Ecological Status of Prioritized Non-Timber forest products in Machhapuchhre Rural Muncipality of Annapurna Conservation Area, Nepal

A Dissertation Submitted for Partial fulfillment of the

Requirements for Masters' Degree in Biodiversity and Environmental Management.

Submitted by

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LETTER OF RECOMMENDATION

It is hereby recommended that **Shikhar Rai**, M.Sc. Biodiversity and Environmental Management (BEM) final semester student at Central Department of Botany, Tribhuvan University, Institute of Science and Technology, Kirtipur Kathmandu has carried out the research work entitled "**Ecological Status of Prioritized Non-Timber forest products in Machhapuchhre rural Municipality of Annapurna Conservation Area, Nepal"** under my supervision. The entire work is based on the field work performed by him and brings out some useful findings.

As per my knowledge, this work has not been submitted for any other academic degree. I, therefore recommend this dissertation to be accepted for the partial fulfillment of the requirement of Master's Degree in Biodiversity and Environmental Management at the Institute of Science and Technology, Tribhuvan University.

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LETTER OF APPROVAL

The M.Sc. dissertation entitled "**Ecological Status of Prioritized Non-Timber forest products in Machhapuchhre rural Municipality of Annapurna Conservation Area, Nepal"** submitted by Mr. Shikhar Rai has been accepted as partial fulfillment of the requirement of Master of Science in Biodiversity and Environmental Management (M.Sc. BEM)

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DECLARATION

I hereby declared that the thesis entitled "**Ecological Status of Prioritized Non-Timber forest products in Machhapuchhre rural municipality of Annapurna Conservation Area, Nepal"** submitted for the completion of the Master degree in Biodiversity and Environmental Management (BEM), to Central Department of Botany Kirtipur, Kathmandu, Nepal, is a record of original research work done by me under supervision of Prof. Sangeeta Rajbhandary, Central Department of Botany Kirtipur, Kathmandu, Nepal, is not submitted for any other degree. I also declare that the thesis represents my own work, study observation and shall contribute to advancing knowledge in this subject.

Shikhar Rai

Date: September, 2019

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ABSTRACT

Non-Timber Forest Products (NTFPs) have been extensively used since long ago when the human life started. Developing countries can benefit largely from the employment and income generation from NTFPs and this holds the potential to alleviate rural poverty. Therefore, proper knowledge on resources management, production of NTFPs and its derivatives in rural areas of Nepal can be helpful to alleviate poverty by creating income generating opportunities locally, and enhance socioecological prosperity if appropriate policies and programs are undertaken carefully. This study was carried out in the Machhapuchhre Rural municipality of Annapurna conservation area. The study is focused on documenting and assessing the ecological status (Diversity, Distribution, Relative requency, Population density, Relative density, Abundance) of most prioritized NTFPs in the study area. In order to achieve objective total 105 plots of 314 m^2 were sampled in seven different sites up to 3000m asl and additional methods such as focus group discussion, informal questionnaire survey and preference ranking also applied for data collection.

Total 50 species of NTFP were recorded belonging to 40 various family and majority of them were recorded in 1000-1500 masl. Among those species most of the species were herbs and used for medicinal and edible purpose. Ecological status, important value index and diversity index of ten most preferred species form each seven site were assessed as well. In addition, existing resource management practice on the Machhapuchhre rural Municipality were also studied.

Findings from this study can be useful in understanding abundance and distribution of NTFP species which are essential to formulate, educate and implement conservation regulations for sustainable management.

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ACRONYMS AND ABBREVIATIONS

ACA	: Annapurna Conservation Area
ACAP	: Annapurna Conservation Area Project
CAMC	: Conservation Area management Committee
CBD	: Convention on Biological Diversity
CITES	: Convention on International Trade in Endangered Species
DFO	: District Forest Office
DFRS	: Department of Forest Resources
FAO	: Food and Agriculture organization
GoN	: Government of Nepal
GPS	: Global Positioning System
ICIMOD	: International Centre for Integrated Mountain Development
IUCN	: International Union for Conservation of Nature
KATH	: National Herbarium and Plant Laboratories
Km	: Kilometer
MAPs	: Medicinal and Aromatic Plants
MOFSC	: Ministry of Forest and soil Conservation
NTFPs	: Non-Timber Forest Products
NTNC	: National Trust for Nature Conservation
TUCH	: Tribhuvan University Central Herbarium
UCO	: Unit Conservation Office
VDC	: Village Development Committee
WWF	: World Wildlife Fund
IVI	: Importantce Value Index

KSL	: Kailsah Sacred Landscape
KCA	: Kanchenjung Conservation Area.
CHAL	: Chitwan Annapurna Landcsape
FDGs	: Focus Group Discission
RRA	: Rapid Rural Assessment Appraisal
PRA	: Participatory Rural Appraisal
KI	: Key Informants
MASL	: Meter above Sea Level

CHAPTER ONE: INTRODUCTION

1.1 Background

Non-timber forest products (NTFPs), are special, non-wood, minor, alternative and secondary forest products, which are useful substances, materials or commodities obtained from forests which do not require logging trees (FAO 2018). They include game animals, fur-bearers, nuts, seeds, berries, mushrooms, oils, foliage, medicinal plants, peat, mast, fuelwood, fish, spices and forage. NTFPs have been extensively used since the beginning of human civilization. NTFPs are most significantly associated with the life of the rural indigenous ethnic communities.

Developing countries can benefit largely from the employment and income generation from NTFPs and this holds the potential to alleviate rural poverty (Ghimire, 2008). Research on NTFPs have focused on their commodifiability for rural incomes and markets, as an expression of traditional knowledge or as a livelihood option for rural household needs, and, as a key component of sustainable forest management and conservation strategies. However, the values of NTFPs have been recognized more since late 1990s (Ojha, 2000; Banjade and Poudel 2008) due to their contribution in rural livelihoods (Olsen, 1998). All research promote forest products as valuable commodities and tools that can promote the conservation of forests.

According to report Nepal's forest occupies a total of 6.61 million ha which is 44.74% of the total area of the country. Out of the total area of forest, 82.68% (4.93 million ha) lies outside protected areas and 17.32% (1.03 million ha) inside protected areas (FRS 2015). This Himalayan region is the primary source of a wide range of non-timber forest products (NTFPs) harvested for trade to India, china and beyond. NTFPs have been subsistence and livelihood commodity since ancient times in this region. The real reflection of traditional knowledge on forest resources and use of those resources in different aspects can be seen in rural and remote areas where modern facilities are not easily available. Local people use a number of plants for food, spices, fiber, medicine, religious purpose, handicrafts and many other purposes.

According to an estimate there are more than 2000 species of plants with the potential of being useful and about 1600-1900 are commonly used as medicinal purpose in Nepal (Shrestha *et al.* 2003; Ghimire 2008). The Government of Nepal has kept 30

species in priority, of which 12 are for commercial cultivation and market promotion (Luintel *et al.* 2004, Subedi 2006, Shrestha and Das 2008). NTFPs are increasingly gaining popularity in international markets as they are important ingredients of several herbal cosmetics, herbal tea, food, medicines, etc. A 1995 survey of collectors, traders and processors of NTFPs operating from the eastern border of the country to the mid-western town of Nepalgunj shows that a total of 100 entrepreneurs handled 42 thousand tons of over 100 different NTFP items, equivalent to USD26 million (Subedi 1997). According to (Agrawal *et al* 2013) in 2010 one third of rural people in Nepal collected and traded forest product which generated US$ 7.66 million which benefitted 78,282 participants. It is estimated that about 10,000 to15, 000 tons of plant products of more than 100 species are exported to India annually, i.e., 90% of total NTFP trade (Edward 1996). Forestry contributes about 15% to the Nepalese GDP, NTFPs make up about 5% of the GDP (CECI 2006). Government of Nepal has considered NTFPs as one of the major components in countries economy and development. A growing interest in the utility and value of NTFPs has emerged in the last two decades in developing countries. In Southeast Asia, at least 29 million people depend on NTFPs for subsistence income. According to the International Centre for Integrated Mountain Development (ICIMOD), global trade in existing MAPs was valued at around US$60 billion in 2000, which is expected to grow to US$5 trillion by 2050 (Pyakurel & Baniya, 2011).

In Nepal, policy for NTFPs begun in 1957 after "Private Forest Nationalization Act" but this discourses was powerful after the Master Plan for Forestry Sector4 (Hammett 1993; Edwards 1996; Manandhar 2002). Government of Nepal has considered NTFPs as one of the vital components in country's economy and development. There are 2,349 species of vascular plants, 65 species of mammals, 758 species of birds considered as NTFPs; which are categorized into 34 different types based on their use values (Kochhar, 1998, FAO 2004, FRA/DFRS 2014, Sharma & Kandel 2014). Over 700 species of plants in Nepal are documented to have medicinal and aromatic values of which about 10% are involved in most of the trade and use. In general, NTFP contribute to about 5% in the national GDP in Nepal (CECI 2006). However, a very few works have been conducted to document knowledge from the entire country about NTFPs including sustainable harvest of these resources (FRA/DFRS 2014)

Recently Importance of NTFPs has shifted to the center stage of the global development agenda (Shackleton and Pandey, 2014). In the past two decades, numbers of countries have begun to update the forest policies to reflect the socio-economic, ecological and cultural realities of NTFP use. This has resulted in improvements to the ways in which these forest products are regulated, including re-thinking the use of costly and complex inventories and management plans for NTFPs (Pandey *et al*. 2016) It is already a known fact that for any natural resource to be managed sustainably, sound knowledge of the ecology, spatial distribution and abundance of the resource is essential (Wong, 2000). Such information could be obtained from a number of sources including indigenous or local peoples' knowledge as well as formal scientific enquiry through forest inventories. Having Knowledge on ecology, spatial distribution and abundance of natural resources are essential for their effective management. Inventories are the procedure to get such information about the natural resources. Inventory also provided essential information about quantity and quality of the resources for their management.

Being rich in NTFPs resources ACA region, provides goods and services to the nearby communities. ACA constitutes diverse climatic zones adding with diverse geographical features provided it as unique place for natural resources. These features provided ACA as habitat for 1233 plant species of which 35% species have NTFPs value (BCDP 1994). Department of Forest (DoF) in 2008/09 collected Rs 100 million revenue from NTFPs, most of them are exported to India. It is also being exported to the third countries such as Japan; US; Germany; Belgium and 50 other countries. Nepal itself is consuming herbal products on an annual increment of 20 per cent (Ghimire *et al*. 2008).

In developing countries, deforestation, forest degradation, biodiversity loss and rural poverty have long been important concerns in forest governance. Long-term economic benefits from sustainable NTFPs extraction might be significant to prevent forests degradation. Quantitative ecological analysis of the abundance, distribution, population dynamics, production and reproduction of NTFPs are rare or nonexistent (Hall and Bawa 1993, Boot and Gullison 1995). Such studies are fundamental for the accurate assessrnent of the potential sustainable harvest of NTFPs. Major issue in inventory is lack of data on species distribution which makes it difficult to understand

their linkages with different vegetation types and other socio-ecological condition which are crucial for monitoring, conservation and management of NTFPs (Chitale *et al*. 2018). In addition to the lack of knowledge regarding the impact of harvesting NTFP from forest ecosystems, the relationship between harvesting intensity and impact is also largely unknown, even for NTFP with a long tradition of use.

Sustainable use of the NTFPs are utmost necessary for long term participation of local people for the management of ACA including its forest areas. This study intended to prioritize the most important NTFPs currently in trade or in useby the people with the Sustainable Harvesting Plan that regulates annual limit of harvestable stock of major tradable NTFPs. This study will provide data for the sustainable use of prioritized NTFPs in ACA.

1.2 Research questions

The study area is a part of Nepal's oldest and largest conservation area, which is one of the major biologically diverse area having diverse tradition and culture. Majority of rural people are heavily dependent upon the local natural resources. The aim of the study is to answer the following questions.

1. What are the existing NTFPs species found in the study area?
2. What are the current ecological status of prioritized NTFPs of in the study area?
3. What are the current harvesting practices and recommendation for sustainable harvest?

1.3 Objectives

General Objective:

To assess the ecological status of most prioritized NTFPs in Machhapuchre rural muncipilaty for the development of sustainable harvesting practices.

Specific Objective:

i) To document available NTFPs in the study area.

ii) To assess the ecological status (Diversity, distribution, Relative frequency, Population density, Relative density, Abundance) of most priortized NTFPs to develop sustainable harvesting practice.

iii) To document the peoples perception and existing management practices and of NTFPs in the study area

1.4 statement of Problem and rationale of the research

In rural area of Nepal, 10-100% of House Holds are involved in commercial collection of NTFPs and medicinal plants. In some rural hilly areas, it contributed up to 50% of total annual family incomes (Larsen and Olsen 2007). Despite the importance of the NTFPs resources have been neglected due to skewed management plans towards the timber resources (Acharya 2005). Unsustainable NTFP harvesting and lack of marketing are the major constraints for sustainable management of NTFPs sector in the landscape despite promising policy provisions (Uprety *et al.* 2016). Promotion of sustainable use of NTFPs could lead to a win-win situation for poverty reduction and biodiversity conservation (Pandey *et al.* 2016). Therefore, proper knowledge on resources , management, production of NTFPs and its derivatives in rural areas of Nepal can helpful to alleviate poverty by creating income generating opportunities locally, and enhance socioecological prosperity if appropriate policies and programs are undertaken carefully

The current management plans are still ineffective and there are cases of resource degradation due to the extensive use of NTFPs resources without adequate knowledge of sustainability issues (Acharya 2005). Because sustainability of resource use requires, at the very least, that harvest rates do not exceed the capacity of populations to replace the individual extracted (Hall & Bawa 1993), many of the studies have attempted to derive harvest limits based on demographic data. The studies illustrate

that the effects of harvest on both individuals and populations are highly variable and are mediated by different sources of variation. Main challenges involved in forest resource management the lack of substantial knowledge on population biology, standing stocks, life cycle, yields and harvesting techniques (Chamberlin *et al.* 2004). Understanding spatial distribution, availability season, regeneration status of species are essential to formulate, educate and implement conservation regulations (Schaafsma *et al.* 2014).

Many studies have been conducted on non-timber forest products (NTFPs) over the years. These studies have however, concentrated more on socio-economic issues of NTFPs than methods of inventory. Forest inventory methods developed for timber have been found to be inefficient for NTFPs because of the special characteristics of NTFPs. Efficient inventory methods are essential to provide quality information on the abundance and distribution of the species for sustainable management.

1.5 Limitation of the study

- The study was carried out in seven CAMCs of Machhapuchre Gaupalika, scatter ness among the human settlements and NTFPs resources in the study area made study difficult. Hence inaccessibility of the area became a hurdle to gather sufficient information.
- NTFP inventory became very difficult due to the unpredictable climatic factor and difficult geographic terrain and various obstacle. Hence limited forest survey was conducted which may influence in the outcome of the study
- Only top ten most preferred NTFPs from each CAMC were considered for study.
- Some locals were reluctant to give information about their resources so it might also affect the outcome of study.
- Time and resources limitation were another constraint for the study.

The study is based on a small sampling area therefore the result can not be generalized for whole ACA.

CHAPTER TWO: LITERATURE REVIEW

2.1 Studies conducted regarding NTFPs in Nepal

Ojha & Bhattrai (2003) reviewed on Assessment and sustainable harvesting of non-timber forest products: Some initiatives in community forestry in the hills of Nepal. They mentioned that wide range of assessment techniques and harvesting practices are required for NTFPs to address the diversity of plant form, life cycle and product type. Assessment and sustainable harvesting technique of NTFPs have to be site and product specific to address both ecological and social issues. Community's interest, capacity and demand must be considered in designing management plan. Sustainable harvestingof NTFPs is a complex issue requiring analysis of multiple dimensions, and matching of social and ecological aspects. Traditional knowledge may not be enough to address issue of the commercial harvesting practices.

Chhetri and Gupta (2003) conducted a survey in Upper Mustang in 2003 for the documentation of NTFPs using Participatory Rural Appraisal and vegetation sampling methods. They recorded 101 species of NTFPs belonging to 36 families and 79 genera. The study revealed that most of the NTFPs are prevalent in the moist places of sub alpine region. Disturbance due to over harvesting and lack of awareness about forest resources were observed as the major factors influencing the NTFPs population. People are unaware of sustainable harvesting and management. They also mentioned that the species, with use of underground part, has the greater chances of extinction from the habitat because of unsustainable harvesting. Illegal and premature collections of plants are another the main threat for the sustainability NTFPs.

Ghimere (2008) stated that in recent decades, harvest of many plant-based NTFPs, has gone from subsistence collection to large-scale commercial extraction, increasing the probability of overexploitation. Knowledge about sustainabl use of such plant resources is thus urgently needed. Sustainability of the NTFP resources can only be assured with an understanding of the biological/ecological, economic, socio-cultural and political aspects of resource and understanding of the complex interactions between many of these factors. Management also requires understanding traditional knowledge and decision making systems relating to the resources which is greatly lacking from the Himalaya.

Humagain and Shrestha (2009) reported 60 species of medicinal plants from Rasuwa district in central Nepal. Most of them were herbs followed by shrubs, trees and climbers. Most of the species of medicinal plants were collected for their underground parts, while some are collected for whole plant, and the rest were collected for other parts.

Uprety & Poudel (2010) carried out study on NTFPs in Bradiya district of western Nepal. They reported 101 species under 48 families and 91 genera as NTFPs, which were commonly used plants by the local people for domestic purposes. Medicinal plants comprised the highest number of 56 species (55%); followed by wild edible 26 (25%) It was observed that the proper management of the NTFPs could play a vital role in the improvement of people's livelihood on a sustainable basis. Destructive harvesting was a serious problem especially for those species whose bark and roots are traded.

Roy (2010) reported 47 NTFPs species were collected from six villages in Humla district. Most were found to be wild edible plants followed by medicinal plants. 72 percent of the total respondents recalled that the availability of NTFPs species in the past 10 years was abundant, and was adequate in the past 5 years. The respondents observed that presently the availability of NTFPs species is scarce, and they are now scattered and sparse. The reasons behind the depletion of NTFPs species were both over-collection and premature harvesting. Because of food deficiency, people are under pressure to make money from NTFPs collection. There is also a competition among primary collectors to collect more NTFPs. In addition, local traders sometimes encourage the primary collectors to collect more quantities, particularly of those species with a higher market demand.

Heinen and Shrestha (2011) mentioned the most important is the need for inventory and research on NTFPs species in widespread use. There is lack of marketing information and capacity building; administrative barriers; royalty rates; and illegal harvesting. The most important immediate need is the development of NTFPs Strategy and Action Plan.

Piya *et al.* (2011) reported that 23 types of NTFPs were collected and sold by the Chepang households in Shaktikhor VDC Makwanpur. Fruits were the most commonly traded plant parts followed by bark. NTFPs were mostly traded for

medicinal purposes and with fast commercialization of the NTFPs, unsustainable harvesting of few species is evident in the field.

Acharya (2012) carried out study on NTFPs of Gulmi district. He reported 161 medicinal plant species belonging to 144 genera and 87 families and majority were herb followed by tree, shrub and climber. Easy access to modern medicines and less recognition of traditional healers are the main causes leading to decrease in interest of young generation in the use of traditional medicinal practices

Chettri *et al*. (2012) studied ecological and social status of *Paris polyphylla* with its antibacterial activity and ethno-medicinal uses of available plant species. *P. polyphylla* showed relative density, frequency and coverage of 5.26/ha, 6.29% and 3.05%, respectively and the importance value index of this plant was found to be 14.6.

Sharma and Kandel (2014) studied the status of potential non-timber forest products for wise use and conservation in buffer zone of Langtang national Park. Study was perform to resource assessment for baseline information on the status and distribution of locally prioritized plant NTFP in Nuwakot and Sindhupalchok districts of Langtang National Park's buffer zones. Total 133 species of plants having use value were identified. They suggested that *Gaultheria fragrantissima* and *Edgeworthia gardneri* were more potential species for commercial production and utilization in the study area.

Uprety *et al.* (2016) reported 363 species of NTFPs used by locals from Kanchenjunga landscape in Nepal, medicinal and edible was the major purpose of use of the NTFPs, although harbouring huge number of NTFPs commercialization was limited due to lack of market information. Unsustainable harvesting was major constraints for sustainable management of NTFPs.

