reporting till 5 yrs back	% Of HH reporting till 10 yrs back	% Of HH reporting at beginning
Shorea robusta	1.0	2	4.1	10.0	48.1
Phyllanthus emblica	1.0	1	0.0	3.0	32.2
Bassia butyracea	1.0	1	1.0	0.0	0.0
Grewia subinaequalis	1.0	1	1.0	1.1	0.0
Gaikhirro	1.0	2	3.0	0.0	3.9
Exbucklandia populnea	1.0	1	0.0	0.0	0.0
Prunus domestica	1.0	1	0.0	0.0	0.0
Eugenia operculata	2.0	4	2.0	5.5	18.1
Cedrela toona	2.0	3	1.0	1.1	1.2
Bredelia retusa	2.0	5	1.0	2.2	2.6
Terminalia belerica	2.0	2	16.3	25.5	44.1
Stereopermum tetragonum	3.1	4	3.0	6.6	32.4
Cocus nucifera	3.1	4	1.0	0.0	0.0
Khirro	3.1	30	1.0	2.2	2.6
Machilus odoratissima	3.1	8	1.0	1.1	3.9
Terminalia tomentosa	3.1	8	4.1	9.9	23.3
Oroxylum indicum	4.1	7	4.1	3.3	22.0
Acacia catechu	4.1	5	3.0	2.2	27.2
Cleyera ochnacea	4.1	6	3.0	2.2	3.9
Amaro	4.1	6	5.1	5.5	14.3

Source : Field study (1999)

Shrestha and Joshi (1996) have mentioned 60 plant species of non-endemic taxa fall under various categories of threats in Nepal. Among them 22 species are rare because of their economic values as exportable items, because of their geographical range lying within human encroachments and also because of their over exploitation for local use. Among the threats, 12 species are listed under endangered category and 11 species under vulnerable category. Farmland of the current study area preserves only two species, which are found under the threatened category in Nepal. *Butea monosperma* is already lost from the area. *Acacia catechu* and *Oroxylum indicum* are still found in the area with very limited distribution. *Shorea robusta* and *Phyllanthus emblica* have loosed their distribution very fast from the area. These species will completely be lost from the farm if present trend continues. In addition, the distribution of *Terminalia belerica, Stereopermum tetragomumi, Terminalia alata* tree species are also decreasing rapidly in the farmland.

Chapter 5

5. Conclusion:

As the forest degradation continues with more restricted access to the forest, increase in the price of the wood, threats in the rural farming system, farmers responds by increasing number of trees and tree species in the various places of the farmland. Traditional agro-ecosystem (agroforestry) not only support the physical needs of the people but also plays vital role in conservation of significant elements of biodiversity found outside natural ecosystem. Farming systems are mixed and complex. Maintaining diversity of the species is an important aspect of traditional farming.

Biodiversity of the tree species, measured in terms of species diversity index and species richness index, were 1.8 and 5.01 respectively. These values were found to be lower than those in similar areas of other south Asian countries such as India, Bangladesh and Sri Lanka. Two main reasons were found responsible for lower biodiversity of tree species in the study area. Firstly, there was wide individual distribution of few tree species. Only two species dominate individual distribution.of trees. *Dalbergia sissoo* and *Melia azedarach* occupies more than three-forth of the total tree number. Secondly, there was wide distribution of households characterized by small farmland, low income, small homegarden size, small and medium sized livestock. Biodiversity is generally less in such households

Biodiversity of fodder and fruit tree species were higher than fuelwood and timber/furniture tree species. However, individual distribution of fuelwood and timber/furniture tree species occupies even more than three-forth of the total tree number. A total of 60 tree species were found in the area. An average household had about 7.7 tree species, 66.7 individual trees, 96.9 trees per ha and 8.9 trees per capita. The figure is consistent what others have found in other parts of the same physiographic region (Terai). But, the species number, tree number and tree density are relatively less than the hilly farmland of the country.

Farm boundaries and homegardens were the most common places for the tree growing. About three-forth of the total number of households have grown trees in farm boundaries and homegardens were found in about half of the total households. Although tree growing in the woodlot was not common, more than half of the tree number was found within this system.

