

2022

Study of Endangered and Rare NTFPs Species in Mustang District, Nepal



Submitted to :
Division Forest Office, Gandaki
Province, Mustang, Nepal

Submitted by :
Eco And Legal Services Pvt. Ltd.

Contact No: +9779846028133



Acknowledgements

We would like to acknowledge the Division Forest Office (DFO), Mustang for giving us the opportunity to undertake this research study. Our special thanks go to **Mr. Basant Keshav Adhikari** for providing the invaluable time, resources, and knowledge on **“Rare and Endangered Medicinal Plants/NTFPs of Mustang district, Nepal”**, without which materialization of the report in this form would not have been possible. We wish to thank Ms. Bishnu Pun (Information Officer, DFO, Mustang) and Mr. Narayan Shrestha (Officer, DFO , Mustang) for their assistance in arranging in the field visit activities. Special thanks go to Mrs. Dhanu Gurung (Natural Resource Conservation Assistant, Unit conservation office, Annapurna Conservation Area Project (ACAP), Jomsom) for sharing their implementation experience and key issues related to endangered medicinal plants, and working strategies. Similarly, we are thankful to Mr. Pramish Gauchan (Secretary, CAMC, Lete), and other chairpersons and secretaries of Conservation Area Management Committees (CAMCs) of ACAP Mustang for their excellent support in arranging field meetings and site observations.

Our cordial thanks go to the DFO Mustang Family, Gandaki Province staff, staff members for describing field situations and conservation strategies of rare and endangered species of Mustang, Nepal. We are indebted to all the participants of the Focus Group meetings and respondents of the interviews for their patience, cooperation, and valuable time in sharing their insights and experiences. We hope that the recommendations proposed from this study will be helpful to further improve and strengthen the DFO, Mustang.

Community people of Lete, Kobang, Gharkot, Tukuche, Ghansha, Lomanthang and have contributed in a myriad of ways by sharing their invaluable time, for providing meaningful ideas, suggestions, and comments during the entire research period. Our consultancy deserves the excessive thanks and special gratitude for providing the opportunity on research on rare and endangered medicinal plants of Mustang district, Nepal.

Team members of Eco and Legal Services

1. Mr. Damodar Gaire, Medicinal Plants Specialist
2. Mr. Shubhashis Bhattarai, Team Coordinator/ Researcher
3. Mr. Aadarsha Neupane, GIS Analyst
4. Ms. Namuna Chapagain , Environmental Conservationist
5. Mr. Shashi Aryal, Assistant Forest Technician

Executive summary

Abstract

The study entitled “**Rare and Endangered NTFPs Species in Mustang district**” was carried out at the major potential sites of Mustang district. Listing out the major rare and endangered species, their status, biophysical analysis, local people’s perception of threatened NTFPs species, and long-term conservation measures were the key objectives of the research. For the biophysical measurement, purposive sampling was carried out with 0.5% sampling intensity of the effective area. Effective areas were identified according to major habitat availability, local people citations, and various bio-climatic variables. In order to find out the degree of risk and threats, the social survey was carried out. According to the perception of local people, it was generalized or documented the possible risk of NTFPs species in Mustang district.

Out of 86 high-valued medicinal plants species in Mustang, 15 major species are under rare and endangered categories, and they are: Panchoule (*Dactylorhiza hatagirea*), Jatamanshi (*Nardostachys grandiflora*), Kutki (*Neopicrohiza scrophulariflora*), Satuwa (*Paris polyphylla* Smith), Laghupatra (*Podophyllum hexandrum* Royle), Louth Salla (*Taxus wallichiana*), Bikh (*Aconitum spicatum*), Okhar (*Juglens regia*), Sugandhawal (*Valeriana Jatamansi*), Talispatra (*Abies spectabilis*), Pakhanbed (*Bergenia ciliata*), Jhyau (*Lichen spp*), Karkati shringi (*Pistacia chinens*), Jangali painyu (*Prunus carmesina*) and Silajit were the major rare and endangered species which need to be conserved.

Due to the border in Tibet, Chinese brokers directly come to villages and contact to village middlemen especially for *Ophiocordyceps sinensis* and *Peris polyphylla*. The threats category of Kutki, Yarsagumba and Satuwa was received as (First (I)), which is needed urgent action, needed for the future courses of action. Most of the medicinal plants species fall under the threat categories (II and III). Due to high demand in the Chinese market, the chances of disappearing would be very high because of the heavy harvesting. The Division Forest Office should prepare a detailed management plan for the rare and threatened NTFPs which are found in Mustang, Nepal. Individual or species based conservation strategies should be prepared. As a result, it helps for the long-term survival of the species in the future courses. Group or individual level of cultivation of endangered species of Medicinal plants/NTFPs is the urgent need in the present situation.