Chitale *et al.* (2018) studied Impacts of Climate Change on Distribution of Major Non-Timber Forest Plants in Chitwan Annapurna Landscape, Nepal. They conducted research on the diversity, distribution and utilization patterns of 109 economically and ecologically important NTFPs of Chitwan Annapuran landscape. The upper subtropical and temperate zones were the most important NTFP hotspots in terms of both value and volume whereas subalpine and alpine zone were characterized by high average unit values. Highest annual harvest of NTFPs was from subtropical zone but

the highest revenue generated is from subalpine zone. It was revealed that under existing climatic conditions, distribution of the species studied is confined from central to west and north-east parts of the landscape. Results of predictions showed that NTFPs will be impacted even under a moderate climate scenario with both range expansion and range reduction

2.2 International Studies regarding NTFPs.

Duchesne & Wetzel (2002) stated that Traditional knowledge and scientific knowledge both have important roles in the sustainable production of NTFPs. In absence of traditional knowledge, basic principles of plant reproduction and growth should provide a guide for developing practices for sustainable use of the NTFP resource. The harvest of NTFPs can affect both the sustainability of the product being harvested and other products from the same plant. Management activities that target one particular NTFP will impact other resources.

Ticktin (2004) reported that harvesting of NTFPs can affect ecological processes at many levels, from individual and population to community and ecosystem. Tolerance to overharvesting depends upon life history and the part of plant that is harvested. Moreover, the effects of harvest for any species are mediated by variation in environmental conditions over space and time, and by human management practices. Management practices can be carried out at different spatial scales and some are highly effective in fostering population persistence. Managers need to coordinate with local harvesters in designing and evaluating management practices that can mitigate the negative effects of harvest.

Shahabuddin and Prasad (2004) reviewed on Assessing Ecological Sustainability of Non-Timber Forest Produce Extraction. They stated that species differ in their responses to harvest depending on the plant part extracted, natural history attributes and harvesting techniques. Regeneration and population densities of some NTFPs species are reported to be adversely affected by overharvesting. Such adverse effects, cannot be attributed to harvesting alone, but rather to a combination of harvests, damaging harvesting practices and accompanying human disturbances such as fire, grazing and fuel wood collection. Study indicate a disturbing trend of ecosystem simplification due to intensive forest use, harvest of NTFPs, which may gradually lead to the weeding out of vulnerable plant species from Indian forests.

Vermeulen (2009) explored the science needed to underwrite management for sustainable use of NTFPs. This was done using case studies of three different products harvested from natural forest in the southern Cape, South Africa. It was concluded that a simple generic process that provides for research to be focused on the relevant fields can be followed effectively with the development of harvest systems for NTFPs. Sustainability also has a socio-economic and political dimension, further influenced by institutional arrangements as well. Wide range of NTFPs used, socioeconomic circumstances and the dependence of rural communities on natural resources are the major challenge for forest managers in South Africa to develop NTFPs harvest systems for sustainable use.

A study in Takamanda National park, Cameroon was done by Ndah *et al.* (2013) reveald that spatial distribution and abundance of selected non-timber forest products harvested from Takamanda National Park, Cameroon.

Basu *et al.* (2013) studied on Diversity and Resource Potential of Non-Timber Forest Product (NTFP) in Bishnupur Forest Division of Bankura District, West Bengal, India. Five major categories of nontimber forest products were recorded. Investigation revealed that although there is high resource potential in the study site lack of awareness, scientific knowledge, expertise and inadequate market information, income through commercialization of such species were found to be very low.

Khakhlary & Sharma (2017) reported diversity of NTFPs of Garampani Wildlife Sanctuary in Karbi Anglong district, Assam, India. They calculated the diversity index and importance value index NTFPs. They concluded that Ferns/Epiphytes/ Climber have high diversity value in comparison to (Herbs/Shrubs) and (wild edible fruit) while Wild edible fruit have a low diversity in comparison other species.

2.3 NTFP categories

Any type resources materials or commodities obtained from forests which do not require harvesting (logging) trees are NTFPs. It includes wide range of forest resources such as game animals, fur, fishes, insect, plants, fruits, pits and forage. NTFPs are commonly grouped into decorative, medicinal plants, foods, flavors and fragrances, fibers, and saps and resins. It can be categorized based on their use values, parts used and their distribution as given in following able.

Table 1: Classification of NTFPs

Category	Variables
Use	Food, Fiber, Medicine, Ornament, Construction, Dye, Lighting, Aromatic/Perfumery, Spices, Culinary, Washing, Basketry
Use propose	Home, Commercial
Parts Used	Rhizome, Tuber, Stem, Bark, Twigs, Leaf, Flower, Fruit, Whole Plant, Seed
Habit	Herb, Shrub, Climber
Distribution	Tropical, Sub Tropical, Temperate, Sub alpine, Alpine

(Source: Pyakurel D. & Baniya A. 2011)

2.4 NTFP inventory

Forest inventory is the procedure of obtaining information on the quantity and quality of forest resources to assist in their formulation of management plan. Most of the research related to NTFP were related to ethnomedical values and trade values followed by pharmacological screening, very few of them are concerned on ecological status (Ghimire *et. al* 2001). Forest inventories are more timber oriented and little attention has been given to inventory of NTFPs. There exist no standard for NTFP inventory in Nepal. As NTFP includes diverse species with different habit, growth form, reproductive mode, and spatial distribution pattern, the method of inventory would be different for different target species and must be adjusted based on the field situations, growing conditions and available habitats (Ghimire, 2007). Participatory forest inventory methods and guidelines, as explained by various authors (Rai *et al.* 2000; Wong *et al.* 2001), were reviewed to design the study.

For the management of any natural resource to be sustainable, excellent knowledge of the ecology, spatial distribution and abundance of the resource is essential. Such information could be only obtained from a number of sources including indigenous or local peoples' knowledge as well as formal scientific enquiry through forest inventories (Wong, 2000). Hence these inventories provide information on the forest resources, based on which management plans are formulated.

CHAPTER THREE: MATERIALS AND METHOD

3.1 Study area

3.1.1 Location

The present study was carried out in Machhapuchhre Gaupalika of Kaski district in central Nepal. The study area falls under Annapurna Conservation Area which is the first & largest Protected Area (PA) of Nepal that covering 5.18% of country's surface area in general but 27% of total PA of Nepal. The entire massif and surrounding area has an extent of 7,629 km2 in between 83°34' to 84°25' E longitude and 28°15' to 28°50' N latitude. ACAP was established in 1986 to involve local people in conservation. Since then ACAP has been functioning with its central headquarter in Pokhara and regional offices in Ghandruk, Lwang, Bhujung, Sikles, Manang, Jomsom and Lomanthang. The study site Miachhapuchhre Gaupalika is situated at 83°43' to 83°92' E longitude and 28°18' to 28°39' N latitude। it is stretched into 544.58 square km constituting eight ward committee which are Lwanghalel, Machhapuchhre, Dhampus, Rivan, Lachok, Ghachok, Sardikhola and Dhital. Machhapuchre Gaupalika is surrounded by Madi Gaupalika on east, Manang district on north, Annpurna Gaupalika on west and Pokhara Lekhnatha sub metropolitan on south. According to 2011 census report total population of Machhapuchre Guapalika is 21868 with 5512 household, among which 11898 were female and 9970 were male population. (MoFALD 2017)

Table 2: Location of different study sites

S.N.	Sites	Latitude	Longitude	Altitude (Meter)
1	Dhampus	28˚18"01.34'	83˚50"57.00'	1740
2	Lwang Ghalel	28˚23"03.90'	83˚52"28.00'	1870
3	Rivan	28˚19"22.64'	83˚54"05.38'	1150
4	Lahchok	28˚18"14.61'	83˚55"42.78'	1168
5	Ghachok	28˚18"41.76'	83˚56"33.56'	1173
6	Machhapuchre	28˚20"00.73'	83˚57"12.39'	1329
7	Sardikhola	28˚20"57.53'	83˚58"34.17'	1444

This study is focused in the Lwang Unit conservation office of ACA. Lwang occupies 6.86% (52,384 ha) land area of the ACA. This is UCO represents Kaski district of Nepal. Lwang UCO incorporates 7 Conservation Area management committee which are Lwanghalel Machhapuchhre, Dhampus, Rivan, Lachok, Ghachok, and Sardikhola representing subtropical to nival climatic zones of Nepal.

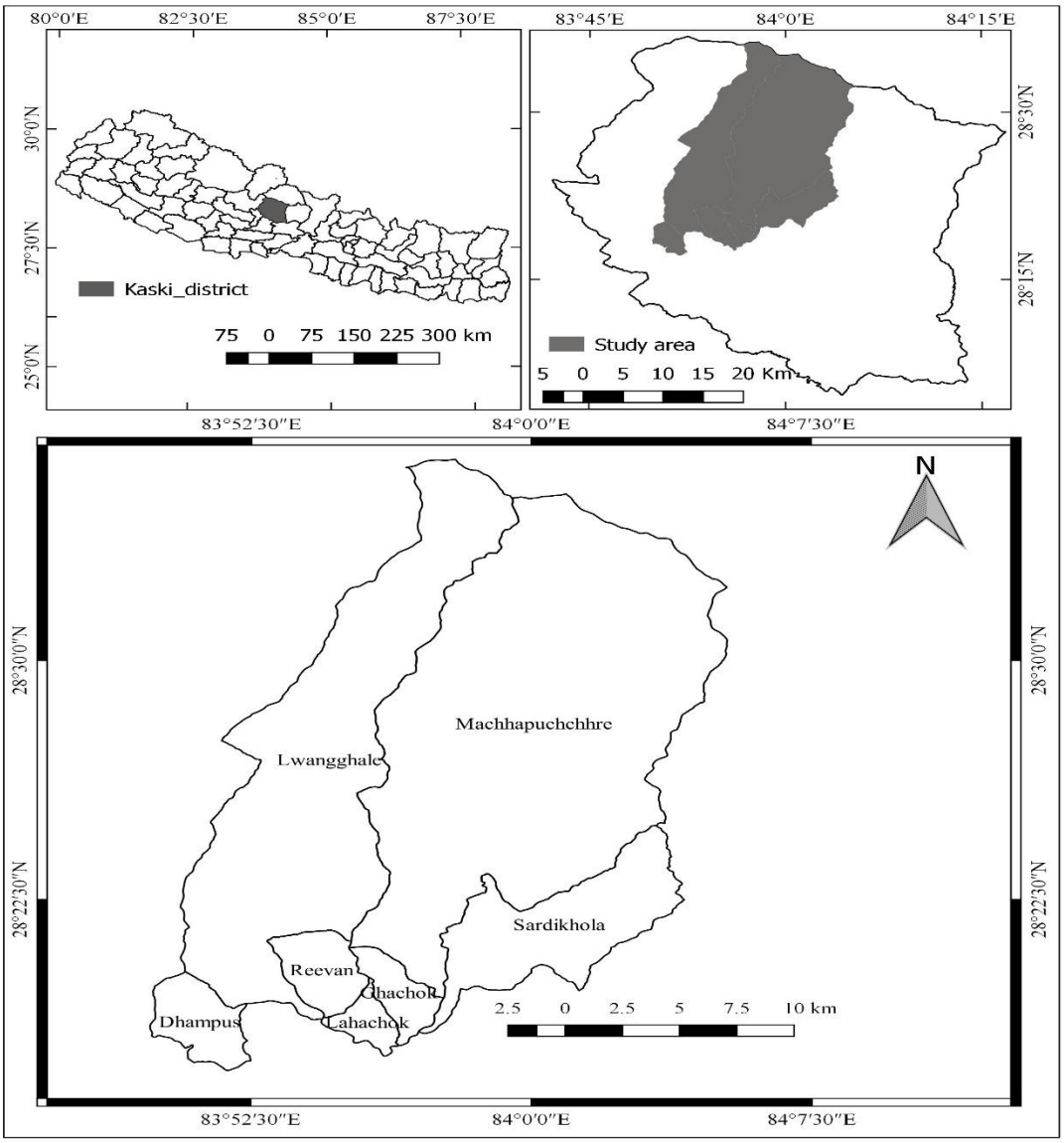

Figure 1: Map of the study area

3.1.2 Physical features and climate

Kaski District is dominated by hills and mountain peaks and lakes. Namely Annapurna peaks and Machhapuchre. It's also known as the district of lakes and main

lakes are Phewa, Rupa, and Begans Lake. This district is one of the major tourist destination of the country which provide various adventurous activities for tourists. The study site Macchapuchre Gaupalika itself constitutes Mt. Machhapuchre. The altitudinal range of Kaski district varies from around 300 masl to 8000 masl resulting in mosaic of different geographical zones from subtropical zones in the south to alpine zone in the north in a stretch of less than 50 km.

Table 3: Climatic zones and coverage of Kaski district

Climate Zone	**Altitude (masl)**	**Percentage cover (%)**
Upper Tropical	300-1000	18.6%
Subtropical	1000-2000	29.4%
Temperate	2000-3000	16.6%
Subalpine	3000-4000	12.1%
Alpine	4000-5000	14.8%
Nival	5000-above	7.4%
Trans-Himalaya	3000-6400	0.6%

Source: Lillesø *et al.* (2005)

The climate is warm and temperate in Kaski district in the lower elevation and gets cooler as the elevation rises. In winter, there is less amount of rainfall than in summer. The average annual temperature is 16.6 °C. About 3517 mm of precipitation falls annually which is highest in the country. The driest month is November, with 3 mm of rainfall. Most precipitation falls in July, with an average of 954 mm. The warmest month of the year is June, with an average temperature of 20.8 °C. In January, the average temperature is 9.5 °C. It is the lowest average temperature of the whole year.

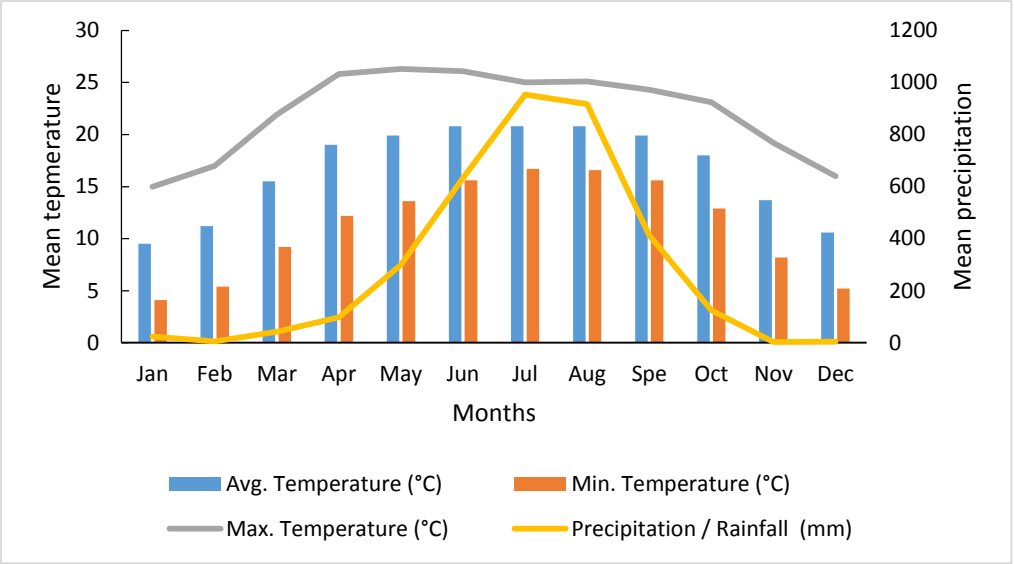

Figure 2: Graph representation of annual mean temperature and annual mean precipitation pattern of Lumle meteorological station which is the nearest station from the study site which is 6.5 km away. (Source: DHM, 2018)

3.1.3 Biodiversity

The complex natural setting and ecological features are reflected in a wide spectrum of vegetation types. Variation in altitude, topography, climate and existing land cover provides wide range of habitat for plants and animals. Major vegetation in the study site were *Schima wallichii* (Chilaune) *Alnus nepalensis* (Uttis) *Engelhardia spicata* (Mauwa) *Daphniphyllum himalense* (Rakchan) *Macaranga denticulate* (Malato) and *Rhododendron arboreum* (Gurans) forest. Among shrub species *Lyonia ovalifolia* (Angeri), *Berberis asiatica* (Chutro) and *Rubus ellipticus (*Ainselu). *Athyrium pectinatum* (Uneu). Precious herb species such as (Chraito) *Swertia chiraytia,* (Paanchaule) *Dactylorhiza hatagirea,* (P*akhnabed) Bergenia ciliata*,(Padamchal*) Rheum austral* , (Nirmasi) *Delphinium denundatum* ,(Majitho*) Rubia manjith* , (Kutki) *Neopicrorhiza scrophulariflora,* (Jatamasi) *Nardostachys grandiflora,* (Niguro*) Dryopteris cochleata* (Kurilo*) Asparagus racemosus (*Satuwa) *Paris polyphylla.*

Study site also has potential diversity of wild faunas. *Panthera pardus* (Leopard), *Herpestes edwardisii* (Squirrel*), Muntiacus muntjak* (Mriga), *Eunambulus sp.* (Lokharke), *Canis aureus* (Jackle) Muschus moschiferus (Kasturi / Musk deer) are

major animal species. Corvus sp. (Crow), Passer sp. (Bhangera), *Tragopan satyra* (Munal*), Lophophorus impeyans* (Danfe) are the major bird species.

3.1.4 Cultural Diversity

Among the seven ward of Mchhapuchre Gaupalika, Brahman (27.80%) and Gurung (16.60%) are main ethnic group while followed by Chettri (14.60%) and Magar (8.7%) (CBS 2011). Gurnug and Magar communities are settled in relatively higher elevation and other communities. The settlement pattern is clumped in most of the Gurung and Magar communities and scattered in other ethnic groups. The region is culturally heterogeneous and is one of the major attraction of eco-tourism in the region. Most of the Gurungs, follows Buddhism while in lower elevation there are people with mixed ethnic background following both Hindusim and Bhuddism.

3.1.5 Economy and livelihood pattern

Most peoples of Machhapuchre Gaupalika as other rural area of country, depends upon traditional agricultural practices and farming for livelihood. Main crops grown are rice, buckwheat, maize, potato, and wheat. Farmers also produce mustard, beans, wheat, and soya beans but apples are limited in some localities. There is a couple of century old tradition in the Gurung and Magar communities to join British and Indian army which greatly helps to improve the economy of the region. Currently foreign employment in the Middle East is another option for locals. Livestock such as sheep, buffalo and cattle rearing is also widely practiced in this region for milk, meat and wool. Large number of Sheep and yaks can be found in the high pasture land.

Tourism is another major livelihood option for the locals of ACA as this region attracts thousands of tourist annually from around the world. It constitutes many beautiful tourist spot and Trekking route in such as, Dhampus village, Lwang village and Mardi Himal trek and many other short side trails which offer great views of Hiamalys and its cultures.

Other economic activities includes running tea house and guest house, handicrafts business, and collecting forest products, medicinal and aromatic plants etc. These activity reflects there is a high dependency of locals on natural resources of the area.

3.1.6 Land use and land cover

Majority of the land is covered by forest and farmland except in the few parts which are above tree lines. In Kaski district 33.41 % of land is covered by forest, 31.08% are by developed areas, and 17.88 % is constituted by barren land (Mishra & Gyawali 2015). Forest type includes from subtropical evergreen, temperate deciduous and alpine coniferous forests. There are also large number of high altitude grasslands above in the mountains. Another major land cover is the ice deposited in the mountain peaks and glacier. Water bodies are another major land cover types. Mardi Khola and Seti River are the two main rivers which flows through the area. Majority of land use cover are Farm lands in the southern region of the ACA. In the lower elevation where the climate is warm and gets high amount of rainfall there are large number of rice and corn fields along the river banks. Human settlements is another land use type in the aca region. Most of the settlements are concentrated in patches in this region.

3.2 Methodology

3.2.1 Addressing Ethical issue

As Study site is located inside the Annapurna Conservation Area, before starting the field work Consent for this study was obtained in writing from the Annapurna Conservation Area Project (ACAP), and department of wildlife and national parks, and prior informed consent (PIC) was obtained verbally from each participant before they were interviewed. The project was approved by the Central Department of Botany, Tribhuvan University.

3.2.2 Collection of ethnobotanical information

a) Key informant Interview

The interview with its various form constitutes the basis of most ethnobotanical data collection (Alexiades, 1996). Local officials, collectors, forest guards and committee members were considered as key informant and information regarding NTFPs in the region were collected through interviewing them. Interview performed were semi-structured interview where causal conversation were carried regarding the availability, distribution, use intensity (preference ranking) and trade of NTFPs.

b) Focus group discussion

Information on NTFPs and its aspects such as uses, growing condition, availability, collection, use, marketing, cultivation were collected in each CAMC by participatory Focus Group Discussion method involving 5-8 member of conservation area management committee and other knowledgeable persons. Informal discussions were also undertaken with the village heads, local authorities were also consulted for gathering information on the use, harvest and trade of NTFPs. In addition, personal observations were made in the fields to note any noticeable event.

c) Questionnaire survey

Informal questionnaire was used to know about the local existing management practices, harvesting patterns and peoples' perception regarding NTFP species in the study area, focusing the age group between 25 - 60 years who are associated with conservation area management committee. We interviewed 30 individuals to both sex male (70%) and female (30%). The attendants mainly comprise the members of local committees. The ideas generated in the group discussion were further used in result portion

3.2.3 Plant collection, identification and herbarium preparation:

NTFP species were collected from various study sites ranging elevation from 1000 masl to 3000 masl. Location, altitude and local area were noted and photographs were also taken in the process. Representative specimen showing vegetative and reproductive parts (in flower, fruit, cone, with sporangia, etc.) were collected. Entire plant of Herbs species were collected to show root or rootstock while one branch was sufficient for Shrubs, trees, vines species.