The regression analysis shows very weak linear relationship between the biodiversity of the tree species (both species diversity and specie richness) and each of the socio-economic factors particularly the farm size, household size, livestock size, homegarden size, income level, fuelwood consumption, forest distance and forest visit. No single factor alone determines the biodiversity correctly. They are unable to predict the biodiversity individually. However, their combined effect is little more ($r^2 = 0.48$, n= 98). On the other hand, analysis of variance showed significant difference of biodiversity in different farm size, homegarden size, livestock size and income source. In general, larger farm size, larger homegarden size, higher income, larger livestock holding encourage the farmers to hold large number of trees and tree species. Agriculture and business based households have maintained higher level of biodiversity. On the other hand, lowest biodiversity exists in labor-based households. Poverty is another problem in biodiversity conservation.

Twenty-six tree species were completely lost from the farm from the beginning of the settlement to date. Further, twenty species were found with very limited distribution and two of them are already under the threatened category in national level. Only 14 new species were introduced until present. Farmers are now attracted to grow fast growing, multipurpose and easily available tree species. Economic return is the major concern for them. Such a situation may lead to the further loss of tree species from the farm. Some species such as *Shorea robusta* and *Phyllanthus emblica*, which were among the widely distributed in the beginning, are now about to be lost because of easy availability in nearby forest, slow growth rate and limited uses etc.

Socio-economic factors were also found responsible for species change from the farmland. Species changes in terms of species lost and species introduced were found influenced by farm size, homegarden size, household size, livestock size, household income and settlement period. Species changes (both lost and introduced) increases as the value of such variables increases.

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Annex 1: Distribution of Tree Species at Present

Local Name	Scientific Name	Distribution in % of HH	Distribution in % of Individuals	Main use	Other use
Anmp	*Mangifera indica*	60.2	2.3	Fruit	Fuel, Timber
Bakaino	*Melia azedarach*	60.2	17.3	Fodder, Fuel, Timber	
Katahar	*Artocarpus heterophyllus*	43.9	1.2	Fruit, Fodder	Fuel