Keywords: Rare, endangered, conservation, long-term, strategies

TABLE OF CONTENTS

ACKNOWLEDGEMENT

EXECUTIVE SUMMARY

CONTENTS

1. BACKGROUND	1
1.1 INTRODUCTION.....	1
1.2 OBJECTIVES	4
General Objectives	4
Specific Objectives.....	4
2. STUDY AREA AND KEY METHODS.....	5
2.1 Study Area.....	5
2.2 Key study methods	6
2.3 Data Analysis	6
3. RESULTS AND DISCUSSION.....	7
3.1 List of threatened NTFPs in Mustang District	7
3.2 Ranking of Medicinal Plants according to availability	8
3.3 Key species of Medicinal and Aromatic Plants in Lower Mustang.....	8
3.3.1. Species of Medicinal and Aromatic Plants in Jhong Area	9
3.3.2. Species of Medicinal and Aromatic Plants in Jomsom Area.....	10
3.3.3. Species of Medicinal and Aromatic Plants in Kagbeni Area	11
3.3.4. Species of Medicinal and Aromatic Plants in Kobang Area	12
3.3.5. Species of Medicinal and Aromatic Plants in Kunjo Area.....	13
3.3.6. Species of Medicinal and Aromatic Plants in Lete Area.....	13
3.3.7. Species of Medicinal and Aromatic Plants in Marpha Area	14
3.3.8. Species of Medicinal and Aromatic Plants in Muktinath Area	14
3.3.9. Species of Medicinal and Aromatic Plants in Tukuche Area.....	15
3.4 Key species of Medicinal and Aromatic Plants in Upper Mustang	15
3.4.1. Species of Medicinal and Aromatic Plants Chhonhup Area	16
3.4.2. Species of Medicinal and Aromatic Plants in Chhoser Area.....	16

3.4.3. Species of Medicinal and Aromatic Plants in Chhusang Area.....	17
3.4.4. Species of Medicinal and Aromatic Plants in Ghami Area.....	17
3.4.5. Species of Medicinal and Aromatic Plants in Lomanthang Area.....	18
3.4.6. Species of Medicinal and Aromatic Plants in Surkhang Area.....	18
3.4.7. Species of Medicinal and Aromatic Plants in T-sarang Area.....	19
3.5 Habitat Map and Status of Endangered Medicinal and Aromatic Plants(MAPs): ...	20
3.5.1 Chiraito:	20
3.5.2 Pakhanbed:.....	21
3.5.3 Panchaunle	22
3.5.4 Jatamansi:	23
3.5.6 Satuwa:	25
3.5.7 Lauth Salla:	26
3.5.8 Yarsagumba :	27
3.5.9 Padamchal:	28
3.5.10 Somlata:	29
3.5.11 Mangan:	30
3.5.12 Talis Patra:	30
3.6 Discussion of existing causes of threats of NTFPs	31
3.6.1 Discussion.....	31
3.7 VULNERABILITY ASSESSMENT	32
3.8 Pocket area	34
3.9 USE VALUE, HEALTH BENEFITS AND RELATED ENTERPRISES	35
4. CONCLUSION AND RECOMMENDATION.....	38
Conclusion.....	38
Recommendation.....	38
References.....	39
ANNEX	46

1. BACKGROUND

1.1 INTRODUCTION

Mustang is a district in Nepal's Central Himalayas, with elevations ranging from 2000 to 6000 meters. The Gurungs, Tibetans, make up the majority of the local population. Because of the region's remoteness, people have continued to employ plants as medicine in an area where ethnobotany has been infrequently documented. NTFPs are expected to provide roughly 5% of Nepal's GDP (ANSAB,1999; Malla et al.,1995) out of the current total contribution of the forestry industry to the national GDP of around 15% (Banko Janakari, 2004).

Experts estimate that there are 700 to 1700 species of MAPs in Nepal (Tiwari et al., 2004), although the Department of Plant Resources (DPR) has only recorded 690. The Medicinal and Aromatic Plant Data Base of Nepal (MAPDON) has identified 1624 species of ethnobotanical value (Shrestha et al., 2000) bringing the total number of plant species with ethnobotanical value to 1624. According to Rawal (2004), Nepal's flora comprises roughly 1000 economic plants (14 percent of the country's vascular plants), including 440 species of wild food plants, 71 species of fiber-producing plants, and 50 species of fish poison, and 30 species of fodder-producing trees.

In Nepal, 2,500 medicinal plant species are utilized in traditional medicine (Kunwar et al., 2011; Luitel et al., 2014; Kunwar et al., 2020), but only around 300 are commercialized in local and international markets (Kunwar et al., 2020, Pyakurel et al., 2019). These plants are frequently harvested in hilly and mountainous areas and traded to China and India in lowland and border districts (Olsen and Helles, 1997; Pyakurel et al., 2018; Kunwar et al., 2020).

