Buffer zone resources and community conservation: a case study of Piple buffer zone Village Development Committee, Chitwan National Park

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

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Majoring in Wildlife Management

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LETTER OF RECOMMENDATION

This is to certify that *Mr Apar Paudyal* has prepared this Master's thesis entitled "**Buffer zone resources and community conservation: a case study of Piple buffer zone Village Development Committee, Chitwan National Park**" for partial fulfillment of the requirement for the completion of Master's Degree in Environmental Science majoring in Wildlife Management and he had worked sufficiently well under my supervision and guidance.

This Master's degree thesis work embodies his own work and fulfills as per the requirement of Central Department of Environmental Science, Tribhuvan University.

I therefore accept and recommend this work for approval.

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DECLARATION

I, Apar Paudyal, hereby declare to the Dean of the Tribhuvan University (TU) that this is my original work and all sources of information used are duly acknowledged. This work has not been published or submitted elsewhere for any academic award.

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APPROVAL

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Title of Thesis	Buffer zone resources and community conservation: a case study of Piple buffer zone Village Development Committee, Chitwan National Park.

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ABSTRACT

The twin objectives of buffer zone are to ensure the ecological integrity of protected areas, and enabling of local communities to sustain their livelihood through active management of natural resources outside the park. To understand ecology, economy and social strata in buffer zone, Piple buffer zone Village Development Committee (VDC) of Chitwan National Park, was examined as a case study. Methods included were stratified random sampling of household economics, analysis of vegetation and landuse change. Forest patches are central to buffer zone communities. The forests (ha) in Piple VDC decreased by 33% between 1978 - 1992. The buffer zone community forest only fulfils 14.88 % and 24.57 % of annual household fodder and fuelwood demand. The deficit was primarily extracted from Chitwan National Park and other community forest outside buffer zone. Several households suggested a combination of alternatives to minimize their impact on the Park, which included more plantation, transparency in managing resource, collection of driftwood from the Rapti River, and allocation of more river bank for grazing and fodder management. All these suggest that buffer zone communities have on- going impact on the park resources and it will take time for them to be self-reliant.

Key words*: Socio-economy, landuse, buffer zone community forest, rhino, forest ecology, anthropogenic pressure, park and people*

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Apar Paudyal

July, 2007

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LIST OF ABBREVIATIONS AND ACRONYMS

KMTNC	King Mahendra Trust for Nature Conservation
BZ	Buffer zone
CNP	Chitwan National Park
VDC	Village Development committee
DNPWC	Department of National Park and Wildlife Reserve
PPP	Park People Programme
BZCF	Buffer Zone Community Forest
BZMC	Buffer Zone Management Committee
UG	User Group
UC	User Committee
BZUC	Buffer Zone User Committee
CF	Community Forest
GCP	Grass Cutting Program
HMG/N	His Majesty Government of Nepal
FSSD	Forest Survey and Statistics Division
FRSC	Forest Resources and Survey Center
LRMP	Land Resource Mapping Project
MPFSN	Master Plan for Forestry Sector Nepal
NPWCA	National Park and Wildlife Conservation Act
UNDP	United Nations Development Program
MEA	Millennium Ecosystem Assessment
APU	Anti Poaching Unit

Chapter 1

INTRODUCTION

1.1 Introduction

Achieving local cooperation and support without jeopardizing conservation goals remains a top priority for the parks (Wells and McShane 2004). People everywhere rely on ecosystem services for their well being. In places where there are no social safety nets, humans tend to increase depend more on ecosystem services. The resultant additional pressures can damages ecosystems to a degree that the probability of conflict increases (Millennium Ecosystem Assessment, 2005). Contemporary conservationists had recognized the need to work beyond protected areas if they are to sustain viable populations of wildlife species and large-scale ecological process (Treves & Salafsky, 2004:319). In this context, the buffer zone approach to protected area management emerged as spin-off with the devolution of resource use right to local communities. Buffer zone had been institutionalized as an operational approach (Ebregt and Greve, 2000:7) to ensure the ecological integrity of protected areas, and enabling of local communities to sustain their livelihood through active management of natural resources outside the park. However, in spite of this approach, the strategy of buffer zone in protected area is ambitious and many anticipated it to resolve the much contested linkages between diminishing societal support for protected areas and the conservation of biodiversity (Sanderson & Redford 2003).

With the establishment of Chitwan National Park in 1973, various conservation models and strategies have been employed for conservation in Nepal. The fortress model with exclusion of people in early seventies was heavily criticized for imposing restriction on local level usury rights and debarring local people (Heinen & Shrestha, 2006). Understanding the local communities need, impact zone concepts of nineties (Sharma and Shaw 1992 cited in KMTNC, 1998) calls for strict control of forests within the adjacent park or reserve, combined with intensified agriculture and forestry on the public and private properties outside the protected areas with an intention to build local people self reliance (KMTNC, 1998). This conservation measures efforts to fix the local communities special needs as they are found to be inhabiting since long in a mix of settlements, agricultural lands, villages, open spaces, cultural heritage areas and other land use forms (KMTNC, 2004; Budhathoki, 2005). This irrefutable conservation thought led to amendment in National Parks and Wildlife conservation Act (NPWCA, 1973) in 1993 that had facilitated the legal foundation for

biodiversity conservation to establish and manage the buffer zone areas outside the protected areas. In 1996, 750 Km^2 of adjacent areas in Chitwan National Park was declared as buffer zone. The concept was to build participatory model between local people, public and government agency for sustainable use and conservation of resources (Furze et. al, 1996). To complement these, the three tier community based institutional model at settlement, sector and park level (Budhathoki, 2005) were implemented with 50 % revenue sharing mechanism from the parks. Community development activities, conservation program, income generation and skills development program, conservation education program and administrative expense were major form of activities administered to leverage biodiversity conservation as well as societal development in the buffer zone areas.

1.2. Background of the problem

The buffer zone (750 Km^2) of Chitwan National Park (CNP; estd: 1973) (932 Km^2) was established in 1996 which encompasses 35 Village Development Committees (VDC's) and 2 municipalities that have 510 settlements with 223,260 populations (DNPWC, 2000). The buffer zone area comprises of mosaic of forests, agricultural lands, settlements, cultural heritage areas, village open spaces and many other types of landuse (Budhathoki, 2005). Buffer zone management had influenced appreciable number of community participation; as to date buffer zone was successful at forming 1400 User groups (UGs) at settlement level out of which about 47% are women UG's, 21 User Committee (UC) at sector/unit level and at park Buffer Zone Development Management Committee (BZMC) with the chief of the park acting as a member secretary (Budhathoki, 2005). CNP had up to date (2004/05) released the budget of approximately NRs 0.19 billion (approx $ 2.8 million) (DNPWC, 2004/05) to buffer zone to facilitate the community based conservation initiatives at settlement, sector and park level (DNPWC, 2004/2005). Other 58 % of the fund released for buffer zone management is unused (DNPWC, 2003. cited in Budhathoki, 2004).

Endangered greater one horned rhinoceros (*Rhinoceros unicornis*) has always been an attraction in CNP. The decrease in rhino number in the past few years had turned down the conservation success stories of 1996 and had now been the biggest challenge to conservation workers in Nepal. There are two reasons for sharp decline in rhino numbers and for increased incidence of poaching in the Chitwan Valley. First, weak law and order situation due to Maoist insurgency imposed cumulative imbalance over rhino conservation efforts as army

guard post get vacated, Chitwan's communication damaged, intelligence funding for the Chitwan was cut and patrolling needed updating with the extra pressure on the parks (Poudyal, 2005; Martin, 2004; Yonzon, 2002). Second, slackness and inefficient leadership, lack of full time experienced and competent senior officer to supervise the anti poaching activities had made confounding role to authorities to conserve rhinos (Martin, 2001). The emerging truth was also that park is too small to maintain viable populations of tigers and rhinos, and the prime habitat in the buffer zones and corridors attached to the park was severely degraded (Dinnerstein, 1998). Nevertheless, functional anti poaching units and the availability of economic opportunities locally seemed to reduce the level of poaching (Poudyal, 2005).

The five year management plans (2001-2005) of CNP have identified issues, strategies and activities for socio-economic development allied with protection measures. Despite of these endeavor, the reality had been festering with meager success for biodiversity conservation as well as community development at large. The nature culture dichotomy fueled by the local community's urgency to illegally use forests in CNP for cattle grazing, thatch and fodder grass cutting, firewood collection, timber cutting, hunting and fishing are the frontline issues to challenge the protected area management through buffer zone management programs (Stræde and Treue, 2006; Budhathoki, 2005; Paudel, 2002; Heinen & Mehta, 2000; Stræde and Helles, 2000; Nepal and Weber, 1993). Suggesting, the socio-economics of adjacent communities plays vital role in shaping the local cooperation for support and conservation.

1.3 Statement of Research Significance

The crux of conservation is the relationship between people and the landscapes that house biodiversity (Chan et al, 2006). In the context of wide spread poverty and unemployment among people living around the CNP, the issue of meeting basic survival needs is the single most threat to conservation of the biological diversity (KMTNC, 1996). The buffer zone management paradigms at CNP have passed ten years. There are few questions that need answering to validate this conservation strategy. Have it or have it not met the positive outcomes for dual goals set for conservation and development in the buffer zone landscape? What were the lessons learned and what are the future prospects?

In this study, Piple Buffer zone (BZ) VDC of Chitwan National Park (CNP) is examined as a case study to understand the linkages between ecology, economy and social realities. The

assessment of community and biophysical resource was major focus to capture the real life experience of changes in ecosystems and human well being. We hypothesize that local social and biophysical contexts shape the viability of the effective buffer zone management. The assessment of multiple variables playing at buffer zone landscape to understand the drivers, their interaction and the consequences of ecosystem services and human well being is crucial to design effective responses (Millennium ecosystem Assessment, 2005). The present study covers five factors associated with buffer zone that have a bearing on park protection (Figure 1.1.1). The factors are: buffer zone household well being, land cover change, buffer zone community forest management, Rhino occurrence, poaching and community conservation, vegetation ecology and human interference in the forest.

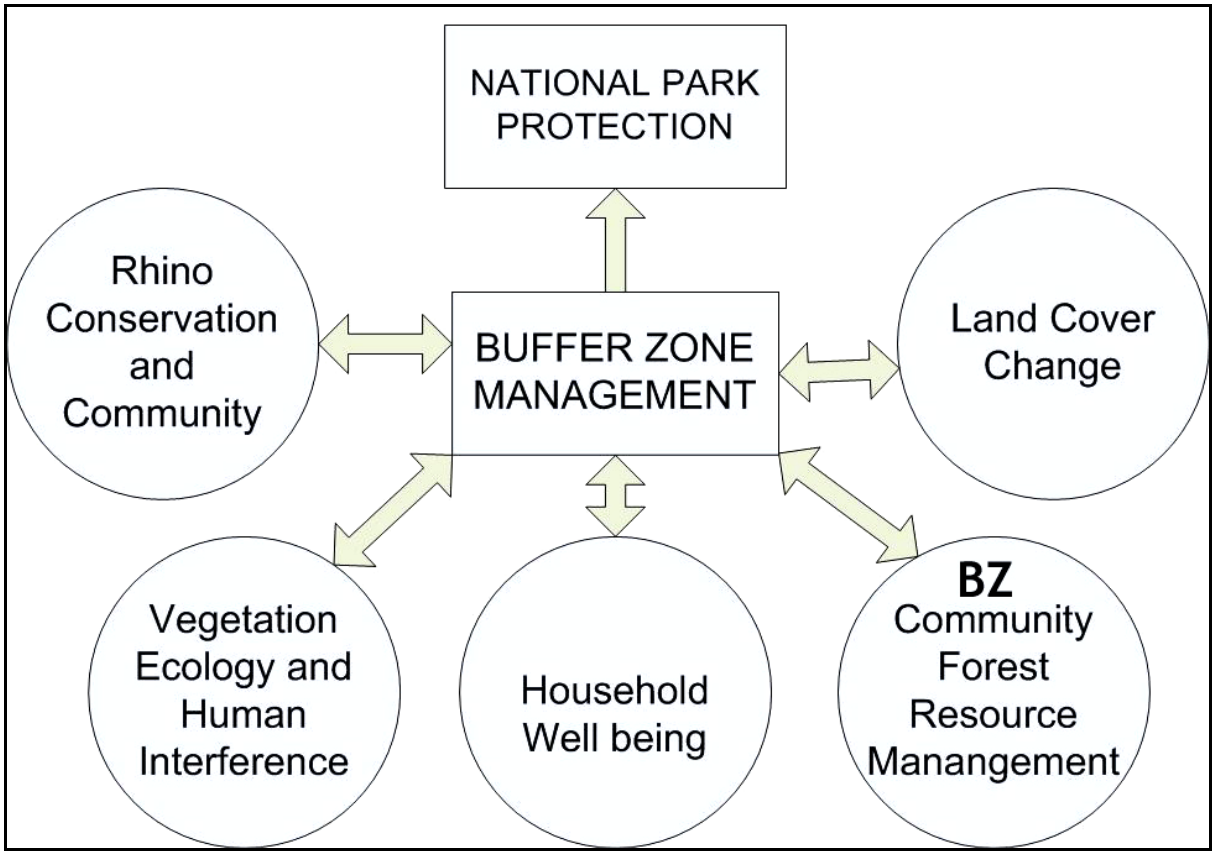


Figure 1.1.1 Conceptual frame work for the study

1.3 Objectives

The broad objective of this study is to understand the inter-linkages between ecology, economy and social context of Piple Buffer Zone Village Development Committee of the Chitwan National Park.

Specific Objectives

- To study Piple buffer zone VDC households and their well being.
- To study changes in land use pattern of Piple buffer zone VDC.
- To study vegetation of Piple buffer zone VDC including assessment of forest resources; household demand, annual yield and human interference.
- To study the Piple buffer zone community forest management.
- To study the Rhino occurrence, poaching and community conservation activities in Piple buffer zone VDC.

1.4. Limitation of the study

There was limitation of time as well as resources to carry out the study. Our six member's graduate team surveyed field during April-May 2006 and we were there collecting data from the field during peak hours of insurgency (Jana-Andalon II) in Nepal. Household's data collection was affected to some extent due to respondent's absence in the home. There was also limitation of data for full coverage analysis to establish better linkages between ecology, economy and social strata. Only vegetation survey was carried using forest measurements and other faunal species assemblage was ignored. Study on other physical factors such as soil and water was also ignored. Much of the details on the buffer zone ground level programs and its impacts on the local communities as such were also not examined.

Chapter 2

STUDY AREA

2.1 Location

Piple Buffer Zone Village Development Committee (BZ VDC) is located under the jurisdiction of the eastern Sauraha sector of Chitwan National Park (fig 2.1.1), inner Terai, Chitwan district (27° 34' to 27° 35' E, 84° 39' to 84° 43' N, and avg. altitude. 250 m). Boundaries of Piple buffer zone are Manahari buffer zone VDC of Makawanpur district in the east, Bhandara VDC in the west, Chitwan National Park in the south and other wards of Piple VDC in the north. Some portion of northern Piple Buffer zone boundaries touches the East West highway. The Lothar River flows from North to South in the eastern boundary and Rapti River flows from east to west in the southern boundary of Piple BZ. Piple Buffer zone VDC is included under Lothar Buffer zone User committee. Only seven wards having 11.70 Km^2 lying in the alluvial plain are included in the Buffer zone, remaining two wards (ward 7 & 9) lying on the Mahabharat range region are not included in the Buffer zone of Piple VDC.

2.2. Climate

The climate is sub tropical (Stræde and Helles, 2000) with mean annual rainfall 1895 mm (Rampur Weather Station, 1994-2003). The rain showers 90 % during summer, from June to September. The average minimum monthly temperature is 8.2°C in January and average maximum monthly temperature is 35.9°C in May (Rampur Weather Station 1994-2003).

2.3 Demography and Household characteristics

The population density of the study area was 368 people/ha. In Total 622 household population living in 8 village settlements, composed of mixed ethnic groups, mostly representing by Brahmin and Chhetri caste group (Karmacharya et al. 2004). Some 72.5 % of the population cannot read and write. Households were predominantly farmers. A few were wage labor (3.9 %) and others were in small business and services (11.6 %) (DNPWC, 2000). The market access is easy due to Bharatpur-Hetuda highway that runs through the VDC.

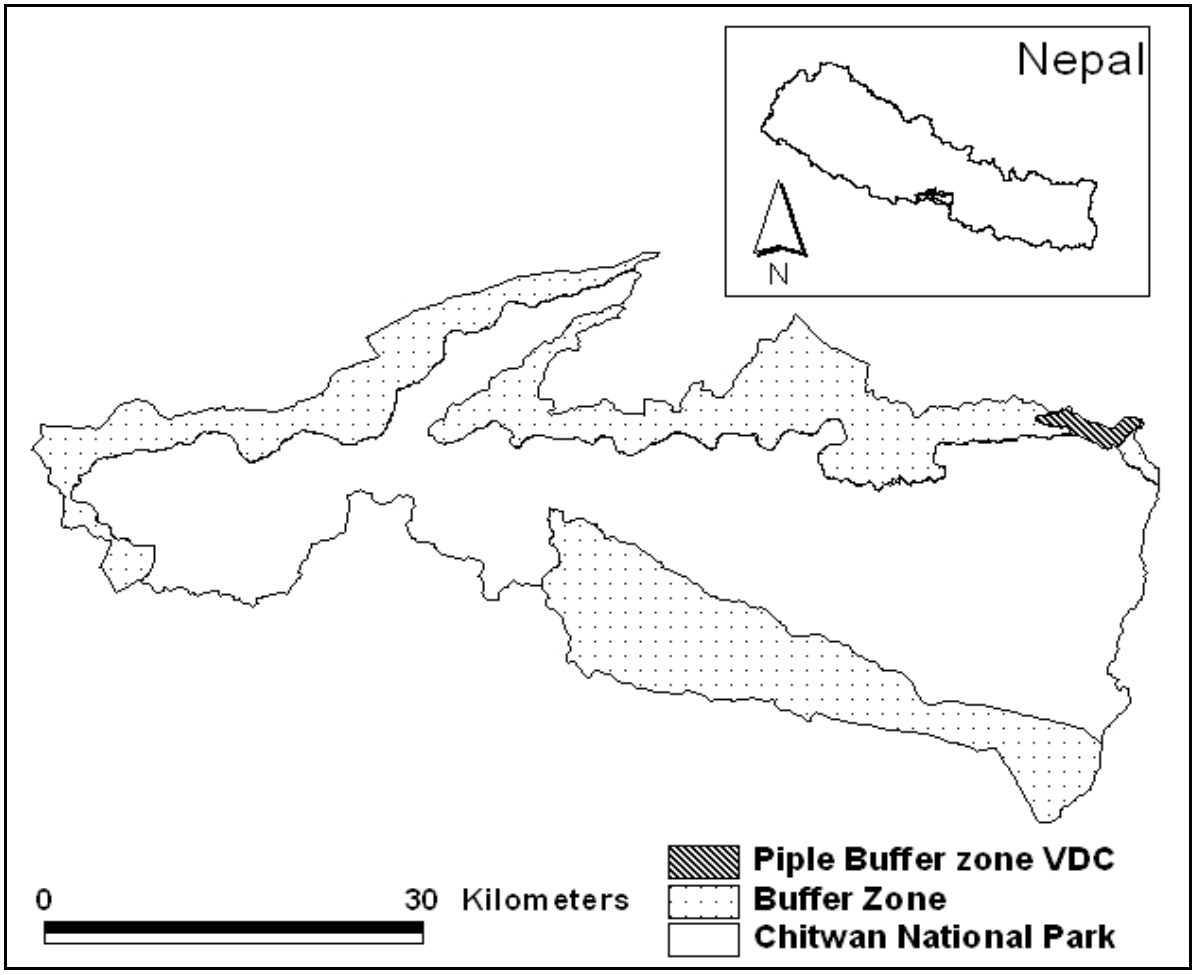


Figure 2.1.1 Location of Study area

2.4 Buffer zone Community Forest

The forest area were managed by four buffer zone community forest user committees (BZCF UC's) namely Jayahari Janachetana, Janashakti, Brahamasthani and Shanti respectively. There were two patches of riverine forest. The first forest patch (245 ha) comprised of *Albizia, Lagerstormia, Trewia* and *Dalbergia* (KMTNC, 2000). The second patch (46 ha) was planted with *Dalbergia sissoo as* it lies in the flood plain of the Rapti River. 17 different wildlife including *Rhinoceros unicornis, Cervus unicolor, Axix axis, Panthera pardus, Felis chaus, Sus scorfa,* etc, and 33 different bird species have been reported from these forests of buffer zone (KMTNC, 2000).

Forest Resources were strictly protected and once a year, collection of dry fuel wood was allowed. For fodder and litter collection, a nominal fee for each day was charged to individual household.

Chapter 3

LITERATURE REVIEW

3.1 Buffer zone issues and analysis

There has been an uninterrupted history of more than 30 years of scientific studies in CNP. Prior to the establishment of buffer zone in CNP, Nepal and Weber (1995) has identified five major causes of park-people conflicts prevailing in the park including illegal transactions of forest products, livestock grazing, illegal hunting and fishing, crop damage, and threats to human from wild animals. The technical report on buffer zone policy analysis KMTNC (1998) suggests sixteen points' guidelines regarding institutional and managerial aspects of the buffer zones.

Heinen and Mehta, (2000) raised the questions on participatory rights handed over to citizens, whether the managerial and research capacities exist to monitor buffer zones for their effectiveness for both conservation and development purpose and make several recommendations to improve implementation. Paudel (2002) suggested adopting social ecology perspectives to balance conservation and local livelihood to manage protected areas. Mclean and Straede (2003) challenges the existing conservation paradigm currently practiced by the CNP and calls for park management to reassess the resettlement policy by initiating new policies toward a more collaborative paradigm integrating conservation and development needs. Budhathoki (2003) argued that conservation model based on the foundation of strict protection has been found to be insufficient during present political crises as protected areas enjoy no or little public support and suggests some alternative mechanism for long-term conservation of biological resources in Nepal. Budhathoki's (2004; 2005) analysis of conservation policy for buffer zone revealed that there are inconsistencies between the vision of the program and it policies and practice. Paudel (2004) has highlighted the two issues associated with buffer zone management in CNP. First, the differential impacts of conservation program to social groups residing in buffer zone. Second, social actors associated with management. The analysis reveals that weak and vulnerable groups are losing the battle. Straede and Treue's (2006) study incorporate economic analyses to investigate the effect of management interventions on local communities' resource use and collection behavior. Nepal (2000), had pointed out that the efforts towards wildlife conservation can only succeed if it is build on the foundation of participatory approach by implementing socio economic reforms including issues of indigenous communities.

Straede and Helles (2000) found that the annual grass cutting program (GCP) had not solved the park-people conflicts but had only postponed it because in its present form it does not comply with the concept of community based conservation but is rather an example of nature based development where important core areas are exploited in the name of development. Straede et al (2002) have assessed the structure and floristic composition of six community forest established through natural regeneration of degraded Sal forests and of former riverine forest areas which have been cleared and overgrazed in the buffer zone areas.