Sissoo	*Darbergia sissoo*	42.9	57.9	Fuel, Timber	
Amba	*Psidium guyava*	38.8	1.2	Fruit	Fuel
Dabdabe	*Garuga pinnata*	37.8	2.4	Fodder	Fuel
Bans	*Dendrocalamus spp*	34.7	1.2	Timber, fuel, fodder	
Ipil	*Leucaena leucocephala*	32.7	2.2	Fodder, Fuel	
Aaru	*Prunus persica*	30.6	0.7	Fruit	Fuel
Khamari	*Gmelina arborea*	29.6	1.5	Fodder, Fuel, Timber	
Kimbhu	*Morus alba*	25.5	1.2	Fruit, Fodder	Fuel
Kavro	*Ficus lacor*	23.5	0.9	Fodder	Fuel
Tote	*Ficus hispida*	21.4	0.9	Fodder	Fuel
Dumri	*Ficus glomerata*	17.3	0.4	Fodder	Fuel
Barro	*Terminalia belerica*	16.3	0.3	Fodder, Fuel	
Khanyo	*Ficus semicordata*	15.3	0.7	Fodder	Fuel
Tanki	*Bauhinia purpurea*	14.3	0.5	Fodder	Fuel
Badahar	*Artocarpus lakoocha*	13.3	0.4	Fodder	Fuel
Linchi	*Linchi chinensis*	13.3	0.4	Fruit	Fuel
Pipal	*Ficus religiosa*	12.2	0.2	Religious, Fodder	Fuel
Rajbriksha	*Cassia fistula*	12.2	0.2	Medicinal	Ornament
Gindari	*Premna integrifolia*	10.2	0.2	Fodder	Fuel
Vellor	*Trewia nudiflora*	10.2	1.0	Fodder	Fuel
Kutmero	*Litsea monopetala*	9.2	0.2	Fodder	Fuel
Sitaphal	*Dillinia indica*	9.2	0.2	Fruit	Fuel
Goldmohar	*Delonix regia*	8.2	0.1	Ornament	Fuel
Firfire	*Acer ablongum*	7.1	0.4	Fodder	Fuel
Nimpatta	*Azadiracta indica*	7.1	0.2	Medicinal	
Parijat	*Nyctanthes arbor-tristis*	7.1	0.2	Ornament	Fuel
Simal	*Bombax ceiba*	7.1	0.4	Fuel	Timber
Jamun	*Syzygium cumini*	6.1	0.2	Fruit	Fuel
Nimaro	*Ficus roxburghii*	6.1	0.1	Fodder	Fuel
Odal		6.1	0.1	Fodder	Fibre
Supari	*Areca catechu*	6.1	0.1	Fruit	
Bayer	*Zizyphus jujuba*	5.1	0.1	Fruit	
Chiple		5.1	0.1	Fodder	Fuel
Harro	*Terminalia chebula*	5.1	0.2	Fuel	Medicine
Imili	*Tamarindus indica*	5.1	0.1	Fruit	
Sitalchini		5.1	0.1	Fruit	Fodder, Fuel
Amaro		4.1	0.1	Fruit	Fuel
Bahunpate	*Cleyera ochnacea*	4.1	0.1	Fodder	Fuel
Khair	*Acacia catechu*	4.1	0,1	Industrial	Fuel, Fodder, Timber
Maltato	*Oroxylum indicum*	4.1	0.1	Fodder	Fuel
Asna	*Terminalia alata*	3.1	0.1	Timber,Fuel	
Kaulo	*Machilus odoratissima*	3.1	0.1	Fodder	Fuel
Khirro		3.1	0.5		
Nariwal	*Cocus nucifera*	3.1	0.1	Fruit	
Padari	*Stereopermum tetragonum*	3.1	0.1	Fodder	Fuel
Bar	*Ficus bengalensis*	2.0	0.0	Religious	
Bel	*Aegle marmelos*	2.0	0.0	Fruit	
Gayo	*Bridelia retusa*	2.0	0.1	Fodder	Fuel
Jingad	*Cedrela toona*	2.0	0.0	Timber, fuel	
Kyamun	*Eugenia operculata*	2.0	0.1	Fruit	Fuel
Aarubakhada	*Prunus domestica*	1.0	0.0	Fruit	Fuel
Amla	*Phyllanthus emblica*	1.0	0.0	Fruit	Fuel
Chiuri	*Busiia butyracea*	1.0	0.0	Fodder, Fruit	Fuel
Fosre	*Grewia subinaequalis*	1.0	0.0	Fodder	Fuel
Gaikhirro		1.0	0.0		Fuel
Pipali	*Exbucklandia populnea*	1.0	0.0	Fodder	Fuel
Sal	*Shorea robusta*	1.0	0.0	Timber	Fuel