High-value medicinal plants such as *Nardostachys jatamansi* (D. Don) DC., *Taxus* species, *Dactylorhiza hatagirea* (D. Don) Soo, and *Paris polyphylla* Sm., among others, have long been collected, bartered, traded, and used traditionally in Nepal for centuries, and contribute significantly to local livelihoods, socio-economics, and culture (GoN, 2017). (Olsen and Larsen, 2003; Pyakurel et al., 2018).

From 2200 to 5000 meters above sea level, *Nardostachys jatamansi* can be found in the Himalayan region of Nepal, China, Bhutan, and India (Singh et al., 2013). Both *N. grandiflora* and *N. jatamansi* are used to make essential oils, and the two species can be distinguished anatomically by the thickness of the periclinal epidermal cell wall beneath the cuticle in the leaf residue and the presence or absence of schlerenchyma cells in the rhizome pith (Tanaka et al.,2008; Paudyal et

al2012). (Yamaji et al., 1999). CITES (Convention on International Trade in Endangered Species) lists *N. jatamansi* as endangered in Nepal and India (Singh et al., 2013), however it is one of Nepal's most widely traded herbs (Paudyal et al., 2012).

Taxus trees have been severely lopped in Nepal due to strong commercial demand (Poudel et al., 2013), and their population is currently deemed endangered (IUCN-Endangered category, Thomas and Farjon, 2011; Poudel et al., 2012). In Nepal, *D. hatagirea* and *P. polyphylla* are locally endangered (KC et al., 2010; Shrestha and Shrestha, 2013; Khadka et al., 2016; Kunwar et al., 2020).

The Conservation Assessment and Management Plan (CAMP) lists *Dactylorhiza hatagirea* as a critically endangered species, while the International Union for Conservation of Nature (IUCN) lists it as threatened (Samant et al., 2001). Furthermore, it is listed on the Government of Nepal's List I as an endangered and closely protected species (GoN 2011). It is found from Pakistan to China and is indigenous to the Hindu-Kush Himalayan region (Raskoti, 2009). The species is found in patches, with densities ranging from 0.1 to 2.18 individuals/m² (Bhattarai et al., 2014 ; Shrestha et al., 2012 ; Khadka et al., 2016 ; Chettri et al., 2007 ;). At altitudes of 2800–4200 m, *Dactylorhiza hatagirea* thrives in pastures in the sub-alpine and alpine zones (IUCN, 2004). In Nepal, it is regarded as a highly useful medicinal species. This orchid's tubers are used to treat diabetes, dysentery, colic discomfort, seminal weakness, and diarrhea, as well as being utilized as an aphrodisiac (Pant et al., 2012; Chamoli et al., 2019; Thakur et al., 2007). *D. hatagirea* has recently been discovered to have anti-cancer effects (Popli, 2017).

Paris polyphylla is taken mostly from wild populations in Nepal for both local and market purposes, and hence its stock is steadily depleting (KC et al., 2010). Because they have a poor understanding of the plant's ecology and growth, local populations have also harvested it in an unsustainable manner (Uprety et al., 2010; Kunwar et al., 2013; Gurung and Pyakurel, 2008; Pyakurel et al., 2017). *P. polyphylla*'s population and distribution are additionally limited by forest degradation, a clumped geographic distribution, and poor growth rates (KC et al., 2010; Cunningham et al., 2018; Zhou et al., 2003). Because of unsustainable collection and harvesting tactics, as well as several other ecological problems, the species is now classified as vulnerable (Meijboom, 2012; Bhattarai, 1992). Not only in Nepal, but also in India (Ved et al., 2005), Vietnam (Huong et al., 2012), and China, the species is considered vulnerable (Ministry of Environmental Protection of China, 2013). It has not, however, been evaluated for inclusion on the global IUCN red list (Cunningham et al., 2018), the CITES list, or the Nepalese Plant Protection Priority List (Ministry of Forests and Soil Conservation, 2014).

The high-value, low-volume Chinese caterpillar fungus *Ophiocordyceps sinensis*, locally known as Yarsagumba (adapted from Yartsagunbu in Tibetan), is one of several important medicinal species harvested by local communities in mountainous parts of India (Kuniyal & Sundriyal,