3.2 Previous study on Piple BZ VDC

There have been only a few studies in the Piple BZ VDC. KMTNC (2000) has prepared the resources assessment report under project title: Chitwan habitat restoration III. Similarly, DNPWC (2000) has prepared the buffer zone resource profile of CNP. Bookbinder et al (1998) study revealed that only 6 % of surveyed households earned income directly or indirectly from ecotourism in CNP. Other independent studies were Mukunda et al (2004) on social mobilization and governance of community forest.

3.3 Rhino related issues

Most of the recent study on one horn Rhino was carried out by Esmond Martin. Martin (1996) studied the importance of park budgets, intelligence networks and competent management for successful conservation of the greater one-horned rhinoceros. In another study, Martin (1998) study focused on the community development projects and it's implication on rhino conservation in Nepal. Likewise, Martin (2001) has also studied on the strategies for effective rhino conservation in Nepal. While, Adhikari (2002) examines the two reasons for classic success of Nepal's rhino conservation.

Martin (2004) studied the rhino poaching in Nepal during an insurgency. Rothley et al (2004) studied on the population model for the greater one-horned rhinoceros in CNP. PREM (2005) study examines how different policy options might reduce poaching; while at the same time alleviate poverty in the areas surrounding the CNP. Recently, Amin et al (2006) studied on an overview of the conservation status of and threat of rhinoceros species in the wild.

3.4 Other relevant literature

Brown, (2003) argued that there are three challenges for a real people centered conservation: a more pluralist approach to understanding knowledge and values of different actors, greater deliberation and inclusion in decision making and a remodeling of institutions to support conservation. Mosozera et. al (2000) suggests agricultural income, household age and size and access to towns and outside markets are the key determinants of forest dependency and concluded that protected areas management plant must be consistent with overall socio-economic development plans.

Baliant, (2006) argued that the outcomes of community based conservation projects will improve if project leaders pay closer attention to four development indicators: rights, capacity, governance and revenue that are often taken for granted or considered beyond the scope of local conservation project. Whereas, Parr (2006) discusses on establishing specialized management units within protected areas for effective protected area management.

Schroth et al (2005) have proposed three hypotheses on how agro forestry could help conserve tropical biodiversity: i) reduce the pressure to deforest remaining forestland and degrade forest through the unsustainable extraction of its resource; ii) provide suitable habitat for forest-dependent plant and animals species, and iii) create a biodiversity-friendly matrix to facilitate movements between existing patches of natural habitat and buffer them against more hostile land uses.

Chapter 4

METHODOLOGY

4.1. Household Socio economic survey

4.1.1. Survey design and Sample size

For household socioeconomic survey, eight settlements were selected. Stratified random sampling method was applied for the survey on the basis of settlement size which was based on population size (Annex II) and land holding (DNPWC/PPP, 2000). All household were grouped into four categories based on land holding (farm size): 1) small farm (0-0.3 ha); 2) Medium farm (0.31-0.6 ha); 3) Big farm (0.61-2.4 ha); and 4) Very big Farm (> 2.4 ha) (Table. 4.1.1).

Table 4.1.1 Land holding categories

Symbol	Land holding	Land holding in ha
Small farm	0-10 Kattha	0-0.3
Medium farm	10-20 Kattha	0.31-0.6
Big farm	1- 4 Bigha	0.61-2.4
Very big farm	> 4 Bigha	> 2.4

The sample size for 622 households at study area was found to be 65 households (Annex III). Random sampling method with replacement was used for equal number of sample size distribution in each settlement and land holding categories with equal probability as being unbiased. Each sample was drawn through lottery method. The lottery was drawn randomly at a time from both categories i.e. settlement name and land holding category for 65 times (Annex IV and Annex III).

At the field level, information regarding landholding of sample households was gathered with the help of Lothar Buffer zone User committee, Irrigation Canal Committee (Kulo samiti), local social organizations, and key persons like ex-VDC chairman, ex-ward chair persons, buffer zone management members and social workers (Annex X). From the list of information obtained on landholding, required number of sample size of each land categories in every ward and settlement was selected randomly and survey was conducted.

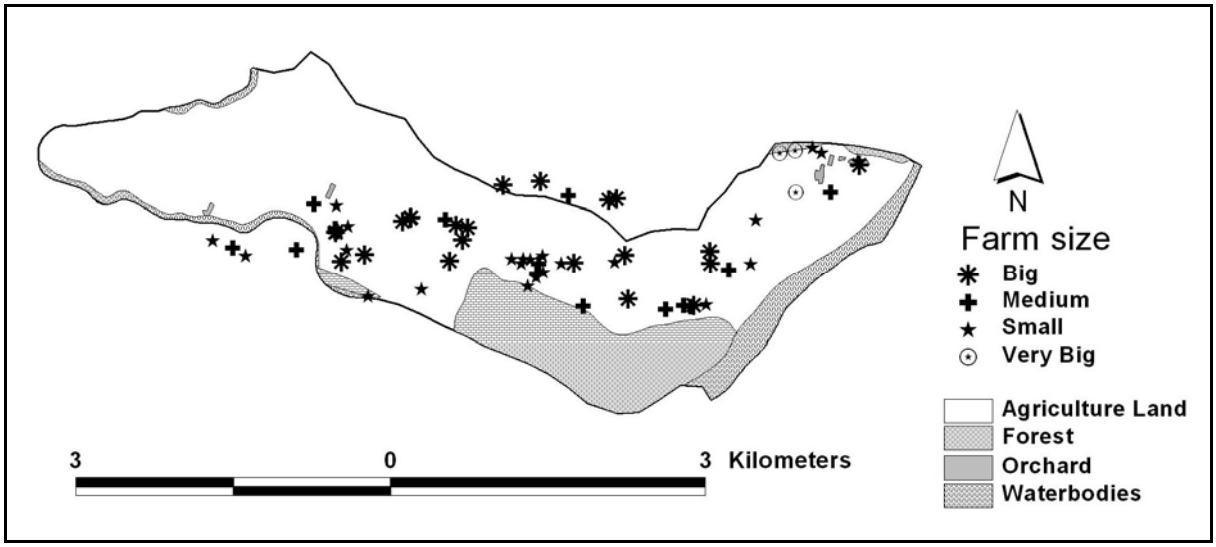


Figure 4.1.1 Distribution of sampled households included in the survey.

4.1.2. Questionnaire survey

The survey was conducted by direct interview with household member using structured and semi structured questionnaire with some close ended and some open ended questions. Before conducting the formal questionnaire survey, the questionnaire was pre tested in some household and some modifications were made. Six members research team (classmates) were mobilized for survey to bring the same level of required information. Before conducting the formal survey, discussions among research members on subject matter was done to obtain the similar and equal understanding for filling the questionnaire. Such discussion was repeated each day after conducting the survey. Interview was made with the family head member as far as possible, in absence of family head interview was made with knowledgeable member of the household.

Questionnaire was developed focusing on three main parts (Annex I) including household information, Buffer zone community forest and buffer zone management issues and rhino/ wildlife related issues.

4.1.2.1. Household information

This part has a focus on the household information to identify the livelihood support mechanism through occupation of respondent and family members, land holding, crop types and its production, livestock holding (including feeding types), resources need (Fuel wood and fodder) and their access, energy use and consumption pattern and annual income and expenditure.

4.1.2.2. Buffer zone related issues

This part was related with Buffer zone community forest and buffer zone management issues. It was designed to obtain the information about condition of buffer zone forest, types of resources extraction, pressure on community forest, resources allocation system, buffer zone budget sufficiency and its transparency and household level participation in Buffer zone management, land categorization within community forest, problems within the community forest, suggestions / recommendation for better management and resources utilization of community forest.

4.1.2.2. Rhino/Wildlife related issues

This part was set to obtain the information on crop and livestock depredation by Rhino and other wildlife, compensation measures for the losses, trend of Rhino movement, reason for rhino decline, rhino poaching events, poachers identity, current ongoing programs to conserve Rhino by authorities (Buffer Zone Management Committee / Buffer Zone Community Forest/ National Park) and their effectiveness and suggestions/ recommendations for future initiatives to protect/ conserve Rhinos.

4.1.3. Data Calculation

4.1.3.1. Household Income

Net household income was determined by subtracting overall expenditure from total income. Income from agriculture production noted in local unit (Muri) was converted into standard production unit (kg) (Annex V), by using following conversion (Nepal and Weber, 1993). Agriculture and livestock production was converted into monetary value by multiplying the local market price. Income from other sources like business, service, wage labor, remittance and others was directly obtained in monetary value. Expenditure was also noted on different topics (education, livestock, agriculture, livestock maintenance, food and others) in monetary value.

4.1.3.2 Estimation of Annual forest Resources (Fuel wood and Fodder) Need.

Annual forest resources use of sampled household and amount of resources from different sources (Buffer zone community forest, National Park, Own land and other community forest outside Buffer zone) were noted in local unit (Bhari). The weight of the Bhari was converted into Kilogram (kg) based on the experience of the villagers. Those who could not convert

Bhari into kg was calculated based on following equivalents (Nepal and Weber, 1993 (Annex V). The livestock unit conversion was taken from Kharal (2000)

4.1.4. Data Analysis

Data were analyzed using different statistical tools in different computer programs. Raw data and information from the questionnaire were first entered into the MS 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 65 sampled household was kept in the row and each characteristics of the household was placed in column. Once the basic calculation and data uniformity were completed variables were categorized and were compared against ethnicity, farm size, and net income. Statistical Package for Social Science (SPSS) software was used to obtain the characteristics of household.

4.2. Vegetation Survey

4.2.1 Survey Design and Sampling

FINNIDA land use map (1992) scaled at 1:25000 was used for vegetation survey by using random sampling method. Random points were fixed on the digital map of Piple VDC by using GIS. The latitude and longitude of these random points were noted and with the help of GPS (Garmin e-trex) the points were located in the field. Those points which are found to be inside the buffer zone community forest were selected to conduct the vegetation survey.

Vegetation survey was carried out in 13 locations (figure 4.2.1) where numbers of plot surveyed for tree, shrub and herb are presented in Table 4.2.1 (Annex VIII & IX). Survey represents all four buffer zone community forests of Piple village.

Table 4.2.1 Sample plot survey

	Area (m^2)	Plot
Tree	20	13
Shrub	5	26
Herb	1	23

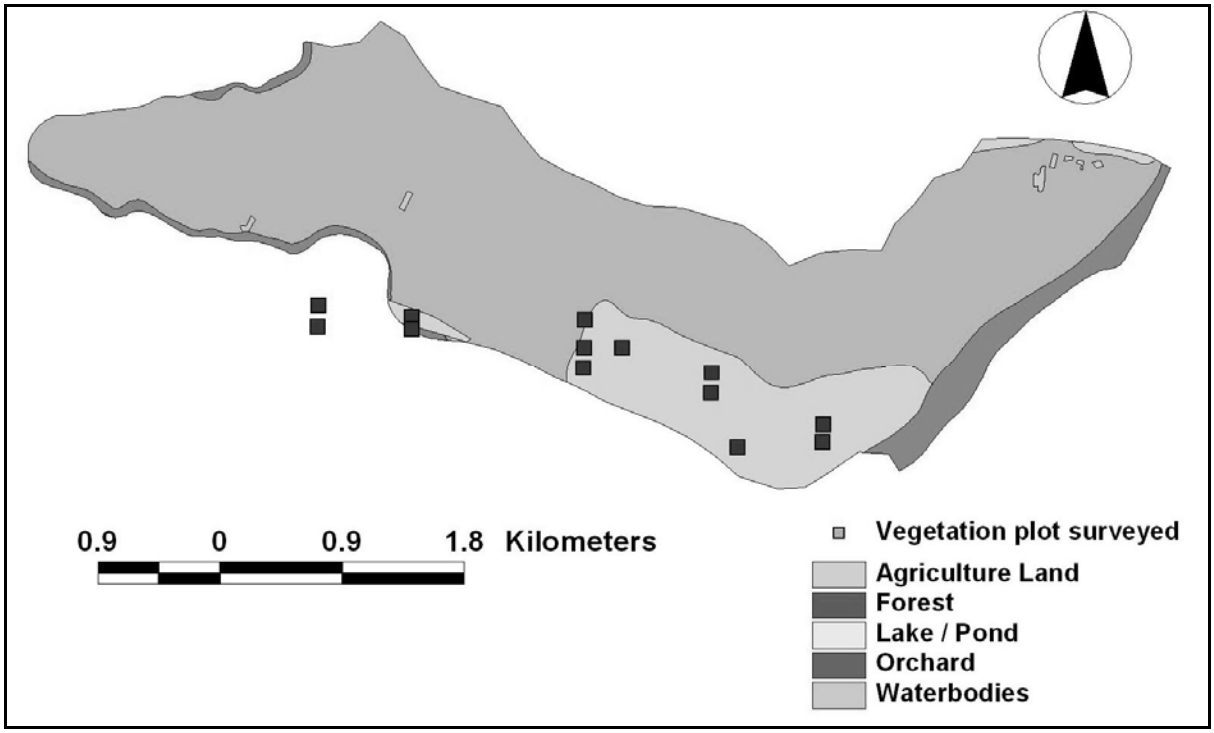


Figure 4.2.1 Distribution of vegetation sample plots

4.2.2 Plot Design

At each sampling points, all together 5 plots were laid out. First plot of 20x20 m^2 for tree species and within plot in opposite corners plots of 5x5 m^2 were laid to study shrub. Similarly for herb species 1x1m^2 plots nested in shrub plots were laid. (Annex VI).

All tree species having DBH greater than 10 cm were taken into account within 20x20 m^2 plot. DBH and height of all trees were measured with the help of DBH tape and clinometers respectively. Crown coverage percentage of trees within the sampling plots was estimated occularly. Height and number of all species having height greater than 10 cm, and less than 10 cm dbh were recorded in nested quadrate of 5x5 m^2. Similarly the number of all herb species and seedlings of shrub and tree with height less than 10 cm were recorded in 1x1 m^2 nested plot.

Number of cut stump of tree species with height and circumference at top and lopping percentage of tree species, grazing percentage, fire evidence and foot trails passages were noted in 20x20 m^2 plots to quantify human interference, grazing pressure and management practices.

4.2.3. Classification of Forest

4.2.3.1. Forest Types

According to Master's plan for forestry Sector (HMGN, 1988a), the buffer zone forest of Piple VDC was classified under two types.

1. Khair- Sissoo (KS)
2. Terai Mixed Hardwood (TMH)

4.2.3.2. Stand size

The following stand size classes as used by Forest Inventory Division (FRSC, 1995) were adopted into the study area (Table 4.2.2).

Table 4.2.2 Stand size classification

Symbol	Stand Size	DBH (cm)
1	Sapling	<12.5
2	Poles	12.5 - 25
3	Small saw timber	25 - 50
4	Large saw timber	> 50

4.2.3.3. Stocking

Determination of stocking is based on forest density, i.e. crown cover percentage (FRSC, 1995). Classes of stocking were as follows (Table 4.2.3).

Table 4.2.3 Stocking of trees

Symbol	Description	% Crown Closure
1	Poorly stocked	10--39
2	Medium	40-69
3	Well stocked	70 or more

4.2.4. Tree Volume

The computerized calculation system called inventory (INV) developed by the Forest Inventory Section, Ministry of Forest and Soil Conservation, Nepal (FSSD, 1991) was used for the calculation of resources of the Piple Buffer zone community forest. INV was used to estimate the volume of each individual tree (Annex VII). The volume parameters were obtained from the study carried out by Forest Survey and Statistical Division (FSSD, 1991).

4.2.5. Biomass of stems, branches and foliage

INV can also compute the biomass of stem, branches, foliage and whole tree. Stem biomass is obtained by multiplying the stem volume by wood density. Wood density was obtained from Forestry Sector Master Plan, 1988 (HMG/N, 1988 a). For obtaining the biomass of branches (fuel wood) and foliage (fodder), ratio of branch to stem biomass and foliage to stem biomass were applied for various species (HMG/N, 1988 a).

4.2.6. Estimates of Annual Yield

The Master Plan for the forestry sector of Nepal (MPFSN) had estimated the annual yield of different forest types of Terai for the Central Development Region. The percent annual yield estimated by Master Plan in similar forest types of Central Development Region were applied to estimate the annual yields of Buffer zone forest in the study area.

The annual yield of the Terai mixed hardwood forest was used for the annual yield of tree species (*Alibizia julibrissin, Bombax ceiba, Trewia nudiflora, Holarrhena pubescens* etc). Although MPFSN had classified the Siwaliks, of which Chitwan valley is a part, as an area having littlte fuel wood deficit, the situation for villages adjoining the park should be no different than the Terai region which suffers from a major shortage (Sharma, 1991). The study area lies in the inner Terai having similar climatic condition, so the annual yield was calculated on the basis of similar forest types of Terai of the Central Development region.

Defining sustainable wood harvest as the sum of stem and branch growth, and stem and branch mortality with only 15 % of stem growth allocated for timber and rest (85%) for fuel wood assuming recovery factor for Terai as 90 % (HMG/N, 1988 a). The annual accumulation of dead wood is 4.9 % of the annual yield. (HMG/N, 1988 a). Hence, for the calculation of fuel wood from dead wood, 4.9 % of total wood was considered as fuel wood. The yield from leaf biomass can be used as fodder if the tree is fodder species. Similarly, fodder yield from buffer zone forest was calculated on the basin on Total Digestible Nutrient (TDN) yields for various categories of land as mentioned in MPFSN (HMG/N, 1988 b).

4.2.7. Anthropogenic pressure on buffer zone community forest

4.2.7.1 Cut stump

The total number of cut stump of tree species was counted within the tree plots, measuring the girth of each cut stump (cm). The girth size was categorized into five classes according to Silori (2001). These girth classes are: (i) < 20 cm, (ii) 20-40 cm, (iii) 41-60 cm, (iv) 61-80

cm, and (v) > 80 cm. Density of each girth category was calculated for each species and buffer zone community forests.

4.2.7.2. Lopping intensity

The intensity of lopped trees was assessed under different damage categories in each tree plots as in Table 4.2.4. The lopping intensity was assessed in terms of percentage damage done to the individual tree by counting the number of cut branches of a tree. It was rated into four categories (Silori, 2001).

Table 4.2.4 Lopping intensity class

Lopping intensity	Scale
Least	1-25 % damage
Medium	26- 50 % damage
High	51-75 % damage
Very High	> 75 % damage
Total	

Density in each lopping intensity class was calculated for each species and buffer zone community forests.

4.3. Landuse change pattern

To study the landuse change of Piple Buffer zone VDC, LRMP-data (1978) and FINNIDA maps (1992) were compared. The data was analyzed using ESRI's software's, Arc info 3.5.2 and Arc view 3.2. From the overlay map of landuse between 1978-1992, comparison of areas of the six lands cover categories was made. And also the overview of land cover changes (%) in the six categories, including land cover gained and lost from each category was calculated. Data analysis was carried out based on the work by Tekle & Hedlund (2000).

Chapter 5

RESULTS

5.1 Socioeconomic survey

5.1.1. General Characteristics of Respondents

The distribution of sample household of the study area according to gender, age group, caste, occupation, education, land holding and land types is summarized in Table 5.1.1. The total numbers of male respondent were five times more than the female, even though no discrimination was made with sex. The age of respondent ranges from 18 to 69 years and slightly more than half (52.3 %) of the respondents were from age groups above 30 and below 50 years of age.

The respondents were from different caste/ethnic groups. Among them 49.2 % were Brahmin/ Chettri, 20 % Rai, 23.1 % Gurung /Magar /Tamang and 7.7 % Darai/Kumal/Praja, Dalit and others.

The occupation of majority of the respondents was agriculture. In total, 60 % of respondent were dependent only on agriculture. Rest of the respondent's was involved in services, business, housework's, skilled labor and unskilled labor. Majority of the respondents were literate (73.9 %) in which general literate who can read and write were 36.9 %, lower class attendance (up to grade 5 and below) were 13.9 % and higher class and college attendance were 23.1 %.

There were no landless among the respondents. Around 38.5 % of respondents have small farm (1-10 Kattha of land), 24.6 % of respondent have medium farm (10-20 Kattha) and 36.9 % of respondent have bigger farm (1 Bigha). However, only 47.7 % of respondents had their land registered, 30.8 % of respondents had their land not registered and 21.5 % of respondents have both kinds of land.

Table 5.1.1 General Characteristics of Respondent in the Study Area

Category		Number of Respondent	%
By Sex			
	Male	55	84.6
	Female	10	15.4
By Age group			
	<=30 years	9	13.9
	>30 to <=50 yrs	34	52.3
	>50 years	22	33.9
By residence period			
	Late settlers (<= 10 years)	9	13.9
	Middle settlers (> 10-<20 years)	11	16.9
	Early settlers (>20 years)	45	69.2
By caste			
	Brahmin/Chettri	32	49.2
	Indigenous Rai	13	20.0
	Gurung/Magar/Tamang	15	23.1
	Darai/Kumal/Praja	2	3.1
	Dalit	1	1.5
	Others	2	3.1
By Occupation			
	Agriculture	39	60.0
	Agriculture + Services	9	13.9
	Agriculture + Business	8	12.3
	Agriculture + Housework	6	9.2
	Agriculture +Skilled labor	2	3.1
	Unskilled/ Wage labor	1	1.5
By Education			
	Illiterate	17	26.2
	General	24	36.9
	Lower class	9	13.9
	Higher Class	9	13.9
	College/University	6	9.2
By Land type			
	Registered land	31	47.7
	Not registered land	20	30.8
	Both	14	21.5

5.1.2.1. Age Structure

The total population of sample household was 455, out of this 240 were male and 215 female (Table 5.1.2). Of the total population, majorities (63.3 %) were from working group and others were from dependent population group. The dependent population both old and young age were distributed in 52.3 % and 75.4 % of sampled household respectively (Table 5.1.3).

Table 5.1.2 Distribution of male and female

Age	Male	Female	Total
0-14 Years	64	71	135
15-59 years	156	132	288
>60 years	20	12	32
Total	240	215	455

Table 5.1.3 Dependent population

Dependent Population	Number	HH Number	% of HH
Old and young age*	53	34	52.3
Student**	136	49	75.4

* above 60 and below 10 years of age and handicapped, ** Student currently undergoing study at school and higher class

5.1.2.2. Occupation

The occupations adapted by households were agriculture, housework, service, unskilled/wage labor, skilled labor, business and foreign earning (Table 5.1.4). 98.46 % of sampled household's were associated with agriculture and housework occupation. The members from 27.69 % of sampled household were in salary based services. Other household were unskilled/wage labor (15.38 %), skilled labor (13.85 %), business (10.77 %) and foreign earning (10.77 %).