Annex 2: Distribution of Tree Species around 5-year back

Local Name	Scientific Name	Distribution in % of HH	Main use	Other use
Anmp	*Mangifera indica*	50.0	Fruit	Fuel, Timber
Katahar	*Artocarpus heterophyllus*	38.8	Fruit, Fodder	Fuel
Bans	*Dendrocalamus spp*	36.7	Fodder, Fuel, Timber	
Dabdabe	*Garuga pinnata*	36.7	Fodder	Fuel
Sissoo	*Darbergia sissoo*	35.7	Timber,Fuel	
Amba	*Psidium guyava*	29.6	Fruit	Fuel
Bakaino	*Melia azedarach*	29.6	Fodder, Fuel, Timber	Fuel
Khamari	*Gmelina arborea*	28.6	Fodder, Fuel, Timber	
Kavro	*Ficus lacor*	22.4	Fodder	Fuel
Ipil	*Leucaena leucocephala*	21.4	Fodder,fuel	
Tote	*Ficus hispida*	18.4	Fodder	Fuel
Dumri	*Ficus glomerata*	17.3	Fodder	Fuel
Kimbhu	*Morus alba*	17.3	Fruit, Fodder	Fuel
Barro	*Terminalia belerica*	16.3	Fuel	
Aaru	*Prunus persica*	15.3	Fruit	Fuel
Khanyo	*Ficus semicordata*	14.3	Fodder	Fuel
linchi	*Linchi chinensis*	13.3	Fruit	Fuel
Pipal	*Ficus religiosa*	13.3	Religious, Fodder	
Tanki	*Bauhinia purpurea*	13.3	Fodder	Fuel, Timber
Vellor	*Trewia nudiflora*	12.2	Fodder	Fuel
Badahar	*Artocarpus lakoocha*	9.2	Fodder	Fuel
Gindari	*Premna integrifolia*	9.2	Fodder	Fuel
Kutmero	*Litsea monopetala*	7.1	Fodder	Fuel
Simal	*Bombax ceiba*	7.1	Fuel	Timber
Odal		6.1	Fodder	Fibre
Amaro		5.1	Fruit	Fuel
Bayer	*Zizyphus jujuba*	5.1	Fruit	
Firfire	*Acer oblongum*	5.1	Fodder	Fuel
Harro	*Terminalia chebula*	5.1	Fuel	Medicine
Jamun	*Syzygium cumini*	5.1	Fruit	Fuel
Parijat		5.1	Ornament	
Asna	*Terminalia alata*	4.1	Fuel, Timber	
Chiple		4.1	Fodder	Fuel
Karang		4.1	Fuel, Timber	
maltato	*Oroxylum indicum*	4.1	Fodder	Fuel
Sal	*Shorea robusta*	4.1	Timer	Fuel
Singane		4.1	Fodder	Fuel
Bahunpate	*Cleyera ochnacea*	3.1	Fodder	Fuel
Bel	*Aegle marmelos*	3.1	Fruit	
Gaikhirro		3.1		Fuel
Khair	*Acacia catechu*	3.1	Industrial	Timber, Fodder
masala	*Eucalyptus spp*	3.1	Timber, fuel	
Nimaro	*Ficus roxburghii*	3.1	Fodder	Fuel
Nimpatta	*Azadiracta indica*	3.1	Medicinal	
Padari	*Stereopermum tetragonum*	3.1	Fodder	Fuel
Sitalchini		3.1	Fruit	Fodder, Fuel
Supari	*Areca catechu*	3.1	Fruit	
Bar	*Ficus bengalensis*	2.0	Religious	
Dhupi	*Cupressus spp*	2.0	Ornament	
Kyamun	*Eugenia operculata*	2.0	Fruit	Fuel
Sandan	*Ougeinia dalbergoides*	2.0	Timber	Fuel
Ashok	*Saraca indica*	1.0	Ornament	
Chiuri	*Busiia butyracea*	1.0	Fruit, Fodder	Fuel
Dudhilo	*Ficus nemoralis*	1.0	Fodder	Fuel
Fosre	*Grewia subinaequalis*	1.0	Fodder	Fuel
Gayo	*Bridelia retusa*	1.0	Fodder	Fuel
Goldmohar	*Delonix regia*	1.0	Ornament	Fuel
Imili	*Tamarindus indica*	1.0	Fruit	
Jingad	*Cedrela toona*	1.0	Timber, fuel	
Kalkiphool	*Callistemon viminalis*	1.0	Ornament	
Kaulo	*Machilus odoratissima*	1.0	Fodder	Fuel
Khirro		1.0		Fuel
Kusum	*Schleichera trijuga*	1.0	Fruit	Fuel, Timber
lampate	*Duabanga grandiflora*	1.0	Fuel, Timber	
Nariwal	*Cocus nucifera*	1.0	Fruit	
Palans	*Butea monosperma*	1.0	Ornament	Fuel
Patke	*Gaultheria hookaris*	1.0	Fuel	Timber
Phaledo	*Erithrina arborescens*	1.0	Fodder	Fuel
Rabar		1.0	Ornament	
Rajbriksha	*Cassia fistula*	1.0	Medicinal	Ornament
Sitaphal	*Dillinia indica*	1.0	Fruit	Fuel
Teak	*Tectona grandis*	1.0	Timber	Fuel