Most of the NTFPs species were identified in the field using the floristic literatures and comparing pictures of the plants and with the help of experts. Collected species were kept in between newspaper sheets for drying, further to be mounted in herbarium sheet following standard procedure. Identified and confirmed species were thoroughly studied based on secondary data as well. All the documented plant were presented alphabetical order by their families with local name, habit, and part used and their occurrence.

3.2.4 Preference ranking:

Preference ranking was done prior to the field sampling process. Based on the knowledge and experience local's informants, CAMC members, traders, and officials the available NTFP in the study area were listed and asked to choose ten most preferred NTFP species according to their use value, market price and availability. Similar procedure were performed in all seven CAMCs since the prioritized species varied among the CAMC.

3.2.5 Sampling Techniques and Data Collection

- For primary data collection, field work was carried out in the study area for around 20 days during the summer of 2018. First of all consultative meetings with conservation area management committee (CAMC) was held in each CAMCs.
- Listing of all the NTFPs abundant in the specific CAMCs was carried out
- Among the list most Prioritized NTFPs were ranked in specific CAMCs based on their use intensity.
- Species-wise abundance (low-moderate-high) of NTFPs was located.
- Allocation of survey plots in the map on the basis of species abundance
- Site visit and inventory of the plots were carried out.

3.2.6 Systematic Sampling strategy

Systematic random sampling method was employed for data collection to cover all the possible habitats and associated vegetation types. The sampling included the entire habitat and vegetation types within 1000 - 3000 masl covering various ecological zones. Longitude, latitude and elevation of each sample plots were recorded by Global Positioning System (GPS, eTrex Garmin). Slope and aspect of each plot were recorded by a clinometer compass. Circular sampling plots measuring 10m radius for tree, 2m radius for shrub/sapling and 0.57m radius for herbaceous species (Yadav *et al.* 2013, FRA/DFRS 2014) was used for data collection following relative analysis approach (Dombois and Ellenberg 1974). Total 105 plots of 314 m^2 were sampled. The distance between two plots was 100 m was approximately. Most of the survey plots were distributed in the south-eastern aspect with 30-40˚ of slope. Major species

inside the sample plot were recorded separately and the process was repeated in the successive plots. Specific tally sheets was used to record data in the field. Secondary data was acquired from various sources. Relevant information on study area such as geography, socio economy, population, land use, volume of annual NTFPs harvest and other required data were collected form ACA office, DFO, DNPWC, WWF, and other literature and online sources.

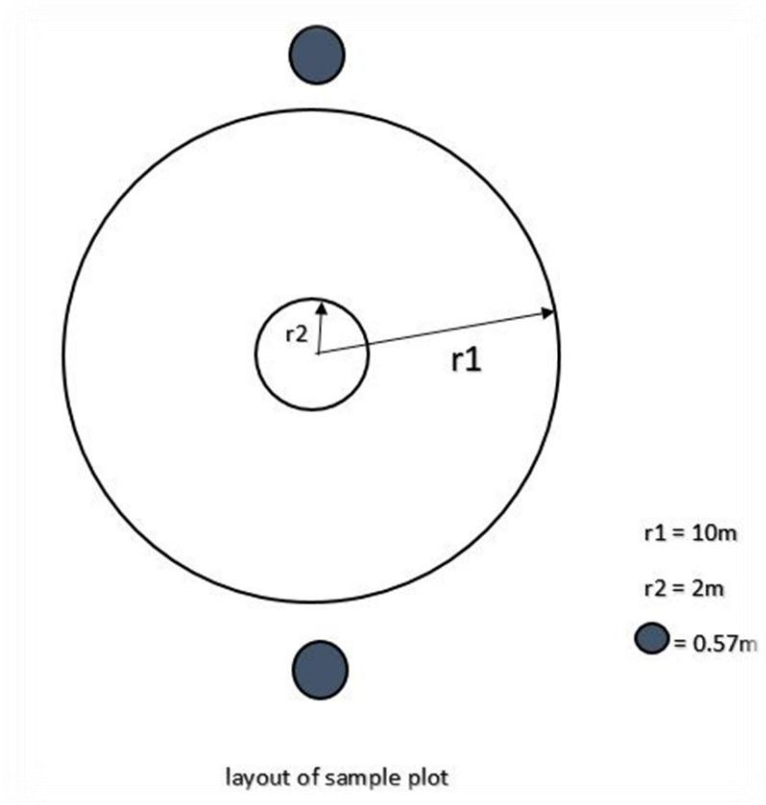

Figure 3: layout of sampling plot

3.3 Data Analysis

Both primary and secondary data and information were the sources for this study. Secondary sources of information were published & unpublished documents and reports gathered from online sources. Collected data from primary and secondary sources were processed and further analyzed. The descriptive statistics such as simple density, frequencies and percentage were used for the analysis of quantitative data. Microsoft excel software was used for the data processing.

3.3.1 Quantitative Data

Quantitative data of NTFPs obtained from sample plots were analyzed based on the formulae given by Zobel *et al.* (1987).

a) Frequency (f)

Frequency is the proportion of sampling units containing the species.

$$fi = \frac{ni}{N} * 100$$

Where,

fi = Frequency of species i
ni = Number of quadrats in which species i occurred
N = Total number of quadrats studied

b) Relative frequency (Rf)

$$Rfi = \frac{fi}{F} * 100$$

Where,

Rfi = Relative frequency
fi = Frequency of species i
F= Sum of frequencies for all species

c) Density (d)

Density is the number of individuals per unit area.

$$di = \frac{ni}{N*A} * 10000$$

Where,

di = Density (ha-1) of species i
ni = Total number of individuals of species i
N = Total number of quadrats studied
A = Area of a quadrat

d) Relative density (Rd)

$$Rdi = \frac{di}{D} * 100$$

Where,

Rdi = Relative density of species i
di = Density of species i
D = Total density of all species

e) Dominance (do)

Dominance is amount of ground covered by the tree trunk.

$$doi = \frac{Bai}{N*A} * 10000$$

Where,

Doi = Dominance (ha-1) of species i
Bai = Total basal/coverage area of species i
N = Total number of quadrats studied
A = Area of a quadrat

f) Relative dominance (Rdo)

$$\text{Rdoi} = \frac{doi}{Do} * 100$$

Where,
Rdoi = Relative dominance of species i
doi = Dominance/coverage of species i
Do= Total dominance/coverage of all species

g) **Importance Value Index (IVI)**

Species dominancy in the surveyed areas were determined by ordering the Importance Values of each species. Importance Value was obtained by summation of the relative frequency, relative density, and relative dominance (cover).

IVIx = RFx + RDx + Rdox

Where,
IVIx = Importance Value Index of species x
RFx = Relative Frequency of species x
RDx = Relative Density of species x
Rdox = Relative Dominance (cover) of species x

3.3.1.1 Shannon index:

It was calculated as: $H' = -p \sum i \, ln \, pi$, where pi is the proportion of individuals found in species i. For a well-sampled community, we can estimate this proportion as pi = ni/N, where ni is the number of individuals in species i and N is the total number of individuals in the community.

Typical values of Shannon index are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase.

3.3.1.2 Simpson's index:

Calculated as $D = \sum pi2$ where pi is the proportion of individuals found in species i .It is based on the probability of any two individuals drawn at random from an infinitely large community belonging to the same species. D is a measure of dominance, so as D

increases, diversity (in the sense of evenness) decreases. Values of D ranges between 0 and 1.

3.3.3 Plant cover:

The most common way to measure plant cover in herbal plant communities is to make a visual assessment of the relative area covered by the different species in a small circle or quadrate (Kent and Coker 1992), and often the visual estimates of cover percentages are categorized using different ordinal classification class.

Daubenmire Cover-Class:

These cover classes were designed to make it faster to estimate cover. Even though Estimates are still very subjective. Midpoint value of the range was taken as consideration for the further data analysis.

Table 4: Daubenmire Cover-Class and its values.

Cover Class	Range of Cover	Midpoint of Range
1	0-5%	2.5%
2	5-25%	15.5%
3	25-50%	37.5%
4	50-75%	62.5%
5	75-95%	85.5%
6	95-100%	97.5%

(Source: Daubenmire, R. F. 1959)

CHAPTER FOUR: RESULTS

4.1 Taxonomic distribution of NTFPs

About 50 potentially important NTFP were recorded in Machhapuchre Rural muncipilaty of Annapurna conservation area. These NTFPs belongs to 41 various family along with Mushrooms and Wild honey, are widely distributed in the area. Among all the families *Asteraceae, Ericaceae, Orchidaceae, Poaceae, Polygonaceae, Ranunculaceae, Urticaceae* each constituted 2 species while the remaining 33 families constituted 1 species each (Table 1). All of these NTFPs have different economic and ethnobotanical values and contributes greatly in the local livelihoods.

Table 5: NTFPs recorded in the study area with their use category, habit, used part and distribution

S.N.	Family	Common Name	Scientific name	Use Category	Habit	Used part	Elevation range (m)
1	*Acanthaceae*	Asuro	*Adhatoda vasica Nees.*	Medicine	Shrub	Leaves	1000-1500
2	*Adoxaceae*	Mahalo	*Viburnum mullah* Buchanan-Hamilton ex D. Don	Medicine	Shrub	Fruit	1000-1500
3	*Anacardiaceae*	Bakhamilo	*Rhus chinensis* Mill.	Food	Tree	fruit	1000-1500
4	*Apiaceae*	Ghodtapre	*Centella asiatica* (L.) Urb.	Medicine	Herb	Whole plant	1000-1500
5	*Araceae*	Dhakayo	*Arisaema propinquum* Schott	Food	Herb	Whole plant	2500-3000
6	*Asparagaceae*	Kurilo	*Asparagus racemosus* Willd.	Food	Herb	Shoot	1000-1500
7	*Asteraceae*	Titepati	*Artemisia indica* Willd.	Fodder	Shrub	Whole plant	1000-1500
8	*Asteraceae*	Bhutkesh	*Saussurea bhutkesh* Fujikawa & H. Ohba, Edinburgh J.	Medicine	Herb	Rizome	3000-4000
9	*Berberidaceae*	Chutro	*Berberis asiatica* Roxb. ex DC.	Food	Shrub	fruit	1000-1500
10	*Brassicaceae*	Khole saag	*Nasturtium officinale* R. Brown	Food	Herb	Whole plant	1000-1500
11	*Cannabaceae*	Gaaja	*Cannabis sativa L*	Medicine	Herb	Leaves and shoots	1000-1500

12	*Caprifoliaceae*	Jatamasi	*Nardostachys jatamansi* (D.Don) DC.	Medicine	Herb	Rizome	3500-4000
13	*Caryophyllaceae*	Sano abhijalo	*Drymaria cordata subsp. diandra* (Blume) J.A.Duke	Medicine	Herb	Whole plant	1000-1500
14	*Convolvulaceae*	Indreni lahara	*Cuscuta reflexa* Roxb.	Medicine	Climber	Whole plant	1000-1500
15	*Dennstaedtiaceae*	Unieu	*Dennstaedtia appendiculata* (Wall. ex Hook.) J.Sm.	Fodder	Herb	Whole plant	1000-1500
16	*Dioscoreaceae*	Githhe Tarul	*Dioscorea bulbifera* L.	Food	Climber	Rizome	1000-1500
17	*Dipterocarpaceae*	Saldhup	*Shorea robusta* Roth	Aromatic	Tree	Resin	1000-1500
18	*Elaeagnaceae*	Guyeli	*Elaeagnus infundibularis* Momiyama	Food	Tree	fruit	1500-2000
19	*Ericaceae*	Sunpati	*Rhododendron anthopogon* - D.Don.	Aromatic	Shrub	leaves	3000-3500
20	*Ericaceae*	Gurans	*Rhododendron arboreum* Sm.	Medicine	Tree	Flower	2000-2500
21	*Gentianaceae*	Chraito	*swertia chirayita* (Roxb. ex Fleming) Karsten	Medicine	Herb	Whole plant	1500-2000
22	*Juglandaceae*	Okhar	*Juglans regia L.*	Food	Tree	Fruit	1500-2000
23	*Lauraceae*	Siltimur	*Lindera neesiana* (Wall. ex Nees) Kurz	Medicine	Tree	fruit	1500-2000
24	*Lauraceae*	Tejpat	*Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm.	Spices	Tree	Leaves, Bark	1000-1500
25	*Lycopodiaceae*	Naagbeli	*Lycopodiella cernua* (L.) Pic. Serm.	ornaments	Climber	Whole plant	1000-1500
26	*Melanthiaceae*	Satuwa	*Paris polyphylla* Sm.	Medicine	Herb	Rizome	2000-2500
27	*Menispermaceae*	Gajurgano	*Tinospora sinensis* (Lour.) Merr.	Medicine	Climber	Rizome	1000-1500
28	*Myricaceae*	Kaphal	*Myrica esculenta* Buch.-Ham. ex D.Don	Food	Tree	fruit	1500-2000
29	*Dryopteridaceae*	Niguro	*Dryopteris cochleata* (D.Don) C.Chr.	Food	Herb	Shoot	1000-1500
30	*Ophiocordycipitaceae*	Yarsagunbu	*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora	Medicine	Fungus	Whole plant	4000-4500
31	*Orchidaceae*	Paancha	*Dactylorhiza*	Medicine	Herb	Rizome	3500-4000

		ule	*hatagirea* (D.Don) Soó				
32	*Orchidaceae*	Sunakhari	*Coelogyne cristata* Lindl.	Medicine	Herb	Whole plant	1500-2000
33	*Piperaceae*	Pipla	*Piper longum* L.	Medicine	Herb	fruit	1000-1500
34	*Plantaginaceae*	Kutki	*Neopicrorhiza scrophulariiflora* (Pennell) D.Y.Hong	Medicine	Herb	Rizome	3000-3500
35	*Poaceae*	Tusa	*Arundinaria maling* Gamble	Food	Shrub	Shoot	2500-3000
36	*Poaceae*	Nigalo	*Drepanostachyum falcatum*	Handicarft	Shrub	Whole plant	1500-2000
37	*Polygonaceae*	Padamchal	*Rheum australe D. Don*	Medicine	Herb	Rizome	3200-4200
38	*Polygonaceae*	Halhale	*Rumex nepalensis* Spreng.	Food	Herb	Shoot	1500-2000
39	*Ranunculaceae*	Nirmasi	*Aconitum palmatum* D.Don	Medicine	Herb	Rizome	3500-4000
40	*Ranunculaceae*	Bikh	*Aconitum palmatum* D.Don	Medicine	Herb	Rizome	3500-4000
41	*Rosaceae*	Ainselu	*Rubus ellipticus* Sm.	Food	Shrub	fruit	1000-1500
42	*Rubiaceae*	Majitho	*Rubia manjith* Roxb. ex Fleming	Medicine	Herb	Rizome	1500-2000
43	*Rutaceae*	Timur	*Zanthoxylum armatum* DC.	Spices	Shrub	fruit	1000-1500
44	*Saxifragaceae*	Pakhnabed	*Bergenia ciliata (*Haw.) Sternb. Revis. Saxifrag. suppl.	Medicine	Herb	Rizome	1000-1500
45	*Taxaceae*	Lothsalla	*Taxus wallichiana* Zucc.	Medicine	Tree	Resin	3000-3500
46	*Thymelaeaceae*	Lokta	*Daphne bholua* Buch.-Ham. ex D. Don	Fibre	Shrub	Bark	2000-2500
47	*Urticaceae*	Allo	*Girardinia diversifolia* (Link) Friis	Fibre	Shrub	Stem Bark	1500-2000
48	*Urticaceae*	Sisno	*Urtica dioica* L.	Food	Shrub	Shoot	1000-1500
49		Bhirmaha	Honey	Food	N/A		1500-2000
50	Morchellaceae	Guchhichyau	Morchella esculenta var. rotunda (Fr.)	Food	Fungus	Whole plant	2000-3500

4.1.1 Life forms of NTFPs

Among the recorded 50 species of NTFPs in the study area, most of them were 22 herbs species (45%) followed by 14 shrub species (25%) 9 tree species (22%) and 4 climbers species(8%) and 1 fungs species (Figure 5).

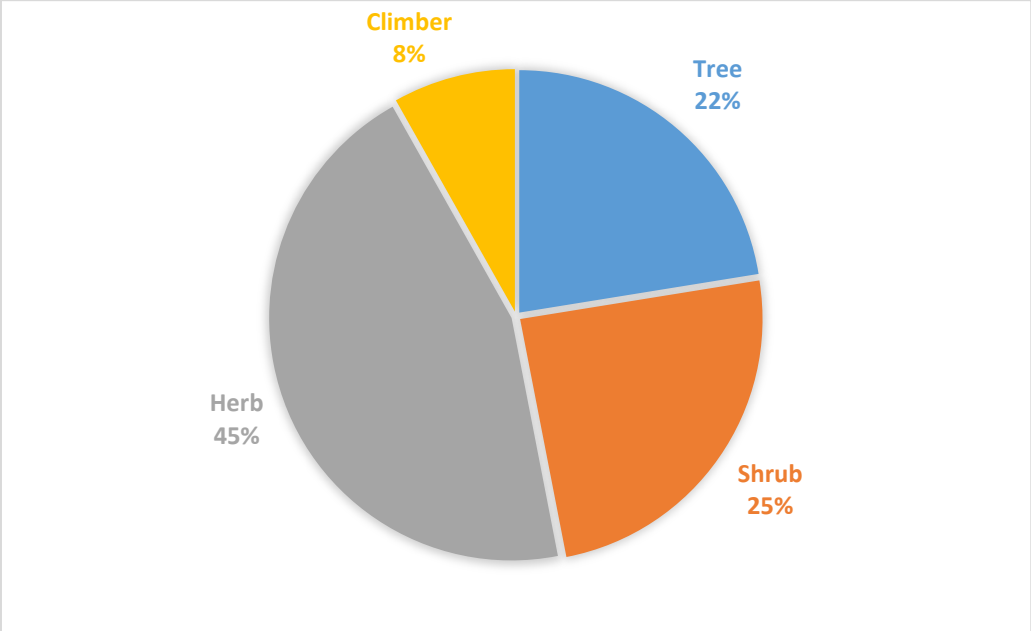

Figure 4: Pie Chart showing the number of NTFP species and their life forms

4.1.2 Use purpose of the NTFPs

Various NTFP species are used for different purpose from eating to treating diseases to use as ornaments. Most 23 species of the NTFPs recorded in the study are were used for medicinal purpose which was followed 16 species used as food. For aroma, fiber and species and fodder constitute 2 species each while 1 species are used for handicraft and ornaments (Figure 6 :).

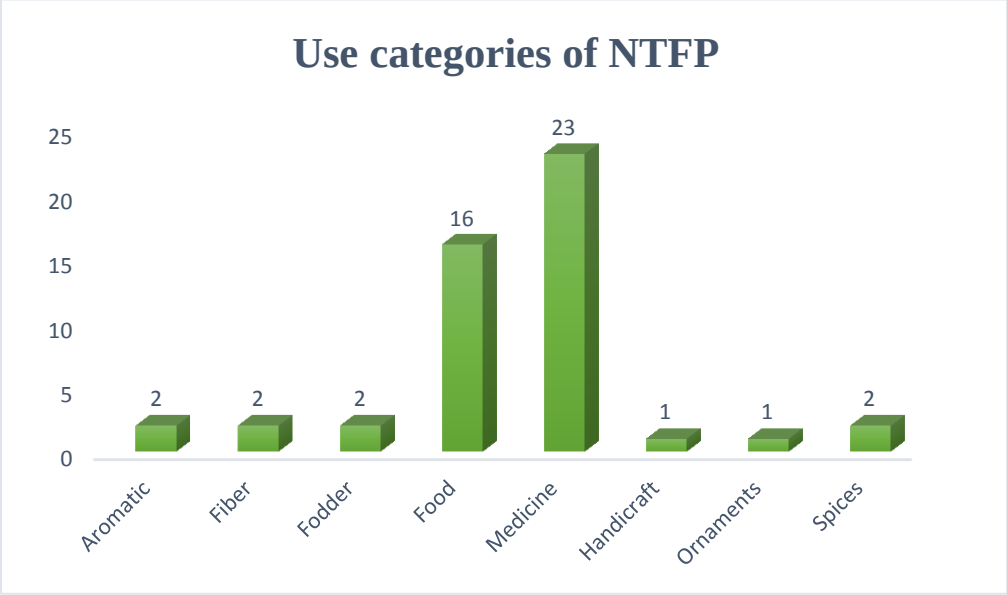

Figure 5: Bar graph showing the number of NTFP species and their uses.