Table 5.1.4 Distribution of population by occupation

Occupation	Population	HH Number	% of HH
Agriculture	228	64	98.5
Housework	123	64	98.5
Service	27	18	27.7
Unskilled/Wage labor	18	10	15.4
Skilled labor	11	9	13.9
Business	10	7	10.8
Foreign earning	8	7	10.8

5.1.2.3. Education

81.7 % of above 5 years of age population were literate (Table 5.1.5). Illiterate and general education background populations were represented in 80 % of sampled household. Primary and high school attendant population were represented from 70.8 % and 60 % of the household's respectively. The college/university level populations were represented only in 24.6 % of the household's.

Table 5.1.5 Distribution of household population by education status

Education	Population*	HH Number	% of HH
Illiterate	77	52	80
General	100	52	80
Lower class	115	46	70.8
High School	101	39	60
College/University	29	16	24.6

* only above 5 years of age are taken

5.1.2.4. Ethnicity and households characteristics

The ethnic composition of the study areas was found to be dominated by Brahmin/Chhettri (49.3 %) followed by Gurung/Magar/Tamang (23 %), Rai (20 %), Darai/Kumal/ Praja (3 .%), others groups includes Newar (3. %) and Dalit (1.5 %).

The household characteristics by caste in the study area are presented in table 5.1.6. Brahmin/Chettri households in average have large farm size, high livestock size, consumes high amount of fodder annually and are found to willing to adopt alternative energy sources than other ethnic groups. Among the 61.5 % of households (Figure 5.1.1) living inside the 500 m boundary from community forest, 72 % of household represent thee small farm size from total households sampled. Among them households from Gurung/Magar/Tamang ethnic groups were comparatively higher (Figure 5.1.2) (Annex V).

Table 5.1.6 Selected Household characteristics by ethnicity in the Study area

Variables	Caste (n=65)						
	Brahmin/ Chettri (n=32)	Indigenous Rai (n=13)	Gurung/ Magar/ Tamang (n=15)	Darai/ Kumal/ Praja (n=2)	Dalit (n=1)	Others (n=2)	Total Avg.
Duration of living (year)	35.8	66.5	17.2	39.5	7.0	15.5	36.7
HH size (Number)	7.1	7.3	6.5	3.5	11.0	8.0	7.0
Farm size (ha)	1.1	0.5	0.4	3.3	0.4	0.3	24.2
Livestock size (LU)	4.8	2.5	2.9	3.6	7.5	3.6	3.9
Fuel wood consumption (kg/yr)	3106.3	2720.0	3719	6480	4600	2970	3293
Fodder consumption (kg/yr)	22551.6	14973.1	17261.7	31937.5	36500	10950.0	19961.5
Biogas installation (%)	25.0	0.0	0.0	0.0	0.0	0.0	12
Net Income (Rs/yr)	69069.2	32103.7	37927.3	-2750	75020	-3000	50153.7

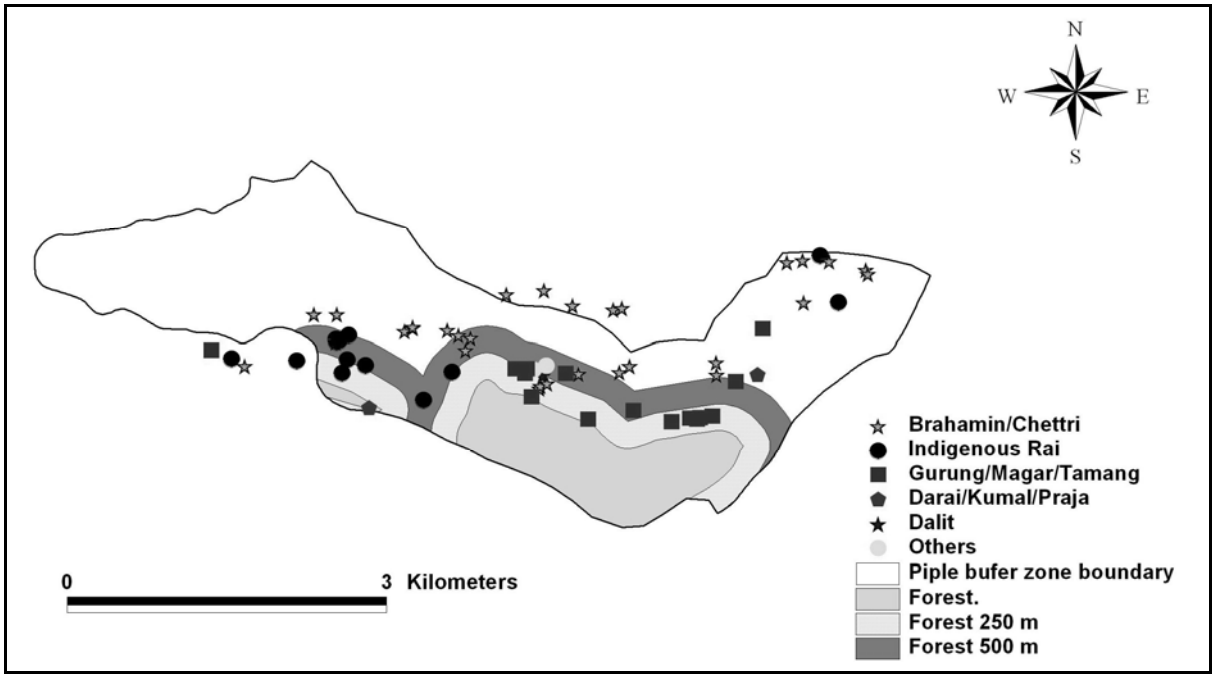


Figure 5.1.1 Households by ethnic groups

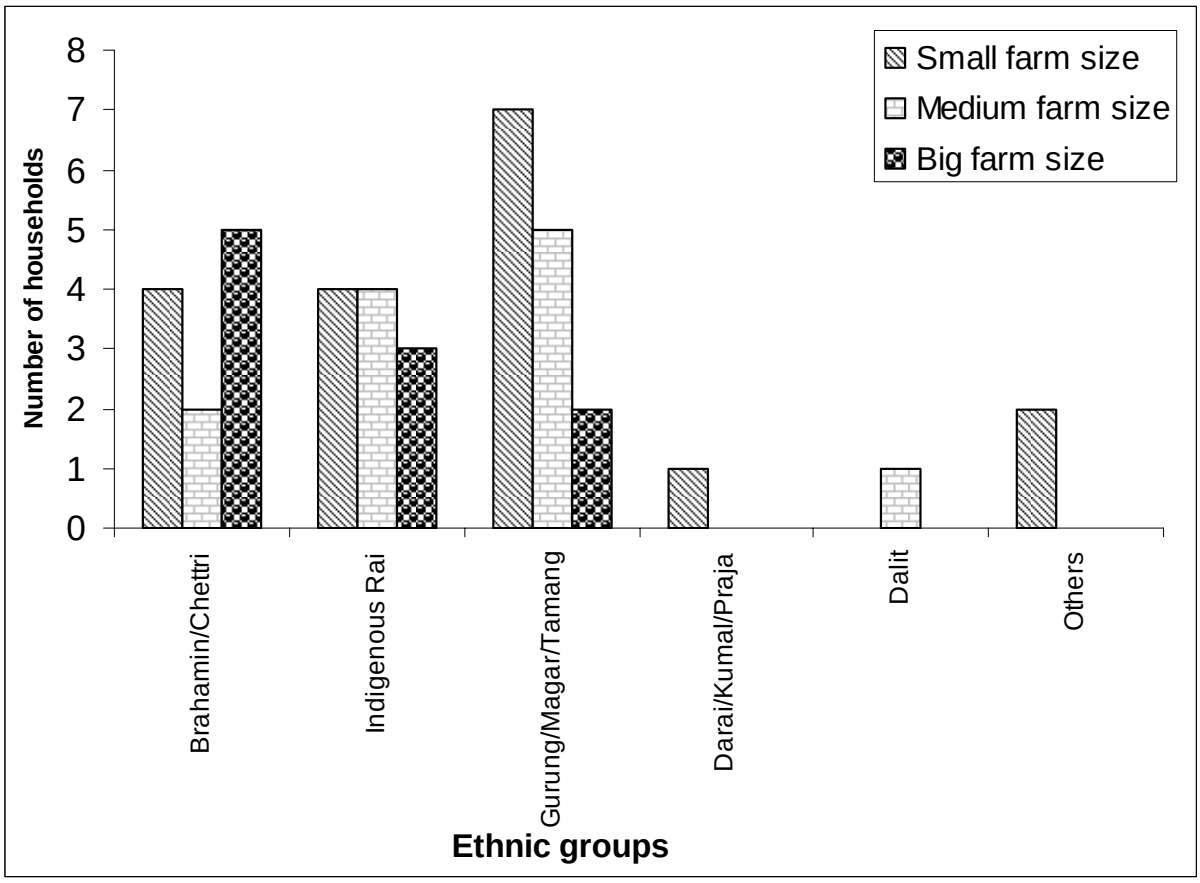


Figure 5.1.2 Households by ethnic groups living within the 500 m from community forest.

5.1.2.5. Residence Period and Ethnicity

The early settlers who are living more than 20 years comprise 69.3 %. Middle settlers and later settlers comprises of 16.9 % and 13.9 % respectively (Table 5.1.7)

Table 5.1.7 Distribution of Households by settlement period

Category of Settlers	Scale(Years)	Number of HH	Percentage of HH
Late Settlers	up to 10	9	13.9
Middle Settlers	> 11 - <= 20	11	16.9
Early Settlers	>21 <=30	12	18.5
Early Settlers	>31	33	50.8

The residence of household based on ethnic groups is presented in Figure 5.1.3. Most of the Brahmin/ Chettri and Rai ethnic groups were the early settler's. Most of the Grung/Magar/Tamang ethnic groups were late settlers in the village.

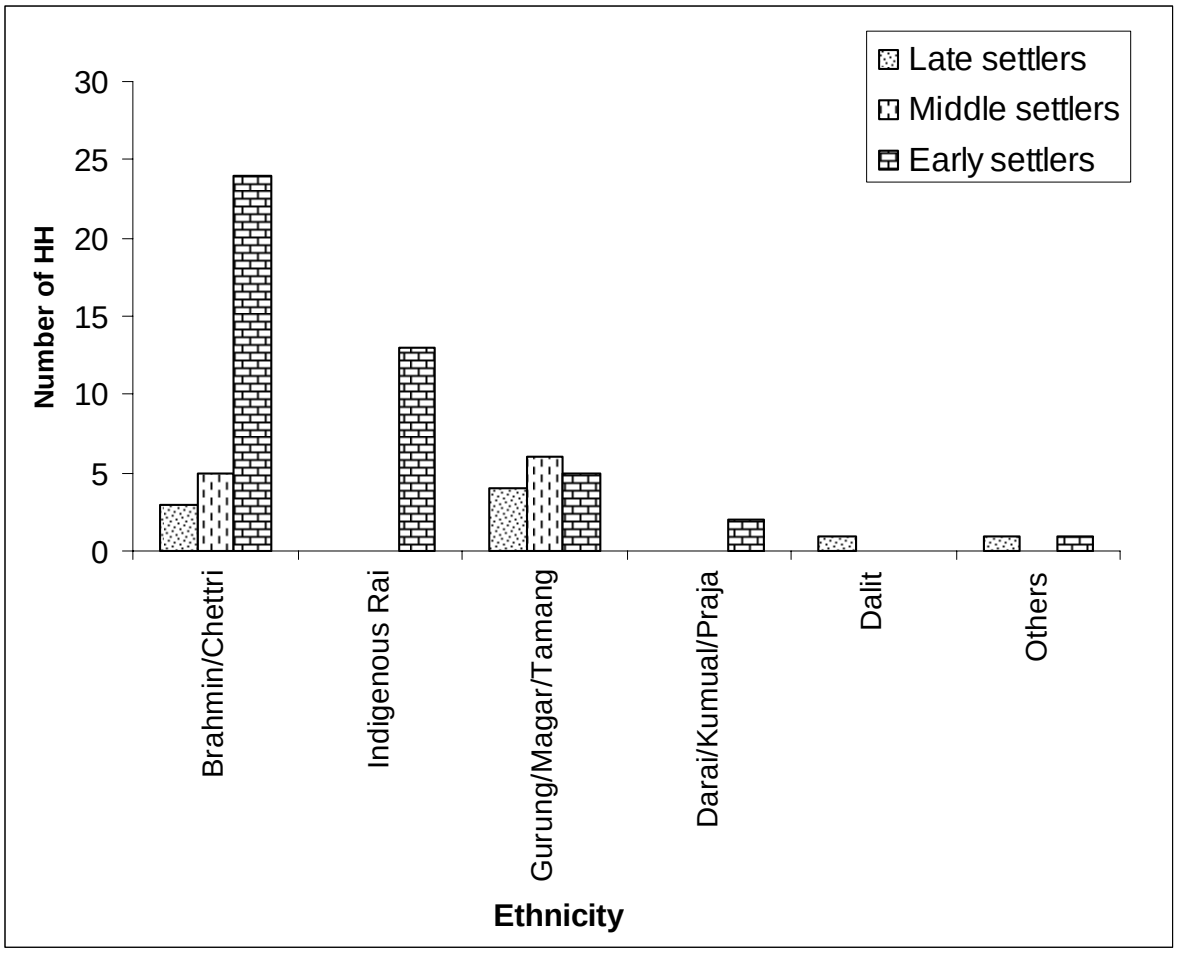


Figure 5.1.3 Residence status of different ethnic groups

Based on these residence categories, the selected characteristic of household is presented in Table 5.1.8. It was noted that those respondents who have settled early had generally large farm size, high net income, high fuelwood consumption and were willingness to adapt technology but low livestock's holding and low fodder consumptions. The respondents who were settled lately had small farm size, low fuel wood consumption, low net income but high livestock's and high fodder consumption and were not adapting the alternative energy technology.

Table 5.1.8 Characteristics of households by residence period

Variables	Settlers Category (n=65)		
	Late (n=9)	Middle (n=11)	Early (n=45)
Residence Period (Year)	7.2	16.1	47.6
Farm size (ha)	0.3	0.5	0.9
Livestock Unit (LSU)	4.5	4.1	3.7
Fuel wood consumption (Kg/yr)	3371.1	2804.1	3396.9
Fodder consumption (Kg/yr)	25377.8	17238.6	19543.9
Biogas installation (Number)	0.0	0.2	0.1
Net income (Rs/yr)	4663.3	41066.8	61473.1

Late Settlers = Living less than 10 years
Middle Settlers= Living more than 10 years but less or equal to 30 years
Early Settlers= Living more than 30 years

5.1.2 Household economy

5.1.3.1 Farm Size

There were 38.5 % of household with small farm, 24.6 % of the household with medium farm, 32.3 % of household with big farm and 4.6 % of household with very big farm (Table 5.1.9).

Table 5.1.9 Distribution of households by farm size

Categories	Scale	Scale (in ha)	Number of HH	Percentage of HH
Small farm	0-10 kattha	0-0.3	25	38.5
Medium farm	11-20 kattha	0.31-0.6	16	24.6
Big farm	1- 4 Bigha	0.61-2.4	21	32.3
Very Big farm	> 4 Bigha	> 2.4	3	4.6

Based on this category, there was significant variation in the general characteristics of household (Table 5.1.10). The residence period, family size, livestock unit, registered land, paddy production, biogas installation and household net income of small farm land households was less than that of household with big and very big farm. However, household with small farm need more fodder and fuel wood from the national park but however their

total fodder consumption was low and total fuel wood consumption was high compared to households with medium, big and very big farm land.

Table 5.1.10 General Characteristics of households by farmland size

Variables	Category of farmland				
	Small (n=25)	Medium (n=16)	Big (n=21)	Very Big (n=3)	Average (n=65)
Residence period (Years)	29.0	40.7	37.7	72.0	36.7
Family size (Number)	5.8	7.4	8.0	8.3	7.0
Farm size (ha)	6.9	15.7	37.6	120.0	24.2
Livestock unit (LU)	3.1	3.3	5.2	5.1	3.9
Registered land (ha)	0.1	0.3	1.0	3.6	0.6
Not Registered land (ha)	0.1	0.2	0.2		0.2
Paddy production (Kg/yr)	1730.0	3837.5	8142.9	19833.3	5156.2
Total Fodder consumption (Kg/yr)	13644.0	16539.1	28161.9	33458.3	19961.5
Fodder consumption NP	16864.3	13127.1	15759.4	-	15375.6
Fuel wood consumption NP (kg/yr)	2612.0	2055.0	1650.7	-	2163.0
Total Fuel wood consumption (Kg/yr)	3808.0	2765.3	3392.4	1120.0	3293.0
Biogas installation (%)	0.0	6.0	29.0	33.0	12.0
Household net income (NRs)	14021.1	28950.0	73750.7	299166.7	50153.7

NP= National Park

5.1.3.2 Farm Production

The overall crop production summary of deficit, balance and surplus status of household is presented in Table 5.1.11. The paddy was produced by 96.92 % of household in which 17.46 % of household were facing annual deficit.

Table 5.1.11 Crops deficit, balance and surplus status of the households

Crops	Deficit		Balance		Surplus		Total	
	N of HH	%	N of HH	%	N of HH	%	N of HH	%
Paddy	11	17.5	13	20.6	39	61.9	63	96.9
Wheat	-	-	6	54.6	5	45.5	11	16.9
Maize	4	8.9	10	22.2	31	68.9	45	69.2
Pulses	10	40.0	13	52.0	2	8.0	25	38.5
Vegetable	30	47.6	27	42.9	6	9.5	63	96.9
Oil seed	8	24.2	12	36.4	13	39.4	33	50.8

The crops production and farm size analysis suggests that households with small farm faced more deficit than other households. Vegetable deficit was more among other crops deficit followed by paddy, maize and pulses. Most of these deficit occurred in household with small farm (Table 5.1.12).

Table 5.1.12 Crops production and land holdings

Crops	State	Land Holding				
		Small farm	Medium farm	Big farm	Very big farm	Total
Paddy	Surplus	5	10	21	3	39
	Balance	9	4	-	-	13
	Deficit	9	2	-	-	11
	Total	23	16	21	3	63
Wheat	Surplus	2	2	1	-	5
	Balance	3	2	1	-	6
	Deficit	-	-	-	-	0
	Total	5	4	2	-	11
Maize	Surplus	8	8	14	1	31
	Balance	7	3		-	10
	Deficit	2	1	1	-	4
	Total	17	12	15	1	45
Pulses	Surplus	1	-	1	-	2
	Balance	4	2	6	1	13
	Deficit	4	2	4	-	10
	Total	9	4	11	1	25
Vegetable	Surplus	1	1	3	1	6
	Balance	10	4	12	1	27
	Deficit	12	11	6	1	30
	Total	23	16	21	3	63
Oil Seed	Surplus	-	3	8	2	13
	Balance	4	2	5	1	12
	Deficit	3	1	1	-	5
	Total	7	6	14	3	30

The deficit of farm production among households is presented in Figure 5.1.13. Households managed their deficits mostly by selling agricultural products (61 %). Few others were wage labor (23 %), services (7 %), business (3 %), skilled wage labor (3 %) and foreign earnings (2 %).

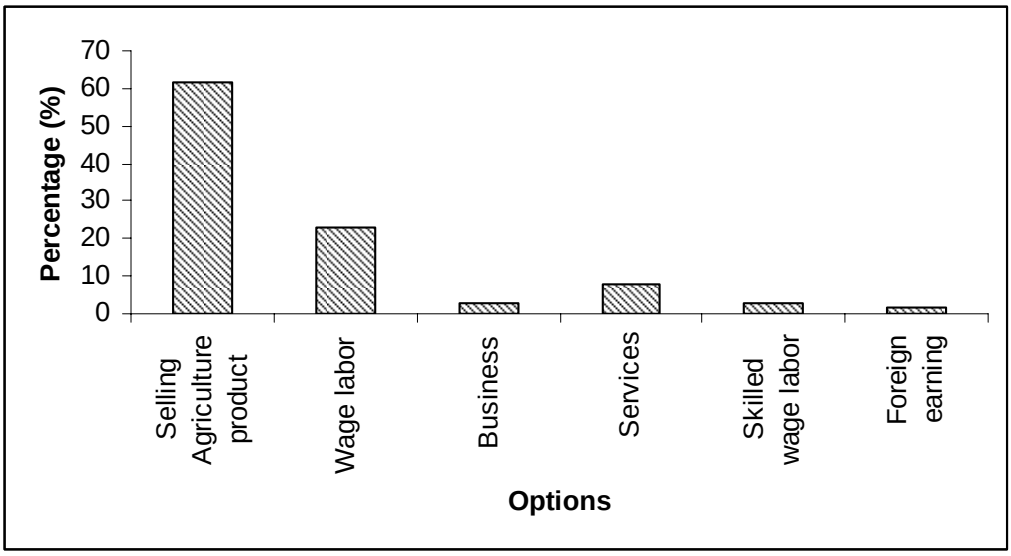


Figure 5.1.4 Household deficit management

Household with small farm manage their deficit mostly from wage labor and by selling agricultural products, where as other farm size household mostly manage their deficit by selling agriculture products (Table 5.1.13).

Table 5.1.13 Deficit management according to land holdings

Land Holding	Deficit Management	N	%
Small farm	Selling Agriculture product	6	24
	Wage labor	13	52
	Business	2	8
	Services	2	8
	Skilled wage labor	1	4
	Remittance	1	4
	Total	25	
Medium farm	Selling Agriculture product	11	68.8
	Wage labor	1	6.3
	Services	3	18.8
	Skilled wage labor	1	6.3
	Total	16	
Big farm	Selling Agriculture product	20	95.2
	Wage labor	1	4.8
	Total	21	
Very big farm	Selling Agriculture product	3	100.00
	Total	3	

5.1.3.3 Livestock Holding

The total livestock unit (LSU) of sampled 65 households was found to be 253.5 (table 5.1.14). The average size of the cattle herd in the study area is small compared to district and national average level of livestocks (Table 5.1.15)

Table 5.1.14 Total livestock unit based on household distribution

Land Holding	N of HH	Mean LSU	Total LSU
Small farm	25	3.05	76.3
Medium farm	16	3.26	52.2
Big farm	21	5.22	109.7
Very big farm	3	5.10	15.3
Total	65	3.90	253.5

The households having small farm size own 30.1 % of livestock's with the mean LSU of 3.05. The medium farm households own 20.5 % of livestocks with the mean LSU of 3.26. The big farm households own 43.2 % of livestock with the mean LSU of 5.2 and very big

farm households own 6 % of livestock's with the mean LSU of 5.1 %. This suggests that rich people own very high numbers of livestock's compared to poor people.

Table 5.1.15 Average livestock holding in Nepal

Livestock type	Field Study Average (2006)	District average (1991)*	National Average 1991)**	National Average (1996)***
Cattle	2.3	3.2	3.5	3.3
Buffalo	3.1	2.9	2.3	2.2
Goat	2.1	3.4	3.9	4.1
Total livestock unit	7.2	9.5	9.7	9.6

Note
* CBS (1991),Nepal
** CBS (1991),Nepal
*** CBS (1996),Nepal

Only 41 % of household own cattle in their household and out of this most of the small farm household and big farm household owned 33 % and 44 % of the cattle respectively (Figure 5.1.5). The Buffalo were owned by 70 % of household, out of which small, medium and big farm size households owned 28.2 %, 26 % and 39.1 % of buffalos respectively. Goats were owned by 38 % of households in which small farm and a big farm size household owes 36 % and 48 % of the goat respectively in their household.