Annex 3: Distribution of Tree Species around 10 years Back

Local Name	Scientific Name	Distribution in % of HH	Main use	Other use
Anmp	*Mangifera indica*	41.11%	Fruit	Fuel, Timber
Dabdabe sp.	*Garuga pinnata*	32.22%	Fodder	Fuel
Katahar	*Artocarpus heterophyllus*	27.78%	Fruit, Fodder	Fuel
Khamari	*Gmelina arborea*	27.78%	Fodder, Fuel, Timber	
Barro	*Terminalia belerica*	25.56%	Fuel	Fodder
Bans	*Dendrocalamus spp*	22.22%	Fodder, Fuel, Timber	
Dumri	*Ficus glomerata*	21.11%	Fodder	Fuel
Tanki	*Bauhinia purpurea*	20.00%	Fodder	Fuel, Timber
Amba	*Psidium guyava*	15.56%	Fruit	Fuel
Tote	*Ficus hispida*	14.44%	Fodder	Fuel
Bar	*Ficus bengalensis*	13.33%	Religious	
Khanyo	*Ficus semicordata*	13.33%	Fodder	Fuel
Pipal	*Ficus religiosa*	13.33%	Religious, Fodder	
Simal	*Bombax ceiba*	13.33%	Fuel	Timber, Fodder
Kavro	*Ficus lacor*	11.11%	Fodder	Fuel
Linchi	*Linchi chinensis*	11.11%	Fruit	Fuel
Vellor	*Trewia nudiflora*	11.11%	Fodder	Fuel
Asna	*Terminalia alata*	10.00%	Timber, Fuel	
Kutmero	*Litsea monopetala*	10.00%	Fodder	Fuel
Sal	*Shorea robusta*	10.00%	Timber	Fuel
Gindari	*Premna integrifolia*	8.89%	Fodder	Fuel
Jamun	*Syzygium cumini*	8.89%	Fruit	Fuel
Odal		8.89%	Fodder	Fibre
Siris	*Albezia spp*	8.89%	Timber	Fodder, Fuel
Sissoo	*Darbergia sissoo*	8.89%	Timber, Fuel	
Harro	*Terminalia chebula*	6.67%	Fuel	Medicine
Kimbhu	*Morus alba*	6.67%	Fruit, Fodder	Fuel
Padari	*Stereopermum tetragonum*	6.67%	Fodder	Fuel
Aaru	*Prunus persica*	5.56%	Fruit	Fuel
Amaro		5.56%	Fruit	Fuel
Ipil	*Leucaena leucocephala*	5.56%	Fodder, Fuel	
Kyamun	*Eugenia operculata*	5.56%	Fruit	Fuel
Badahar	*Artocarpus lakoocha*	4.44%	Fodder	Fuel
Bel	*Aegle marmelos*	4.44%	Religious	Fruit
Palans	*Butea monosperma*	4.44%	Ornament	Fuel
Amla	*Phyllanthus emblica*	3.33%	Fruit	Fuel
Bakaino	*Melia azedarach*	3.33%	Fodder, Fuel, Timber	Fuel
Firfire	*Acer ablongum*	3.33%	Fodder	Fuel
Karang		3.33%	Fuel, Timber	
Maltato	*Oroxylum indicum*	3.33%	Fodder	Fuel
Masala	*Eucalyptus spp*	3.33%	Timber, Fuel	
Singane		3.33%	Fodder	Fuel
Sitalchini		3.33%	Fruit	Fodder, Fuel
Sitaphal	*Dillinia indica*	3.33%	Fruit	Fuel
Bahunpate s	*Cleyera ochnacea*	2.22%	Fodder	Fuel
Bodhdhayero	*Lagerstroemia parviflora*	2.22%	Fuel	
Chiple		2.22%	Fodder	Fuel
Gayo	*Bridelia retusa*	2.22%	Fodder	Fuel
Goldmohar	*Delonix regia*	2.22%	Ornament	Fuel
Imili	*Tamarindus indica*	2.22%	Fruit	
Khair	*Acacia catechu*	2.22%	Industrial	Fuel,Timber, Fodder
Khirro		2.22%		Fuel
Kusum	*Schleichera trijuga*	2.22%	Fruit	Fuel
Nimaro	*Ficus roxburghii*	2.22%	Fodder	Fuel
Rajbriksha	*Cassia fistula*	2.22%	Medicinal	Ornament
Valayo	*Rhus wallichii*	2.22%	Fruit, Fodder	Fuel
Bayer	*Zizyphus jujuba*	1.11%	Fruit	
Fosre	*Grewia subinaequalis*	1.11%	Fodder	Fuel
Jingad	*Cedrela toona*	1.11%	Timber, Fuel	
Karma	*Adina cordifolia*	1.11%	Fuel, Timber	
Kaulo	*Machilus odoratissima*	1.11%	Fodder	Fuel
Lampate	*Duabanga grandiflora*	1.11%	Timber, Fuel	
Naspati		1.11%	Fruit	
Nimpatta	*Azadiracta indica*	1.11%	Medicinal	
Parijat		1.11%	Ornament	
Phaledo	*Erithrina arborescens*	1.11%	Fodder	Fuel
Pakhuri	*Ficus glaberrima*	1.11%	Fruit	Fruit
Sandan	*Ougeinia dalbergoides*	1.11%	Timber	Fuel
Supari	*Areca catechu*	1.11%	Fruit	
Tatari	*Dillenia pentagyna*	1.11%	Fodder	Fuel, Timber
Tikauli	*Grewia optiva*	1.11%	Fodder	Fuel