4.1.3 Used Parts of the NTFP

Various parts of NTFPs are used depending upon its use purpose. Normally for eating purpose parts such as leaves and fruit are widely used while bark, resins and roots are used for medicinal purpose. Whole plant and shoot are used to as fodder as well. In this study 14 number of the NTFPs are used as a whole plants, followed by roots with 12 species and fruits 10 species. Shoot, leaves are only used from 5 species and 3 species respectively while bark are used from 2 species resin are also used from 2 species and flower are used from 1 species (Figure 7).

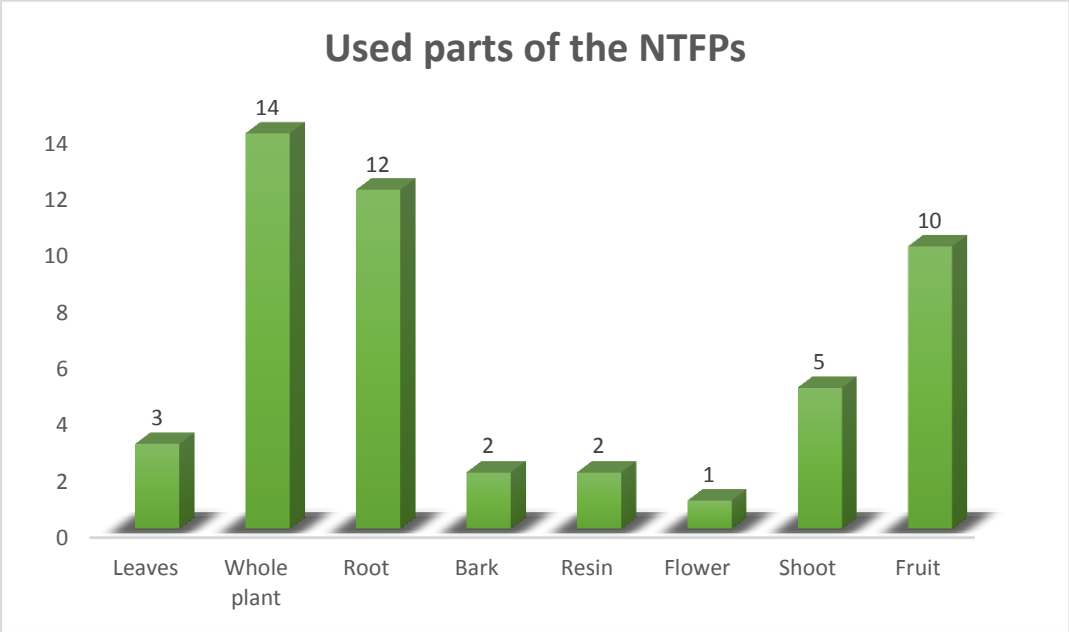

Figure 6: Bar graph showing the number of NTFP species and their parts used.

4.1.4 Distributional Range of NTFPs

23 species in the study area were found in the elevational range in between 1000-1500 meter above sea level which is the highest. Due to the optimum climate in this elevational range there is a presence high biodiversity with high amount of rainfall and favorable habitat for plant species. With increase in elevation further in between 1500-2000 the number dropped to 12 species. Above 3000m the number of NTFPs species decreases greatly with exception in between 3500-4000 meter with alpine grassland which is known for its high per unit value of NTFPs. and above 4000 environment is extreme and unfavorable for any species where only few species can survive in that environment.(Figure:8)

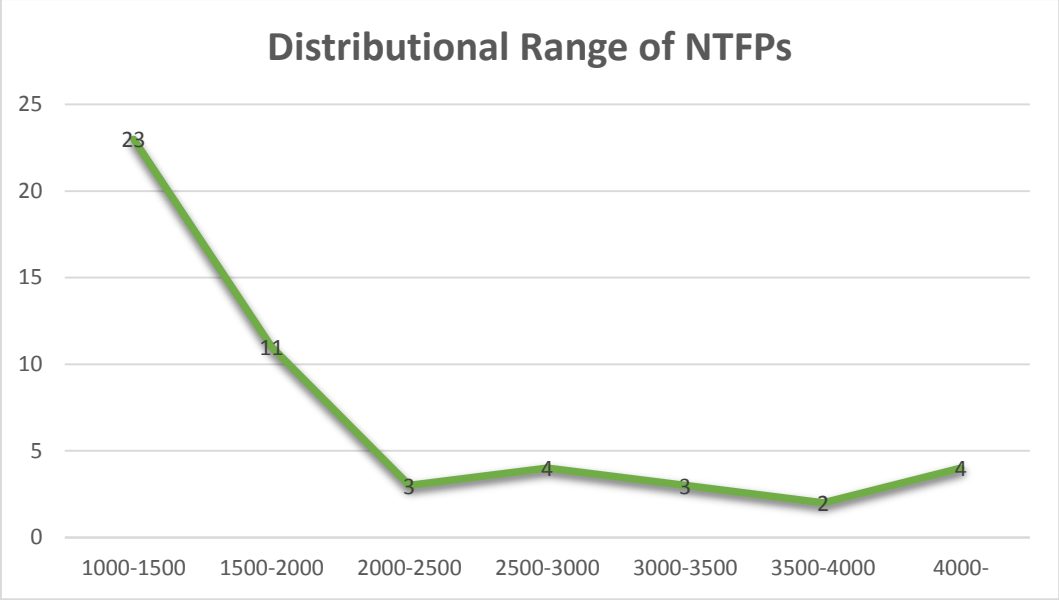

Figure 7: Graph showing the abundance of NTFP species along the elevation.

4.1.5 Distribution of NTFP in different study sites

Among the all the 7 CAMCs of the study area, Highest number of NTFPs species richness were recorded in Machhapuchre with 40 species and Lawng ghalel with 39 species followed by Sardikhola 35 species ,Rivan 31 species, Ghachok 29 species and lowest number of NTFP were recorded in Lahchok 19 species and Dhampus 17 species. (Figure 8)

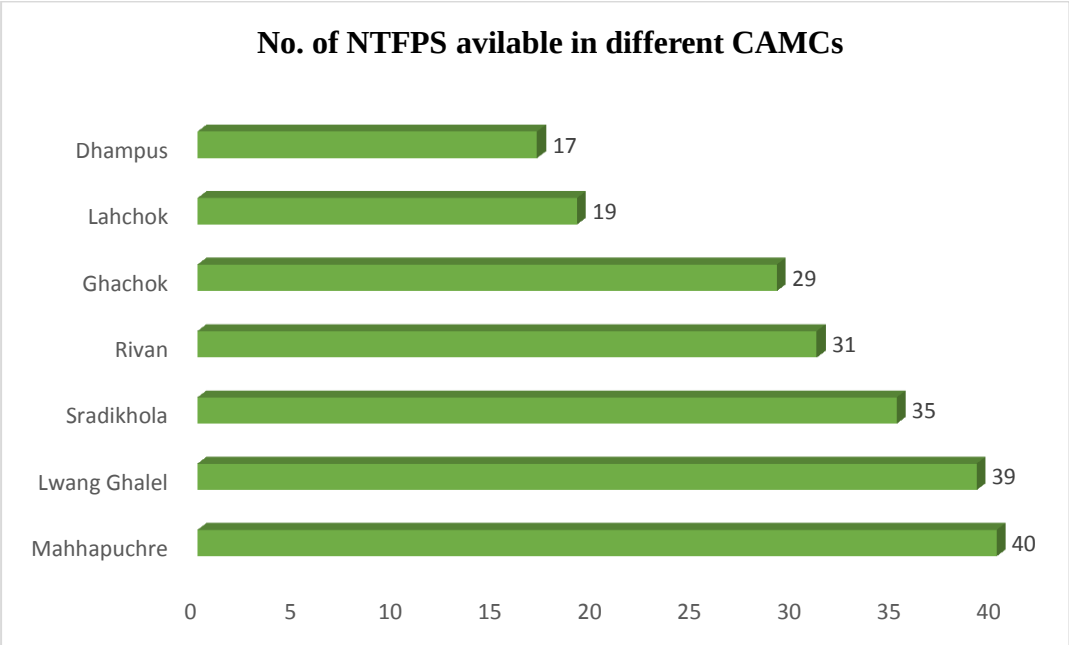

Figure 8: Bar graph showing the number of NTFP species in different CAMCs.

4.1.6 Distribution of NTFP species along the Canopy and altitudinal gradients

To study the distribution pattern of NTFPs with respect to environmental gradients (Canopy and Altitude) we performed Detrended correspondence analysis (DCA) on the species environment data set and obtained axis length more than 2.5 (i.e. 4.567) so we further performed canonical correspondence analysis (CCA) (Annex IV). The result showed that species such as *Neopicrorhiza scrophulariiflora, Arisaema griffithii, Arundinaria maling, Paris polyphylla* were positively correlated with altitude while species such as *Matteuccia struthiopteris, Rumex nepalensis Spreng. , Girardinia diversifolia and Paris polyphylla* were corelated with canopy cover (Figure: 9)

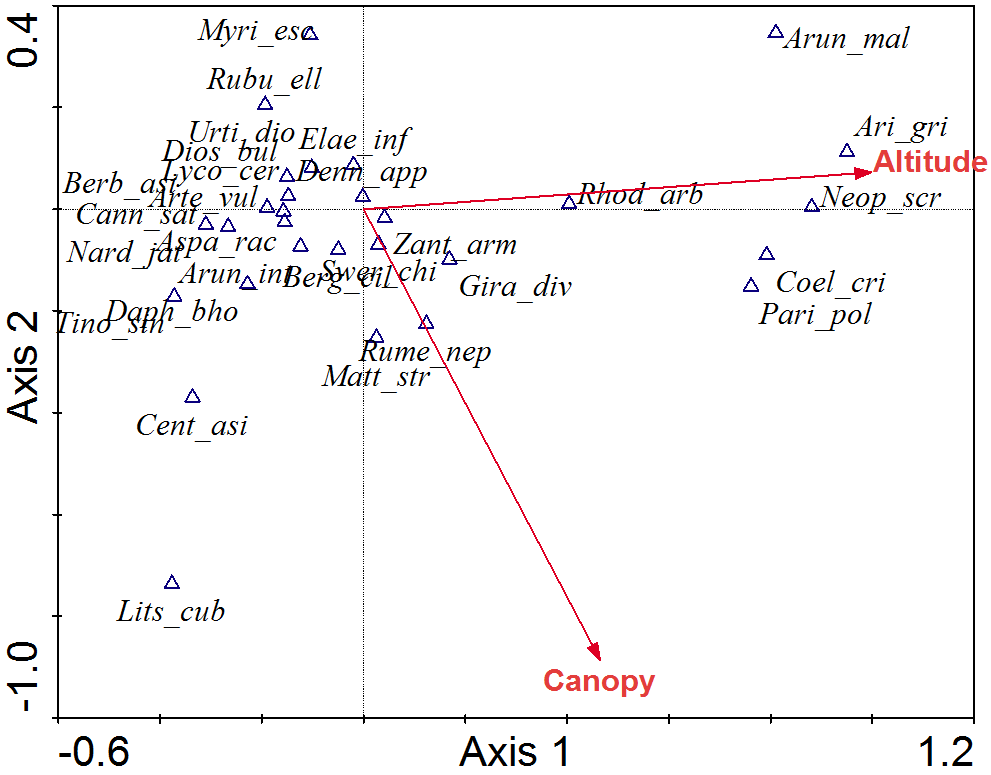

Figure 9: CCA plot of species distribution with respect to altitude and canopy

4.2 Most preferred NTFP species in each study site (CAMC)

Based on the consultation among locals, meeting with conservation area management committee and other local officials we identified ten most prioritized NTFP for seven different CAMCs in the study area. After brief discussion among the participants, ten most preferred species in each CAMC was identified. The ranking is roughly based on

the amount, availability, importance ad value of the NTFP species. Due to the diverse geographical features (elevation, aspect), biodiversity and area covered, preference of NTFPs varied with each CAMCs based upon their availability, uses and commercial values. Following (Table 6) consists the prioritized top ten NTFPs of seven different CAMCs Machhapuchre Rural muncipilaty.

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Table 6: Ten most preferred NTFPs in each CAMCs are given below in the table

	Lwang UCO						
S.N.	**Dhampus**	**Lwang Ghalel**	**Rivan**	**Lahchok**	**Ghachok**	**Machhapuchre**	**Sardikhola**
1	*Matteuccia struthiopteris* (L.) Tod.	*Arundinaria maling* Gamble	*Matteuccia struthiopteris* (L.) Tod.	*Asparagus racemosus* Willd.	*Matteuccia struthiopteris* (L.) Tod.	*Zanthoxylum armatum* DC.	*Arundinaria maling* Gamble
2	*Rubus ellipticus* Sm.	*Matteuccia struthiopteris* (L.) Tod.	*Arundinaria maling* Gamble	*Berberis asiatica* Roxb. ex DC.	*Asparagus racemosus* Willd.	*Arundinaria maling* Gamble	*Matteuccia struthiopteris* (L.) Tod.
3	*Nasturtium officinale* R. Brown	*Asparagus racemosus* Willd.	*Asparagus racemosus* Willd.	*Rubus ellipticus* Sm.	*Arundinaria maling* Gamble	*Matteuccia struthiopteris* (L.) Tod.	*Asparagus racemosus* Willd.
4	*Paris polyphylla* Sm.	*Paris polyphylla* Sm.	*Elaeagnus infundibularis* Momiyama	*Tinospora sinensis* (Lour.) Merr.	*Zanthoxylum armatum* DC.	*Asparagus racemosus* Willd.	*Dioscorea bulbifera* L.
5	*Dennstaedtia appendiculata* (Wall. ex Hook.) J.Sm.	*Swertia chirayita* roxb. Ex. Fleming K arsten	*Rubus ellipticus* Sm.	*Matteuccia struthiopteris* (L.) Tod.	*Dioscorea bulbifera* L.	*Paris polyphylla* Sm.	*Arundinaria intermedia* Munro.
6	*Berberis asiatica* Roxb. ex DC.	*Dioscorea bulbifera* L.	*Berberis asiatica* Roxb. ex DC.	*Artemisia vulgaris L.*	*Arisaema griffithii* Schott	*Rhus chinensis* Mill.	*Paris polyphylla* Sm.
7	*Asparagus racemosus* Willd.	*Mushroom*	*Myrica esculenta* Buch.-Ham. ex D.Don	*Centella asiatica* (L.) Urb.	*Berberis asiatica* Roxb. ex DC.	*wild honey*	*Girardinia diversifolia (*Link) Friis
8	*Rumex nepalensis* Spreng.	*Arisaema griffithii* Schott	*Zanthoxylum armatum* DC.	*Myrica esculenta* Buch.-Ham. ex D.Don	*Myrica esculenta* Buch.-Ham. ex D.Don	*Juglans regia* L.	*Arisaema griffithii* Schott
9	*Elaeagnus infundibularis* Momiyama	*Artemisia vulgaris L.*	*Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm.	*Adhatoda vasica* Nees.	*Rubus ellipticus* Sm.	*Viburnum mullaha* Buchanan-Hamilton ex D. Don	*Daphne bholua* Buch.-Ham. ex D. Don
10	*Myrica esculenta* Buch.-Ham. ex D.Don	*Zanthoxylum armatum* DC.	*wild honey*	*Zanthoxylum armatum* DC.	*Cinnamomum tamala*	*Cinnamomum tamala*	*Dactylorhiza hatagirea* (D.Don) Soó

4.2.1 Ten most preferred NTFPs in the study area

Among the 50 NTFPs recorded in the Machhapuchre, NTFP mentioned in below (Table: 7) are the most preferred species in the whole study area. *Dryopteria cochleata, Asparagus racemosus, Arundinaria maling, Zanthoxylum armatum* are most preferred NTFPs in all CAMCSs. All of them are easily available and can be collected easily for the direct consumption as a food and also has great commercial value.

Table 7: Ten most preferred NTFPs in of Lwang UCO

S.N.	Local Name	Scientific Name	Preferred by CAMC (%)
1	Niguro	*Dryopteris cochleata* (D.Don) C.Chr.	100
2	Kurilo	*Asparagus racemosus* Willd.	100
3	Tusa	*Arundinaria maling* Gamble	71.42
4	Timur	*Zanthoxylum armatum* DC.	71.42
5	Dhakayo	*Arisaema propinquum* Schott	42.85
6	Kaphal	*Myrica esculenta* Buch.-Ham. ex D.Don	42.85
7	Tetipati	*Artemisia indica* Willd.	42.85
8	Satuwa	*Paris polyphylla* Sm.	42.85
9	Chutro	*Berberis asiatica* Roxb. ex DC.	42.85
10	Bantarul	*Dioscorea bulbifera* L.	28.57

4.3 Ecological Study of Most preferred NTFPs in seven different study sites (CAMC)

NTFPs were heterogeneously distributed among the seven different study sites depending upon the area, altitude and environment of the study sites. Lawng Ghalel, Machhapuchre and Sardikhola constitutes larger area with much diverse topography stretching from bottom of the valley to the snowy mountain hence containing diverse climate, less human disturbance, resulting in much diverse species of NTFPs. Other area such as Dhampus, Lahchok, Ghachok, and Rivan constitutes much small area with less diverse environment and high human disturbance resulting in low number of NTFPs diversity and availability (Figure 8 & Figure 10) .

4.3.1 Dhampus

The area of Dhampus is 1180 ha (2.3% of Lwang UCO, 0.2% of ACA). Major NTFPs in this area are *Rubus ellipticus, Dryopteris cochleata, Elaeagnus infundibularis, Artemisia indica, Athyrium pectinatum, Berberis asiatica, Asparagus racemosus, filicinus, Myrica esculanta*.

Dhampus CAMC forests are dominated with huge numbers of *Schima wallichii*, *Alnus nepalensis*, *Engelhardia spicata*, and *Daphniphyllum himalense* trees. Most abundant shrubs are *Lyonia ovalifolia*, *Berberis asiatica* and *Rubus ellipticus*. Locally preferred NTFPs are *Artemisia indica (IVI=65.15)*, *Athyrium filix-femina*, *Rubus ellipticus* (IVI = 24.3) and *Berberis asiatica* (IVI = 40.30). Among herbs *Dryopteris cochleata* (IVI=12.92) is mostly preferred in this area. In this CAMC the potential habitats of commercial species like *Asparagus racemosus, Myrica esculenta*, and *Dryopteris cochleata* are higher than other species. In terms of production all prioritized species, except Niguro, have harvestable quantity in this CAMC.

The values of Shannon-Wiener index (H), Simpson's Diversity Index (D) of biodiversity in Dhampus area were 2.62 and 0.11, respectively.

Table 8: Ecological status of ten most prioritized species in Dhampus.

S. N.	Name of NTFPs	R. frequency	R. Density	R. Dominance	R. Cover	IVI	Avg. Wt.	Total Qt.
1	*Rubus ellipticus* Sm.	13.043	8.823	N/A	2.5	24.36	90.77	14453.82
2	*Dryopteris cochleata* (D.Don) C.Chr.	9.375	2.546	N/A	2.5	14.41	18.57	256.671
3	*Elaeagnus infundibularis* Momiyama	1.88	1.769	0.003	N/A	7.727	1200	5091.002
4	*Artemisia indica Willd.*	21.88	27.777	N/A	15.5	65.15	37.25	9481.991
5	*Dennstaedtia appendiculata* (Wall. ex Hook.) J.Sm.	25	20.833	N/A	2.5	48.33	27.222	5197.064
6	*Berberis asiatica* Roxb. ex DC.	13.043	11.764	N/A	15.5	40.3	91.2	19363.06
7	*Asparagus racemosus* Willd.	4.347	2.941	N/A	2.5	9.78	16	849.256
8	*Myrica esculenta* Buch.-Ham. ex D.Don	9.434	8.348	3.134	N/A	20.9	1000	8824.403
9	*Rumex nepalensis Spreng.*	-	-	-	-	-	-	-
10	*Nasturtium officinale* R. Brown	-	-	-	-	-	-	-

R= Relative, **IVI** = Important value index, **Qt**. = quantity.

Relative dominance was only calculated for tree species and Relative Cover was only calculated for Herbs and shrubs. **Avg. Wt. =** average weight of product (fruit, root, bark) per plant in gram**, Total Qt. =** Total production quantity per hectare.