2013), Nepal (Shrestha & Bawa, 2014), Bhutan (Wangchuk et al., 2012), and China (Wang (Woodhouse et al., 2014). Yarsagumba plays a significant part in the rural economy of the Himalayan region (Shrestha et al., 2014 ; Pant et al., 2017). A localized study in Nepal's Nubri and Tsum valleys discovered that Yarsagumba income amounted for 77–92 percent of households' total cash income (Childs & Choedup, 2014). Similarly, Yarsagumba accounted for up to 72 percent of total income for the poorest households in Dolpa, Nepal (Shrestha & Bawa, 2014). The most important source of monetary income has become Yarsagumba in many mid-hills of Nepal. In 2004, the fungus provided 40% of annual cash income to local communities and 8.5 percent of GDP in Tibet, as well as a source of annual income for many Himalayan-dwelling people in Nepal from west to east. (Gaire, 2019). Collecting Yarsagumba can earn a villager up to Rs 2,500 (about \$35) every day, which is well over the monthly pay of many Nepalese households. (Gaire, 2019). Based on income statistics from 11 districts, the Yarsagumba trade in Nepal was valued an estimated USD 4.7 million in 2014. (NRB, 2015). In addition, Yarsagumba produces 41% of total revenue from the non-timber forest products industry, providing a financial resource to fund social welfare programs like as village electrification and school maintenance (Thapa et al., 2014). Yarsagumba, which grows in resource-scarce areas and is primarily picked by poor locals, has the potential to pull people out of poverty and alleviate inequality. Previous research, on the other hand, lacked a grasp of the connections between Yarsagumba income and economic inequality and poverty (Childs & Choedup, 2014; Shrestha & Bawa, 2014). To protect indigenous and high-value medicinal plants, the Nepalese government banned the collection and trade of 18 species (GoN, 2001; GoN, 2011) and advocated ex-situ conservation for 30 others (GoN, 2006).

The Mustang district is hilly, with fragile ecosystems, and local biodiversity plays a vital role in meeting the basic daily requirements of the region's indigenous peoples. Mixed forest (*Pinus wallichiana* forest, *Betula utilis* forest, *Hippophae salicifolia* forest, *Caragana gerardiana* forest, *Caragana gerardiana*, and *Lonicera spinosa* forest, Juniperus forest) with grasslands with pure stocks of Poaceae (Anonymous, 2004). With altitudinal fluctuations of 1,500 to 8,000 m a.s.l., the area is characterized by its high altitude, chilly climate, and semi-desert habitat (KMTNC, 2004). The territory features distinct vegetation, with a freezing season ranging from 73 to 119 days (Marpha-Lo-Man-thang) with shrubby and dwarf plant groupings dominating (Noshiro, 2008). Some medicinal plant species grew well at altitudes as high as 6000-6300 meters above sea level (Ghimire et al., 2008) because of the influence of such unique environmental circumstances in the Himalayan region, especially Mustang.

In the isolated desert trans-Himalayan region of Nepal (Mustang, Manang, Dolpa, and Tibet), which has similar geology and bioclimate, ethnobotanical knowledge of distinct plant species has acquired importance (Bhattarai et al., 2005; Bhattarai et al., 2006; Bhattarai et al., 2009). There are an estimated 246-310 flowering plant species that are indigenous to Nepal, with the majority of these species (78 species) found in Mustang (Hamilton et al., 2007; Shrestha et al., 1996)

Upper mustang is abundant in a variety of non-timber forest products (NTFPs), which have potential commercial and ethnobotanical significance. Locals rely on the region's plant resources for timber, fodder, medicine, food, and raw materials to produce handicrafts and tools. According to many published studies, more than 100 species have ethnobotanical significance, such as *Allium Wallichii*, Junipers, Yarsagumba , and Jatamansi.

Although local efforts to conserve medicinal plant resources are still inadequate, the long-held traditional beliefs of the population regarding folk medicine have their own unintentional role in conservation, management, and sustainable utilization. While over-harvesting of some important medicinal plants has increased, many Amchi are working towards both biological conservation of the medicinal plants through sustainable harvesting and protection of wild species and conservation of their cultural heritage. In some villages (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 the measures necessary to conserve these species. The involvement of local communities and local stakeholders with effective monitoring of the local community resources will be the fundamental ingredient of in situ conservation of medicinal plants in Mustang. Over-harvested populations of medicinal plants from natural habitats can be improved with the aid of collaborative research projects between the local indigenous people and national and international partners having associated experts Research has shown that Mustang is an important district for many useful plant resources (Bista, 2005; Brohl, 2006; Kunwar et al.,2006; Bhattarai et al., 2009) and the district has not been adequately explored.

1.2 OBJECTIVES

General Objectives

To identify and study the rare and endangered species and their contributions to the people of the mountain regions of mustang district.