Annex 4: Distribution of Tree Species at Early Settlement

Local Name	Scientific Name	Distribution in % of HH	Main use	Other use
Sal	*Shorea robusta*	48.1	Timber	Fuel
Barro	*Terminalia belerica*	44.2	Fuel	Fodder
Dabdabe	*Garuga pinnata*	44.2	Fodder	Fuel
Harro	*Terminalia chebula*	37.7		Fuel
Khamari	*Gmelina arborea*	35.1	Fodder, Fuel, Timber	
Pipal	*Ficus religiosa*	35.1	Religious, Fodder	
Tatari	*Dillenia pentagyna*	33.8	Fodder	Fuel
Amla	*Phyllanthus emblica*	32.5	Fruit	Fuel
Padari	*Stereopermum tetragonum*	32.5	Fodder	Fuel
Dumri	*Ficus glomerata*	31.2	Fodder	Fuel
Nimpatta	*Azadiracta indica*	29.9	Medicinal	
Khair	*Acacia catechu*	27.3	Industrial	Fodder,Fuel, Timber
Palans	*Butea monosperma*	27.3	Ornament	Fuel
Tanki	*Bauhinia purpurea*	24.7	Fodder	Fuel
Asna	*Terminalia alata*	23.4	Timber, Fuel	
Simal	*Bombax ceiba*	23.4	Fuel	Fodder
Jamun	*Syzygium cumini*	22.1	Fruit	Fuel
Maltato	*Oroxylum indicum*	22.1	Fodder	Fuel
Bodhdhayero	*Lagerstroemia parviflora*	19.5	Fuel	
Bans	*Dendrocalamus spp*	18.2	Timber, fuel, fodder	
Khanyo	*Ficus semicordata*	18.2	Fodder	Fuel
Kyamun	*Eugenia operculata*	18.2	Fruit	Fuel
Valayo	*Rhus wallichii*	18.2	Fruit	Fodder
Gindari	*Premna integrifolia*	16.9	Fodder	Fuel
Tote	*Ficus hispida*	16.9	Fodder	Fuel
Amaro		14.3	Fruit	Fuel
Odal		14.3	Fodder	Fibre
Gaikhirro		13.5		Fuel
Anmp	*Mangifera indica*	13.0	Fruit	Fuel, Timber
Kusum	*Schleichera trijuga*	13.0	Fruit	Fuel
Karang		11.7	Timber, Fuel	
Kutmero	*Litsea monopetala*	11.7	Fodder	Fuel
Karma	*Adina cordifolia*	10.4		Fuel
Amba	*Psidium guyava*	9.1	Fruit	Fuel
Bar	*Ficus bengalensis*	7.8	Religious	
Firfire	*Acer ablongum*	6.5	Fodder	Fuel
Imili	*Tamarindus indica*	6.5	Fruit	
Bel	*Aegle marmelos*	5.2	Religious	Fruit
Katahar	*Artocarpus heterophyllus*	5.2	Fruit, Fodder	Fuel
Kavro	*Ficus lacor*	5.2	Fodder	Fuel
Patke	*Gaultheria hookaris*	5.2	Fuel	Timber
Singane		5.2	Fodder	Fuel
Sitalchini		5.2	Fruit	Fodder, Fuel
Vellor	*Trewia nudiflora*	5.2	Fodder	Fuel
Bahunpate	*Cleyera ochnacea*	3.9	Fodder	Fuel
Phaledo	*Erithrina arborescens*	3.9	Fodder	Fuel
Kaulo	*Machilus odoratissima*	3.9	Fodder	Fuel
Tikauli	*Grewia optiva*	3.9	Fodder	Fuel
Badahar	*Artocarpus lakoocha*	2.6	Fodder	Fuel
Chiple		2.6	Fodder	Fuel
Dar	*Boehmeria rugulosa*	2.6	Timber	Fuel
Gayo	*Bridelia retusa*	2.6	Fodder	Fuel
Jingad	*Cedrela toona*	2.6	Timber, Fuel	
Khirro		2.6		Fuel
Latikath	*Cornus oblonga*	2.6	Timber, Fuel	Fuel
Pakhuri	*Ficus glaberrima*	2.6	Fodder	Fuel
Siris	*Albezia spp*	2.6	Timber	Fodder, Fuel
Sisso	*Darbergia sissoo*	2.6	Timber, Fuel	
Dudhilo	*Ficus nemoralis*	1.3	Fodder	Fuel
Ipil	*Leucaena leucocephala*	1.3	Fodder, Fuel	
Khari	*Celtis australis*	1.3	Fodder, Fuel, Timber	
Koiralo	*Bauhinia verietata*	1.3	Fruit, Fodder	Fuel
Kumbhi		1.3	Fodder	Fuel
Lampate	*Duabanga grandiflora*	1.3	Timber, Fuel	
linchi	*Linchi chinensis*	1.3	Fruit	Fuel
Nimaro	*Ficus roxburghii*	1.3	Fodder	Fuel
Rajbriksha	*Cassia fistula*	1.3	Medicinal	Ornament
Rudhilo		1.3	Fodder	Fuel
Sandan	*Ougeinia dalbergoides*	1.3	Timber	Fuel