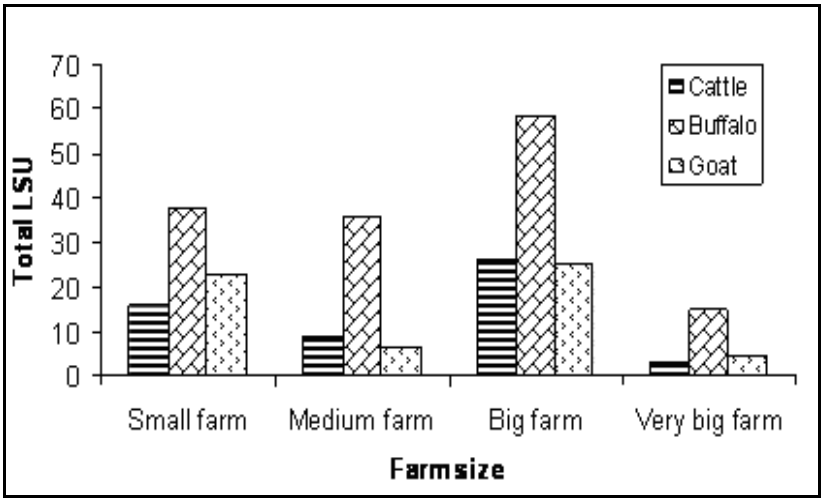


Figure 5.1.5 Livestock holding according to land holdings

In average, 67.6 % of household livestocks in the study area were stall fed, 2 % of livestock were grazed and 30.4 % of livestocks were both grazed and stall fed (Table 5.1.16).

Table 5.1.16 Distribution of households by livestock and feeding types

	Household's Livestock Feeding Types					
	Stall Feed		Grazing		Both	
	HH Number	Livestock Number	HH Number	Livestock Number	HH Number	Livestock Number
Cow	17	33	2	5	8	16
Buffalo	35	74	-	-	11	24
Goat	18	62	-	-	7	36

5.1.3.4. Household resources dependency

5.1.3.4.1 Fodder consumption

The household fodder consumption was mainly from four sources namely Buffer zone community forest, National Park, own land (private land) and other community forests outside buffer zone. The annual fodder consumption by household and their sources is presented in table 5.1.17. The annual consumption of fodder by sampled household was 1297.5 metric ton. Of the total consumption, Buffer zone community forest supply 14.9 % , rest of the demand was managed by other sources like the Park (49.8%), own land (16.9 %), other community forest (14.6 %).

Table 5.1.17: Household Fodder consumption and sources

Sources	Fodder* (Kg/yr)	%
Buffer zone community forest	193025	14.9
National Park	645775	49.8
Own land	219100	16.9
Other community forest	188750	14.6
Total	1297500	

* Green fodder only are taken into account

The livestock per household was greater in big farm households and comparatively less in small farm households. The big farm households had also comparatively higher consumption of green fodder than small farm size households (Table 5.1.18).

Table 5.1.18 Green fodder consumption per live stock unit

Land category	N of HH	LSU/ HH	Fodder consumption (Kg/Yr) / LSU
Small farm	25	3.05	4470.5
Medium farm	16	3.26	5069.4
Big farm	21	5.22	5391.07
Very Big farm	3	5.10	6560.5
Total	65	3.90	5118.34

The overall fodder consumption pattern of households shows that big farm size household consumes more fodder from their own land and community forest outside the buffer zone but less from buffer zone community forest (Table 5.1.19). However, for small and medium farm size households, more fodder was consumed from the National Park and less from the buffer zone community forest and very little from their own land and community forest outside buffer zone.

Table 5.1.19 Household green fodder access

Land Category	Fodder Access								Total Fodder (kg/yr)
	CF		NP		OL		OCF		
	A	%	A	%	A	%	A	%	
Small farm	43225	12.7	236100	69.2	16900	5.0	44875	13.2	341100 (26.2)
Medium farm	54800	20.7	157525	59.5	34800	13.2	17500	6.6	264625 (20.3)
Big farm	81300	13.8	252150	42.6	122400	20.7	94000	15.9	591400 (45.5)
Very big farm	13700	13.7	-	-	45000	44.8	32375	32.3	100375 (7.7)
Total	193025	14.9	645775	49.8	219100	16.9	188750	14.6	1297500

CF= Community Forest, NP = National Park, OL= Own land, OCF= Other community forest, A= Amount (Kg/yr). Amount in parenthesis denotes percentage

Fodder demand of 56 % of the small farm size households was supplied from the National Park and 69.2 % of fodder demands of these farm size categories were supplied by the National Park (Table 5.1.20). 75 % medium and 76.1 % big farm households were dependent on National Park and of their total demand National Park supplies 59.5 % and 42.6 % respectively. However very big farm household were not found using National Park for fodder.

Table 5.1.20 Dependency on National Park for green fodder

Land Category	N of HH			Fodder consumption (kg/yr)		
	NP Fodder	HH sampled	% Dependent	NP	Total	%
Small farm	14	25	56	236100	341100	69.2
Medium farm	12	16	75	157525	264625	59.5
Big farm	16	21	76.2	252150	591400	42.6
Very big farm	-	3	-	-	100375	-
Total	42	65	64.6	645775	1297500	49.8

5.1.3.4.2. Fuelwood consumption

The main sources of households fuelwood were four: namely Buffer zone community forest, National Park, Own land and community forest outside the buffer zone (Table 5.1.21). The annual consumption of fuelwood by sampled household was 2140.45 metric tons. Of this,

buffer zone community forest fulfils only 24.6 % and rest were supplied from National Park (47.5 %), own land (3.2 %) and other community forest outside buffer zone (28.8 %).

Table 5.1.21 Household Fuelwood consumption and sources

Sources	Kg/yr	%
Buffer zone community forest	52600	24.6
National Park	101660	47.5
Own land	6905	3.2
Other community forest	61630	28.8
Total	214045	

The per capita fuel wood consumption was high among the small farm households (Table 5.1.22). Among the very big farms the per capita fuel consumption was less.

Table 5.1.22 Per capita Household Fuelwood consumption

Land Category	Total HH	Total Family Size	Total Fuel wood	FW/HH	FW/person
Small farm	25	144	95200	3808.00	661.1
Medium farm	16	118	44245	2765.31	374.9
Big farm	21	168	71240	3392.38	424.05
Very Big farm	3	25	3360	1120.00	134.4
Total	65	455	214045	3293.00	470.4

FW = Fuel wood, unit Kg/yr, HH= Number of Household

The overall fuelwood supply statistics of households shows that small and medium farm size households were more dependent on the National park and their consumption were supplied less from own land and other community forest (Table 5.1.23). However very big farm size households fuelwoods were supplied mainly from own land and community forest outside buffer zone, were not dependent on buffer zone community forest and the National Park.

Table 5.1.23 Household fuelwood access

Land Category	Fuel wood Access								Total
	CF		NP		OL		OCF		Fuel wood (Kg/yr)
	A	%	A	%	A	%	A	%	
Small farm	21100	22.2	52240	54.9	360	0.4	18940	19.9	95200 (44.4)
Medium farm	15100	34.1	24660	55.7	1565	3.5	13370	30.2	44245 (20.6)
Big farm	16400	23	24760	34.8	3220	4.5	28020	39.3	71240 (33.2)
Very big farm	-	-	-	-	1760	52.4	1300	38.7	3360 (1.5)
Total	52600	24.6	1E+05	47.5	6905	3.2	61630	28.8	214045

CF= Community Forest, NP = National Park, OL= Own land, OCF= Other Community forest, A= Amount (Kg/yr). Amount in parenthesis denotes percentage.

72. 3 % of households were dependent on the National Park for their fuelwood supply. Out of this 80 % belonged to small farm, 75 % to small farm and 71.4 % to big farm households. Of the total fuel wood demand National park supplies 54.9 % of small, 55.7 % of medium and 34.8 % big farm household need (Table 5.1.24).

Table 5.1.24 Dependency on National Park for fuelwood

Land Category	N of HH			Fuel wood Consumption (kg/yr)		
	NP Fuel wood	HH Sampled	% Dependent	NP	Total	%
Small farm	20	25	80	52240	95200	54.9
Medium farm	12	16	75	24660	44245	55.7
Big farm	15	21	71.4	24760	71240	34.8
Very big farm	-	3	-	-	3360	-
Total	47	65	72.3	101660	214045	47.5

5.1.3.5 Household Energy Consumption

Kerosene was used by 81.54 % of the household with mean use of 20.26±2.49 liter per year (Table 5.1.25). Electricity was used by 96.9 % of household with mean use of 320.18±13.14 unit per year. The LPG was used by 21.5 % of household with the mean cylinder use 3.71±0.58 per year. The batteries were used by 38.5 % of household with the mean pair's use 20.08±1.68 per year. The biogas was used by only 12.3 % of household.

Table 5.1.25 Types of energy in use

Energy used	N	%
Kerosene	53	81.5
Electricity	63	96.9
LPG	14	21.5
Batteries	25	38.5
Biogas	8	12.3

The household distribution of energy use types varied with the household farm size (Table 5.1.26). Almost 80 % of all farm size households used kerosene. The electricity was used by more than 95 % households and of these 44 % small, 37.5 % medium and 9.5 % big farm household were using electricity illegally, i.e., by hooking directly from main line without permit. Biogas use was not evenly distributed among the households and only 6.2 % medium, 28.5 % big and 33.3 % very big farm household had biogas plant. None of the small farm households had biogas plant.

Table 5.1.26 Energy use and farm size

Land Holding	N of HH	Kerosene	Electricity	Electricity Theft	Biogas	LPG
Small farm	25	20 (80)	12 (48)	11 (44)		3 (12)
Medium farm	16	14 (87.5)	10 (62.5)	6 (37.5)	1(6.25)	5(31.2)
Big farm	21	17 (80.9)	19 (90.4)	2 (9.5)	6(28.5)	4 (19)
Very big farm	3	2 (66.6)	3		1(33.3)	2(66.6)
Total	65	53	44	19	8	14

The amount in parentheses denotes percentage

The type of energy use among different ethnic group suggests that Brhamin/ Chettri households used all kinds of energy (Table 5.1.27). The percentage use of kerosene, electricity, biogas, LPG, batteries by Brahmin/Chettri households were 78.2 %, 100 %, 25 %, 40.6 % and 50 % respectively. The use of biogas and LPG was mainly found among Brahmin/Chettri households.

Table 5.1.27 Household energy use types according to caste/ethnicity

Ethnicity	N	Kerosene	Electricity	Biogas	LPG	Batteries
Brahmin/ Chettri	32	25 (78.2)	32	8 (25)	13(40.6)	16 (50)
Indigenous Rai	13	12(92.3)	13			4 (30)
Gurung /Magar/ Tamang	15	13(86.6)	14		1(6.6)	3 (20)
Darai/ Kumal/Praja	2		1			1 (50)
Dalit	1	1	1			1
Others	2	2	2			
Total	65	53	63	8	14	25

The amount in parentheses denotes percentage

5.1.3.6. Household net income

Agriculture was main source of income (Figure 5.1.6) and almost 98.46 % of household were dependent on agriculture related occupation (Figure 5.1.28). Beside agriculture, the occupation of small farm size household was unskilled wage labor (77.78 %), skilled labor (36.36 %), Service (11.11 %), business (10 %) and foreign earnings (25 %). However big farm and very big farm population were mainly dependent on business and service related occupation.

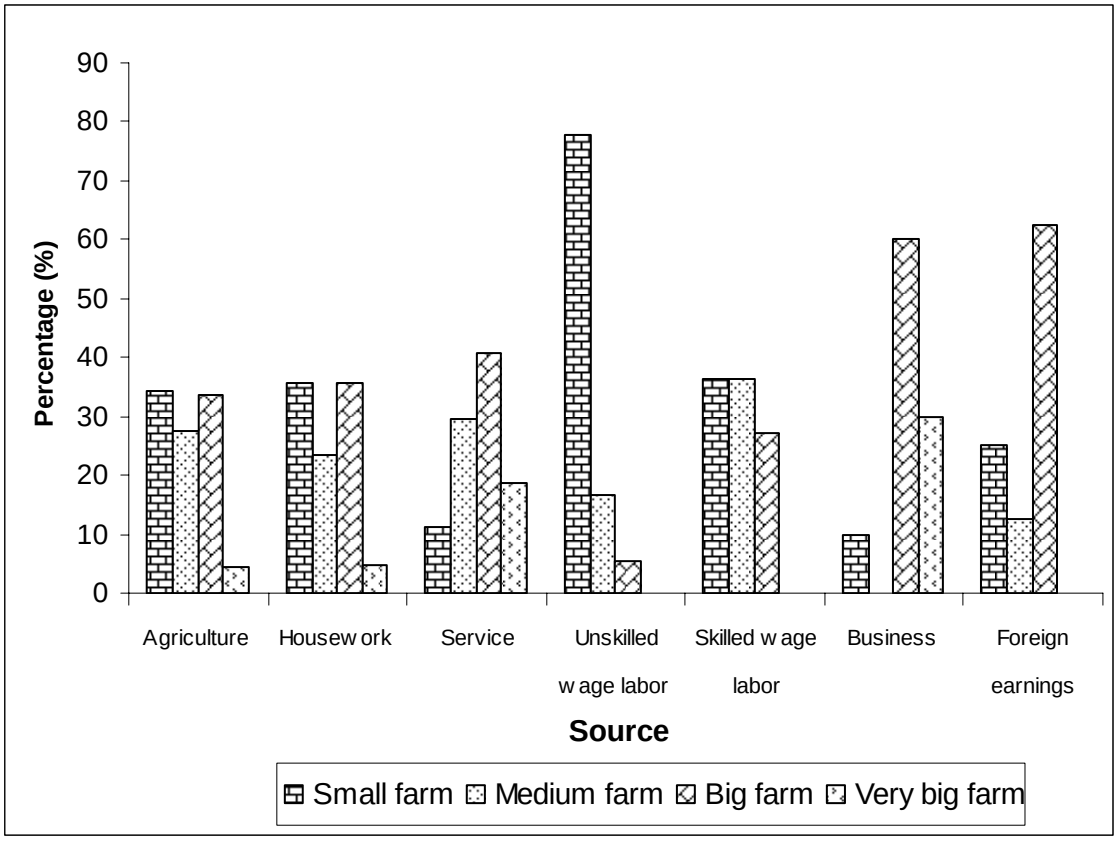


Figure 5.1.6 Distribution of household by source of income

For comparison household were divided into three categories based on their net annual income and their distribution is given in Table 5.1.28

Table 5.1.28 Distribution of number of household in different net income group

	Household net income category*		
	Low (<= 0)	Medium (< = 50000)	High (=>50000)
N of HH	21	25	19
% of HH	32.3	38.5	29.2

* Nepalese Rupee

More than 38 % of the households had medium, 32.3 % households had low and 29.2 % of households had high net income. Other selected characteristics of the different net income households are presented in Table 5.1.29.

Net income influences many aspects of the household. Household size, farm size, livestock unit, land size and ownership, crop production, fodder consumption, fuel wood consumption, biogas plants were found influenced by net income in the study area. Medium to high net

income households had big families, big farm, large livestock unit, large area of registered land and less area of unregistered land, high paddy production, high fodder consumption, low fuelwood requirement and had willingness to adopt alternative energy sources. However low income households had just reverse situation. The households living within the 500 m from forest edge is presented in Figure 5.1.7. The analysis of households shows that most of the small farm size households having low income were residing near the forest (Figure 5.1.8).

Table 5.1.29 Average characteristics of Households by net income level

Variables	Category of Net income		
	Low (n=21)	Medium (n=25)	High (n=19)
Residence period (Years)	29.5	35.6	46.1
Family size (Number)	6.2	6.8	8.2
Livestock unit (LSU)	3.3	4.1	4.2
Farm size (ha)	0.4	0.8	1.4
Registered land (ha)	0.2	0.6	1.2
Not registered land (ha)	0.2	0.1	0.2
Paddy production (Kg/yr)	2666.7	5226.0	7815.8
Fodder demand (Kg/yr)	16694.1	19146.0	24646.1
Fodder extraction from NP (Kg/yr)	16296.7	15494.4	13602.8
Fuel wood demand (Kg/yr)	3371.4	3356.8	3122.4
Fuel wood extraction from NP (Kg/yr)	2124.4	1806.7	2809.1
Biogas installation (%)	0.0	24.0	11.0
Household net income (NRs)	-8385.3	21925.0	151997.9

NP= National Park

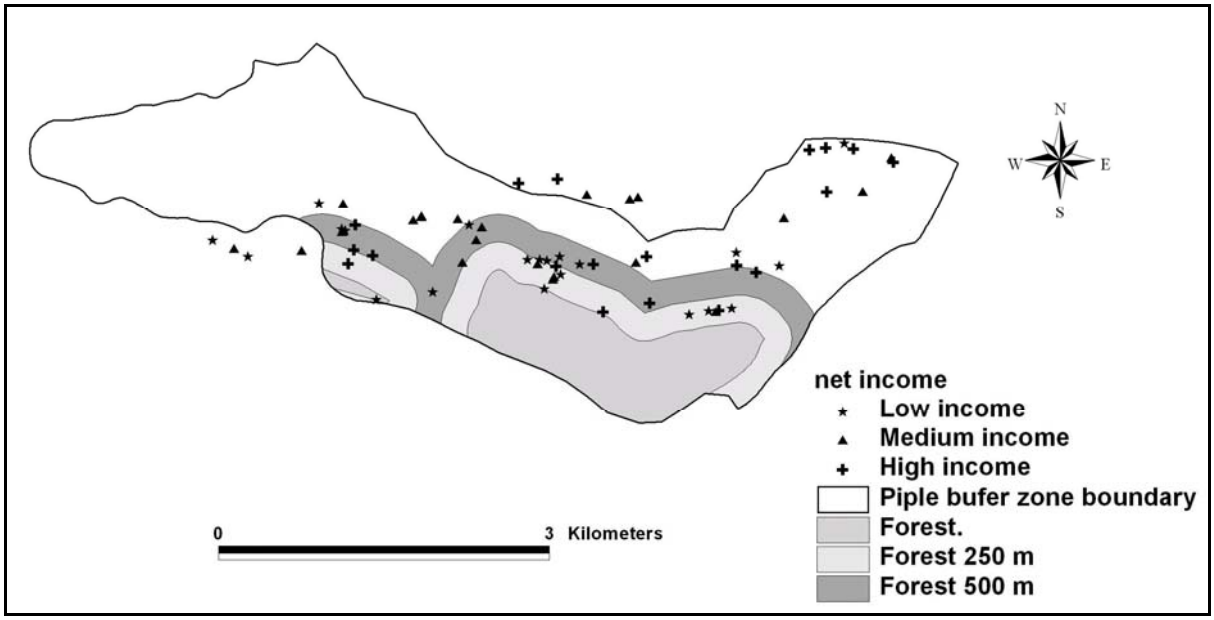


Figure 5.1.7 Distribution of different income households

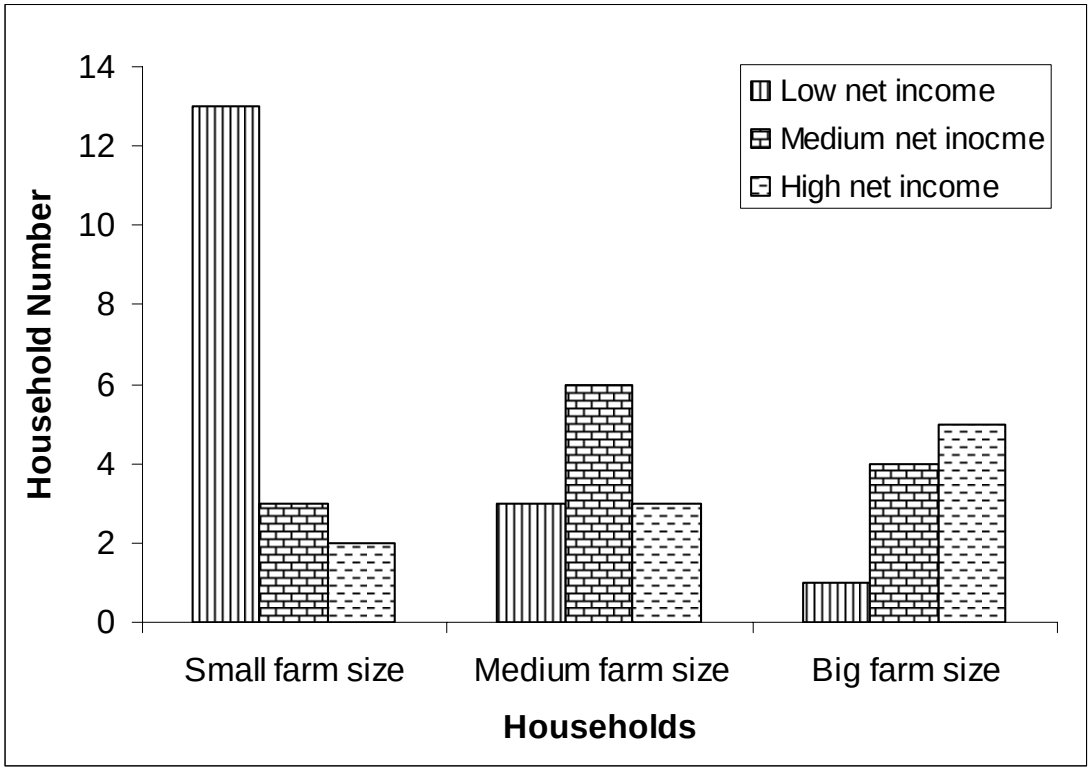


Figure 5.1.8 Households within 500 m from forest boundary according to income

5.2 Landuse pattern in Piple VDC (1978-1992)

The total land occupied by Piple Buffer zone VDC is 11.7 Km^2. Comparison (figure 5.2.1) of areas of the six land cover categories (1978-1992), indicated loss in forest, grassland and river and gain in agricultural land, orchard and lake/pond in Piple Buffer zone VDC (Table 5.2.1).

Table 5.2.1 Land cover change between 1978 and 1992.

Land cover categories	1978 Land Cover (Km^2)	% of land cover 1978	1992 Land Cover (Km^2)	% of land cover 1992	Difference in land cover 1978-1992 (Km2)	Change in cover 1978-1992 (%)
Agriculture land	6.91	59.05	8.99	76.73	2.07	29.96
Forest	2.82	24.11	1.9	16.23	-0.92	-32.7
River	1.53	13.05	0.79	6.76	-0.74	-48.17
Lake/Pond	0	0	0.03	0.23	0.03	2.67
Orchard	0	0	0.01	0.05	0.01	0.58
Grassland	0.44	3.8	0	0	-0.44	-44.46

In between 1978-1992 there was loss of 0.92 Km^2 of forest area and that constitutes the 32.7 % loss in the VDC. Also there was 0.74 Km^2 loss of water bodies and total loss of 0.4 of

grassland. The agricultural land had been increased by 2.07 Km^2 and that constitutes 29.9 % increase. Also there was total gain of lake/pond and orchard by 0.03 and 0.01 Km^2 respectively (Table 5.2.2).