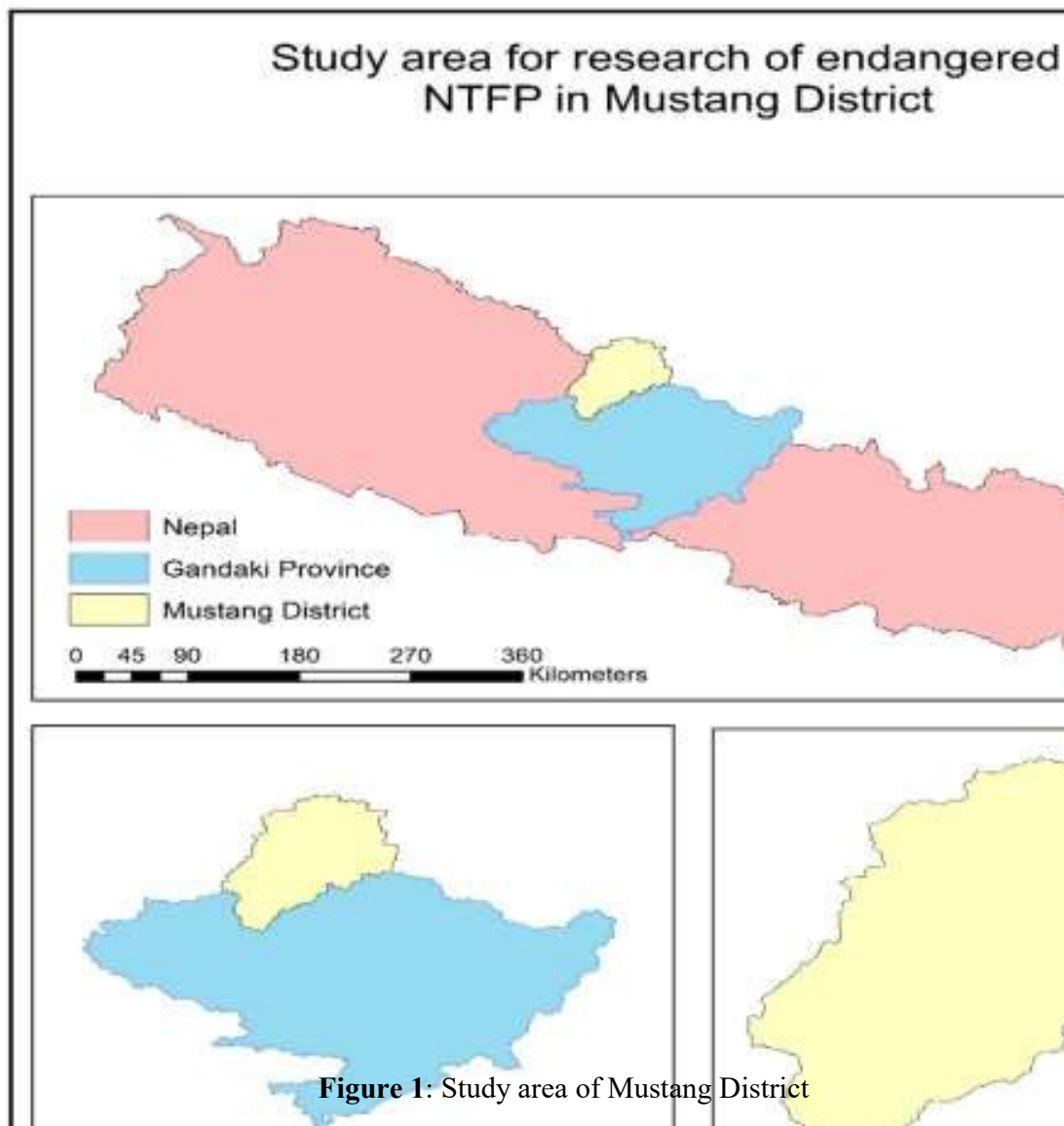
Specific Objectives

1. To determine the Status, Condition, and habitat of high-value Endangered NTFPs in Mustang District.
2. To prepare details information about Endangered NTFPs and their ethno-botanical values.
3. To assess the existing management techniques and find a way out for the best management practice.
4. To recommend and be aware of the importance of Endangered NTFPs that could help to enhance the livelihood of Local People in the Mustang District.

2. STUDY AREA AND KEY METHODS

2.1 Study Area

Mustang, the second least populated district of Nepal, is flanked by the Nepalese districts of Manang, the least populated, to the east, and Dolpa, the third least populated, to the west. The Tibetan frontier stretches north from Mustang's borders. Mustang is divided into two sub-regions, Lower and Upper. This is a high-altitude trans-Himalayan region spread over 3,640 square kilometers in an area barely north of the main Himalayan mountain range. Geographically this cold high-altitude steppe is a part of the Tibetan highlands. Our study starts from the Lower parts of Lale to Upper Mustang (Lo-Man-Thang).