Annex 5: Questionnaire for Household Survey

Household Survey Questionnaire

Diversity and Dynamics of Tree Species and Its Sustainability in Rural Farmland
(A Case Study from Chitwan District, Central Nepal)
1999

A. **Household Information:**

I.
Name of VDC: Ward no:
Village:

II. Respondent Information:

Name: Gender:
Age: Marital Status:
Education: Social Status:
1.No formal education 2. Primary education 3. S.L.C
4. Intermediate level 5. Bachelor lever 6. Above
Occupation: 1. Agriculture 2. Business 3. Service 4. Other

1. How long have you been to this place? From where did you come here and why?

III. Household Size and Composition:

Age Group	Number of Household Member				
	At settled time (S)	10 Yrs before (10)	5 Yrs before (5)	At present (0)	Remarks
Economically Inactive *Children (<10 years)* Male Female *Old (> 65 years)* Male Female					
Economically Active *Adult (10 to 65 years)* Male Female					

B.

I. Land use type:

Area in Local Units (1 ha.= 30 Kathaa)

Nature of land	Period				
	S	10	5	0	Remarks
Cultivated land Irrigated Non-irrigated					
Non culitvated land					
Total land area					

II. Land use distribution:

Area in Local Units (1 ha.= 30 Kathaa)

Utilization of land	Period				
	S	10	5	0	Remarks
Area of Homegarden					
Area of woodlot					
Fallow land					
Others					

IV. Land fragmentation:

Area in Local Units (1 ha.= 30 Kathaa)

	Period				
	S	10	5	0	Remarks
Piece of land					
Total piece of land after disassociation of family					

Agricultural Production System:

Crops/vegetables	Area of Cultivation (In local unit)				production				Sale/Buy of products			
	S	10	5	0	S	10	5	0	S	10	5	0
Paddy												
Maize												
Wheat												
Finger Millet												
Mustard												
Lentils												
Vegetables												

Level of production: 1= very high, 2= high, 3= medium, 4= low
Sale/Buy of product: S= sale, B= buy

Use of fertilizer/Insecticide/Improved seed:

In per unit of land

Utilization of fertilizer	Period				
	S	10	5	0	Remarks
Organic manure (compost)					
Inorganic fertilizer					
Insecticide/pesticide					
Improved seed					
IPM					

Level of use: 1= very high, 2= high, 3= medium, 4= low

III. Cultivation Practice:

In per unit of land

Practices	Period				
	S	10	5	0	Remarks
Ox ploughing					
Tractor					
Other					

Level of practice: 1= very high, 2= high, 3= medium, 4= low

Livestock Size:

Unit In Number

Types	Period				
	S	10	5	0	Remarks
Cattle					
Buffalo					
Sheep					
Goat					
Other					
Total (In Livestock Unit)					

III. Feeding practices:

Unit in Month per Year

Feeding characteristics	Period				
	S	10	5	0	Remarks
Stall feeding					
Crop residues					
Tree fodder					
Natural grasses					
Others					
Grazing					
Grazing in cropland					
Grazing in forest/shurbland					
Grazing in common or public land					
Others					

Level of use of resources: 1= very high, 2= high, 3= medium, 4= low

Source of Family Income:

Income source	Indicate the sources for previous time period				Remarks
	S	10	5	0 (Mention Amount in Rs.)	
On farm income: *Agricultural production; Food crops Vegetables Livestocks Others *Tree production:					
Off- farm Income: Regular Job Business Labor Cottage Industry Others					
Total					

E. Forest Resources:

	Period				
	S	10	5	0	Remarks
Type of forest					
Distance to reach the forest					
Average time to bring a unit of fuelwood					
Average time to bring a unit of fodder					
Number of days to go forest per year					

Availability of forest products					
Accessibility to the forest					
Quality of the forest					

Type of forest: 1. Government forest 2. Community forest 3. Other forest type
Accessibility: 1. Open 2. Restricted 3. Regulated
Quality of forest: 1= very high, 2= high, 3= medium, 4= low

F. Energy resources:

In per capita

Energy resources	Period				
	S	10	5	0	Remarks
Fuelwood					
Agri. Residue					
Animal dung					
Kerosene					
Electricity					
Biogas					
Other					

Level of use: 1= very high, 2= high, 3= medium, 4= low

Questions about Farm forest/Agroforest:

What kind of tree species do/did you have in your farm?