(-) = were not found found during field sampling.

4.3.2 Lwang ghalel

Area of Lwang Ghalel CAMCs is 16510 ha (31.5% of UCO, 2.2% of ACA), it is the largest CAMC of Lwang UCO. It constitutes from subtropical evergreen forest to high mountain alpine grassland and stretches up to mount Machhapuchre. Forest of Lwang ghalel are composed by *Schima wallichii*, *Michelia s*p (Chaap), *Quercus glauca* (Phalat), *Daphniphyllum himalense* (Rakchan), *Macaranga denticulate* (Malato), *Engelhardia spicata* (Mauwa) and *Rhododendron arboretum* (Gurans).

Due to its diverse physiography and large area it is very rich in NTFPs. Variety of NTFPs are abundant in this region and among them NTFPs with high potential are*: ophiocordyceps sinensis*, *Rheum nobile*, *Dactylorhiza hatagirea*, *Neopicrorhiza scrophulariflora*, *Nardostachys grandiflora*, *Daphne bholua*. Because these species

are high altitude species with high commercial values and this CAMC constitutes the suitable habitat for these species.

Among the Most prioritized NTFPs by local in this area species with high IVI are *Arundinaria maling* (IVI=59.6), *Arisaema propinquum Schott* (IVI=13.86), *Artemisia indica* (IVI=22.84). The values of Shannon-Wiener index (H), Simpson's Diversity Index (D) of biodiversity in Lwang Ghalel area were 2.707 and 0.092 respectively.

Table 9: Ecological status of ten most prioritized NTFPs in Lwang Ghalel.

S. N.	Name of NTFPs	R. frequency	R. Density	R. Dominance	R. Cover	IVI	Avg. Wt.	Total Qt.
1	*Zanthoxylum armatum* DC.	5.714	1.169	N/A	2.5	9.37	360	38216.56
2	*Arundinaria maling* Gamble	8.571	48.538	N/A	2.5	59.6	32.3	142298.3
3	*Asparagus racemosus* Willd.	8.571	1.754	N/A	2.5	12.82	18.333	2919.321
4	*Swertia chirayita* roxb. Ex. Fleming K arsten	5.26	1.481	N/A	15.5	22.24	30	39215.69
5	*Artemisia indica* Willd.	7.017	13.333	N/A	2.5	22.84	38.4	451764.7
6	*Dryopteris cochleata* (D.Don) C.Chr.	7.017	1.851	N/A	15.5	24.36	19.6	32026.14
7	*Paris polyphylla* Sm.	1.754	0.370	N/A	2.5	4.62	22	7189.542
8	*Arisaema propinquum* Schott	8.771	2.592	N/A	2.5	13.86	106.428	243464.1
9	*Dioscorea bulbifera* L.	-	-	-	-	-	-	-
10	*Mushrrom*	-	-	-	-	-	-	-

4.3.3 Rivan

The Area of Rivan CAMC is 1350 ha (2.6% of Lwang UCO, 0.2% of ACA). Forest are composed with trees such as *Schima wallichii*, *Daphniphyllum himalense, Engelhardia roxburghiana.* NTFPs species such as *Dryopteris cochleata, Arundinaria maling, Asparagus racemosus, Rubus ellipticus, and Myrica esculanta* are the most prioritized species in this area. Among them *Asparagus filicinus* (IVI=23.25*) Myrica esculanta* (IVI=20.22) has the highest IVI values. Other NTFPs with high potential are *Cinnamomum tamala*, *Zanthoxylum armatum*and *Girardinia diversifolia*. The values of Shannon-Wiener index (H), Simpson's Diversity Index (D) of biodiversity in Rivan area were 2.23 and 0.167 respectively.

Table 10: Ecological status of ten most prioritized species in Rivan.

S. N.	Name of NTFPs	R. frequency	R. Density	R. Dominance	R. Cover	IVI	Avg. Wt.	Total Qt.
1	*Myrica esculenta* Buch.-Ham. ex D.Don	3.45	1.71	N/A	2.5	7.66	1500.00	6363.75
2	*Arundinaria maling* Gamble	1.72	0.85	N/A	2.5	5.07	1200.00	2545.50
3	*Asparagus racemosus* Willd.	14.29	3.96	N/A	2.5	20.75	208.75	44320.59
4	*Elaeagnus infundibularis* Momiyama	10.71	3.96	0.664	N/A	15.33	20.25	4299.36
5	*Rubus ellipticus* Sm.	3.57	0.99	N/A	2.5	7.06	320.00	16985.14
6	*Berberis asiatica* Roxb. ex DC.	7.14	1.98	N/A	2.5	11.62	112.50	11942.68
7	*Dryopteris cochleata* (D.Don) C.Chr.	8.33	1.89	2.81	N/A	13.03	23.25	30392.16
8	*Zanthoxylum armatum* DC.	-	-	-	-	-	-	-
9	*Cinnamomum tamala (*Buch.-Ham.) T.Nees & C.H.Eberm.	-	-	-	-	-	-	-
10	*Wild honey*	-	-	-	-	-	-	-

4.3.4 Lhachok

The Area of Lahchok is just 400 ha (0.8% of UCO, 0.1% of ACA) which is one of the smallest CAMCs of Annapurna conservation area. Forest are composed by trees such as *Schima wallichii, Daphniphyllum himalense*, *Engelhardia spicata*, *Castanopsis indica,* and *Alnus nepalensis*. Due to its small area low numbers of NTFPs are available in this CAMCs. *Asparagus racemosus, Berberis asiatica*, *Rubus ellipticus, Dryopteris cochleata, Artemisia indica* are the most prioritized species with high important value index in this area.The values of Shannon-Wiener index (H), Simpson's Diversity Index (D) of biodiversity in Lhachok area were 2.633 and 0.105 respectively.

Table 11: Ecological status of ten most prioritized species in Lahchok.

S. N.	Name of NTFPs	R. frequency	R. Density	R. Dominance	R. Cover	IVI	Avg. Wt.	Total Qt.
1	*Asparagus racemosus* Willd.	7.14	2.82	N/A	2.5	12.46	15.00	1592.36
2	*Berberis asiatica Roxb.* ex DC.	10.71	4.23	N/A	15.5	30.44	201.67	32112.53
3	*Rubus ellipticus* Sm.	7.14	2.82	N/A	15.5	25.46	135.33	14366.60
4	*Tinospora sinensis* (Lour.) Merr.	3.57	1.41	N/A	2.5	7.48	450.00	23885.35
5	*Dryopteris cochleata* (D.Don) C.Chr.	6.45	1.96	N/A	2.5	28.55	18.50	12091.50
6	*Artemisia indica Willd.*	12.90	5.88	N/A	15.5	34.28	38.50	75490.20
7	*Centella asiatica* (L.) Urb.	0.03	0.98	N/A	2.5	3.51	11.00	3594.77
8	*Myrica esculenta* Buch.-Ham. ex D.Don	-	-	-	-	-	-	-
9	*Adhatoda vasica* Nees.	-	-	-	-	-	-	-
10	*Zanthoxylum armatum* DC.	-	-	-	-	-	-	-

4.3.5 Ghachok

Area of Ghachok is 1010 ha. It is 1.9% of UCO, 0.1% of ACA. It is Second smallest CAMC of the Lwang UCO. Forest are dominated with tree species such as *Schima wallichii*, *Daphniphyllum himalense*, *Macaranga denticulate* and *Alnus nepalensis*. Major Shrubs Species are *Rubus ellipticus*, *Urtica dioca, and Berberis asiatica*. Most Prioritized NTFPs of this CAMCs are *Zanthoxylum armatum, Girardinia diversifolia*, *Dryopteris cochleata*, *Asparagus racemosus* and *Dioscorea bulbifera* (G). The values of Shannon-Wiener index (H), Simpson's Diversity Index (D) of biodiversity in Ghachok area were 2.465 and 0.0718 respectively.

Table 12: Ecological status of ten most prioritized species in Ghachok.

S. N.	Name of NTFPs	R. frequency	R. Density	R. Dominance	R. Cover	IVI	Avg. Wt.	Total Qt.
1	*Dryopteris cochleata* (D.Don) C.Chr.	6.67	2.40	N/A	15.5	24.57	17.00	8169.93
2	*Asparagus racemosus* Willd.	5.71	2.46	N/A	2.5	10.13	16.00	2547.77
3	*Zanthoxylum armatum* DC.	2.86	0.82	N/A	37.5	41.18	400.00	21231.42
4	*Dioscorea bulbifera* L.	8.57	2.46	N/A	2.5	13.53	200.00	31847.13
5	*Girardinia diversifolia (*Link) Friis.	5.71	1.64	N/A	15.5	9.85	225.00	23885.35
6	*Myrica esculenta* Buch.-Ham. ex D.Don	1.724	0.571	22.96	-	25.25	1800	3818.251
7	*Rubus ellipticus* Sm.	-	-	-	-	-	-	-
8	*Arundinaria maling* Gamble	-	-	-	-	-	-	-
9	*Delphinium denudatum* Wall.	-	-	-	-	-	-	-
10	*Berberis asiatica Roxb.* ex DC.	-	-	-	-	-	-	-

4.3.6 Machapuchhre

With an Area of 26840 ha (51.2% of UCO, 3.5% of ACA). It is the Largest CAMC of Lwang UCO covering up to half of the total UCO area. Its vast area constitutes subtropical vegetation from the bank of Seti River to alpine vegetation up to Mount Mchhapuchre. Major Forest tree species are *Schima wallichii*, *Macaranga denticulate, Daphniphyllum himalense*, *Alnus nepalensis* and *Rhododendron arboretum* in the temprate region. Due to the inaccessibility in the higher elevation of this area we only managed to sample in the lower elevation which are easily accessible from settlements. Major prioritized NTFPs are *Zanthoxylum armatum, Arundinaria maling, Asparagus racemosus, and Dryopteris cochleata*. Not any tree species except *Cinnamomum tamala* were in the prioritized list. This CAMC constitutes large area with diverse habitat so High elevation NTFPs species like *Ophiocordepsis sinensis Rheum austral, Dactylorhiza hatagirea, Neopicrorhiza scrophulariflora, Nardostachys grandiflora*. These NTFPs species also has great commercial values as well.The values of Shannon-Wiener index (H), Simpson's Diversity Index (D) of biodiversity in Machhapuchhre area were 3.044 and 0.057 respectively

Table 13: Ecological status of ten most prioritized NTFPs in Machhapuchre

S. N.	Name of NTFPs	R. frequency	R. Density	R. Dominance	R. Cover	IVI	Avg. Wt.	Total Qt.
1	*Zanthoxylum armatum* DC.	6.25	1.97	N/A	37.5	45.72	323.33	51486.2
2	*Arundinaria maling* Gamble	4.17	1.32	N/A	2.5	7.99	20	2123.14
3	*Asparagus racemosus* Willd.	2.08	10.53	N/A	15.5	28.11	32	27176.2
4	*Dryopteris cochleata* (D.Don) C.Chr.	8.33	2.77	N/A	2.5	13.6	26.25	34313.7
5	*Paris polyphylla* Sm.	-	-	-	-	-	-	-
6	*Rhus chinensis* Mill.	-	-	-	-	-	-	-
7	*Wild honey*	-	-	-	-	-	-	-
8	*Juglans regia* L.	-	-	-	-	-	-	-
9	*Viburnum mullaha* Buchanan-Hamilton ex D. Don	-	-	-	-	-	-	-
10	*Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm.	-	-	-	-	-	-	-

4.3.7 Sardikhola

Total area of Sardikhola CAMC is 5090 ha (9.7% of UCO, 0.7% of ACA). Forest are dominated with *Schima wallichii*, Engelhardia spicata, Macaranga denticulate, *Castanopsis indica, Daphniphyllum himalense*, and *Rhododendron arboreum* in the higher elevation. Major shrubs species are *Berberis asiatica*, *Butea minor*, *Arundinaria falcata Nees*. Locally most preferred NTFPs are *Arundinaria maling Gamble, Arundinaria falcata Nees, Girardinia diversifolia, Asparagus filicinus*. These species also has high IVI among other species. Another major NTPFs with high potential in this region is *Swertia chiraytia* which is abundant in high quantity but local people seem to be much unaware about the species. The values of Shannon-Wiener index (H), Simpson's Diversity Index (D) of biodiversity in Sardikhola area were 3.095 and 0.06 respectively.

Table 14: Ecological status of ten most prioritized species in Ghachok

S. N.	Name of NTFPs	R. frequency	R. Density	R. Dominance	R. Cover	IVI	Avg. Wt.	Total Qt.
1	*Arundinaria maling* Gamble	4.081	25.27	N/A	37.5	66.85	32.54	79458.60
2	*Dryopteris cochleata* (D.Don) C.Chr.	9.433	4.25	N/A	15.5	29.18	20.22	59476.47
3	*Asparagus racemosus* Willd.	8.163	2.75	N/A	2.5	13.41	17.60	4670.91
4	*Arundinaria falcata* Nees	8.163	29.120	N/A	15.5	52.78	181.132	509554.14
5	*Girardinia diversifolia* (Link) Friis	14.285	8.791	N/A	15.5	38.57	10.18	8645.435
6	*Paris polyphylla* Sm.	1.923	0.473	N/A	2.5	4.8	37.5	6535.947
7	*Daphne bholua* Buch.-Ham. ex D. Don	-	-	-	-	-	-	-
8	*Dioscorea bulbifera* L.	-	-	-	-	-	-	-
9	*Dactylorhiza hatagirea* (D.Don) Soó	-	-	-	-	-	-	-
10	*Arisaema propinquum* Schott	-	-	-	-	-	-	-

4.4 Biodiversity index:

Comparing Among the seven CAMCs of the Study area the highest Shannon-Wiener index (H) value was observed in Sardikhola, Machhapuchre and Lwang Ghalel with the value of 3.095, 3.044 and 2.707. Similarly Simpson's Diversity Index (D) value was lowest in these CAMCs as compared to others with the value of 0.06, 0.057 and 0.009. These values of both index implies that there is higher biodiversity in these three CAMCs than the others (Fig: 10).

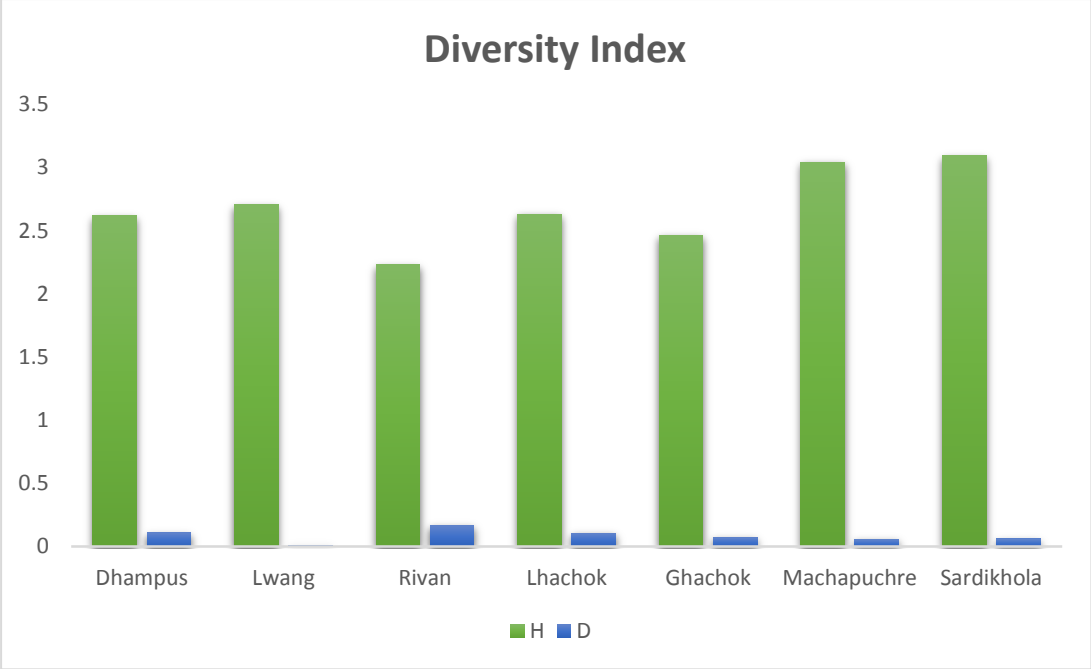

Figure 10: Graph representing the Shannon-Wiener index **(H),** Simpson's Diversity Index **(D)** of biodiversity of different CAMCs.

4.5 Local's Perception regarding Non-timber forest products

General People of the study area seemed less aware about the NTFPs. Locals were quite unaware about some of the high valued NTFPs and its uses. Younger generation didn't showed much attention in the discussion about NTFPs and its availability in their area. Only few peoples were able to recognize the plants (pictures) and their use and commercial value of NTFPs. The focus group discussion and key informants' survey revealed that the availability of the high value MAPs and NTFPs from the area has declined over the years. More than 70% of the informants mentioned that the major cause for such changes were uncontrolled harvesting as well as a heavy dependency of local people on NTFPs. During the informal group discussion (30 people) people were asked about the general trends of these resources availability in last 4 decades years and more than 90% reported that 4 decades back the availability of high value NTFPs was not a problems but at present availability of NTFPs is very low in areas. The two major factors suggested to facilitate sustainable use of NTFPs was increased awareness and restrictions in the use of these rare NTPFs plant resources .The conclusion from key informant's interview and group discussion suggest that participatory natural resources management programs are essential to encourage local people for the better conservation and management of NTFPs.

4.6 Existing management practices:

Existing Management for forest resource and other NTFPs in the rural areas of Nepal is part of traditional forest management system. Such resources are collected for local uses, trade and export with the permission of local community user groups and District Forest Offices of the Government of Nepal, which regulates the collection and trade of forest resources. Government regulation is particularly difficult to execute in remote high-altitude areas. Studies show that a large number of high value species are traded without following proper management and control protocol.

Existing Resources management practices of NTFPs comprises practices such as domestication of rare species, cultivation, enhancing natural regeneration, long term storage of used parts by sun drying or fermentation, optimum utilization of resources and marketing. Most commercial NTFPs are of wild origin and collected from forest sources. While few high altitude species with specific niche are difficult to domesticate, most low altitude species such as Niguro, Chiraito, Timur, Kurilo etc can be cultivated in private or fallow land. Cultivation and domestication of these NTFPs resources will release the pressure off from wild species; therefore, cultivation techniques and equipment should be provided with to interested locals. These kind of practices can be sustainable during the limited demand. But at present the situation has changed and there are huge demand of NTFPs and MAPs than it was ever before so traditional management practices are updated and became more specific and strictly regulated. With the collaboration with local peoples, local government and other organizations such as ACA new management practices has been developed and being implemented. Many awareness programs has been carried out on conservations of NTFP resources and its importance and its consequences in future. Now more People are aware about the resources and its value but even with all these efforts for management and conservation of resources we found out that illegal harvesting and poaching of banned species is still prevalent in the study area.

ACA is reviving the traditional forest management system through the establishment of various local forest management committees using local leaders in the community. These committees are called conservation area management committees (CAMC), which are given the authority for the management of forest establishing the traditional use rights for locals. Local people selects and elects the CAMC which formulates its

own rules and regulation based under ACA supervision. The CAMC regularly organizes the interaction program among locals to discuss about issues related to forestry and management.

Major functions and responsibility of CAMCs are

i) To make rules about resource management and make people aware about them
ii) Employ forest guards (Ban Heralu)
iii) Regulating the collection of NTFPs, fuelwood and fodder, punishing upon the violation of rules
iv) Collect permit fees for certain NTFPs species and timber species
v) Utilize the funds and fines collected from into conservation and local development projects.
vi) Monitor the conservation and local development projects funded by other local committees and ACA.

Enforcement: It is a community based mechanism for the conservation for forest resources with forest guards being appointed by CAMCs. They look after the forest and its resources and reports to the CAMCs. Other enforcement mechanism are fines, community sanction and other punishment based on the offence committed.

CHAPTER FIVE: DISCUSSION

5.1 Existing NTFP resources in the study area

About at least 50 species of NTFPs were reported in the study area. There could be even more in the number of potential NTFPs species and this study doesn't conclude that it is limited to only 50 species. Due to the remoteness, time limitation, geography of the study area and other constraints we could not explore and find the exact number of NTFP species. Similar study conducted by Bhattrai *et al.* (2010) reported traditional use of 121 NTFPs species from neighboring Mustang district while Chettri and Gupta (2003) identified 101 species of NTFPs from upper Mustang area. Study conducted in another neighboring village of Sikles by Rana *et al.* (2015) reported 42 plant species belonging to 36 families. Ghimire 2007 reported 203 species of NTFP from Kanchenjunga Conservation area while Uprety *et al.* (2016) reported 363 species of NTFPs used by locals from Kanchenjunga landscape in Eastern Nepal. Sharma and Kandel (2014) identified 133 species from a study conducted in Langtang national park and its buffer zone in the central Nepal. Similarly Humagain and Shrestha 2009 reported 60 species from Rasuwa district. Study conducted Roy (2010) in Upper Humla district of western Nepal reported 47 species from two VDCs.