Table 5.2.2 Overview of land cover changes (%) between 1978 and 1992.

Land cover categories	% of land cover in 1978 and unchanged in 1992	% of land cover in 1978 lost to other categories by 1992	% of land cover in 1978 gained from other categories by 1992	Difference in % of land cover lost or gained (1978-1992)
Agriculture	92.33	7.78	37.75	+29.97
Forest	52.12	47.89	15.18	-32.70
River	38.03	61.97	13.80	-48.17
Lake/Pond	0.00	0.00	100.00	+100.00
Orchard	0.00	0.00	100.00	+100.00
Grassland	100.00	100.00	0.00	-100.00

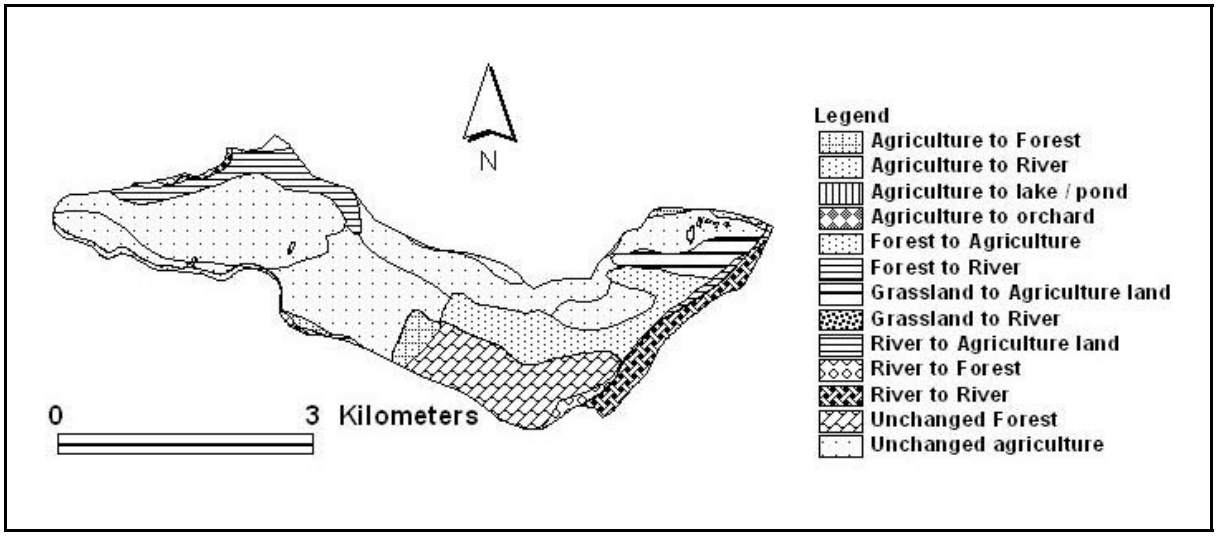


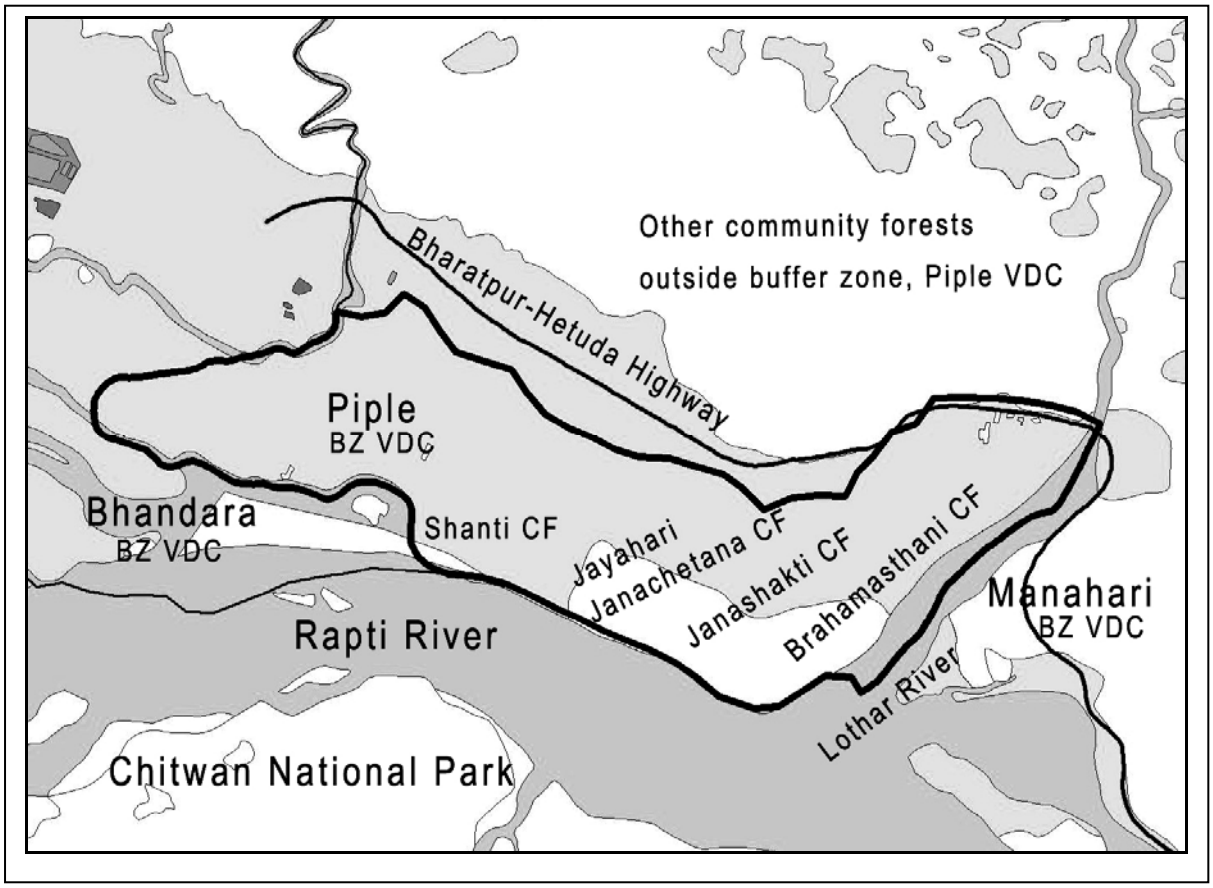
Figure 5.2.1 Land use change of Piple Buffer zone VDC (1978-1992)

5.3 Buffer Zone Community Forest and Management

There are four community forests in Piple buffer zone VDC (Figure 5.3.1). Out of them three buffer zone community forests (245 ha) were together namely Jayahari Janachentana, Janashakti and Brahamasthani and Shanti buffer zone community forest (46 ha) were in the process to submitting their work plan.

The buffer zone forest resources were shared by 842 households from Piple and adjoining buffer zone areas (Table 5.3.1). The forest areas were managed by four buffer zone

community forest (BZCF) and at present the land area was 291[1] ha. The average area per user group households was highest in Jayahari Janchetana whereas lowest in Janashakti buffer



zone community forest user committee (Figure 5.3.2)

Figure 5.3.1 Piple buffer zone VDC

Table 5.3.1 Buffer zone community forest

Buffer zone community forest	Area (ha)	User groups HH	Forest Types
Jayahari Janachetana	59.63	118	Riverine
Shanti	46	120	*Dalbergia sissoo*
Janashakti	91.21	314	Riverine
Brahamsthani	94.99	290	Riverine

Riverine: *Trewia nudiflora, Bombax ceiba, Albiza julibrissin* etc

[1] Data obtained from Piple buffer zone forest user committee. Recent forest area includes some portion of area which was previously (FINIDA map, 1992) in Bhandara BZ VDC.

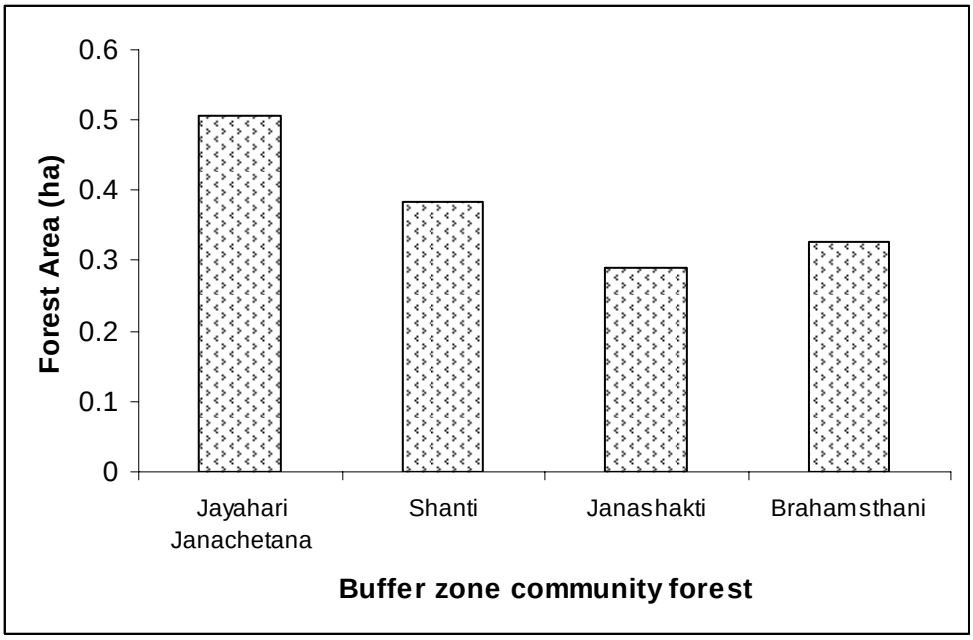


Figure 5.3.2 Average buffer zone community forest area (ha) per households

5.3.1 Buffer zone household member and participation

92 % of the sampled household in the study area were member of buffer zone management and among them 29.2 % had participated in the buffer zone management activities (table 5.3.2). The household buffer zone member and management level participation is presented in Table 5.3.2. Big farm households participation in buffer zone management activities was relatively higher (38 %).

Table 5.3.2 Households buffer zone member and management level participation

landholding	N of HH	BZM		MLP
		Member	Non member	
Small farm	25	24 (96)	1	5 (20)
Medium farm	16	14 (88)	2	5 (31)
Big farm	21	21	-	8 (38)
Very big farm	3	1 (33)	2	1 (33)
Total	65	60 (92)	5	19 (29.2)

BZM = Buffer zone member, MLP= Management level participation

Participation in buffer zone program among ethnic groups (table 5.3.3) shows higher participation from Brahmin/Chettri (63.2 %) and 21.1 % from Rai, 10.5 % from Gurung Magar/Tamang and from Darai/Kumai/Praja 5.3 %.

Table 5.3.3 Management level household participation by ethnic groups

Ethnicity	Farm size	N	% of Total N
Brahmin/Chettri	Small	2	10.5
	Medium	3	15.8
	Big	6	31.6
	Very Big	1	5.3
	Total	12	63.2
Indigenous Rai	Small	1	5.3
	Medium	2	10.5
	Big	1	5.3
	Total	4	21.1
Gurung/Magar/Tamang	Small	1	5.3
	Big	1	5.3
	Total	2	10.5
Darai/Kumal/Praja	Small	1	5.3
	Total	1	5.3

5.3.2 Condition of buffer zone community forest

The household's perception regarding condition of buffer zone community forest in the past and present is presented in Figure 5.3.3. 92.3 % of households responded that the condition of buffer zone community forest in the past was poor. At present only 7.7 % of responded that the condition of buffer zone is poor, 38.4 % of households responded that the condition is satisfactory, 44.6 % responded the condition is good and 9.2 % responded the condition is very good.

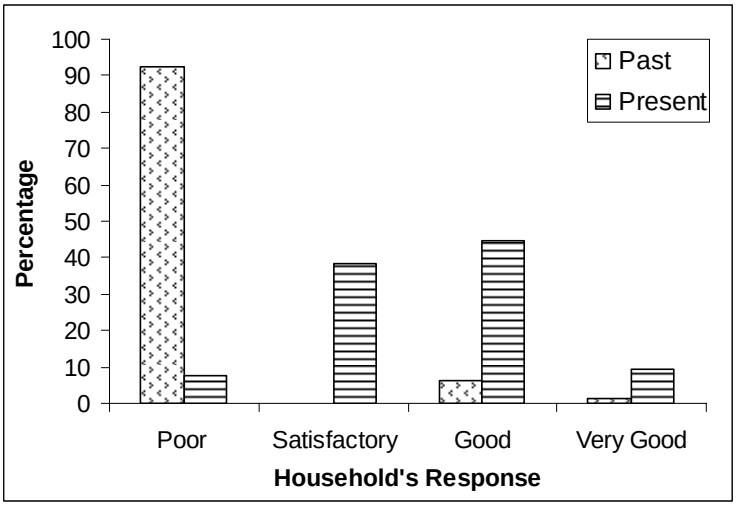


Figure 5.3.3 Household perception on status of buffer zone community forest

The response from management level participants about condition of buffer zone community forest is presented in Table 5.3.4. Among them, 89.5 % feel that the condition of buffer zone community forest was poor in past. At present, 10.5 % feel the condition is poor, 31.5 % feel the condition is satisfactory, 52.6 % feel the condition is good and 5.2 % feel it is very good.

Table 5.3.4 Management level participant response on status of community forest.

Response	Past	Present
Poor	17 (89.5)	2 (10.5)
Satisfactory	2 (10.5)	6 (31.5)
Good	-	10 (52.6)
Very Good	-	1 (5.2)

5.2.3 Resources use from the buffer zone community forest

The resource use from buffer zone community forest is presented in Table 5.3.5. 29.2 % of households were using only fuelwood from buffer zone community forest, 36.9 % households were using fuelwood and fodder, 10.8 % of household were using fuelwood, fodder and timber, and 20 % of household were not using buffer zone community forest (Table 5.3.6).

Table 5.3.5 Use of resources by household from Buffer zone community forest (BZCF)

Resources	N of HH	%
Fuel wood	19	29.2
Fodder	1	1.5
Timber	1	1.5
Fuel wood + Fodder	24	36.9
Fuel wood + Fodder + Timber	7	10.8
No use of BCZF	13	20
Total	65	

Table 5.3.6 Households resources use from BZCF by land holding

Land Holding	RCF	N	%
Small farm	Fuel wood	10	40
	Fuel wood + Fodder	9	36
	Fuel wood + Fodder + Timber	3	12
	No use of BCZF	3	12
Medium farm	Fuel wood	5	31.3
	Timber	1	6.3
	Fuel wood + Fodder	5	31.3
	Fuel wood + Fodder + Timber	3	18.8
	No use of BCZF	2	12.5
Big farm	Fuel wood	4	19
	Fodder	1	4.8
	Fuel wood + Fodder	10	47.6
	Fuel wood + Fodder + Timber	1	4.8
	No use of BCZF	5	23.8
Very big farm	No use of BCZF	3	100

5.3.4 Problem of Community Forest

The result of problems faced by household from the community forest is presented in Table 5.3.7. In response to problems of community forest 32.8 % of household said that resources is insufficient in buffer zone community forest, 17.6 % said area of community forest insufficient and 13.6 % said there is stealing and excessive litter collection from the buffer zone community forest. Others comments were frequent occurrence of wildlife, forest fire, risk of river cutting/flooding, proliferation of invasive species, lack of strong management and lack of awareness program. Among all responses, 5.6 % households were unknown about the problems they face from their community forest and 1.6 % responded that there is no problem at all in buffer zone community forest (Table 5.3.7).

Table 5.3.7 Household responses for problem in community forest

Problem in Community Forest	Frequency Response	%
Insufficient resources in BZCF	41	32.8
Insufficient area	22	17.6
Stealing/ excessive litter collection at CF	17	13.6
Wildlife occurrence	7	5.6
Unknown about problem	7	5.6
Fire blazing	5	4
No fencing	5	4
River cutting/flooding	5	4
Forest Dying due invasive species	5	4
No strong management	5	4
No knowledge about conservation to people	4	3.2
No problem	2	1.6
Total	125	100

5.3.5 **Suggestions for better management of the forest resources**

The results of households suggestion for better management of forest resources is presented in Table 5.3.8. About 15.32 % responses was for more plantation and 12.9 % suggested to enforce strong management team having transparency of management works. Likewise 8.06 % responses were suggests fencing and more security and control over illegal collection, felling and trade of resources from the community forest (Table 5.3.8).

Table 5.3.8 Household suggestions for better management of BZCF

Suggestions for better management of BZCF	Frequency Response	%
More plantation	19	15.3
Enforce strong management team having transparency	16	12.9
No suggestion/Don't know	10	8.1
Fencing/More security	10	8.1
Control on Illegal collection/felling/ trade	10	8.1
Utilization of drift wood	7	5.7
Control of livestock grazing	7	5.7
Alternative skill development promotion for livelihood support	7	5.7
More area for grazing/Community managed use of fodder and fuel wood from the shore of RCNP	6	4.8
Awareness/Education needed	6	4.8
Agro forestry	5	4.0
Better protection measures from Wildlife	4	3.2
Alternative energy promotion	4	3.2
Conservation with utilization	3	2.4
BZ Policy change	3	2.4
BZ population management	3	2.4
Tourism development	2	1.6
Diverting resources use outside BZ	1	0.8
Control on fire blazer	1	0.8
Total	124	100

5.4 Rhino occurrence and conservation

5.4.1 Rhino Movement and crop damage

The rhino movement was very high in the past causing severe crop damage in Piple. But recently the movement has declined and was found time specific. In winter (Nov-March) when wheat and other crops begin inflorescence then rhino visit increase at night to damage the crops. 10-15 rhinos used to visit in the past (10-15 years) and this had declined to 1-3. Around 90.77 % of household said that Rhinos still move in the village. 92.31 % of household said that the Rhino generally damage crop when it arrives in the villages. 56.92 % of sampled household had faced crop damage problems (Table 5.4.1) due to Rhinos in the past and among them 56.7 % households were within the boundary of 500 m from the forest area (Figure 5.4.1).

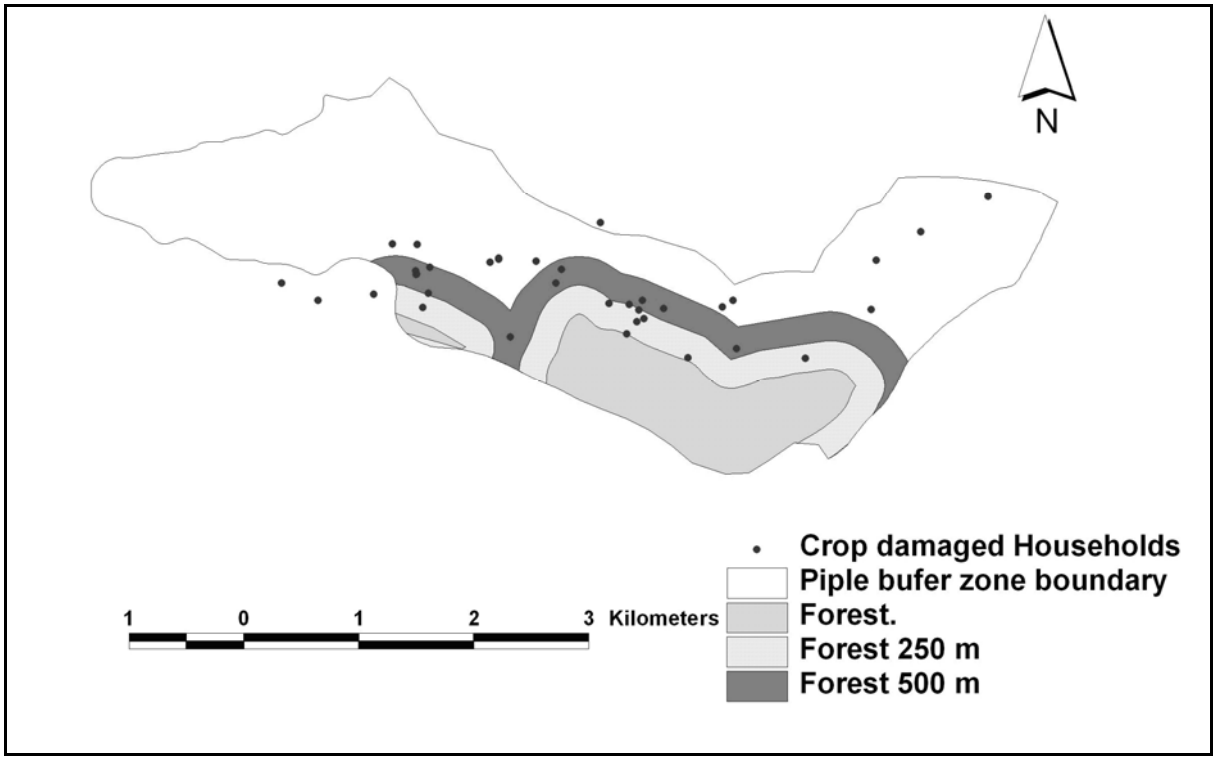


Figure 5.4.1 Rhino crop damaged households in Piple VDC

For the damage done by Rhino only 24 % of household responded that the compensation measures for loss are adequate (Table 5.4.1).

Table 5.4.1 Household crop damage and compensation

Response	Yes	No	% Yes	% No
Household Crop damage by Rhino	37	28	56.92	43.08
Compensation measure adequate	9	56	13.85	86.15

5.4.2 Reasons for Rhino decline

Household responded that the main reasons for Rhino decline in the village was due to poaching and habitat loss (65 %) and other includes fencing and dyke construction (25 %), translocation and natural death (Table 5.4.3). The dyke construction was made due to recurrent flood from Lothar and Rapti River in the eastern and southern boundary of Piple.

Table 5.4.2 Household response for reason for Rhino number decline

Response	Households	%
Poaching	34	40.5
Wire fencing/Dyke	21	25
Poaching + Habitat loss	12	14.3
Unknown	9	10.7
Habitat Loss	6	7.1
Translocation	1	1.2
Natural Death	1	1.2

Household responded that poor people (Table 5.4.3) are more involved in poaching and they were doing this for money (Table 5.4.4). Other respondent's believe that encouragement given to high level poachers, increased value of horn, and easy access to park were the reasons for rhino poaching. However many respondent were either unknown or reluctant to discuss on the main reasons for rhino poaching.