Characteristics	Period				
	S	10	5	0	Remarks
Fodder species					
Fuelwood species					
Timber species					
Furniture species					
Fruit trees					
Medicinal species					
Religious species					
Ornamental species					
Shade tree					

What characteristics of tree species do/did you have in your farm?

Characteristics	Period				
	S	10	5	0	Remarks
Fast growing					
Multipurpose					
Big size					
Indeginous					
Exotic					
Insect/pest resistance					
Easy to establish					
High yielding					
Financially attractive					

How much important the tree species of farmland and outside farmland are/were for your livelyhood?

Categories	Tree species of Farmland				Tree species of natural forest			
	S	10	5	0	S	10	5	0
Compare to past								
Compare to other sources								

Level of importance: 1= Very high, 2= High, 3= Medium, 4= Low

How much benefit do/did you get from the tree species of farmland and forestland?

Categories	Tree species of Farmland				Tree species of natural forest			
	S	10	5	0	S	10	5	0
Compare to past								
Compare to other sources								

Level of benefits: 1= Very high, 2= High, 3= Medium, 4= Low

5. What kind of tree growing pattern do/did you have in the farm?

Pattern	Period				
	S	10	5	0	Remarks
As a border plantation					
As a homegarden					
As a pure tree stand					
As a sparsely distributed in the farm					
Other pattern					

Level of presence: 1= Very high, 2= High, 3= Medium, 4= Low

How do you compare the quality of tree species in farm land?

Categories	Period				
	S	10	5	0	Remarks
Compare to past (in farmland)					
Compare to natural forest					

Level of quality: 1= Very high, 2= High, 3= Medium, 4= Low

What is the frequency of changes of tree species in Farm and Natural forest land?

Type of land	Period				
	S	10	5	0	Remarks
Trees in farmland					
Trees in natural forest land					

Level of change: 1= Very high, 2= High, 3= Medium, 4= Low

Qualitative questionnaire:

Do you notice the disadvantages of the tree species growing in the farm? If yes, what are they?

Do you want to Introduce/increase the number of trees in the farm? If yes, what are they and why?

S.N	Species	Number	Reasons for Introducing/Increasing	Remarks
1				Introduce/increase
2				Introduce/increase
3				Introduce/increase
4				Introduce/increase
5				Introduce/increase

Do you want to eliminate/reduce the number of trees in the farm? If yes, what are they and why?

S.N	Species	Number	Reasons for Eliminating/Reducing	Remarks
1				Eliminate/reduce
2				Eliminate/reduce
3				Eliminate/reduce
4				Eliminate/reduce
5				Eliminate/reduce

1. Do you want to change the existing pattern of tree growing in the farm? If yes, mention new one?

2. Do you think that the more tree species produce greater benefit compared to less number of tree species? How?

3. Do you think that the existing tree species will be replaced or lossed in the future?

4. Will you again grow/maintain the tree species in your farm even if the existing tree species are lossed from the farm?

5. In which situation you will increase the number of trees in the farm?

6. In which situation you will eliminate/decrease the number of trees in the farm?

7. Have you noticed the changes of tree species from nearby natural forest? If yes, what are they?

8. Which tree species do you find in the nearby natural forest?

9. Do you think that some tree species are going to be lost from the forest in near future? If yes, what are they?

Structure and Composition of Tree Species in Farmland: (direct observation)

I. Information about the existing situation:

S.N	Name of species		Number of trees	Place of growing	Land use	Regeneration	Uses	Remarks
	Local	Scientific						

Uses: 1= Fuel , 2= Fodder, 3= Timber, 4= Ornamental, 5= Shade, 6= Medicinal, 7= Fruits, 8= Fence, 9=Furniture, 10= Others
Place of growing: 1=Homegarden , 2= Border of the farm, 3= Middle of the farm, 4= Corner of the farm
Regeneration: 1= Natural, 2= Planted
Land use: 1= Irrigated 2= Non irrigated, 3= Non cultivated

II. Information about the past situation:

Which species did you have in your farm since the beginning?

S.No.	List of Tree Species in Different Time Period			
	At Settled time	10 yrs before	5 yrs before	Remarks
	Species with approx. number	Species with approx. number	Species with approx. number	