According to an estimate there are more than 2000 species of NTFPs in Nepal, including about 1600-1900 species commonly used for medicinal purposes (Shrestha *et al.* 2000; Ghimire 2008). These wide number of NTFPs served as a source of diverse materials products, such as food, fodder, dye, medicine, fibers, gums/resins, handicrafts, construction materials, ornaments etc.

Among seven sites in the study area, highest number of NTFPs species richness were recorded in Machhapuchre (40 species), Lwang Ghalel (39 species), Sardikhola (35), as they constitute more area and more diverse habitat (elevational gradient) and less human disturbances than Dhampus (17 species), Rivan (31), Lachok (19), and Ghachok (29). Rai *et al.* (2016) reported that effects of elevation, land-use types, slope angle, aspect, temperature and precipitation are significant drivers of species richness in Manaslu and Sagarmatha National park. In Similar study Manish *et al* (2017) revealed that the combination of ambient energy (air temperature, solar radiation, and potential evapo-transpiration) and water availability (soil water content

and precipitation) were the main drivers of elevational plant species richness patterns in the Himalaya. On the other hand Christensen and Hermann-Clausen (2009) reported Species richness of trees, climbers, generally responded negatively to human impact, whereas species richness of herbs and shrubs showed a positive relation from Mustang district of ACA.

5.1.1 Life forms, Use purpose, part used and distribution of NTFPs

Majority of NTFP's life form reported in study area were Herbs which accounted 45% followed by shrub species 25%, tree species 22% and limbers species 8% respectively. Similar results were observed in other studies conducted in Nepal. Bhattarai (2010) reported, the most common growth form was herbs followed by shrubs, trees, and climbers in Mustang district. Similar trend was reported by (Ghimire 2007, Humagain and Shrestha 2009, Acharya 2010, Uprety & Poudel 2010, Rana *et al*. 2015, Uprety *et al.* 2016, Silwal et al. 2018.). Ghimire (2008) reported that 45-70% of the total naturally growing species are long-lived herbaceous perennials followed by shrubs (16.6%), annual/biennial herbs (15.6%), tree (13.6%), woody climbers (6.5%), and herbaceous climbers (2.3%).

NTFP species are used for different purpose as food, treating diseases to use as ornaments. Most species of the NTFPs recorded in the study are were used for medicinal purpose (23) and followed by food (16), aroma, fiber and species and fodder constitute (2) species each while (1) species are used for handicraft and ornaments. Uprety & Poudel 2010 reported medicinal plants comprised the highest number of 56 species (55%); followed by wild edible 26 (25%) (Vegetables 13 and fruits 13) in a study conducted in Bardiya district of western Nepal. Similar results were reported by Uprety (2016) from Kanchenjunga Landscape in eastern Nepal. Piya *et al.* (2011) reported similar results from study conducted in chepang community of Shaktikhor, Chitwan central Nepal. Other similar results were observed by (Chettri *et al*. 2005, Ghimire 2008, and Roy 2010)

Various parts of NTFPs are used depending upon the use purpose ranging from root, tuber, stem, shoot, flower, seed, leaves, bark, latex and resins to whole plant. In this study we found that whole plant of the NTFP species are most commonly used which accounted for 14 species and followed by roots with 12 species and fruits 10 species. Shoot, leaves are only used from 5 species and 3 species respectively while bark are

used from 2 species resin are also used from 2 species and flower are used from 1 species. Malla (2010) reported roots (35%) were used predominantly followed by leaf (32%), whole plant (12%), and bark (6%) from the study conducted in neighboring district of Parbat. In Similar study conducted in Nepal, roots were the most commonly used parts of NTFPs for medicinal purpose (Ghimire 2008, Piya *et al* 2011, and Uprety 2016).

The study area (Machhapuchre Rural muncipilaty) is situated above 1000 masl to above 6000 masl, constituting subtropical, temperate, sub alpine, alpine and nival climatic zone. Most of the NTFP in the study area were distributed in the elevational range of 1000-2000 in sub-tropical zone, constituting 34 species of NTFPs and followed by Temeparte zone (2000-3000) with 7 species, Sub-alpine zone (3000-4000) with 5 species and alpine zone (4000-5000) with 4 species. In similar study conducted in Chitwan - Annapurna landscape, Chitale *et al.* (2018) reported maximum number of NTFP species from subtropical zone with 31 specices followed by temperate zone with 27 species, tropical zone with 22 species, subalpine zone with 16 species and alpine zone with 8 species respectively. The result of this also supports the study of Acharya *et al.* (2009) and Rokaya *et al.* (2012). Most of the NTFP distributed in subalpine and alpine zone are relatively high valued species such as *Ophiocordyceps sinensis,, Dactylorhiza, Rheum nobile, Nardostachys jatamansi, Aconitum palmatum.* The upper tropical, subtropical and temperate eco zone are significant areas in terms of both volume and economic values, while subalpine and alpine areas are known for high average unit values of NTFPs (Larsen *et al* 2005)

5.2 Ecological status of the ten most preferred NTFP species on seven different sites

Density, frequency, area coverage (for herbs and shrubs), Dominance (for Trees), Important Value Index (IVI) and average weight of production per plant and total quantity of production per hector of ten most preferred species were calculated for seven different sites.

In Dhampus, *Artemisia indica* had the highest IVI value (65.15) among other NTFP in Dhampus *Dennstaedtia appendiculata* had the second highest IVI value (48.33) followed by *Berberis asiatica* (40.3). It indicates that these are the most commonly available NTFP in the area with high density, frequency and coverage, since it is very

common species which can grow even in the area with high disturbance and these species are widely used as fodder and bedding material for livestock. Species with lowest IVI were *Asparagus racemosus* (9.78*) Elaeagnus infundibularis* (7.72) and *Dryopteris cochleata* (14.41) which can be due to their scattered distribution or low abundance in the area as these species need specific environmental condition and cannot tolerate the disturbances.

Arundinaria maling had the highest IVI value (59.6) in Lwang ghalel, as it was widely distributed in the rhododendron forest for Lwang ghalel above 2500 masl. *Dryopteris cochleata* (24.36), *Swertia chirayita* (22.24), *Artemisia indica* (22.84) were other species with high IVI. Species like *Paris polyphylla* (4.26) were extremely sparse and were found only in very small numbers even though the area has suitable habitat and according to locals it was very common species until 20 years ago. Madhav *et al.* (2010) from neighboring village of Ghandruk, reported higher density of *Paris polyphylla* (1.78 per m^2) but the distribution was restricted to certain sites only around 2900 m and the number was very low which may be due to the study was strictly focused on *Paris polyphylla* and conducted more than a decade ago. This result also supports the finding of Chettri *et al.* (2012) who reported the IVI value of *Paris polyphylla* (14.6) from Panchase area of the same district. Illegal and over harvesting of the species resulted in the low availability of this species. *Arisaema propinquum* (13.86), *Zanthoxylum armatum* (9.37) were another major NTFP which are declining in numbers due high human pressure.

Asparagus racemosus was found to be most widely distributed species in Rivan with highest IVI value (23.24) which is still quite low IVI comparing to other species from another area. According to the study carried out in Langtang National park by Shrestha and Shrestha (2012) *Asparagus racemosus* was identified as the among the most vulnerable species . All remaining species had IVI value lower than 20 which indicates that all the preferred species like *Dryopteris cochleata, Rubus ellipticus, and Arundinaria maling* have very low density in the area.

Lahchok, was the least significant ward in terms of NTFP resources. *Artemisia indica* (34.28) had the highest IVI closely followed *by Berberis asiatica* (30.44*) Dryopteris cochleata* (28.55) and *Rubus ellipticus* (25.46). These species are the commonly available species in the area near human settlements. As this area is highly populated

resulting in high human pressure on forest resources. Species such as *Centella asiatica, Tinospora sinensis, and Asparagus racemosus* had very low IVI indicating low availability or decreasing trend of these species.

In Gahchok, Zanthoxylum armatum had the highest IVI value (41.18) among other species. These shrubs generally used as spice and medicinal purpose is widely distributed in the forest of northern side of Ghachok village. Myrica esculenta and Dryopteris cochleata are another major NTFP species of this area with (25.25) and (24.57) IVI values. Rest of the species viz. *Dioscorea bulbifera Asparagus racemosus, Girardinia diversifolia* all have IVI below 20 indicating their low abundance in area.

Zanthoxylum armatum were widely distributed in the upper north forest of Machapuchhre, with IVI value of (45.72) followed by Asparagus racemosus (28.11). These two species are most dominant NTFP which are easily available in lower altitude of Machhapuchre. Dryopteris cochleata (13.66), Arundinaria maling (7.99) are another preferred species with low availability, which can be due their patchy distribution. Other higher altitude species are also available in this ward viz. *Ophiocordyceps sinensis, Paris polyphylla, Neopicrorhiza scrophulariiflora, Nardostachys jatamansi, Rheum nobile* but their access is very limited to the locals due to the difficult geographical terrain and altitude. According to the key informants very few peoples goes to collect these species except few shepherds and few professional NTFP collectors.

In Sardikhola, *Arundinaria maling* had the highest IVI value (66.85) followed by *Drepanostachyum falcatum* (52.78). , *Arundinaria maling* is the used as a food delicacy and it also has a good market value. It can also be stored for long term by fermenting. It generally grows above 2200 masl to 3000 masl. *Drepanostachyum falcatum* (52.78) is used for manufacturing household items such as doko, dalo and other products. (Nigalo) *Drepanostachyum falcatum* craft making and trade is the main source of cash income for many farmers in the KSL, including in Ranishikhar VDC in Darchula District (ICIMOD 2015). *Girardinia diversifolia* (38.57), *Dryopteris cochleata* (29.18) are also among the most preferred species. Study conducted in western Nepal by Shah *et al.* (2017) *Girardinia diversifolia* (Himalayan nettle) revaled that value chain development has positive and significant impact on the

households' annual income from the sale of nettle products. Households' annual income from the Himalayan nettle increased by NPR 2265-2410. *Dryopteris cochleata* was also among the most preferred species for wild vegetable and also has good market value in Makwanpur district of central Nepal but their abundance were considered to be rare because they had a high demand at local markets which supports the result of present study (Joshi *et al.* 2015). Aryal *et al.* (2018) also mentioned that the use value of *Dryopteris cochleata* was found highest (0.98) among frequently used vegetable species in Kailash Sacred Landscape, Western Nepal.

5.3 Biodiversity index

Shannon-Wiener index **(H)** was recorded greater in study area such as Machhapuchre (3.044), Sardikohla (3.095) and Lwang (2.70) with larger area with high altitudinal gradients. For further understanding of Shannon-Wiener index value 2.62 it can be converted into effective number of species (ENS), which is real biodiversity and allows to compare the biodiversity with other similar communities. Community with Shannon-Wiener index of H has equivalent diversity as a community containing equally common species of exponential (H), in this case of Machhapuchre Exp (3.044)= 20.98 . This means that this community has an equivalent diversity as a community with 20.98 equally common species. Simpson's Diversity Index represents the probability that two individuals randomly selected belong to different species. It is a measure of diversity which takes into account both richness and evenness. The value (D) ranges between 0 and 1, greater the value of D lesser the diversity. Chettri and Gupta (2007) also revealed that the difference in altitude and the aspect of sampling sites have significant impact on species distribution and there was higher NTFP diversity in lower region of Mustang with relatively wet habitat than the other sites. Thapa and Chapman (2010) reported Shannon–Wiener index value of 2.66 in Thakurdwara and 2.08 in Shivapuri buffer zone of Bardia National Park, western Nepal. In similar study conducted in forest of Ethiopia, Fetene *et al.* (2010) mentioned that Species diversity were highest at intermediate altitude around (2300-2750 m) indicating the influence of altitude in species distribution. Simpson's biodiversity index (D) value was also correlated with the Shannon-Wiener index (H) as area with higher (H) value got the lower (D) value which indicates higher diversity.

5.4 Existing management practices and people's perception

Majority of the locals in the study area belongs to indigenous Gurungs, who were settled in the area since long time and they practice their own traditional and resource management tradition. Richards *et al.* (1999) and Fisher (1990) has documented as such practices in mid Kaveplanchok and Sindhupalchok in mid hills of Nepal. Management for MPs and other NTFPs in most of the rural areas of Nepal is part of traditional forest management system (Ghimire 2008). Local people have developed rules and decides the harvesting period, punishment for violating the rules. Identical practice was reported in Drachula and Humla of KSL by Chaudhary *et al.* (2017) where traditional institutions used to play a decisive role in resource conservation and management of resources. As the study area also falls under the ACA people also follows the rules and regulation implemented by ACA .In recent years their livelihood are now more focused and depended upon tourism industry rather than forest. Existing management practices also includes domestication, commercial farming, call for tender for certain species harvest, appointment of forest guards and regular monitoring from ACA and forest officials and strong rules and regulation implemented by ACA. Chhetri and Gupta (2007) reported that People in mustang are unaware of sustainable harvesting and management similar case was observed in the study area as well. They just freely collect and use the resources and Illegal and premature collections of plants are the main threat for the conservation of NTFPs. Few important medicinal NTFP were found cultivated in home gardens. Bhattrai *et al.* (2010) also mentioned in (Lete, Lomanthang, etc), people have started to conserve medicinal plants by domesticating them in home gardens, but these efforts make up only a small portion of measures necessary to conserve these species. Management and regulation by ACA and government is difficult and expensive in remote high-altitude areas. Management issues such as illegal logging, poaching, grazing, and road construction are the threat to forest resources. Out-migration, is having a positive impact on biodiversity and Decrease in population resulting from out-migration has considerably lowered pressure on the forest in Bhadure Tamagi VDC, Kaski (Kunwar and Acharya, 2013). Similar trend was observed in Rivan and Sardikhola where most of the people had migrated to the city area in lower valleys leaving whole villages empty. Younger generations seemed less interested in NTFP and its potential except for few high valued species such as *Ophiocordyceps sinensis, Paris polyphylla* etc.

Younger generation needs to be informed well about the potential of NTFPs and its role in livelihood and income generation in the study area. Similar tred was reported in Gulmi by Acharya (2012) that Elderly people of a community and the local traditional healers have greater knowledge on NTFP than young people who showed less interest due to which the practice of using plants and plants parts for medicinal use is decreasing in Gulmi district. Madhav *et al.* (2010) also reported the need of awareness among the local people about the sustainable use its cultivation practice for the conservation of *Paris polyphylla* in neighboring VDC of Ghandruk.

People living near forest area were more familiar with NTFP species and their use and values. They store various kinds of medicinal NTFP species for further local use and only few people are well known about the location of specific NTFPs and they harvest upon its need.

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CHAPTER-SIX: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Machhapuchre Rural Municipality of ACA constitutes rich diversity of NTFPs, more than 50 species of NTFPs were recorded to be available in the area. Among those species most of the species were herbs and used for medicinal and edible purpose.

Based on the field visit, consultation with locals and officials from each CAMC we selected most preferred species and among those preferred species top 10 most preferred species all over the study area were *Dryopteris cochleata , Asparagus racemosus , Arundinaria maling , Zanthoxylum armatum , Arisaema propinquum , Myrica esculenta , Artemisia indica , Berberis asiatica, Dioscorea bulbifera and Paris polyphylla* .

Most of them are routinely used as food resources and medicine and they are easily accessible, can be found around forest near settlements. Due to their use value, use intensity and easy access these species were mostly preferred than those rare species which has very high values but are only found in high pasture land. some of those high value rare species such as *Dactylorhiza hatagirea, Neopicrorhiza scrophulariiflora* are also prohibited from commercial collection because of their decreasing number as per law and there are lots of paper work to get permit for collection of those high value species so local people often focuses on easily accessible species around their surroundings.

After assessing Ecological status (frequency, density, coverage, important value index and species diversity index) of top ten most preferred species from each of seven site, CAMC with small area such as Dampus, Rivan, Lahchok, and Ghachok with less diverse habitat, species like *Artemisia indica*, *Berberis asiatica* were found to have higher important value index than other NTFPs species. These species can be found anywhere in the forest and even outside forest area as well so their ecological parameters such as frequency, density, coverage are higher. On other hand CAMC with larger area with much diverse habitat such as Lawng, Machhapuchre, and Sardikhola species like *Arundinaria maling, Zanthoxylum armatum, Dryopteris cochleata* has higher IVI value. CMAC with has larger area and diverse altitudinal gradient containing more diverse habitat had high biodiversity index. There are high

per unit value medicinal species such *as Dactylorhiza hatagirea, Neopicrorhiza scrophulariiflora*, *Ophiocordyceps sinensis, Nardostachys jatamansi,* in the high pasture land of these CAMC which are not easily accessible due to the difficult geographical terrain. IVI value of the most NTFPs were low indicating low abundance and density hence the proper awareness, and knowledge on sustainable harvesting is required for preventing gradual disappearance of these NTFP species. Implementation of effective management plan coordinating with traditional management practices and creating more option for livelihoods for locals can be highly effective for the long term conservation of NTFPs species. Sustainable extraction processing and export of such high value NTFPs can also contribute in the growth of nation's economy.

6.2 Recommendations

Based form the study following recommendation were made for the conservation and sustainability of NTFPs in Machhapuchre Rural muncipilaty, Kaski.

- Extensive study and documentation of NTFPs resources in the area especially which are not easily accessible needs to be carried out.
- More awareness program about NTFPs resources, its status and value and importance and consequences should be carried out. Locals should be informed more about sustainable harvesting practices.
- Training on domestication, value addition, processing of NTFP species with required technology and tools should be provided.
- Fair and equitable benefit sharing among the people and local organization should be carried out with inclusive and transparent mechanism.
- Regular monitoring of forest resources from locals and government officials must be carried not just only in easily accessible area but also in remote areas.
- Strong regulations with effective taxing mechanism should be implemented. Illegal trade should be discouraged with strong punishment. Reducing the lengthy paperwork for permits and taxing of high value species will also discourage illegal trade.
- Must have excellent coordination between local peoples, local organization and governmental organization and scientific experts. Regular meeting and sharing information and new ideas should be carried out.

- Local culture and their traditional management practice must not be overlooked, they should be incorporated in the new management practices for more effective results.

RFERENCES:

Agrawal, A., Cashore, B., Hardin, R., Shepherd, G., Benson, C., Miller, D., 2013. Economic contributions of forests. In: *Background Paper 1*, United Nations Forum on Forests 10th Session. Instanbul

Acharya, G. R., Koirala, P. N., Neupane, L., and Devkota, S. C. (2009). Livelihood option from minor forest produce: context of non-timber forest product and poverty reduction in mid hills of Nepal. *Journal of wetlands ecology*, 57-66.

Acharya, K.P. (2005). Private, collective, and centralized institutional arrangements for managing forest commons in Nepal. *Mountain Research and Development*, **25**(3): 269-277.

Acharya, R. (2012). Ethnobotanical study of medicinal plants of Resunga hill used by Magar community of Badagaun VDC, Gulmi district, Nepal. *Scientific world*, **10**(10): 54-65.

Alexiades, M. N. (1996). Collecting ethnobotanical data: an introduction to basic concepts and techniques. *Advances in economic botany*, **10:** 53-96.

Aryal, K. P., Poudel, S., Chaudhary, R. P., Chettri, N., Chaudhary, P., Ning, W., and Kotru, R. (2018). Diversity and use of wild and non-cultivated edible plants in the western Himalaya. *Journal of ethnobiology and ethnomedicine*, **14**(1): 10.

Banjade, M.R, and Poudel, M.S. (2008) Economic potential of non-timber forest products in Nepal: Myth or reality? *Journal of forest and livelihood* **7**(1): 36–48

Basu, P.S., Banerjee, A., and Palit, D. (2013). Assessment of diversity and resource potential of non-timber forest product (NTFP) in selected sites of Bishnupur forest division of Bankura district, west Bengal, India. *New York Sci. J.*, **6**(5): 46-53.

BCDP. 1994. Final report. Biodiversity Conservation Data Project (BCDP). King Mahendra Trust for Nature Conservation. Annapurna Conservation Area, Kathmandu, Nepal.

Bhattarai S, Chaudhary RP, Quave CL, Taylor RSL. (2010). The use of medicinal plants in the Trans-Himalayan arid zone of Mustang district, Nepal. *Journal of Ethnobiology and Ethnomedicine*. 2010, 6: 14- doi: 10.1186/1746-4269-6-14

Boot, R.G., and Gullison, R.E. (1995). Approaches to developing sustainable extraction systems for tropical forest products. *Ecological Applications*, **5**(4): 896-903.