Table 5.4.3 Household response regarding poacher involvement

Response	HH	%
Poor	17	26.2
Rich and Poor	10	15.4
No idea	38	58.5

Table 5.4.4 Household response for reasons for rhino poaching

Response	Frequency	%
Unknown	30	40
For money/employment	18	24
Benefit from low security / Unstable political situation	10	13.3
Encourage from high level poachers	5	6.7
Trade value	5	6.7
Protection for high level poachers..	3	4
Lack of awareness	2	2.7
High income in short period	1	1.3
Easy access to park and forest area	1	1.3

5.4.3 Rhino conservation activities

47.69 % of household were familiar with the activities carried out to conserve rhino by management authorities. There was one Anti poaching unit run by Youth club of Manahari BZ VDC which works under Lothar buffer zone user committees and implements their conservation activities program to raise awareness among local villagers and their field

activities to control poaching. There has also been development works activity like security enhancement and plantation in the buffer zone community forest. However majority of household were not informed about the activities for Rhino conservation (Table 5.4.5). Among the respondents from the survey, 78.46 % stressed that the current activities were not efficient solution for rhino conservation at the present situation.

Table 5.4.5 Activities done by conservation authorities to conserve Rhino

Response	Frequency	%
Unknown	27	34.6
Awareness Program	15	19.2
Ant poaching unit mobilization	12	15.4
security enhancement	9	11.5
Nothing	8	10.3
Skill development trainings	4	5.1
Physical development works	2	2.6
Monitoring	1	1.3

5.4.3 Suggestions

The household's suggestion to control poaching activities is presented in Table 5.4.6. Household suggested that the employment and education opportunities can stop poaching activities. This can divert the attention toward productive works and discourage poaching acts. In addition people believe that law and policy needs to be strict and were complaining much on the current penalty system that is given to wildlife poachers. There were quite a few suggestions for giving more power to anti poaching unit for their surveillance. But still large household response frequency was unknown on the issues of repressing poachers.

Table 5.4.6 Household suggestions to control poaching.

Response	Frequency	%
Unknown	34	41.5
Employment generation	18	21.9
Awareness program for poacher's	9	10
Literacy build up	6	7.3
Alternative job and skill development	4	4.9
Strict law and policy	4	4.9
Security high	3	3.7
Empower Anti poaching unit	2	2.4
Access on resources for livelihood	1	1.2
Good governance	1	1.2

Household also suggested that there should be wide range of social and mental development activities needed to conserve rhino (Table 5.4.7).Conserving rhino became a complicated work due to its failure to reach the target groups. The weak law, policy and management have also in effect produced bad results for rhino conservation. Also the process has not been successful at discouraging the poacher's activities. There were also suggestions for good governance and monitoring.

Table 5.4.7 Household suggestions for activities needed to conserve Rhinos

Response	Frequency	%
Unknown	16	17
Awareness to target group	13	13.8
Habitat management	12	12.8
Community mobilization	11	11.7
Strict law/policy/management	8	8.5
Security strengthen	8	8.5
punishment for high ranking poachers	4	4.3
Empower APU	4	4.3
Policy reform	3	3.2
Removing hotel n concessionaire inside the park	2	2.1
Employment to poor	2	2.1
Monitoring	2	2.1
Good governance	2	2.1
Fencing	2	2.1
Raise literacy among communities	1	1
Proper utilization of BZMC income	1	1
Relocate the household residing nearby forest	1	1
Compensation measures should be high	1	1
Establishment of conservation unit	1	1

5.5. Vegetation status and human interference

There were 91 plant species from 41 families (Annex XI) in the buffer zone community forest of Piple.

5.5.1 Trees species

A total of 13 tree species from 8 families (13 species) were found. The diameter of trees ranges from > 10 to 78.5 cm with a total density of 563.5/ha. The density, frequency, basal area and IVI value of tree species is presented in Table 5.5.1. *Alibizia lucidor* (Steud). IC. Neilson, *Dalbergia sissoo* Roxb. ex DC., and *Trewia nudiflora* L. were relatively dense, frequent and had high basal area compared to other species. Among them the highest density was of *Dalbergia sissoo* (234.6/ha). The highest frequency and basal area was observed in

Albizia lucidor. The important value index was also high for *Alibizia lucidor* followed by *Dalbergia sissoo* and *Trewia nudiflora*

Table 5.5.1 Important value index (IVI) of trees species

Species	D/ha	RD (%)	F (%)	RF (%)	BA m^2/ha	RBA	IVI
Acacia catechu (L.f) Willd.	23.1	4.1	7.7	3.0	0.4	2.2	9.3
Adina cordifolia (Wild. ex Roxb.) Benth. & Hook.f ex Brandis.	1.9	0.3	7.7	3.0	0.0	0.2	3.6
Aegle marmellos L. Corr.	1.9	0.3	7.7	3.0	0.2	0.9	4.2
Alibizia lucidor (Steud). IC. Neilson	140.4	24.9	61.5	24.2	8.4	44.6	93.8
Alstonia scholaris (L.) R. Br.	1.9	0.3	7.7	3.0	0.1	0.3	3.7
Bombax ceiba L.	36.5	6.5	23.1	9.1	1.0	5.4	21.0
Butea monsoperma (Lam.) Kuntze.	1.9	0.3	7.7	3.0	0.1	0.4	3.8
Dalbergia sissoo Roxb. ex DC.	234.6	41.6	38.5	15.2	4.9	26.0	82.8
Dysoxylum gobara (Bich.-Ham.) Merrill	1.9	0.3	7.7	3.0	0.2	0.9	4.2
Ehretia laevis Roxb.	11.5	2.1	15.4	6.1	0.2	0.8	9.0
Holarrhena pubescens (Buch.-Ham.) Wll. ex G. Don.	7.7	1.4	7.7	3.0	0.3	1.6	6.0
Syzygium cerasoides (Roxb.) Raiz.	1.9	0.3	7.7	3.0	0.1	0.3	3.7
Trewia nudiflora L.	98.1	17.4	53.9	21.2	3.1	16.4	55.0
Total	563.5	100.0	253.9	100.0	9.8	100.0	300.0

D= Density, RD= Relative Density, F= Frequency, RF=Relative Frequency, BA= Basal Area, RBA=Basal Area Ratio, IVI =Important Value Index, ha= hectare

From the stand size classification (Table 5.5.2) of observed trees there were high percentages of poles (63.1 %) in the sampled plot. Timber size stand only contributes quite a few in total trees and even less than sapling.

Table 5.5.2 Stand size classification of trees

Stand Size	Dbh Class (cm)	n	Percentage
Sapling	< = 12.5 cm	67	22.9
Poles	>12.5 -<=25	185	63.1
Small Saw Timber	>25 - < =50	33	11.3
Large Saw Timber	>50	8	2.7
N		293	

There were 56.3 % of trees which were less than 10 m height and 36.2 % of trees were in between 10-20 m of height. Rests of the trees were more than 20 m height (Table 5.5.3).

Table 5.5.3 Height class classification of trees

Height Class (m)	Number	Percentage
<10	165	56.3
11-20	106	36.2
21-30	19	6.5
31-40	2	0.7
>40	1	0.3
N	293	

5.5.2. Shrubs

A total of 4894 individual species from 32 different plant families were found in the shrub plot. The density and frequency of shrub species is presented in Table 5.5.4. *Urtica dioica* L., *Mikania micarantha* Kunth., *Clerodendrum viscosum* Vent., and *Pogostemon glaber* Benth., were relatively dense and most frequent species. The total density of species in shrub plot was 75292.31/ha. Among them, the highest individual density was observed in *Urtica dioica* (20723.08/ha) and the frequency of occurrence was highest in *Mikania micarantha* (65.38).

Table 5.5.4 Density and Frequency of species in shrub plot

Species	D	RD	F	R.F
Acacia catechu (L.f) Willd.	30.8	0.0	3.9	0.4
Acacia pennata (L.) Willd.	107.7	0.1	15.4	1.6
Acacia rugata (Lam.) Voigt.	153.9	0.2	3.9	0.4
Achyranthes aspera L.	830.8	1.1	30.8	3.2
Aegle marmellos L. Corr	30.8	0.0	3.9	0.4
Ajuga macrosperma Wall. ex Benth.	46.2	0.1	3.9	0.4
Alibizia lucidor (Steud). IC. Neilson.	892.3	1.2	42.3	4.4
Alstonia scholaris (L.) R. Br.	46.2	0.1	3.9	0.4
Boehmeria ternifolia D. Don.	1615.4	2.2	23.1	2.4
Bombax ceiba L.	15.4	0.0	3.9	0.4
Bridelia sclerophyla	46.2	0.1	3.9	0.4
Butea monsoperma (Lam.) Kuntze.	61.5	0.1	7.7	0.8
Callicarpa macrophylla Vahl.	353.9	0.5	11.5	1.2
Calotropis gigantea (L.) Dryand.	46.2	0.1	3.9	0.4
Casearia elliptica Willd.	15.4	0.0	3.9	0.4
Chenopodium sps	169.2	0.2	19.2	2.0
Cissampelos pareira L.	292.3	0.4	23.1	2.4
Cissus javana DC.	230.8	0.3	7.7	0.8
Cissus repens Lam.	1861.5	2.5	23.1	2.4
Clematis grata Wall.	353.9	0.5	3.9	0.4
Clerodendrum viscosum Vent.	6400.0	8.5	61.5	6.4
Colebrookea oppositifolia Sm.	3338.5	4.4	50.0	5.2
Dalbergia sissoo Roxb. ex DC.	523.1	0.7	15.4	1.6
Ehretia laevis Roxb.	523.1	0.7	15.4	1.6
Eupatorium adenophorum Spreng.	92.3	0.1	3.9	0.4
Eupatorium odoratum L.	4261.5	5.7	38.5	4.0
Urena lobata L.	15.4	0.0	3.9	0.4
Ficus sps	169.2	0.2	7.7	0.8
Ficus hederaceae Roxb.	215.4	0.3	7.7	0.8
Flemingia macrophylla (Wild.) Merr.	15.4	0.0	3.9	0.4
Hedytois scandens Roxb.	184.6	0.3	19.2	2.0
Holarrhena pubescens (Buch.-Ham.) Wll. ex G. Don.	46.2	0.1	3.9	0.4
Ipomea sps	230.8	0.3	3.9	0.4
Ipomea sps I	338.5	0.5	7.7	0.8
Labiateae (Mirre)	15.4	0.0	3.9	0.4
Lantana camara L.	569.2	0.8	15.4	1.6
Dysoxylum gobara (Bich.-Ham.) Merrill	92.3	0.1	11.5	1.2

Miliusa velutina (Dunal) Hook. f. & Thomson.	61.5	0.1	3.9	0.4
Mikania micarantha Kunth.	11246.2	14.9	65.4	6.8
Miliusa tomentosa (Roxb.) Sinclair.	15.4	0.0	3.9	0.4
Mimosa pudica L.	492.3	0.7	3.9	0.4
Morus serrata Roxb.	15.4	0.0	3.9	0.4
Murrya Koenigii (L.) Spreng.	3923.1	5.2	53.9	5.6
Natsiatum herpeticum Buch.-Ham. ex Arn.	76.9	0.1	3.9	0.4
Piper longum L.	261.5	0.4	11.5	1.2
Pogostemon glaber Benth.	5630.8	7.5	50.0	5.2
Porona sps	492.3	0.7	11.5	1.2
Potentilla fulgens var. intermedia Hook. f.	107.7	0.1	7.7	0.8
Premna integrifolia (L.) Willd.	123.1	0.2	3.9	0.4
Rauvolifa serpentiana (L.) Benth. ex Kurz.	46.2	0.1	3.9	0.4
Sida acuta Burm.f	876.9	1.2	7.7	0.8
Sida cordifolia L.	276.9	0.4	26.9	2.8
Solanum erianthum D.Don	676.9	0.9	26.9	2.8
Solanum torvum Sw.	61.5	0.1	3.9	0.4
Solanum xanthocarpum Schrad. & J.C. Wendl	4646.2	6.2	15.4	1.6
Stephania elegans Hook. f.& Thomson	276.9	0.4	19.2	2.0
Syzgium cumini(L.) Skeels	15.4	0.0	3.9	0.4
Tinospora sinensis (Lour.) Merr.	384.6	0.5	7.7	0.8
Trewia nudiflora L.	307.7	0.4	42.3	4.4
Triumfetta pilosa Roth.	61.5	0.1	3.9	0.4
Uncaria sps	76.9	0.1	7.7	0.8
Urtica dioica L.	20723.1	27.5	42.3	4.4
Vallaris solanacea (Roth.)Kuntze.	15.4	0.0	3.9	0.4
Wallichia densiflora Mart.	46.2	0.1	3.9	0.4
Wendlandia puberula DC.	15.4	0.0	3.9	0.4
Woodfordia fruticosa (L.) Kurz.	107.7	0.1	3.9	0.4
Total	75292.3		965.4	100

D= Density, RD=Relative Density, F=Frequency, RF=Relative Frequency

5.5.3 Ground vegetation

A total of 2450 individuals from 20 different plant families were found in the herb plot. The density and frequency of ground vegetation is presented in Table 5.5.5. *Oplismenus burmanii* (Retz.) P. Beauv., *Desmostachys bipinnata* (L.) Stapf., *Dryopteris sparsa* (D.Don) Kuntz., and *Carex sps* were the most dense species and most frequent were *Oplismenus burmanii*, *Cyanodon dactylon* (L.) Pers., *Ageratum conyzoides* L., *Equisetum* sps, and *Oxalis corniculata* L. compared to other observed species. The total density of herb was 960384.6/ha. Among them, *Oplismenus burmanii* have highest density (478846.2/ha) and frequency (30.8).

Table 5.5.5 Density and Frequency of species in herb plot

Species	D	RD	F	R.F
Achyranthes aspera L.	2692.3	0.3	11.5	4.0
Ageratum conyzoides L.	18846.2	2.0	15.4	5.3
Boehmeria ternifolia D. Don.	2307.7	0.2	7.7	2.6
Carex sps	53846.2	5.6	15.4	5.3
Chenopodium sps	769.2	0.1	7.7	2.6
Cissampelos pareira L.	384.6	0.0	3.9	1.3
Commelina sps	3461.5	0.4	3.9	1.3
Compositae	4230.8	0.4	7.7	2.6
Croton bonplandianus Baill.	9615.4	1.0	11.5	4.0
Cyanodon dactylon (L.) Pers.	36538.5	3.8	23.1	7.9
Cyperus platistylis R.Br.	2307.7	0.2	7.7	2.6
Desmostachys bipinnata (L.) Stapf.	88461.5	9.2	3.9	1.3
Digitaria ciliaris (Retz.) Koeler	8076.9	0.8	7.7	2.6
Dryopteris cochleata (D.Don) C.Chr.	45384.6	4.7	7.7	2.6
Drypoteris sparsa (D.Don) Kuntz.	58461.5	6.1	7.7	2.6
Duchesnea indica (Andrews) Focke.	1923.1	0.2	3.9	1.3
Equisetum sps	32307.7	3.4	15.4	5.3
Gonostegia sps	769.2	0.1	3.9	1.3
Lippia nodiflora (L.) Rich *Phylla nodiflora* (L.) Rich	1538.5	0.2	7.7	2.6
Justicia procumbens var Simplex (D.Don) R. Yamaz	384.6	0.0	3.9	1.3
Commelina bengalensis L.	769.2	0.1	3.9	1.3
Labiateae (Mirre)	33076.9	3.4	15.4	5.3
Mikania micarantha Kunth.	2692.3	0.3	7.7	2.6
Murrya Koenigii (L.) Spreng.	384.6	0.0	3.9	1.3
Oplismenus contorta	30769.2	3.2	3.9	1.3
Oplsimenus burmanii (Retz.) P. Beauv.	478846.2	49.9	30.8	10.5
Oxalis corniculata L.	22692.3	2.4	15.4	5.3
Persicaria barbata (L.) H. Hara.	769.2	0.1	3.9	1.3
Pogostemon glaber Benth.	5769.2	0.6	11.5	4.0
Saussurea sps	2692.3	0.3	3.9	1.3
Solanum torvum Sw.	769.2	0.1	3.9	1.3
Stephania elegans Hook. f. & Thomson.	769.2	0.1	3.9	1.3
Thelypteris auriculata (J. Sm.) K. Iwats	8076.9	0.8	7.7	2.6
Total	960384.62	100	292.31	100

D=Density, RD=Relative Density, F=Frequency, RF=Relative Frequency

5.5.4 **Regeneration pattern**

The regeneration of 15 species from 8 different families was observed. The density of regenerating species with their height class is presented in Table 5.5.6. The total density of regenerating plant species was 2846.2 /ha. The relative density was higher for <0.99 m height class (62.16 %). The regenerating species above 4 m had very low relative density (7.02 %).

Table 5.5.6 Height class regeneration species status

Height Class	Density(No/ha)	Relative Density (%)
< 0.99	1769.2	62.2
1-2	461.5	16.2
2-4	415.4	14.6
4-6	76.9	2.7
> 6	123	4.3
Total	2846.2	

Among the observed species, the highest density was observed for *Albizia lucidor, Dalbergia sissoo, Ehretia laevis and Trewia nudiflora* (Table 5.5.7). The height class classification of *Alibiza lucidor* and *Dalbergia sissoo* suggests that regeneration species from all height class (<0.99 to >6 m) are distributed in the forest. The density of below ground (<0.99 m) regeneration species was higher (62.2 %) than that of total observed species.

Table 5.5.7 Regeneration density

Species	Density (No/ha) at different height class					Total density (No/ha)
	< 0.99 m	1-2 m	2-4 m	4-6 m	> 6m	
Acacia catechu	-	-	-	-	30.8	30.8
Acacia pennata	46.2	15.4	46.2	-	-	107.7
Acacia rugata	153.9	-	-	-	-	153.9
Aegle marmellos	-	30.8	-	-	-	30.8
Albizia luciodor	661.5	92.3	107.7	15.4	15.4	892.3
Alstonia scholaris	46.2	-	-	-	-	46.2
Bombax ceiba	15.4	-	-	-	-	15.4
Butea monosperma	-	-	15.4	-	46.2	61.5
Dalbergia sissoo	215.4	184.6	76.9	30.8	15.4	523.1
Dysoxylum gobara	-	30.8	46.2	-	-	76.9
Ehretia laevis	492.3	-	30.8	-	-	523.1
Holarrhena pubescens	46.2	-	-	-	-	46.2
Syzgium cuminii	15.4	-	-	-	-	15.4
Trewia nudiflora	76.9	107.7	76.9	30.8	15.4	307.7
Wendlandia puberula	-	-	15.4	-	-	15.4
Total	1769.2	461.5	415.4	76.9	123.1	2846.1

5.5.5 Volume and biomass of tree

The volume and biomass of tree species is presented in Table 5.5.8. The standing volume and total biomass of observed tree species was found to be 42.9 m^3/ha and 49287 kg/ha respectively. *Albizia lucidor, Dalbergia sissoo, Trewia nudiflora Bombax ceiba* and *Acacia catechu* constituted the large percentage of volume and biomass of the forest. *Adina cordifolia, Alstonia scholaris Syzgium cerasoides, Butea monosperma, Ehertia laevis*, and others constituted very small percentage only.

Table 5.5.8 Volume and biomass of tree

Species	Standing Volume (m^3/ha)	Total biomass kg/ha	Total Stem Biomass kg/ha	Total Branch Biomass (Kg/ha	Total leaf biomass (kg/ha)	Total Volume (%)	Total Biomass (%)
Acacia catechu	1.2	1971.2	1163.6	795.9	11.6	2.8	4.0
Adina cordifolia	0.1	77.0	51.0	22.6	3.4	0.2	0.2
Agele marmelos	0.2	240.6	154.4	78.9	7.3	0.5	0.5
Albizia lucidor	17.9	20263.1	12049.4	7642.4	571.3	41.8	41.1
Alstonia scholaris	0.1	87.8	58.6	25.4	3.9	0.2	0.2
Bombax ceiba	2.4	1358.9	893.8	412.3	52.8	5.7	2.8
Butea monosporma	0.1	111.4	73.8	32.7	4.9	0.2	0.2
Dalbergia sissoo	16.3	22101.3	12689.2	9285.2	126.9	37.9	44.8
Dysoxylum gobara	0.2	209.1	134.2	68.6	6.3	0.4	0.4
Ehretia laevis	0.2	259.4	171.9	76.2	11.4	0.6	0.5
Holarrhena pubescens	0.5	578.9	373.7	186.4	18.8	1.2	1.2
Syzygium cerasoides	0.1	106.2	70.4	31.2	4.7	0.2	0.2
Trewia nudiflora	3.6	1922.2	1254.1	596.9	71.2	8.3	3.9
Total	42.9	49,287.1	29,138.0	19,254.6	894.4	100	100

5.5.6. Sustainable resource yield

The sustainable resources yield from the buffer zone forest is presented in Table 5.5.9. The forest can supply 1966.7 kg/ha/yr and 43.2 kg/ha/yr of fuel wood and green fodder. The fuel wood yield for *Dalbergia sissoo, Albizia lucidor, Acacia catechu, Trewia nudiflora,* and *Bombax ceiba* were comparatively higher than other species. The fodder yield for *Albizia lucidior, Dalbergia sissoo, Trewia nudiflora* and *Acacia catechu* were comparatively higher than other species.

Table 5.5.9 Sustainable yield of forest

Species	Stem annual yield (kg/ha/yr)	Branch annual yield (kg/ha/yr)	Leaf annual yield (kg/ha/yr)	Sustainable Fuel wood Yield (kg/ha/yr)	Sustainable Fodder Yield (kg/ha/yr)
Acacia catechu	59.7	40.8	0.6	82.4	0.5
Adina cordifolia	2.5	1.1	0.2	2.9	0.2
Agele marmelos	7.5	3.9	0.4	9.3	0.0
Albizia lucidor	588.0	376.0	30.9	788.2	27.8
Alstonia scholaris	1.2	1.3	0.2	2.1	0.2
Bombax ceiba	20.1	20.3	2.9	33.7	2.6
Butea monosporma	3.6	1.6	0.3	4.2	0.2
Dalbergia sissoo	651.0	476.3	6.9	926.7	6.2
Dysoxylum gobara	6.6	3.4	0.3	8.1	0.3
Ehartia laevis	8.4	3.8	0.6	9.8	0.6
Holarrhena pubescens	18.2	9.2	1.0	22.2	0.9
Syzygium cerasoides	3.4	1.5	0.3	4.0	0.2
Trewia nudiflora	61.2	29.4	3.9	73.3	3.5
Total	1431.5	968.5	48.4	1966.7	43.2

5.5.7 Estimated resource supply and demand

The estimated sustainable resource yield and demand is presented in Table 5.5.10. The estimation of supply and demand situation of the resources from the buffer zone community forest suggests that both fuel wood and fodder was in short supply. Buffer zone population needs 2.6 times more fuel wood and 6.9 times more green fodder than the present supply from buffer zone community forest.

Table 5.5.10 Sustainable supply from buffer zone community forest (BZCF) and resource need in Piple buffer zone.