2.2 Key study methods

Capturing the bio-physical information regarding rare and endangered medicinal plants in Mustang was the main aim of the research. In order to fulfill the intended aim, we computed both biophysical as well as socio-economic data collection, directly in the field. We selected the field site randomly from Lale to upper Mustang (Lo-Man-Thang) followed the route the Myagdi to Mustang highway. After conducting bio-physical information from Ghasa, lete, Kobang, Marpha, Titi, Jomsung, Gharkot, Muktinath area and Lo-Man-Thang areas, we focused on social information related to the perception of people towards high-value medicinal plants of Mustang, Nepal. Focus Group Discussion (FDGs), Key Informants Interview (KII), Transit walk, and individual interviews were carried out in the field.

Bio-Physical and social data collection

Data were collected both from primary and secondary sources.

Focal group discussion, Informant survey, Household survey, and sampling of endangered NTFPs species. For the endangered NTFPs survey in the field, we carried out according to the NTFP guideline 2069.

Table 1 : NTFP inventory guideline

Type	Plant size	Plot size	Radius
Tree	>30cm DBH	25m*20m	12.61 m
Pole	10-29.9 cm DBH	10m*10m	5.64 m
Shrub/Sapling	<10cm DBH and >1m height	5m*5m	2.82m
Herb	<1m height	2m*2m	1.12m

1. Recording of GPS points for habitat distribution of the particular medicinal plants.
2. Interaction with concerned stakeholders (Government and private organizations, community people, research institutions, etc)
3. First of all, we visited the respective community forest to evaluate the uses, importance and availability of endangered NTFPs at those places and then rank them accordingly. Discussion with local people about the significance of endangered NTFPs in medical treatment, industrial and tourism sectors were carried out. This ultimately nurtures economic growth. Then we determined the major economically important plant species, categorized them and also discussed their current status with local concerned personals. We carried out the resource survey and prepare maps from GIS, Geo-referencing.
4. Review of Technical reports
5. Policy Review

2.3 Data Analysis

1. Quantitative data were analyzed through the NTFP guidelines.
2. Collected data were interpreted by graphs/charts using MS-Excel, SPSS.
3. Mapping of vulnerability, habitat suitability and distribution pattern were analyzed using ArcGIS 10.5 version.

3

Chapter

Result and Discussion

3. RESULTS AND DISCUSSION

3.1 List of threatened NTFPs in Mustang District

While identifying the rare and endangered NTFPs in Mustang district, we recorded 15 important NTFPs which needed further research towards NTFPs. The majority of rare and endangered species fall into herbs and tree categories. The followings are the recorded rare and endangered NTFPs in the Mustang district:

Table 2: Rare and endangered NTFPs in Mustang, Nepal

1	Panchoule (<i>Dactylorhiza hatagirea</i>)	Endangered
2	Jatamanshi (<i>Nardostachys grandiflora</i>)	Vulnerable
3	Kutki (<i>Neopicrorhiza scrophulariflora</i>)	Vulnerable
4	Satuwa (<i>Paris polyphylla</i> Smith)	Vulnerable
5	Laghupatra (<i>Podophyllum hexandrum</i> Royle)	Vulnerable
6	Louth Salla (<i>Taxus buccata</i>)	Endangered
7	Bikh (<i>Aconitum spicatum</i>)	Vulnerable
8	Okhar (<i>Juglens regia</i>)	Near threatened
9	Sugandhawal (<i>Valeriana Jatamansi</i>)	Vulnerable
10	Talispatra (<i>Abies spectabilis</i>)	Low Risk
11	Pakhanbed (<i>Bergenia ciliata</i>)	Critically threatened
12	Jhyau (<i>Lichen spp.</i>)	Endangered by the Government of Nepal
13	Karkati shringi (<i>Pistacia chinens</i>)	Rare
14	Jangali painyu (<i>Prunus carmesina</i>)	Rare
15	Silajit	Rare

In our field research, we identified the major 15 species of NTFPs that are going to be endangered at the local level. IUCN also categorised them as engendered, vulnerable and rare. Most of the species fall into CITES I and II categories.

3.2 Ranking of Medicinal Plants according to availability

After visiting the various study areas of Mustang district, we finalized the list of medicinal herbs/NTFPs which are found in those areas. The list is the open list according to the focus group discussion and provided literature of NTFPs in that areas. The list of medicinal plants/ NTFPs is as follows:

Table 3: Gaupalika-wise listing of NTFPs in Mustang district

Thasang	Gharapjhong	Barhagaun Muktikshetra	Dalome	Lomanthang
Jatamansi	Yarsagumba	Yarsagumba	Kutki	Chiraito
Yarsagumba	Sunpati	Kutki	Yarsagumba	Jatamansi
Padamchal	Lauth Salla	Sunpati	Padamchal	Jimbu
Sunpati	Kutki	Nirmasi	Sunpati	Yarsagumba
Panchaunle	Nirmasi	Padamchal	Tora	Kutki
Kutki	Padamchal	Ban Lasun	Titepati	Padamchal
Ban Lasun	Ban Lasun	Titepati	Ban Lasun	Sunpati
Titepati	Titepati	Somlata	Jimbu	Ban Lasun
Nirmasi	Nigalo	Dhupi	Somlata	Titepati
Lauth Salla	Rosa	Tora	Rosa	Tora
Nigalo	Bikh	Dhupi	Bikh	Nirmasi
Pakhanbed	Bajradanti	Sisno		
Satuwa		Jatamansi		
Bojho		Ganja		
Ban Mula		Bikh		
Dhupi		Jimbu		