Chamberlain, J., Cunningham, A.B. and Nasi, R. (2004). Diversity in forest management: non-timber forest products and bush meat. *Renewable Resources Journal,* **22** (2): 11-19.

Chaudhary, R. P., Bhattarai, S. H., Basnet, G., Bhatta, K. P., Uprety, Y., Bhatta, L. D. & Sharma, U. R. (2017). Traditional practice and knowledge of indigenous and local communities in Kailash Sacred Landscape, Nepal. *ICIMOD Working Paper*, (2017/1). ISBN978 92 9115 464 7 (printed) 978 92 9115 465 4 (electronic)

Chettri, N., Sharma, E., and Lama, S. D. (2005). Non-timber forest produces utilization, distribution and status in a trekking corridor of Sikkim, India. *Lyonia*, **8**(1), 89-101.

Chhetri, H.B., and Gupta, V.N.P. (2003). A survey of non-timber forest products (NTFPS) in upper mustang. *Scientific World* **5**(5): 89-94.

Chhetri, M.S., Timilsina, Y.P., Tripathee, H.P., and Devkota, K. P. (2012). Socio-ecological status and antibacterial activity of *Paris polyphylla* from Panchase area of Kaski district. *Nepal journal of science and technology*, **13**(2): 167-174.

Chitale, V., Silwal, R., & Matin, M. (2018). Assessing the Impacts of Climate Change on Distribution of Major Non-Timber Forest Plants in Chitwan Annapurna Landscape, Nepal. *Resources, 7*(4), article no. 66.

Christensen, M., and Heilmann-clausen, J. (2009). Forest biodiversity gradients and the human impact in Annapurna Conservation Area, Nepal. *Biodiversity and conservation*, **18**(8): 2205-2221.

Daubenmire, R. F. (1959). Canopy coverage method of vegetation analysis. Northwest Sci, 33, 39-64.

DFRS. (2015). State of Nepal's forests. Forest resource assessment (FRA) Nepal, Department Of Forest Research and Survey (DFRS). Kathmandu, Nepal.

Dombois, D., & Ellenberg, H. (1974). *Aims and methods of vegetation ecology*. Wiley.

Duchesne, L. C., and Wetzel, S. (2002). Managing timber and non-timber forest product resources in Canada's forests: needs for integration and research. *The forestry chronicle*, **78**(6): 837-842.

Edward, D.M. (1996). Non-timber forest products from Nepal: Aspects of the trade in medicinal and aromatic plants. *Forest monographs*. Kathmandu, Nepal: Forest Research and Survey Center, pp 134

Fetene, A., Bekele, T., and Lemeneh, M. (2010). Diversity of non-timber forest products (ntfps) and their source species in menagesha-suba forest. *Ethiop. J. Biol. Sci*, **9**: 11-34.

Fisher, R.J. (1989). Indigenous systems of common property forest management in Nepal. Working paper no. 18, environment and policy institute, east-west center, Hawaii

FRA/DFRS, (2014). Terai forests of Nepal (2010–2012). Forest resource assessment Nepal project/department of forest research and survey, Babar Mahal, Kathmandu

Ghimire, S.K. (2008). Medicinal plants in the Nepal Himalaya: current issues, sustainable harvesting, knowledge gaps and research priorities. In – *Medicinal Plants in Nepal: An Anthology of Contemporary Research* (eds.: P. K. Jha, S. B. Karmacharya, M. K. Chettri, C. B. Thapa and B. B. Shrestha), Ecological Society (ECOS) Nepal, Pp. 25-44.

Ghimire, S.K., Mckey, D. and Aumeeruddy-Thomas, Y. (2004). Heterogeneity in ethnoecological knowledge and management of medicinal plants in the Himalayas of Nepal: implications for conservation. *Ecology and Society,* **9** (3): article no. 6

Ghimire, S. K. (2007). Developing a community-based monitoring system and sustainable harvesting guidelines for non-timber forest products (NTFP) in Kangchenjunga Conservation Area (KCA), East Nepal. *Final Report submitted to WWF Nepal Program,* Baluwatar, Kathmandu, Nepal.

Ghimire, S. K., Lama, Y. C., Tripathi, G. R., Schmit S. and Aumeeruddy-Thomas, Y.. 2001. *Conservation of the Plant Resources, Community Development and Training in Applied Ethnobotany at Shey Phoksundo National Park and its Buffer-zone, Dolpa.* Fourth Year. WWF Nepal Program Report Series No. 41, WWF Nepal Program, Kathmandu, Nepal.

Hall, P., and Bawa, K. (1993). Methods to assess the impact of extraction of non-timber tropical forest products on plant populations. *Economic Botany* **47**(3): 234-247.

Hall, R.R. (1993). Local knowledge and conventional soil science approaches to erosional processes in the Shvalik Himalaya. *Mountain Research and Development*, **13**(1): 61-72.

Hammett, A.L. non-timber forest products: profits and panacea. *Focus on jaributi* (1993): 2-3.in: biodiversity and conservation, vol. 18, no. 8, 07.2009, p. 2205-2221.

Hammett AL (1993) Non-timber forest products: profits and panacea. In: Edwards DM and Bowen MR (Eds) Focus on Jaributi, pp 2–3. *Biodiversity and*

Conservation, vol. 18, no. 8, 07.2009, p. 2205-2221 Forest Research and Survey Center, Ministry of Forest and Soil Conservation, Nepal

Heinen, J.T., and Shrestha-Acharya, R. (2011). The non-timber forest products sector in Nepal: emerging policy issues in plant conservation and utilization for sustainable development. *Journal of Sustainable Forestry*, **30**(6): 543-563.

Humagain, K., and Shrestha, K.K. (2009). Medicinal plants in Rasuwa district, central Nepal: trade and livelihood. *Botanica Orientalis: Journal of Plant Science*, **6**: 39-46.

Joshi, N., Siwakoti, M., and Kehlenbeck, K. (2015). Wild vegetable species in Makawanpur district, central Nepal: developing a priority setting approach for domestication to improve food security. *Economic Botany*, **69**(2): 161-170.

Kent, m., & coker, p. (1992). *Vegetation description and analysis: a practical aproach* (no. 581.5072 k475v.).

Khakhlary, B. and Sharma, S. (2017). Non-timber forest product: case study of diversity in Garampani Wildlife Sanctuary, Karbi Anglong district, Assam, India. *International Journal of Innovative Research and Advanced Studies* **4** (5): 2394-4404.

Kochhar, S. L. (1998) Economic Botany in the Tropics. Macmillan India, Limited, Madras, India; ISBN 0333931181, 9780333931189,

Larsen, H.O., and Olsen, C.S. (2007). Un-sustainable collection and unfair trade? Uncovering and assessing assumptions regarding central Himalayan medicinal plant conservation. *Biodiversity and conservation*, **16**(6): 1679-1697.

Larsen, H.O., Smith, P.D., and Olsen, C.S. (2005). Nepal's conservation policy options for commercial medicinal plant harvesting: stakeholder views. *Oryx*, **39**(4), 435-441.

Lillesø J-PB, Shrestha TB, Dhakal LP, Nayaju RP, Shrestha R (2005) The map of potential vegetation of Nepal – a forestry/agro-ecological/biodiversity classification system. Forest & Landscape Development and Environment Series 2-2005, Centre for Forest, Landscape and Planning, The Royal Veterinary and Agricultural University, Copenhagen

Luintel H, Banjade MR, Neupane HR & Pandey RK. (2004). Sustainable non-timber forest product management: issues and ways forward. Pp. 43-46 in Kanel K et al. (Eds.). 25 Years of Community Forestry: Contributing to Millennium Development Goals. Proceedings of the Fourth National Workshop on Community Forestry. 4—6 August 2004, Kathmandu.

Madhav, K.C., Phoboo, S., and Jha, P.K. (2010). Ecological study of *Paris polyphylla* sm. *Ecoprint: An International Journal of Ecology*, **17**: 87-93.

Malla, B., and Chhetri, R.B. (2012). Indigenous knowledge on medicinal non-timber forest products (NTFP) in parbat district of Nepal. *Indo Global Journal of Pharmaceutical Sciences*, **2(**2), 213-225.

Manandhar, N.P. (2002). *Plants and people of Nepal*. Timber press. ISBN 0881925276, 9780881925272

Manish, K., Pandit, M.K., Telwala, Y., Nautiyal, D.C., Koh, L.P., and Tiwari, S. (2017). Elevational plant species richness patterns and their drivers across non-endemics, endemics and growth forms in the eastern Himalaya. *Journal of Plant Research*, **130**(5), 829-844.

Mishra, B. and Gyawali, B. (2015). A comparison of land cover change in Kaski district, Nepal. 10.13140/rg.2.1.4880.2401.

Ndah, R. N., Chia, E. L., Andrew, E. E., Bechem, E., Yengo, T. (2013). Spatial distribution and abundance of selected non-timber forest products in the Takamanda National Park. *Int. J. Biodiver. Conserv.* **5**(6): 378-388.

Ojha, H., & Bhattarai, B. (2003). Learning to manage a complex resource: a case of NTFP assessment in Nepal. *International Forestry Review*, *5*(2), 118-127.

Ojha, H. 2000. Current Policy Issues of NTFP Development in Nepal. Kathmandu: *Asia Network for Sustainable Agriculture and Bioresources* (ANSAB).

Olsen, C. S. (1998). The trade in medicinal and aromatic plants from central Nepal to Northern India. Economic Botany, 52(3), 279–292.

Pandey, A.K., Tripathi, Y.C. and Kumar, A. (2016). Non timber forest products (NTFPS) for sustained livelihood: challenges and strategies. *Research Journal of Forestry*, **10**(1): 1-7.

Piya, L., Maharjan, K. L., Joshi, N. P., & Dangol, D. R. (2011). Collection and marketing of non-timber forest products by Chepang community in Nepal. *Journal of Agriculture and Environment*, *12*, 10-21.

Pyakurel, D. and Baniya, A. 2011. *NTFPS, impetus for conservation and livelihood support in Nepal*. Report submitted to WWF Nepal,

Rai, L. K., Prasad, P. and Sharma, E. (2000). Conservation threats to some important medicinal plants of the Sikkim Himalaya. *Biological Conservation* **93**(1): 27-33.

Rai, S. K., Sharma, S., Shrestha, K. K., Gajurel, J. P., Devkota, S., Nobis, M. P., And Scheidegger, C. (2016). Effects of the environment on species richness and composition of vascular plants in Manaslu Conservation Area and Sagarmatha Region of Nepalese Himalaya. *Banko janakari*, **26**(1): 3-16.

Rana, S. K., Oli, P. S., and Rana, H. K. (2015). Traditional botanical knowledge (tbk) on the use of medicinal plants in sikles area, Nepal. *Asian Journal of Plant Science and Research*, **5**(11): 8-15.

Richards, M., Kanel, K., Maharjan, M., & Davies, J. (1999). *Towards participatory economic analysis by forest user groups in Nepal*. ODI.

Kunwar, R. M., & Acharya, R. P. (2013). *Impact Assessment of Invasive Plant Species in Selected Ecosystems of Bhadaure Tamagi VDC, Kaski: An Ecosystem-Based Adaptation in Mountain Ecosystem in Nepal*. IUCN Nepal.

Rokaya, M. B., Münzbergová, Z., Shrestha, M. R., and Timsina, B. (2012). Distribution patterns of medicinal plants along an elevational gradient in central Himalaya, Nepal. *Journal of mountain science*, **9**(2), 201-213.

Roy, R. (2010). Contribution of NTFPS (Non-Timber Forest Products) to livelihood in upper Humla, Nepal. PhD thesis, submitted to School of Environment, Resources and Development, Asian institute of technology.

Schaafsma, M., Morse-Jones, S., Posen, P., Swetnam, R. D., Balmford, A., Bateman, I. J. & Geofrey, V. (2014). The importance of local forest benefits: Economic valuation of Non-Timber Forest Products in the Eastern Arc Mountains in Tanzania. *Global Environmental Change*, *24*, 295-305.Shackleton, C.M., and Pandey, A.K. (2014). Positioning non-timber forest products on the development agenda. *Forest Policy and Economics* **38**: 1-7.

Shah, G. M., Khadka, M. S., Ahmad, F., Budhathoki, N., and Shrestha, A. J. (2017). Assessment of Himalayan nettle (*Girardinia diversifolia*) value chain development interventions: evidences from rural households in the far western Nepal. *J. Agric. Sci*, **9**: 19.

Shahabuddin, G. and Prasad, S. (2004). assessing ecological sustainability of non-timber forest produce extraction: the Indian scenario. *Conservation and Society*, 235-250.

Sharma, B.K., and Kandel, R.C. (2014). Status of potential non-timber forest products for wise use and conservation in the Langtang National Park's Buffer zone. *Journal of Natural History Museum*, **28**: 102-107.

Shrestha, K. K., Tiwari, N. N., Rajbhandari, S., Shrestha, S., Uprety, Y., & Poudel, R. C. (2003). Non-timber forest products (NTFPs) in the critical bottlenecks and corridors of Terai Arc-Landscape Nepal: Documentation, utilization, trade and people's livelihood. *Kathmandu, Nepal: WWF Nepal Program*.

Shrestha, K.K., Tiwari, N.N. and Ghimire, S.K. (2000). Mapdon-medicinal and aromatic plant database of Nepal. *In: Proceedings of Nepa/- Japan Symposium on Conservation and Utilization of Himalayan Medicinal Resources*. Department of Plant Resources, Ministry of Forest and Soil Conservation,

Government of Nepal, Kathmandu, Nepal and Society For the Conservation and Development of Himalayan Medicinal Resources (Scdhmr), Tokyo, Japan. Pp. 53-74.

Shrestha, N., and Shrestha, K.K. (2012). Vulnerability assessment of high-valued medicinal plants in langtang national park, central Nepal. *Biodiversity*, **13**(1): 24-36.

Shrestha, P.R., and Das, P.K. (2008). Critical review of policy issues and strategic vision related to sustainable harvesting transportation and trade of NTFPS in Nepal. A paper presented in the national workshop on 'non- timber forest products and medicinal plants based enterprise development opportunities and challenges' organized by Nepal foresters 'Association, 20 Feb., 2008. *Kathmandu: medium enterprise development program, UNDP and government of Nepal*.

Silwal, R., Maharjan, S., Shrestha, B., Chitale, V., & Murthy, M. (2018). An Innovative Approach for Understanding the Patterns in Distribution and Extraction of Non-Timber Forest Products in Chitwan Annapurna Landscape, Nepal. *Indian For*, *144*, 243-251.

Subedi, B.P., 2006. Linking Plant-Based Enterprises and Local Communities to Biodiversity Conservation in Nepal Himalaya. Adroit Publishers, New Delhi, India, ISBN-13: 9788187392705

Subedi, B.P. 1997. Utilization of NonTimber Forest Products: Issues and Strategies for Environmental Conservation and Economic Development. A Theme Paper for the Workshop on the Utilization of NTFPs for Environmental Conservation and Economic Development in Nepal, March 29, 1997, Kathmandu: Asia Network for Small Scale Bioresources.

Thapa, S., and Chapman, D.S. (2010). Impacts of resource extraction on forest structure and diversity in Bardia National Park, Nepal. *Forest ecology and management*, **259**(3): 641-649.

Ticktin, T. (2004). The ecological implications of harvesting non- timber forest products. *Journal of Applied Ecology*, **41**(1): 11-21.

Uprety, Y., Poudel, R.C. (2010). *Medicinal plants of Nepal: an analysis of use, trade and conservation in the Rasuwa district*. Germany: Lap Lambert Academic Publishing, pp 124

Uprety, Y., Poudel, R. C., Gurung, J., Chettri, N., and Chaudhary, R. P. (2016). Traditional use and management of NTFPS in Kangchenjunga landscape: implications for conservation and livelihoods. *Journal of Ethnobiology and Ethnomedicine*, **12**(1), 19.

Vermeulen, W. J. (2009). *The sustainable harvesting of non-timber forest products from natural forests in the southern Cape, South Africa: Development of*

harvest systems and management prescriptions (Doctoral dissertation, Stellenbosch: University of Stellenbosch).

BCDP 1994. Biodiversity Conservation Database Project Report. King Mahendra Trust for Nature Conservation, Jawalakhel. Nepal.

Wong, J. (2000, May). Developing need-based inventory methods for NTFP. In Application and development of current research to identify practical solutions for developing countries. *Paper submitted in workshop on developing need based inventory methods for NTFP* (pp. 4-5).

Wong, J. L. G., Thornber, K., and Baker, N. (2001). Resource assessment of non-wood forest products: experience and biometric principles (vol. 13). *Food and agriculture org.*

Yadav, B. R., Dutta, I. C., Chilese, M. K., Williums, C., & Sharma, B. K. (2013). Habitat utilization by Asiatic wild elephant (Elephus maximus) in Parsa Wildlife Reserve, Nepal. *Ecoprint: An International Journal of Ecology*, *20*, 41-52.

Zobel, D.B., P.K. Jha, M.J. Behan and U.K.R. Yadav. 1987. A Practical Manual for Ecology. Ratna Book Distributors, Kathmandu, Nepal.

Online sources:

https://www.ceicdata.com/en/country/nepal retrived on 2018/12/20

Http://www.dhm.gov.np/climate/ dhm 2018 department of hydrology and meteorology retrieved on 2018/12/20

Https://portals.iucn.org/library/efiles/documents/iucn-2014-017.pdf retrieved on 2019/01/06

http://www.fao.org/forestry/nwfp/6388/en/ retrived on 2018/10/7

Http://mofaga.gov.np retrived on 2018/12/20

Http://www.icimod.org/ar2015 retrieved on 2019/01/05

Https://cbs.gov.np/ cbs 2011 retrieved on 2019/01/10

MoFALD. 2017. Ministry of Federal Affairs and Local Development, Kathmandu, http://www.mofald.gov.np/en/node/2935 retrieved on 2019/01/13

ANNEX-I

Annex I Availability of different NTFPs species among different sites in the study area. (+) signs indicating the presence of species while (-) signs indicating absence.