Forest Area (ha)	291
Stem Yield (t/yr)	416.6
Branch Yield (t/yr)	281.8
Sustainable Fuel wood yield from BZCF (t/yr)	572.3
Estimated Fuel wood Extraction from BZCF (t/yr)	689.6
Total Household Fuel wood Need (t/yr)	2079.2
Deficit Fuel wood (t/yr)	**-1506.9**
Total household green Fodder need (t/yr)	15244.3
Estimated green fodder extraction from BZCF (t/yr)	2137.0
Sustainable green fodder yield from BZCF (t/yr)	473.4
Deficit green fodder (t/yr)	**-14770.8**

5.5.8. Stocking of forest

From the coverage study, the well stocked sampled plot were relatively higher for the trees (69.3 %) (Table 5.5.11). The better stock of trees was found in Shanti buffer zone community forest and there were no poor area within the buffer zone community forest (figure 5.5.1).

Table 5.5.11: Stocking of trees

Stocking	Area (m^2)	%
Poorly Stocked	-	-
Medium	1600	30.7
Well Stocked	3600	69.3

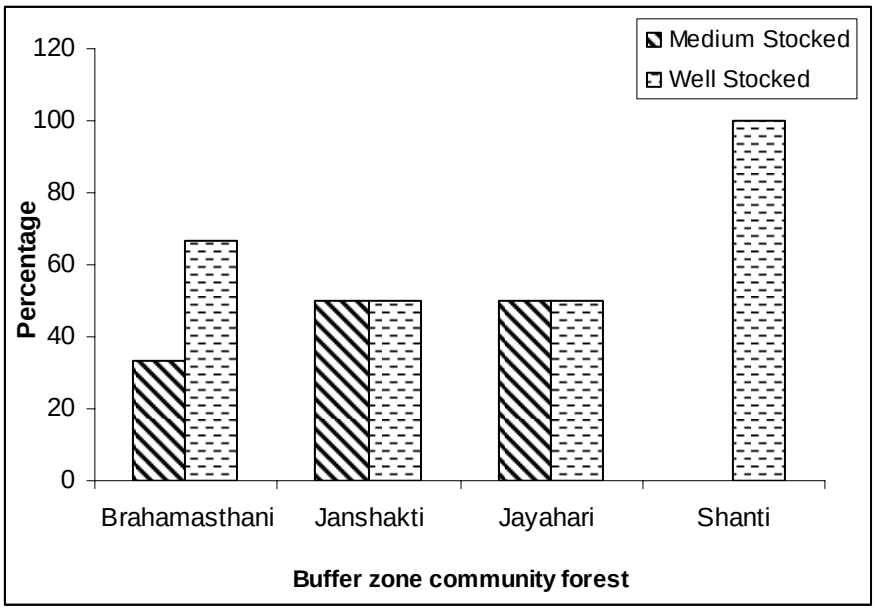


Figure 5.5.1 Percentage of stocking of tree species in a plot by community forest

5.5.8. Anthropogenic pressure on buffer zone community forest

5.5.8.1 Cut stump

A total of six types of woody species were recorded from the study area (Table 5.5.12). The total density of cut stumps was 107.7/ha. *Albizia lucidor* and *Ehretia laevis* were the most common cut stump species having density of 82.7/ha in total. Other less common species were *Dalbergia sissoo* (11.5/ha), *Trewia nudiflora* (7.7/ha), *Dysoxylum gobara* (3.9/ha) and *Bombax ceiba* (1.9/ha).

Table 5.5.12 Percentage of cut stump compared to live tree

Species	Cut stump density (No/Ha)	Live Tree density (No/ha)	Percentage of Cut stump compared to Live tree
Albizia lucidor	48.1	140.4	34.3
Dysoxylum gobara	3.9	1.9	200
Trewia nudiflora	7.7	98.1	7.8
Ehretia laevis	34.6	11.5	300
Dalbergia sissoo	11.5	234.6	4.9
Bombax ceiba	1.9	36.5	5.3
Total	107.7	523.1	

The maximum cut stump was recorded for *Albizia lucidor* (112.5/ha) in Janashakti buffer zone community forest. *Ehretia laevis* (106.5/ha), *Trewia nudiflora* (18.8/ha) and *Dysoxylum gobara* (12.5/ha) were other species recorded from same community forests (Table 5.5.13).

The minimum cut stump was recorded for *Albizia lucidor* (8.3/ha) in Brahamasthani buffer zone community forest.

Table 5.5.13 Comparison of live tree and cut stump by community forest

	Brahamasthani		Jayahari Janachetana		Janashakti		Shanti	
Species	LTD (No/ha)	CSD (No/Ha)	LTD (No/ha)	CSD (No/Ha)	LTD (No/ha)	CSD (No/Ha)	LTD (No/ha)	CSD (No/Ha)
Acacia catechu	100	-	-	-	-	-	-	-
Adina cordifolia	8.3	-	-	-	-	-	-	-
Agelis marmellos	8.3	-	-	-	-	-	-	-
Albizia lucidor	58.3	8.3	400	75	212.5	112.5	-	-
Alstonia scholaris	-	-	-	-	-	-	6.25	-
Bombax ceiba	-	-	-	-	-	-	118.75	6.5
Butea monsoperma	8.33	-	-	-	-	-	-	-
Dalbergia sissoo	116.7	-	-	-	-	-	675	37.5
Dysoxylum gobara	-	-	-	-	6.25	12.5	-	-
Ehretia laevis	-	-	-	-	37.5	106.3	-	6.3
Holarrhena pubescens	33.3	-	-	-	-	-	-	-
Syzygium cerasoides	8.3	-	-	-	-	-	-	-
Trewia nudiflora	166.7	-	87.5	12.5	150	18.8	-	-
Total	508.3	8.33	487.5	87.5	406.5	250	800	50

LTD = Live tree density, CSD = Cut stump density

The density /ha of the cut trees species were higher for the girth class 20-40 cm (Table 5.5.14). The density of species under this class was 75/ha and maximum cut stump was recorded for *Albizia lucidor* (30.8/ha), *Ehretia laevis* (26.9/ha) and *Dalbergia sissoo* (7.7/ha) and minimum density was recorded for *Bombax ceiba* (1.9/ha), *Dysoxylum gobara* (3.9/ha) and *Trewia nudiflora* (3.9/ha).

The girth class classification of cut trees in different buffer zone community forest is presented in Table 5.5.15. The maximum density/ha of species at girth class 20-40 cm were recorded highest (168.8/ha) for *Trewia nudiflora* in Janashakti community forest. Brahamasthani buffer zone community forest had minimum cut trees density (8.3/ha).

Table 5.5.14 Girth classification of cut stump

Species	Density (No/ha) of cut stump by different girth class					Total
	< 20 cm	20-40 cm	41-60 cm	61-80 cm	81-100 cm	
Albizia lucidor	13.5	30.8	3.9	-	-	48.1
Bombax ceiba	-	1.9	-	-	-	1.9
Dalbergia sissoo	-	7.7	3.9	-	-	11.5
Dysoxylum gobara	-	3.9	-	-	-	3.9
Ehretia laevis	1.9	26.9	3.9	1.9	-	34.6
Trewia nudiflora	-	3.9	-	1.9	1.9	7.7
Total	15.4	75	11.5	3.8	1.9	107.7

Table 5.5.15 Girth class classification of cut stump in different buffer zone community forests

Community Forest	Girth class	Density (No/ha)	% of Density
Bramasthani	20-40 cm	8.33	100
Janashakti	< 20 cm	37.5	15
	21-40 cm	168.8	67.5
	41-60 cm	25	10
	61-80 cm	12.5	5
	81-100 cm	6.3	2.5
Jayahari	< 20 cm	12.5	14.3
	21-40 cm	75	85.7
Shanti	< 20 cm	6.3	12.5
	21-40 cm	31.3	62.5
	41-60 cm	12.5	25

5.5.7.2 Lopping

The lopping intensity in buffer zone community forest is presented in Table 5.5.16. The density/ha of lopped trees were maximum (86.1 %) in least and medium class lopping damage. The density/ha of lopped species by lopping intensity is presented in Table 5.5.17. The total density/ha by lopping intensity were recorded highest for *Dalbergia sissoo* (115.3/ha) and *Trewia nudiflora (*57.7/ha) and *Albizia lucidior* (51.9/ha).

Table 5.5.16 Lopping intensity in buffer zone community forest

Lopping damage	Scale	Density/ha
Least	25 % damage	100
Medium	26- 50 % damage	126.9
High	51-75 % damage	19.2
Very High	> 75 % damage	17.3
Total		263.46

Table 5.5.17 Density/ha of lopped species by lopping intensity

	Lopping intensity class				Total density (No/ha)
Species	Least	Medium	High	Very High	
Albizia lucidor	23	21.2	3.9	3.9	51.9
Butea monsoperma	-	1.9	-	-	1.9
Trewia nudiflora	3.9	38.5	5.8	9.6	57.7
Acacia catechu	21.1	1.9		-	23.
Dalbergia sissoo	44.2	57.7	9.6	3.9	115.4
Holarrhena pubescens	1.9	-	-	-	1.9
Adina cordifolia	-	1.9	-	-	1.9
Syzgyium cersasides	1.9	-	-	-	1.9
Ehertia laevis	1.9	3.6	-	-	5.8
Bombax ceiba	1.9	-	-	-	1.9
Total	99.9	126.9	19.2	17.3	263.46

The situation of lopping intensity of trees in buffer zone community forest is presented in Table 5.5.18. Brahamasthani and Shanti buffer zone community forests together accounts for 65.3 % of lopping intensity. *Dalbergia sissoo* and *Trewia nudiflora* were the two most common species lopped maximum in the Brahamasthani (Table 5.5.20) and Shanti (Table 5.5.19) buffer zone community forest

Table 5.5.18 Lopping intensity in different buffer zone community forest (Number of trees/hectare)

Lopping Intensity	Brahamasthani	Janashakti	Jayahari Janachetana	Shanti	Total density (No/ha)
Least	225	75	37.5	62.5	400
Medium	133.3	87.5	75	187.5	483.3
High	8.3	18.7	12.5	31.2	70.8
Very High	-	43.7	-	12.5	56.3
Total	366.6	225	125	293.7	1010.4

In case of Janashakti (Table 5.5.21) and Jayahari janachetana (Table 5.5.22) buffer zone community forests, maximum lopping intensity was recorded for *Albizia lucidor* and *Trewia nudiflora*.

Table 5.2.19 Lopping intensity in Shanti Community forest

Species	Lopping intensity	Density/ha
Dalbergia sissoo	Least	56.2
	Medium	187.5
	High	31.2
	Very High	12.5
Bombax ceiba	Least	6.2

Table 5.5.20 Lopping intensity in Brahamasthani Community forest

Species	Lopping intensity	Density/ha
Albizia lucidor	Medium	16.7
Beuea monsoperma	Medium	8.3
Trewia nudiflora	Medium	91.7
	High	8.3
Acacia catechu	Least	91.7
	Medium	8.33
Dalbergia sissoo	Least	116.7
Adina cordifolia	Medium	8.3
Holarrhena pubescens	Least	8.3
Syzgyium cersasides	Least	8.3

Table 5.5.21 Lopping intensity at Janashakti community forest

Species	Lopping intensity	Density/ha
Albizia lucidor	Least	56.2
	Medium	25
	High	12.5
	Very High	12.5
Trewia nudiflora	Least	12.5
	Medium	50
	High	6.2
	Very High	31.2
Ehrertia leavis	Least	6.2
	Medium	12.5

Table 5.5.22 Lopping intensity at Jayahari Janachetana community forest

Species	Lopping intensity	Density/ha
Albizia lucidor	Least	37.50
	Medium	62.50
Trewia nudiflora	Medium	12.50
	High	12.50

5.5.9 Species diversity in the forest

A plant diversity index of buffer zone community forests is presented in Table 5.5.23 and Figure 5.5.12. In total, the diversity of trees, shrubs and herbs were 1.9, 2.6 and 1.8 respectively. The tree diversity was high in Brahamasthani BZCF, shrub diversity was high in Jayahari janachenta BZCF and herb diversity was high Janashatki BZCF.

Table 5.5.23 Shannon diversity index of the community forest

Shannon's diversity index	S	Ja	Jn	B	Total
Tree	0.5	0.9	1.6	1.9	1.9
Shrub	2	2.4	1.7	2.2	2.6
Herb	1	1.3	1.8	0.6	1.8

S= Shanti BZCF, Ja=Jayahari Janachetana BZCF, Jn=Janashakti BZCF, B= Brahamasthani BZCF, BZCF= Buffer zone community forest

Chapter 6

DISCUSSION

6.1 Household well being

Social advocates contest over three reasons that had influenced the local communities' livelihood by the establishment of the protected areas. First, they argue that only those initiatives focusing on root cause of environmental destruction will in reality lead to successful biodiversity conservation (c.f. Wilkie et al 2006). Second, protected area drags unjustly the property and rights of local people (c.f. Wilkie et al 2006). Third the role of parks in local development has been negligible as the distribution of benefit has always been skewed against poor people (c.f. Wilkie et al 2006).

In this study, the household socio-economics relationship with natural resources extraction had been found to be playing the major role in shaping conservation measure obliged at the buffer zone areas. Buffer zone comprises populations from various ethnic groups and social status having differing well being in the community. Brahamin/chettri's were dominant followed by Rai groups. Brahamin/Chettri's were hill migrants who have settled in study village since 1965 and in average holds more farm lands than others. There are five distinct settlements within the 500 m distance from the forest edge and it encompasses 61 % of the buffer zone households. The household were dominantly from small to medium farm households representing all ethnic groups. Households were predominantly farmers. A few were wage laborers and others were small business and service holders. Having market access to the Bharatpur-Heatuda highway, households have adopted modern farming system by practicing new verities of seeds and there have been a shift from manual tilling to use of tractors. All farmlands had irrigation facilities. Households own an average of 3.9 livestock unit with fodder consumption on an average 5118.34 Kg/yr/LSU. Most of the household were practicing stall feeding to their livestock however few household were grazing their livestock's in buffer zone community forest and even on the banks of the Rapti River. Buffer zone households on an average need 470 kg/person per year of fuel wood. Around 70 % of household had low to medium net income and most of them live inside the distance of 500 m from the forest.

From the analysis of results based on the household land holding, livestock unit per household and green fodder and fuel wood supply options, the household's needs for green fodder and fuel wood has not been supplied sufficiently from buffer zone community forest. Household with big farm required more green fodder as they had comparatively large number of livestock's than those of small farm households. Small farm households were more dependent on fuel wood as they have less access to biogas, electricity, kerosene and liquefied petroleum gas. Though big farm household, usually lives near the Bharatpur-Hetauda highway and away from the buffer zone community forest have options to use their own land and other community forest outside the buffer zone, the bulk of local communities had alternative sources other than CNP, household practically derive all the needed forest produce from the park. The data suggests that 14.88 % and 24.57 % of green fodder and fuel wood is supplied by the buffer zone community forest. In total, household derive 47.49 % fuel wood and 49.77 % of green fodder from the park. An earlier study reported that 37.1 % of fuel wood and 55.5 % of fodder were collected from National Park (DNPWC, 2000).

Box 1 Resettlement, emigration and immigration

The resettlement of households at Piple BZ VDC after 1990's from other VDC after flood event in 1990's had also played major role for conservation as few land are shared by many. Also, in-migration and out-migration are the general phenomena at the buffer zone. As people at no cost settle at the buffer zone and if they get better opportunities then they move away from the place. This kind of situation had played major role in the local landscape conversion for agriculture and household survival. As the majority of these poorer households livelihood have no other options than to extract resources from buffer zone community forest and from the park.

The amount of forest produce supply to support household's livelihood and the amount of land they own play vital role in accelerating environmental degradation at the buffer zone. The pressing needs were evident in the poorer household who dwell near the buffer zone community forest and adjacent park and annually fulfilling their 69.22 % and 80 % of green fodder and fuel wood demand from the park. Also the disputes arise over land ownerships as there were three types of land ownership among the households, which include registered land, not registered land and both. Of these poorer household mostly had unregistered land (See Box 1).

6.2 Land cover change

In year 1978-1992, the land cover of Piple BZ VDC show dramatic loss in forest cover and grassland but for the same period there was an increase in cultivated land. Banskota et al (1997 c.f. KMTNC (1998) has reported that the Piple BZ VDC forest area to be 86 ha. During 2000, the forest and cultivated land ratio in Piple BZ VDC was 3:1 and the forest land was only 277 ha (DNPWC/PPP, 2000). At present there are two patches of riverine forest (291 ha) which have been restored. One small patch (46 ha) of forest managed under Shanti BZCF was planted *Dalbergia sissoo* plantation, is the result of flood in Rapti river during 1993 (Box 2). Another forest patch was mixed hardwood forest (245 ha) managed by other three BZCF user groups committees, which is also adjacent to the bank of Rapti River.

Box 2 Change in Piple Buffer zone map

During field survey there were two patches of forest in the study area. The forest patch in 1978 was originally one and at that time was shared with grassland but coming to 1992 there were two patches but not from the same original patch. At the SW face of the Piple VDC boundary (at the bank of Rapti River) heavy flood in the (1990's) caused change in agricultural area to plantation forest and that brings second patch of forest in Piple Buffer zone VDC. Forest area now is 291 ha. Also after DNPWC/PPP (2000) map at the same region, Piple VDC boundary had been changed (to include Shanti BZ CF) by including some portion of previously Bhandara VDC and by deducting some upper portion of Piple VDC and they have totaled the Piple VDC area now to be 1083 ha, which is less than what we have analyzed for 1978 and 1992 map area (1170 ha).

6.3 Forest management

The average buffer zone community forest area per households was 0.42 ha. The forest resources were shared by 842 households from Piple and adjoining VDC's. All households were the member of buffer zone community forest. At management level the household from Brahmin/Chettri and Rai were seen active than the other ethnic groups. The local communities also admit that the forest have been restored from very poor situations. Even so, the local communities who were bound to protect and use buffer zone community forest were facing several problems like, limitation of resources, stealing and illegal collection, unmanaged fire, open boundary and invasion by unpalatable exotic species. Among villagers conservation was not first priority. Household had no other major suggestions than to have more plantations within the buffer zone community forest land. In addition, they had complains against the buffer zone management team who were not able to provide enough

benefits to locals and in distribution. Moreover, households suggested legalizing drift wood collection from the Rapti River which could help to meet firewood and timber needs.

92 % of sampled household were member of the buffer zone community forest and among them are also members (55 %) of other community forest outside the buffer zone namely. The hilly areas outside the buffer zone of Piple were covered with *Shorea robusta* forest. Most of the buffer zone household's demands for timber tree species were met through these forests as buffer zone community forest were riverine forest composed of Terai mixed hardwood species and *Acacia-Dalbergia* forest. The forest outside buffer zone was helping buffer zone population to meet their needs. This could not remain sustainable forever and other alternatives are required if forest in or outside buffer zone are to be protected. The loss of buffer zone forest could have damaged in wide magnitude and affects tourism, biodiversity, environment and socio economy of locals

6.4 Rhino occurrence, poaching and community conservation

KMTNC (2000) reported occasional sightings of tiger and rhinoceros from the Piple buffer zone community forests. Villagers responded that in recent years, there has been a dramatic decline in the rhino number and movement in the areas. The rhinos generally pay visit to eat wheat and vegetables in the farms. Over 50 % of household living within 500 m from the forest edge reported crops damage by rhinos. Households were not satisfied with the current compensation arrangement as they said compensation is far less than real damage.

The causes of decline were mainly due to poaching, habitat loss and wire fencing/dyke located at the river faced SE boundary of Piple. There had been several poaching incidences in the past. Household were largely unaware and very reluctant to talk on rhino's issues. 41.54 % disclose the poacher's identity from the village while rest of the household did not have any idea about kind of people involved in the poaching. Respondents mentioned that both poor as well rich people are involved in poaching. Most of the household were unaware of activities being carried out in the village to conserve rhinos. People suggested alternative livelihood opportunities, employment incentives and strict penalties to control poaching. The poaching was continuing because local people were losing more than they gain from rhino conservation (PREM, 2005). The weak security, policy and laws, lack of awareness and poverty were the root causes of rhino killing and these suggest need of shift in management to community based wildlife management.

6.5 Vegetation Ecology and Human Interference

The present study identified 91 plant species from 41 families (Annex III) in the buffer zone community forest of Piple. KMTNC (2000) reported 53 plant species from Janashakti, Jayahari and Brahamasthani buffer zone community forest. Also, local people are using 30 species of plants for fire wood, 49 species for fodder and 18 species for medicine. The density per ha of *Dalbergia sissoo* was found to be markedly higher than previous study carried out by Rijal (1994) in buffer zone areas. However, other species like *Acacia catechu* and *Bombax ceiba* show little increase in their density/ha. The present study show higher density/ha of *Acacia catechu, Bombax ceiba and Dalbergia sissoo* compared to density/ha of previous study carried out by Rijal (1994 c.f. KMTNC, 1996) in the buffer zone forest. The IVI values of Albizia lucidor was found to be approximately similar to the previous study carried out in Piple buffer zone community forest by KMTNC (2000). However there has been marked decrease in IVI value of *Trewia nudiflora* and *Acacia catechu* in this study. Only 13.9 % of stands are of timber category and others stand of tree are largely pole size constituting 63.14 % and most of the trees were below 10 m of height. The IVI value for *Trewia nudiflora* was found to be less compared to previous study carried out in same forest (KMTNC, 2000)

A total of 66 different species was reported in shrub study with a total density of 75292.3/ha. Of these the frequency of *Mikania micarantha* was found to be high among other species but KMTNC (2000) study show high frequency of species such as *Urtica dioca, Murrya koenigii, and Colebrookea oppositifolia* and at that time *Mikania micrantha* was not reported from the forest. However locals have argued that after 1990's flood this vine has started colonizing the forest and had been harming to health of the forest and more importantly this vine weed is not palatable to livestock's. Amin et al (2006) have reported that the succession of invasive alien species *Mikania micarantha* along with *Lantana camara* over natural riparian vegetation have increased risk of survival of the endangered Rhino that primarily inhabit the riverine environment.

A total of 33 different species were reported in herb study with a total density of 960384.6/ha. KMTNC (2000) study has shown *Salvia* sp, *oxalis corniculata,* and *Ageratum conyzoides* among others species to be the most frequent herb species. However present study did not report *Salvia* species. In addition species like that household and rhino preferred species such as *Imperata cylindrica* and *Saccharum spontaneum* were not observed during study but

previous KMTNC (2000) study had reported *Imperata cylindrica* only having very low frequency. This could be due to invasion by exotic species like *Mikania micarantha*.

Total density of 15 different regenerating species was 2846.15/ha. Among them the high densities were from below 1 m height calss. The density per ha of regenerating species was observed highest for *Albizia lucidor, Dalbergia sissoo, Trewia nudiflora*, *Ehretia laevis*. The composition of Shanti buffer zone community forest is *Dalbergia sissoo,* a monoculture plantation forest after 1990's flood. Only four regeneration species were reported from Shanti BZCF, all other regeneration species were from other three community forest.