S. N.	Common Name	Scientific name	Dhampus	Rivan	Lwang Ghalel	Lahchok	Ghachok	Machhapuchhre	Sardikhola
1	Nigalo	*Drepanostachyum falcatum*	-	-	+	-	-	-	+
2	Bhutkesh	*Saussurea bhutkesh Fujikawa & H. Ohba, Edinburgh J.*	-	-	-	-	-	+	-
3	Chutro	*Berberis asiatica Roxb. ex DC.*	+	+	+	+	+	+	+
4	Pipla	*Piper longum L.*	-	-	-	-	-	-	+
5	Sunakhari	*Coelogyne cristata Lindl.*	-	-	+	-	-	+	-
6	Tejpat	*Cinnamomum tamala (Buch.-Ham.) T.Nees & C.H.Eberm.*	-	+	-	-	+	+	-
7	Khole saag	*Nasturtium officinale R. Brown*	+	-	+	-	-	-	-
8	Yarsagunbu	*Ophiocordyceps sinensis (Berk.)*	-	-	+	-	-	+	-
9	Kurilo	*Asparagus racemosus Willd.*	+	+	+	+	+	+	+
10	Mahalo	*Viburnum mullaha Buchanan-Hamilton ex D. Don*	-	-	-	-	+	+	+
11	Kutki	*Neopicrorhiza scrophulariiflora (Pennell) D.Y.Hong*	-	-	+	-	-	+	+
12	Jatamasi	*Nardostachys jatamansi (D.Don) DC.*	-	-	+	-	+	+	+
13	Sano abhijalo	*Drymaria cordata subsp. diandra (Blume)*	-	+	-	-	-	-	-
14	Tusa	*Arundinaria maling Gamble*	-	+	+	+	+	+	+
15	Indreni lahara	*Cuscuta reflexa Roxb.*	-	-	+	-	-	-	-
16	Unieu	*Dennstaedtia appendiculata (Wall. ex Hook.)*	+	+	+	+	+	+	+

		J.Sm.							
17	Halhale	*Rumex nepalensis Spreng.*	+	+	-	-	-	+	+
18	Satuwa	*Paris polyphylla Sm.*	-	+	+	-	+	+	+
19	Githhe Tarul	*Dioscorea bulbifera L.*	-	-	+	-	+	+	+
20	Padamchal	*Rheum nobile Hook.f. & Thomson*	-	+	+	-	+	+	+
21	Saldhup	*Shorea robusta Roth*	-	-	+	-	-	-	+
22	Guyeli	*Elaeagnus infundibularis Momiyama*	+	+	-	-	-	+	-
23	Gajurgano	*Tinospora sinensis (Lour.) Merr.*	-	-	+	+	+	+	+
24	Asuro	*Adhatoda vasica Nees.*	-	+	-	+	+	-	+
25	Sunpati	*Rhododendron anthopogon - D.Don.*	-	-	+	-	-	-	-
26	Gurans	*Rhododendron arboreum Sm.*	-	-	+	-	-	+	+
27	Bakhamilo	*Rhus chinensis Mill.*	-	+	+	-	-	+	-
28	Paanchaule	*Dactylorhiza hatagirea (D.Don) Soó*	-	+	+	-	+	+	+
29	Titepati	*Artemisia indica Willd.*	+	+	+	+	+	+	+
30	Naagbeli	*Lycopodiella cernua (L.) Pic. Serm.*	-	-	+	-	-	-	+
31	Nirmasi	*Aconitum palmatum D.Don*	-	+	+	-	+	+	-
32	Okhar	*Juglans regia L.*	-	+	+	+	-	+	-
33	Niguro	*Dryopteris cochleata (D.Don) C.Chr.*	+	+	+	+	+	+	+
34	Siltimur	*Litsea cubeba (Lour.) Pers*	-	-	+	-	-	+	+
35	Gaaja	*Cannabis sativa L*	+	+	+	+	+	+	+
36	Kaphal	*Myrica esculenta Buch.-Ham. ex D.Don*	+	+	+	+	+	+	+
37	Ghodtapre	*Centella asiatica (L.) Urb.*	+	+	+	+	-	+	-
38	Dhakayo	*Arisaema propinquum Schott*	-	+	+	-	+	+	+

39	Chiraito	*Swertia chirayita roxb. Ex. Fleming K arsten*	+	+	+	+	+	+	+
40	Bikh	*Aconitum palmatum D.Don*	-	-	+	-	-	+	+
41	Ainselu	*Rubus ellipticus Sm.*	+	+	+	+	+	+	+
42	Majitho	*Rubia manjith Roxb. ex Fleming*	-	-	+	-	+	-	-
43	Timur	*Zanthoxylum armatum DC.*	+	+	+	+	+	+	+
44	Pakhnabed	*Bergenia ciliata (Haw.) Sternb. Revis. Saxifrag. suppl.*	-	+	+	+	+	+	+
45	Lothsalla	*Taxus wallichiana Zucc.*	-	+	-	-	+	+	+
46	Lokta	*Daphne bholua Buch.-Ham. ex D. Don*	-	+	+	+	+	+	+
47	Allo	*Girardinia diversifolia (Link) Friis*	+	+	+	-	+	+	+
48	Sisno	*Urtica dioica L.*	+	+	+	+	+	+	+
49	Bhirmaha	*Apis dorsata laboriosa*	-	+	-	-	-	+	-
50	Chyau	*Mushroom*	+	+	+	+	+	+	+

ANNEX-II

Field Sampling details and location of the study sites

Plot No	Date	District	CAMC	Altitude	Forest type	Aspect	Canopy cover	Locality	Easting	Northing
	DHAMPUS									
1	15-Jun-17	kaski	Dhampus	1560 m	chilaune forest	south	71%		83,51'17.92"	28,17'51.28"
2	15-Jun-17	kaski	Dhampus	1573 m	chilaune forest	south	45%		83,51'16.32"	28,17'51.77"
3	15-Jun-17	kaski	Dhampus	1587 m	chiluane forest	south west	67%		83,51'15.75"	28,17'52.74"
4	15-Jun-17	kaski	Dhampus	1613 m	chilaune forest	south west	21%		83,51'14.97"	28,17'54.34"
5	15-Jun-17	kaski	Dhampus	1640 m	chilaune forest	south	32%		83;51'15.28"	28,17'55.97"
6	15-Jun-17	kaski	Dhampus	1420 m	mixed forest	south	74%	bhun khola	83,50'54.73"	28,18'41.16"
7	15-Jun-17	kaski	Dhampus	1424 m	mixed forest	south	69%	bhun khola	83,50'52.01"	28,18'42.50"
8	15-Jun-17	kaski	Dhampus	1434 m	mixed forest	south	72%	bhun khola	83,50'49.22"	28,18'43.83"
9	15-Jun-17	kaski	Dhampus	1405 m	mixed forest	south east	87%	bhun khola	83,50'46.94"	28,18'46.84"
10	15-Jun-17	kaski	Dhampus	1431 m	mixed forest	south east	76%	bhun khola	83,50'43.31"	28,18'46.67"
11	15-Jun-17	kaski	Dhampus	1342 m	mixed forest	south	86%		83,50'54.91"	28,18'59.64"
12	15-Jun-17	kaski	Dhampus	1362 m	mixed forest	south	86%		83,50'55.56"	28,18'57.04"
13	15-Jun-17	kaski	Dhampus	1372 m	mixed forest	south	49%		83,50'54.25"	28,18'57.52"
14	15-Jun-17	kaski	Dhampus	1358 m	mixed forest	south	65%		83,50'54.24"	28,18'58.65"
15	15-Jun-17	kaski	Dhampus	1351 m	mixed forest	south	67%		83,50'54.15"	28,19'00.26"
	RIVAN									
1	17-Jun-17	Kaski	Rivan	1399 m	mixed forest	south	80%		83,54'36.77"	28,19'24.03"
2	17-Jun-17	Kaski	Rivan	1386 m	mixed forest	south	78%		83,54'34.95"	28,19'24.54"
3	17-Jun-17	Kaski	Rivan	1378 m	mixed forest	south	87%		83,54'33.67"	28,19'25.09"
4	17-Jun-17	Kaski	Rivan	1353 m	mixed forest	south	95%		83,54'31.89"	28,19'24.86"
5	17-Jun-17	Kaski	Rivan	1333 m	mixed forest	south	81%		83,54'31.17"	28,19'23.53"
6	17-Jun-17	Kas	Rivan	1658	mixed	south	84%		83,54'3	28,19'4

		ki		m	forest	west			1.87"	1.78"
7	17-Jun-17	Kaski	Rivan	1610 m	mixed forest	south	84%		83,54'28.51"	28,19'40.29"
8	17-Jun-17	Kaski	Rivan	1665 m	mixed forest	south	91%		83,54'33.08"	28,19'40.07"
9	17-Jun-17	Kaski	Rivan	1684 m	mixed forest	east	79%		83,54'35.97"	28,19'43.28"
10	17-Jun-17	Kaski	Rivan	1696 m	mixed forest	south west	81%		83,54'40.40"	28,19'46.26"
11	17-Jun-17	Kaski	Rivan	1423 m	mixed forest	south west	69%	Kaur ebhir	83,54'32.75"	28,20'07.08"
12	17-Jun-17	Kaski	Rivan	1425 m	mixed forest	south west	69%	Kaur ebhir	83,54'32.00"	28,20'09.33"
13	17-Jun-17	Kaski	Rivan	1463 m	mixed forest	south west	74%	Kaur ebhir	83,54'32.79"	28,20'11.15"
14	17-Jun-17	Kaski	Rivan	1394 m	mixed forest	south west	81%	Kaur ebhir	83,54'30.74"	28,20'05.09"
15	17-Jun-17	Kaski	Rivan	1423 m	mixed forest	south west	69%	Kaur ebhir	83,54'32.16"	28,19'57.66"
	Lahchok									
1	16-Jun-17	Kaski	Lahchok	1424 m	chilaune forest	south	59%		83,55'34.43"	28,19'04.48"
2	16-Jun-17	Kaski	Lahchok	1472 m	chilaune forest	south	46%		83,55'35.53"	28,19'06.53"
3	16-Jun-17	Kaski	Lahchok	1498 m	chilaune forest	south	23%		83,55'35.61"	28,19'07.86"
4	16-Jun-17	Kaski	Lahchok	1534 m	chilaune forest	south	84%		83,55'36.11"	28,19'09.62
5	16-Jun-17	Kaski	Lahchok	1549 m	chilaune forest	south	70%		83,55'37.33"	28,19'11.03"
6	16-Jun-17	Kaski	Lahchok	1602 m	chilaune forest	south	75%		83,55'33.55"	28,19'18.13"
7	16-Jun-17	Kaski	Lahchok	1599 m	chilaune forest	south	49%		83,55'33.34"	28,19'19.45"
8	16-Jun-17	Kaski	Lahchok	1603 m	chilaune forest	south	66%		83,55'33.40"	28,19'22.77"
9	16-Jun-17	Kaski	Lahchok	1606 m	chilaune forest	south	71%		83,55'31.76"	28,19'25.54"
10	16-Jun-17	Kaski	Lahchok	1590 m	chilaune forest	south	66%		83,55'29.60"	28,19'27.26"
11	16-Jun-17	Kaski	Lahchok	1614 m	mixed forest	south	81%		83,55'29.44"	28,19'30.28"
12	16-Jun-17	Kaski	Lahchok	1638 m	mixed forest	south	81%		83,55'29.70"	28,19'32.00"
13	16-Jun-17	Kaski	Lahchok	1630 m	mixed forest	south	86%		83,55'27.99"	28,19'33.86"
14	16-Jun-17	Kaski	Lahchok	1619 m	mixed forest	south	79%		83,55'26.15"	28,19'33.42"
15	16-Jun-17	Kaski	Lahchok	1561 m	mixed forest	south	74%		83,55'23.12"	28,19'32.35"
	GHACH									

	OK									
1	18-Jun-17	Kaski	Ghachok	1462m	mixed forest	south west	69%		83,56'16.22"	28,19'52.36"
2	18-Jun-17	Kaski	Ghachok	1472m	mixed forest	south west	64%		83,56'18.74"	28,19'55.63"
3	18-Jun-17	Kaski	Ghachok	1483m	mixed forest	south west	84%		83,56'15.60"	28,19'56.80"
4	18-Jun-17	Kaski	Ghachok	1524m	mixed forest	south west	66%		83,56'12.92"	28,19'56.83"
5	18-Jun-17	Kaski	Ghachok	1551m	mixed forest	south west	68%		83,56'10.92"	28,19'56.39"
6	18-Jun-17	Kaski	Ghachok	1622m	mixed forest	south west	61%		83,56'05.98"	28,19'55.35"
7	18-Jun-17	Kaski	Ghachok	1651m	mixed forest	south	69%		83,56'04.31"	28,19'55.86"
8	18-Jun-17	Kaski	Ghachok	1677m	mixed forest	south	76%		83,56'02.37"	28,19'55.02"
9	18-Jun-17	Kaski	Ghachok	1679m	mixed forest	south	72%		83,56'01.77"	28,19'55.99"
10	18-Jun-17	Kaski	Ghachok	1669m	mixed forest	south	86%		83,56'02.40"	28,19'56.79"
11	18-Jun-17	Kaski	Ghachok	1517m	mixed forest	south	89%		83,56'31.71"	28,19'43.09"
12	18-Jun-17	Kaski	Ghachok	1448m	mixed forest	south	73%		83,56'34.47"	28,19'43.30"
13	18-Jun-17	Kaski	Ghachok	1501m	mixed forest	south	75%		83,56'36.20"	28,19'45.02"
14	18-Jun-17	Kaski	Ghachok	1543m	mixed forest	south	54%		83,56'36.47"	28,19'46.57"
15	18-Jun-17	Kaski	Ghachok	1348m	mixed forest	south	59%		83,56'29.23"	28,19'41.73"
	MACHAPUCHRE									
1	19-Jun-17	Kaski	Machapuchre	1410m	mixed forest	east	44%		83,57'02.21"	28,20'11.33"
2	19-Jun-17	Kaski	Machapuchre	1437m	mixed forest	east	48%		83,57'13.70"	28,20'13.70"
3	19-Jun-17	Kaski	Machapuchre	1455m	mixed forest	east	24%		83,56'58.58"	28,20'16.33"
4	19-Jun-17	Kaski	Machapuchre	1495m	mixed forest	east	51%		83,56'58.69"	28,20'19.71"
5	19-Jun-17	Kaski	Machapuchre	1556m	mixed forest	east	56%		83,56'58.75"	28,20'23.50"
6	19-Jun-17	Kaski	Machapuchre	1753m	mixed forest	east	61%		83,56'44.60"	28,20'27.50"
7	19-Jun-17	Kaski	Machapuchre	1777m	mixed forest	east	66%		83,56'42.42"	28,20'25.46"
8	19-Jun-17	Kaski	Machapuchre	1800m	mixed forest	east	36%		83,56'40.28"	28,20'24.57"

9	19-Jun-17	Kaski	Machapuchre	1821m	mixed forest	east	39%		83,56'38.49"	28,20'24.97"
10	19-Jun-17	Kaski	Machapuchre	1840m	mixed forest	east	50%		83,56'36.63"	28,20'25.69"
11	19-Jun-17	Kaski	Machapuchre	1851m	mixed forest	east	64%		83,56'35.86"	28,20'24.93"
12	19-Jun-17	Kaski	Machapuchre	1861m	mixed forest	north east	66%		83,56'35.19"	28,20'23.86"
13	19-Jun-17	Kaski	Machapuchre	1883m	mixed forest	north east	84%		83,56'33.23"	28,20'23.96"
14	19-Jun-17	Kaski	Machapuchre	1893m	mixed forest	east	86%		83,56'31.51"	28,20'23.21"
15	19-Jun-17	Kaski	Machapuchre	1909m	mixed forest	east	88%		83,56'29.23"	28,20'23.79
	SARDIKHOLA									
1	20-Jun-17	Kaski	Sardikhola	1605m	mixed forest	south	39%	mili lehe	83,58'47.41"	28,21'08.86"
2	20-Jun-17	Kaski	Sardikhola	1652m	mixed forest	south	74%	mili lehe	83,58'48.51"	28,21'11.27"
3	20-Jun-17	Kaski	Sardikhola	1682m	mixed forest	south	29%	mili lehe	83,58'46.88"	28,21'12.72"
4	20-Jun-17	Kaski	Sardikhola	1735m	mixed forest	south	84%	mili lehe	83,58'46.18"	28,21'15.27"
5	20-Jun-17	Kaski	Sardikhola	1781m	mixed forest	south	64%	mili lehe	83,58'45.49"	28,21'17.58"
6	20-Jun-17	Kaski	Sardikhola	1881m	mixed forest	north	81%		83,59'03.52"	28,21'23.70"
7	20-Jun-17	Kaski	Sardikhola	1920m	mixed forest	north west	42%		83,59'05.63"	28,21'26.53"
8	20-Jun-17	Kaski	Sardikhola	1989m	mixed forest	north west	51%		83,59'09.00"	28,21'29.98"
9	20-Jun-17	Kaski	Sardikhola	2044m	mixed forest	north west	54%		83,59'12.29"	28,21'33.69"
10	20-Jun-17	Kaski	Sardikhola	2072m	mixed forest	west	58%		83,59'15.11"	28,21'35.28"
11	20-Jun-17	Kaski	Sardikhola	2430m	mixed forest	south	81%	piprang	83,59'30.52"	28,21'58.55"
12	20-Jun-17	Kaski	Sardikhola	2466m	mixed forest	south	78%	piprang	83,59'33.17"	28,22'01.25"
13	20-Jun-17	Kaski	Sardikhola	2487m	mixed forest	south	94%	piprang	83,59'35.41"	28,22'03.93"
1	20-Jun-	Kas	Sardikh	249	mixed	sout	91	pipra	83,59'3	28,22'

4	17	ki	ola	6m	forest	h	%	ng	8.07"	06.93"
15	20-Jun-17	Kaski	Sardikhola	2505m	mixed forest	south	89%	piprang	83,59'42.11"	28,22'08.42"
	LAWNG GHALEL									
1	22-Jun-17	Kaski	Lwang Ghalel	2075m	mixed forest	east	86%	siding	83,52'09.17"	28,23'09.99"
2	22-Jun-17	Kaski	Lwang Ghalel	2096m	mixed forest	east	84%	siding	83,52'07.37"	28,23'11.12"
3	22-Jun-17	Kaski	Lwang Ghalel	2127m	mixed forest	east	75%	siding	83,52'05.34"	28,23'11.50"
4	22-Jun-17	Kaski	Lwang Ghalel	2160m	mixed forest	east	75%	siding	83,52'03.13"	28,23'11.57"
5	22-Jun-17	Kaski	Lwang Ghalel	2189m	mixed forest	east	91%	siding	83,52'00.68"	28,23'12.24"
6	22-Jun-17	Kaski	Lwang Ghalel	2824m	dense rhododendron forest	south east	96%	low camp	83,51'27.70"	28,23'58.30"
7	22-Jun-17	Kaski	Lwang Ghalel	2896m	dense rhododendron forest	south east	97%	low camp	83,51'27.12"	28,24'02.30"
8	22-Jun-17	Kaski	Lwang Ghalel	2924m	dense rhododendron forest	south east	91%	low camp	83,51'26.13"	28,24'03.73"
9	22-Jun-17	Kaski	Lwang Ghalel	2957m	dense rhododendron forest	south east	93%	low camp	83,51'25.40"	28,24'05.71"
10	22-Jun-17	Kaski	Lwang Ghalel	2980m	dense rhododendron forest	south east	96%	low camp	83,51'24.50"	28,24'07.55"
11	22-Jun-17	Kaski	Lwang Ghalel	3209m	dense rhododendron forest	south east	89%	badal danda	83,51'22.67"	28,24'43.74"
12	22-Jun-17	Kaski	Lwang Ghalel	3223m	dense rhododendron forest	south east	79%	badal danda	83,51'20.54"	28,24'46.33"
13	22-Jun-17	Kaski	Lwang Ghalel	3235m	dense rhododendron forest	east	64%	badal danda	83,51'20.95"	28,24'48.79"
1	22-Jun-	Kas	Lwang	324	dense	east	71	badal	83,51'2	28,24'

4	17	ki	Ghalel	7m	rhododendron forest		%	danda	0.11"	51.31"
15	22-Jun-17	Kaski	Lwang Ghalel	3278m	dense rhododendron forest	south east	43 %	badal danda	83,51'19.38"	28,24'56.03"

Annex-III

Field form used for data collection

District: …… CAMC: ……. Plot No: ……. Altitude: ……..……m

Date: …… Forest type: ……..……
Aspect: ……..……

Canopy cover (for tree plot only): ……. N …… E …… S ……..… W ……C ……..%

Coordinates: Easting: ……..……..… Northing: ……...……

Locality: ……

Tree characteristics (>5cm dbh) – in 10 m radius circular plot

SN	Species Name	DBH (cm)	Height (m)	Yield (gm)							Remarks
				Leaf	Bark	Stem/Shoots	Roots	Fruit/seeds	Whole plant	Other/Specify	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
Shrubs Climbers and seedlings Characteristics in 2m radius plot											
SN	Species Name	Collar diameter (cm)	Height (m)	Yield (gm)							Remarks
				Leaf	Bark	Stem/Shoots	Roots	Fruit/seeds	Whole plant	Other/Specify	
1											
2											
3											

4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											

Herbs characteristics – in 0.57 m radius circular plots (N & S cardinal directions in tree plots)

SN	**Species Name**	**Collar diameter (cm)**	**Height (m)**	**Yield (gm)**							**Remarks**
				Leaf	**Bark**	**Stem/Shoots**	**Roots**	**Fruit/seeds**	**Whole plant**	**Other/Specify**	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											

Annex IV

DCA					
Axes	1	2	3	4	Total inertia
Eigenvalues :	0.763	0.655	0.438	0.316	7.782
Lengths of gradient :	4.567	6.935	4.184	4.843	
Species-environment correlations :	0.343	0.71	0.206	0.123	
Cumulative percentage variance					
of species data :	9.8	18.2	23.9	27.9	
of species-environment relation:	5.9	55.5	0	0	

CCA					
Axes	1	2	3	4	Total inertia
Eigenvalues :	0.437	0.098	0.748	0.665	7.782
Species-environment correlations :	0.877	0.512	0	0	
Cumulative percentage variance					
of species data :	5.6	6.9	16.5	25	
of species-environment relation:	81.7	100	0	0	

Questionnaire

1. What are the Non timber forest products available in your area?
2. Use purpose of the NTFPs?
3. Used parts of the NTFPs?
4. What are the ten most preferred NTFPs in the area based on availability, use intensity, accessibility and trade value?
5. Where is the most NTFPs are found (Hotspot) in your area?
6. How do you harvest the NTFPs? Do you know about sustainable harvesting?
7. What is the past and present status of NTFPs regarding its availability in your area?
8. What are the existing management practices of forest resources in your area?

Photo plate 1

Paris polyphylla Sm.

Zanthoxylum armatum DC.

Asparagus racemosus Willd.

During field visit in Dhamp

Photo plate 2

Consulting with locals in Sardikhola

Field visit in Sradikhola

Swertia chirayita (Roxb. ex Fleming) Karsten

Arundinaria maling Gamble