A total standing volume and total biomass of trees was obtained to be 42.88 m^3/ha and 49287.05 kg/ha respectively. The growing stock volume of *Acacia-Dalbergia* forest (17.48 m^3/ha) as well as Terai mixed hardwood forest (25.4 m^3/ha) was less than volume estimated by MFPSN (1988) for Terai, Central Development Region (Annex XII). The biomass of *Acacia-Dalbergia* forest (24.07 ton/ha) and Terai mixed hardwood forest (25.21 ton/ha) was also less than biomass estimated by MFPSN (1988a & 1988b).

Based on potential resources supply and household demand of forest produce from the buffer zone community forest, the status of forest was found to be degraded and subjected to greater harvest. The data suggests that there is annual deficit of 1507 tons/year of fuel wood and 14771 tons/year of green fodder at Piple BZ VDC and these were dependent on other community forest and national park for their traditional dependency of the NTFP's and timber that had was not found in the regenerated buffer zone community forest (Straede et al, 2002)

More than two third of the trees in the forest were well stocked. In general, stocking varies with the area of forest. The well stocking of trees was found higher in plantation within Shanti BZCF compared to other community forest.

The anthropogenic pressure on buffer zone community forest was prominent. The total density of cut stump was 107.69/ha. *Albizia lucidor* and *Ehretia laevis* were the most common cut stump species among other species. The cut stumps were observed in all BZCF. Households fodder and fuel wood need may have fulfilled by this. The density of cut stumps was observed higher in Janashakti BZCF. The density of lopping damage to tree was 263.46/ha. *Dalbergia sissoo, Trewia nudiflora, Albizia lucidor* were the most common species lopped among others. The higher density of lopped species was observed in Brahamasthani BZCF followed by Shanti, Janashakti and Jayahari BZCF.

The diversity index for shrub was highest in the forest compared to trees and herbs. The diversity of tree species was higher in Brahamasthani BZCF. This result differs with KMTNC (2000) reporting as they have recorded higher diversity index of tree and shrub species from Janshakti BZCF.

Chapter 7

CONCLUSION AND RECOMMENDATION

Socioeconomic status of local communities in Piple is the driving force for biodiversity conservation and management of the buffer zone resources. All buffer zone households irrespective of their land holding size need forest produce for fodder and fuelwood. The concept of natural regeneration and rehabilitation of degraded forests as a means to establish forests with a high compatibility with villagers demand have not yet been sustainable despite the restoration to present forest size. As estimates of annual forest yield and household demand for forest products do not match in Piple and deficits are met through park resources and other community forests outside buffer zone. As a result of this, Piple buffer zone community forest was degraded as both tree and leaf biomasses are subjected to greater harvest pressure. The inadequate forest area to supply forest produce to villagers further aggravates the dire situations. In addition, the spread of invasive alien species *Mikania micarantha* poses serious biological threat to community forest health and wildlife habitat.

Villagers were largely unaware about the rhino conservation activities and argued against the inadequate compensation measures for rhino crop damage loss. Villagers also assumed that community forest is not faring well. Although they wished to have their prioritized activities in the community forest management, there was no such plan forthcoming. Therefore, how to cope with forest resource demand is fundamental question to the ecological integrity of Chitwan National Park. Truly, the Piple VDC can not be an example of a functional Buffer Zone. If this is an ongoing trend in other buffer zone VDC, a major up scaling in the buffer zone management is needed. Based on this, few suggestions were made for improvement.

i. Poverty alleviation
ii. Plantation and agro-forestry.
iii. Energy alternatives.
iv. Capability enhancement of local human resources to ensure good governance in buffer zone management and wildlife conservation.
v. Use of socio-ecological data for periodical review of natural resources and for forest and wildlife management planning in Piple.
vi. Annual performance measurement of all buffer zone (35 VDC's and 2 municipalities) to sustain development and conservation.

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ANNEX I

HOUSEHOLD QUESTIONNAIRE SURVEY

RESPONDENT INFORMATION

Respondent Name: Date:
Caste/Ethnic Group: Lat:
Sex: Long
Age (yrs):
Education:
Occupation:
Current Address (VDC/Ward):
Residence Period (Year):
Family Structure: a) Nuclear b) Joint
Name of the data Collector:

Please provide some information of individuals who belong to this household (Begin with the oldest person)

Individual ID (Full Name)	Relation to Respondent	Sex	Age (Yrs)	Marital Status (M/U)	Occupation			Education
					I	II	III	

FARM SIZE AND PRODUCTION

Ownership	Area			Land Type
	Bigha	Kattha	Dhur	
Own				Parti/Ailani
Shared Tenant				Parti/Ailani

1. What type of crop do you grow?

Crop Type		Area			Production		Consumption (Kg)	Surplus (Kg)	Deficit (Kg)	Deficit Period (Month)
		Bigha	Kattha	Dhur	Mann	Kg				
Food Crop	Wheat									
	Paddy									
	Maize									
Pulses										
Cash crop	**Vegetables**									
	Oil seeds									
	Others									

2. How will you manage for the deficit months?
   Buy/Borrow/Barter/Wage lobor /others.....

3. If surplus what do you do with the surplus crops?
   Store /Sale/ others.....

LIVESTOCK'S TYPE AND HOLDINGS

Types of Animals	Numbers	Stall Feeding	Grazing	Both

FOODER/FUELWOOD/TIMBER

Season/ Month	**Fodder**		
	Species	Quantity	Access

Fuel Wood		
Species	Quantity	Access

ALTERNATIVE ENERGY

Fill in the information energy consumption (Record use for the each month, Liter for Kerosene, No. of Cylinder for Gas, Number of Batteries)

Source	Amount	Expenditure	Season	Remark
Kerosene				
Electricity				
Solar				
LP Gas				
Battery				
Other				

4. Do you have biogas plant in your house? Yes/No
5. If Yes,

Installed Date	**Biogas**	
	Capacity (cb.m)	Expenditure

6. Did you receive any support from others while installing Biogas? Yes/No

.....

How much Livestock's are needed to operate your biogas plant

Livestock	Numbers	Fodder requirement

7. If No, why are you not having Biogas plant. Are there any constraints?

.....

.....

8. Do you have any plans to install biogas plant? Yes/No

.....

BUFFERZONE COMMUNITY FOREST

1. Which BZ community forest do you use?
   .....
2. Are you member of User group? Yes/No
3. What is your User Group name?
   .....
4. What is your position in User group: General Member or if any other specify……
5. Any other household member involved in Buffer zone management council, UC, UG?

Date	Buffer zone Management UC/UG	Status	Relation with respondent

6. What type of resources do you bring from your BZCF?
   Fodder/Fuel wood/Timber/All
7. What do you say about your BZ community forest status?
   Very Good/ Good/Satisfactory/ Bad/Very Bad
8. What was the condition of your Buffer zone CF in Past/ Present?
   .....
   .....
   .....
9. What do you think about current management practice of your community forest?
   Very Good/ Good/Satisfactory/ Bad/Very Bad

HOUSEHOLD DEMAND AND MANAGEMENT ISSUES

10. Are available resources from your community forest fulfilling your demand? Yes/No
    If No and if you buy from your CF/ Others CF/Go to RCNP/ how much you need?

Resources	Time	Demand	Amount Paid (Rs)	Access
Fodder (Bhari/Kg)	Daily/Monthly/Weekly/Yearly			
Fuelwood (Bhari/Kg)	Daily/Monthly/Weekly/Yearly			

11. Do you have any idea of resources allocation system in your BZCF? Yes/No
    If yes, on what basis
    Well being/Population/ No. of livestock/Profession/Others.....
    .....
12. Is there any land categorization for different purposes in your BZCF? Yes/No.....

If yes, are there following zone
Pasture land/Recreation zone/Habitat management zone/Fodder zone/Fuel wood zone/ Soil mining zone/others.....

13. Are you happy with distribution and consumption of available resources from your Community Forest? Any problems. Yes/ No
    .....

Any other problems,……..

14. Do you have any suggestions/ recommendations for better management of your CF resources utilization as well as conservation?
    .....
15. What do you think about Budget allocated by RCNP for Buffer zone VDC for management? Is it being spending wisely for conservation as well as development of your area? Yes/No
    .....
16. What kind of programs User committee launched in the past? Did you involve/participate in those programs? Yes/No. If yes what kind of program?
    .....

RHINO RELATED ISSUES

1. Crop Damage caused by Rhino/Wildlife

Wildlife	Crop	Time of Damage				Damage amount/Year in local unit	Compensation Amount (Rs)
		Morning	Day Time	Evening	Night		

2. Livestock Loss by Wild animals

Wildlife	Livestock	Number of Loss	Time in Year and month	Compensation

3. Frequency of Human Loss by wild animals

Wild animal	Date/Time	Killed	Injured	Compensation

4. Are you satisfied with compensation measures for loss made by wildlife? Yes/No
5. If No, what do you think it should be?

   .....

6. How many Rhino you have observed into your area?

Time	Season/Month/Year	Place	Number of Rhino
Past Years			
Recent Years			

7. Do rhino comes every year around your area. Yes/No
8. How do you defense against rhino movement into your area?
   Fence/Trench/ Firing/Shouting/Any other…….
9. What do you know about Rhino movement into your area?
   Increasing/ decreasing/remains the same/No idea
10. If decreasing, do you know why it is happening?
    Natural death/ Killing (Poaching)/Habitat loss/Translocation /Any others……
11. Do you know when and where Rhino were killed?

Date	Place

12. Do you know what types of people are involved in Rhino poaching?
    a)Poor/Medium/Rich b)Educated/Uneducated
13. Do you know any household who have been accused of rhino poaching? Yes/No, If yes

Name	Address	Involved date

14. What do you think, why they are killing the rhino?

    .....

15. Would any opportunities to poachers help stop killing? Yes/No
    If Yes what.....
16. What kind of activities are/ were done by BZCF/BZMC/Park management to stop Rhino poaching?
    .....
17. Do you think existing activities/policies/conservation practices have helped conserve Rhino? Yes/No/No idea

18. If No, What do you think what kind of activities/polices/conservation practices will help conserve rhino?
    .....

ANNUAL INCOME AND EXPENDITURE (OPTIONAL)

1. How much is your annual income in terms of money?

Source	Amount	
	Calculated	Rectified
Agriculture		
Service		
Livestock		
Business		
Tourism		
Off-Farm employment		
Others		
Total		

Remarks.....
.....
.....

2. How much is your annual expenditure in terms of money?

Item	Amount	
	Calculated	Rectified
Education		
Health		
Maintenance		
Agriculture		
Livestock Poultry Maintenance		
Loss of livestock		
Loss of crops		
Total		

Remarks.....
.....

3. Who will help you incase of need for taking loan?
   ……
   ……..
4. From the above two tables the saved amount becomes Rs....., Do you save this much annually? Yes/No

ANNEX II

DISTRIBUITON OF SETTLEMENT BY POPULATION SIZE (Source: DNPWC/PPP, 2000)

Symbol	Settlement	Population
S1	Jitpur	up to 100
S2	Pratapur	up to 100
S3	Piple bazar	up to 100
S4	Prasuani	up to 100
M1	Dubechaur	101- 400
M2	Mahadevtar	101-400
B1	Simara	above 400
B2	Naya Basti	above 400

ANNEX III

SAMPLE SIZE DETERMINATION

The sample size (n) of the household to represent the study area was determined by using formula (Arkin and Colton, 1963; cited in Sharma, A. 2000) at 95 % confidence level.

$$n = \frac{N Z^2 P(1-P)}{Nd^2 + Z^2 P(1-P)}$$

Where, n = sample size

N= total number of households
Z= confidence level (at 95% level z=1.96)
P=estimated population proportion (0.05, this maximize the sample size)
d=error limit of 5% (0.05)

ANNEX IV

SAMPLE SIXE DISTRIBUTION

Ward No	Settlement Name	Household Land holdings				Total
		small farm	Medium farm	Big farm	Very Big farm	
1	Jitpur / Pratapur	4	3	2	0	9
2	Simara	2	1	8	0	11
3	Prasuani	2	1	1	0	4
4	Dubechaur	3	3	5	0	11
5	Piple bazar /Naya Basti	10	7	4	0	21
6	Mahadevtar	4	1	1	3	9
	Total	25	16	21	3	65

ANNEX V

UNIT CONVERSION

	Local unit Un-milled (Muri)	Standard unit (kg)
Paddy	1 =	50
Maize	1 =	60
Wheat	1 =	69
Oil seed	1 =	57

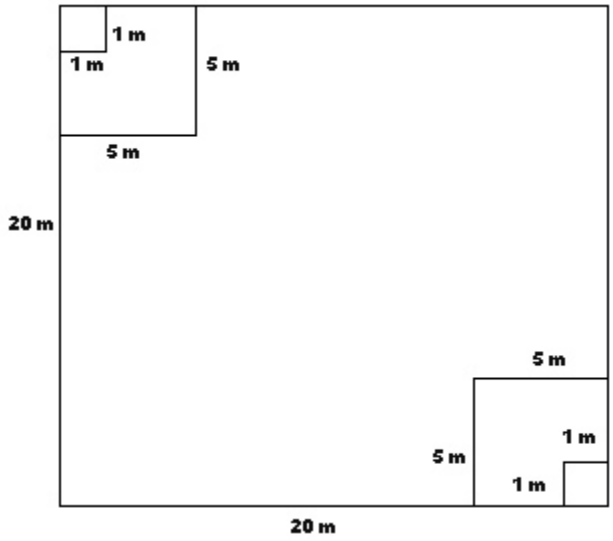
Source: Nepal and Weber, 1993

Local unit	Resource		Standard unit (Kg)
1 Bhari	Fodder	=	50
1 Bhari	Fuelwood	=	40

Source: Nepal and Weber, 1993

ANNEX VI

PLOT DESIGN- NESTED QUADRATE PLOT



ANNEX VII

VOLUME COMPUTATION (FSSD, 1991)

The system estimates for computing the total volume of the whole stem is

$$Ln (V) = a + b \times Ln(d) + c \times Ln (h)$$

Where, Ln refers to logarithm

V = total stem volume with bark

d = Diameter at breast height

h = Total height

a, b and c are the volume parameters, which are constant for each species but different between species.

ANNEX VIII

Date:……
Plot No:……..…..
Method:……...

VEGETATION
TREE SHEET

Lat:……
Long:… …….....
Altitude:……m

Name of the Forest/CF/Buffer zone ……..
Forest Type:…… ……Coverage:……..% Grazing:…… …..%
Interference:……Aspect:…… Status:…….

S/N	Plant Species	Dbh (cm)	Ht. (m)	No	Lp (%)	CS (no)	No. of branch	Remark

Note:……
…….....……

Dbh: Diameter at breast height (1.3 m) **Ht**= Height, **No**= Number, **Lp**= Lopping, **CS**= Cut stump **Tree** = Plant with diameter > 10 cm

ANNEX IX

VEGETATION SURVEY
SHRUB/HERB SHEET

Name of the Forest/CF/Buffer zone ……..
Forest Type:…… ……Coverage:……..% Grazing:…… …..%
Interference:……Aspect:…… Status:……

S/N	Plant Species	Ht. (m)	No	Remark

Note:……
…….....……

Dbh: Diameter at breast height (1.3 m) **Ht**= Height, **No**= Number, **Lp**= Lopping, **CS**= Cut stump **Tree** = Plant with diameter > 10 cm

ANNEX X
HOUSEHOLD LOCATION WITH FARM SIZE

ID	Lat	Long	Farm size	ID	Lat	Long	Farm size
1	27.57567	84.69828	Small	39	27.57984	84.69166	Big
2	27.58241	84.70519	Big	40	27.57588	84.69838	Medium
3	27.58258	84.70597	Big	41	27.58063	84.68613	Big
4	27.57377	84.68211	Small	42	27.57327	84.7133	Medium
5	27.58269	84.70127	Medium	43	27.58672	84.72158	Very Big
6	27.58044	84.68944	Medium	44	27.57302	84.71086	Medium
7	27.57666	84.6795	Big	45	27.5739	84.70722	Big
8	27.58158	84.67672	Medium	46	27.58583	84.72933	Big
9	27.57778	84.67997	Small	47	27.58688	84.72563	Small
10	27.57728	84.67025	Small	48	27.57336	84.71263	Medium
11	27.5795	84.67883	Medium	49	27.57769	84.70683	Big
12	27.57925	84.67889	Medium	50	27.57816	84.71505	Big
13	27.57927	84.67892	Medium	51	27.57712	84.71512	Big
14	27.57925	84.67889	Big	52	27.57716	84.719	Small
15	27.57925	84.67884	Small	53	27.57716	84.70589	Small
16	27.58158	84.67892	Small	54	27.57677	84.69855	Medium
17	27.57983	84.68005	Small	55	27.57358	84.71473	Small
18	27.57762	84.67516	Medium	56	27.57491	84.69752	Small
19	27.57938	84.67912	Small	57	27.57722	84.69769	Small
20	27.57734	84.68172	Big	58	27.57694	84.70072	Small
21	27.57878	84.69119	Big	59	27.57655	84.71692	Small
22	27.57447	84.68727	Small	60	27.57312	84.70294	Medium
23	27.57697	84.70197	Big	61	27.57611	84.699	Small
24	27.58333	84.72325	Very Big	62	27.57756	84.69886	Small
25	27.58692	84.72308	Very Big	63	27.57727	84.69705	Small
26	27.58394	84.69856	Big	64	27.57688	84.69688	Small
27	27.58619	84.72912	Small	65	27.57727	84.69592	Small
28	27.58733	84.72475	Small				
29	27.58102	84.71938	Small				
30	27.58355	84.695	Big				
31	27.58002	84.6905	Big				
32	27.57691	84.68994	Big				
33	27.57769	84.66897	Medium				
34	27.57836	84.66702	Small				
35	27.5803	84.68536	Big				
36	27.58056	84.68612	Big				
37	27.58338	84.72655	Medium				
38	27.57341	84.71358	Big				

ANNEX XI

LIST OF SPECIES

Species	Family
Acacia catechu (L.f) Willd.	Leguminosae
Acacia pennata (L.) Willd.	Leguminosae
Acacia rugata (Lam.) Voigt.	Leguminosae
Achyranthes aspera L.	Amaranthaceae
Adina cordifolia (Wild. ex Roxb.) Benth. & Hook.f ex Brandis	Rubiaceae
Aegle marmellos L. Corr	Rutaceae
Ageratum conyzoides L.	Compositae
Ajuga macrosperma Wall. ex Benth.	Lamiaceae
Alibizia lucidor (Steud). IC. Neilson.	Leguminosae
Alstonia scholaris (L.) R. Br.	Apocynaceae
Boehmeria ternifolia D. Don.	Urticaceae
Bombax ceiba L.	Bombacaceae
Bridelia sclerophyla	Euphorbiaceae
Butea monsoperma (Lam.) Kuntze	Leguminosae
Callicarpa macrophylla Vahl.	Vebernaceae
Calotropis gigantea (L.) Dryand.	Asclepiadaceae
Carex sps	Cyperaceae
Casearia elliptica Willd.	Flacourtiaceae
Chenopodium sps	Chenopodiaceae
Cissampelos pareira L.	Menispermaceae
Cissus javana DC.	Vitaceae
Cissus repens Lam.	Vitaceae
Clematis grata Wall.	Ranunculaceae
Clerodendrum viscosum Vent.	Verbenaceae
Colebrookea oppositifolia Sm.	Labiatae
Commelina bengalensis L.	Commelinaceae
Commelina sps	Commelinaceae
Compositae	*Compositae*
Croton sparsiflorus Morong. = *Croton bonplandianus* Baill.	Euphorbiceae
Cyanodon dactylon (L.) Pers.	Graminae
Cyperus platistylis R.Br.	Cyperaceae
Dalbergia sissoo Roxb. ex DC.	Leguminosae
Desmostachys bipinnata (L.) Stapf.	Graminae
Digitaria ciliaris (Retz.) Koeler	Graminae
Dryopteris cochleata (D.Don) C.Chr.	Drypteridaceae
Drypoteris sparsa (D.Don) Kuntz.	Drypteridaceae
Duchesnea indica (Andrews) Focke	Rosaceae
Dysoxylum gobara (Bich.-Ham.) Merrill	Meliaceae
Ehertia laevis Roxb.	Cordiaceae
Equisetum sps	Equisetaceae
Eupatorium adenophorum Spreng.	Compositae
Eupatorium odoratum L.	Compositae
Ficus hederaceae Roxb.	Moraceae
Ficus sps	Moraceae
Flemingia macrophylla (Wild.) Merr.	Leguminosae
Gonostegia sps	Urticaceae
Hedytois scandens Roxb.	Rubiaceae
Holarrhena pubescens (Buch.-Ham.) Wll. ex G. Don.	Apocynaceae
Ipomea sps	Convolvulaceae

Ipomea sps I	Convoluvlaceae
Justicia procumbens var Simplex (D.Don) R. Yamaz	Acanthaceae
Mirre	Labiateae
Lantana camara L.	Verbenaceae
Lippia nodiflora (L.) Rich *Phylla nodiflora* (L.) Rich	Valerianaceae
Mikania micarantha Kunth.	Compositae
Miliusa tomentosa (Roxb.) Sinclair.	Annonaceae
Miliusa velutina (Dunal) Hook. f. & Thomson.	Annonaceae
Mimosa pudica L.	Luguminosae
Morus serrata Roxb.	Moraceae
Murrya Koenigii (L.) Spreng.	Rutaceae
Natsiatum herpeticum Buch.-Ham. ex Arn.	Icacinaceae
Oplimenus burmanii (Retz.)P. Beauv	Graminae
Oplimenus contorta	Graminae
Oxalis corniculata L.	Oxalidaceae
Persicaria barbata (L.) H. Hara	Polygonaceae
Piper longum L.	Piperaceae
Pogostemon glaber Benth.	Labiatae
Porona sps	Convoluvlaceae
Potentilla fulgens var. intermedia Hook. f.	Rosaceae
Premna integrifolia (L.) Willd.	Vitaceae
Rauvolifa serpentiana (L.) Benth. ex Kurz.	Apocynaceae
Saussurea sps	Compositae
Sida acuta Burm.f	Malvaceae
Sida cordifolia L.	Malvaceae
Solanum erianthum D.Don	Solanaceae
Solanum torvum Sw.	Solanaceae
Solanum xanthocarpum Schrad. & J.C. Wendl = *Solanum virginianum* Dunal.	Solanaceae
Stephania elegans Hook. f.& Thomson	Menispermaceae
Syzgium cumini(L.) Skeels	Myrtaceae
Syzygium cerasoides (Roxb.) Raiz	Myrtaceae
Thelypteris auriculata (J. Sm.) K. Iwats	Thelypteridaceae
Tinospora sinensis (Lour.) Merr.	Menispermaceae
Trewia nudiflora L.	Euphorbiaceae
Triumfetta pilosa Roth.	Tiliaceae
Uncaria sps	Rubiaceae
Urena lobata L.	Malvaceae
Urtica dioica L.	Urticaceae
Vallaris solanacea (Roth.)Kuntze.	Apocynaceae
Wallichia densiflora Mart.	Palmae
Wendlandia puberula DC.	Rubiaceae
Woodfordia fruticosa (L.) Kurz.	Lythraceae

ANNEX XII

COMPARISON OF VOLUME AND BIOMASS