After analyzing, we got to the conclusion that Thasang and Barhagaun Muktichhera have the highest medicinal plants. The cultivation practices of NTFPs can easily carry out in Thasang and Muktichhetra areas. However, most the high-value medicinal plants can be found in Gharapjong, Dalome and Lomangthang areas. *Ophiocordyceps sinensis*, Kutki and Jatamansi were found after the altitude of 3800m (MSL). In a nutshell, we can say that Mustang district as a whole is a full of potential of high-value medicinal plants/NTFPs. Some of them, 15 species were under threats.

3.3 Key species of Medicinal and Aromatic Plants in Lower Mustang

Lower Mustang is part of the Annapurna Conservation Area Project, which encompasses Nepal's largest protected biodiversity zone. Mustang is known for its extensive historical and cultural ties with Tibet, therefore the walk provides an opportunity to learn about Tibetan culture.

Table 4: High potential medicinal plants in Lower Mustang

S.N.	Local name	Scientific name
1	Ban Lasun	<i>Allium wallichii</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Padamchal	<i>Rheum australe</i>
4	Yarsagumba	<i>Ophiocordyceps sinensis</i>
5	Tetepati	<i>Artemisia gmelinii</i>
6	Dhupi	<i>Juniperus indica</i>
7	Nirmasi	<i>Delphinium denudatum</i>
8	Chi-Chi	<i>Hippophae salicifolia</i>
9	Lauth Salla	<i>Taxus baccata</i>
10	Sunpati	<i>Rhododendron anthopogon</i>
11	Tora	<i>Hippophae tibetana</i>
12	Ban Lasun (vegetable)	<i>Lilium nepalense</i>
13	Nigalo	<i>Thamnocalamus spathiflorus</i>
14	Jatamansi	<i>Nardostachys grandiflora</i>
15	Bojho	<i>Acorus calamus</i>
16	Satuwa	<i>Paris polyphylla</i>
17	Sisnu	<i>Urtica dioica</i> ,
18	Somlata	<i>Ephedra gerardiana</i>
19	Pakhanbed	<i>Bergenia ciliata</i>
20	Panchaunle	<i>Dactylorhiza hatagirea</i>

3.3.1. Species of Medicinal and Aromatic Plants in Jhong Area

The Jhong lies in Upper Mustang of Nepal. Most of the people recognized Jhong as a beautiful archaeology. Not only is the beautiful archaeology, Jhong also famous for valuable medicinal plants. The Jhong is also the home for many high-value medicinal plants. Some are fallen under rare and endangered categories. The **Jhong cave in Chhoser** is one of the most amazing caves in upper mustang Nepal. Secrets of the sky caves Nepal are attracting attention of archaeologist from around the world. They are very curious to know more about mysteries caves in upper mustang region. Upper mustang is one of the best examples of cave civilization. There are numerous multi-storied man made caves in the hills of Upper Mustang. The Jhong is very famous

for Yarsagumba , Nirmansi and Kutki. The cold climate with high altitude supports many medicinal plants. Most of the medicinal plants found in Jhong fall under rare and endangered categories. Therefore, it need to be protected in the natural habitat. The following medicinal plants/NTFPs were recorded in Jhong area:

Table 5: Key medicinal plant in Jhong area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Nirmashi	<i>Delphinium densiflorum</i>
4	Sunpati	<i>Rhododendron anthopogon</i>
5	Padamchal	<i>Rheum australe</i>
6	Ban Lasun	<i>Allium wallichii</i>
7	Tora	<i>Hippophae tibetana</i>
8	Dhupi	<i>Juniperus indica</i>
9	Tetepati	<i>Artemisia gmelinii</i>
10	Somlata	<i>Ephedra gerardiana</i>

3.3.2. Species of Medicinal and Aromatic Plants in Jomsom Area

The probable extinction of medicinal plant species in Jomsom would undoubtedly have a substantial influence on the lives of many vulnerable communities worldwide as many underprivileged people depend not just for their primary health care but also as a major source of revenue. With the current scenario, climatic changes might make the herbal community more stressed and may have an impact on the consumers, harvesters, and producers of medicinal plants. If action is not taken promptly, this might lead to greater human suffering and unavoidable fatalities. Although the future consequences of climate change are mostly unknown, existing data shows that these phenomena are having an impact that certain possible risks are worth discussing. These plants are in danger of being lost for good unless a global move is made. Further research must be focused in the affected areas for developing conservation strategies. The following medicinal plants are under rare and endangered in JOMSOM areas:

Table 6: Major medicinal plants species in JOMSOM areas

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Padamchal	<i>Rheum australe</i>
4	Sunpati	<i>Rhododendron anthopogon</i>

5	Dhupi	<i>Juniperus indica</i>
6	Ban Lasun	<i>Allium wallichii</i>
7	Tora	<i>Hippophae tibetana</i>
8	Tetepati	<i>Artemisia qmelinii</i>
9	Jatamansi	<i>Nardostachys grandiflora</i>
10	Sisnu	<i>Urtica dioica</i>

3.3.3. Species of Medicinal and Aromatic Plants in Kagbeni Area

Kagbeni and its irrigated oasis are surrounded by subdesert dwarf scrubland. Pioneer communities on scree, and alluvial shrub formations, grow on some special sites, occupying only very small portions of the total area. Currently, forests with open canopies occur only at greater distances from the village. At higher elevations, several types of matted dwarf shrub thickets can be found. For interpreting the current state of vegetation, strong anthropogenic influences have to be taken into account; particularly, pasture farming has promoted the development of degraded dwarf scrubland. In the present study, a list of 78 species of vascular plants is presented for Kagbeni and its immediate surroundings, supplemented with data on the distribution of the species within the entire Mustan District. The data are arrived from own investigations and the geobotanical literature. A phytogeographical analysis shows the prevalence of western over eastern elements. Species with a wide distribution in Eurasia, which constitute one third of the total flora of Kagbeni, are of great importance as weeds on arable fields and in ruderal places within the irrigated oasis. Their occurrence is closely related to human activity. Presumably, most of these weeds have reached the area under study in connection with agriculture a long time ago. Weeds from the New World, although recorded in other villages of Mustan District, have not been found in Kagbeni. The weed vegetation of Kagbeni is documented by nine vegetation relevés, and is compared to relevés from Jomsom and Marpha. A floristic gradient from south to north that has been detected by earlier investigations throughout the whole district can be reproduced at the local scale. With regard to the weed flora, the effects of different crops are minimal, compared to effects of altitude and other factors related to altitude.

Upper Mustang is a restricted area and visitors must obtain an Upper Mustang Permit before heading for any trips in the region. While Lo Manthang is the center of attraction in Upper Mustang, the trails to this ancient town are full of remarkable beauties as well. Passing the Tibetan-influenced villages of Ghiling, Ghami, and Dhakmar, the journey immerses the travelers into the prevalent Tibetan culture. Views of Annapurna and Nilgiri Himalayas to the south also ensure exciting views in contrast to the brown desert-like lands. The trails culminate in Lo Manthang which was once the capital of Upper Mustang and a part of the Silk Route that connected Tibet and Europe. The royal palace and the monasteries around the city reflect the Tibetan heritage of Lo. Festivals like Tiji and ancient monasteries in Chooser and Namgyal add pinches of cultural awakening in Lo Manthang. The sky caves to the north of Lo Manthang even guarantee thrilling excursions and exploration of the ancient lifestyle. Kagbeni areas are also the home for many medicinal plants. Some of medicinal plants are under threats. The following key medicinal plants were recorded in Kagbeni areas:

Table 7: Key medicinal plants/NTFPs in Kagbeni areas

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Padamchal	<i>Rheum australe</i>
4	Sunpati	<i>Rhododendron anthopogon</i>
5	Tora	<i>Hippophae tibetana</i>
6	Dhupi	<i>Juniperus indica</i>
7	Ban Lasun	<i>Allium wallichii</i>
8	Jatamansi	<i>Nardostachys grandiflora</i>
9	Tetepati	<i>Artemisia gmelinii</i>
10	Sisnu	<i>Urtica dioica</i>

3.3.4. Species of Medicinal and Aromatic Plants in Kobang Area

Upper area of Kobang is the very famous for rare and endangered medicinal plants. The area is also famous for Lauth Salla (Vulnerable category of IUCN and CITES II), Nirmasi and Yarshagumba are also the vulnerable medicinal plants in kobang area. Cultivation of such rare species is urgent need in the present situations. The following high value medicinal plants, which are enriched in Kobang area, are enlisted below:

Table 8: Key medicinal plants found in Kobang area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Padamchal	<i>Rheum australe</i>
4	Nirmasi	<i>Delphinium denudatum</i>
5	Chi-Chi	<i>Hippophae salicifolia</i>
6	Lauth Salta	<i>Taxus baccata</i>
7	Ban Lasun	<i>Lilium nepalense</i>
8	Nigalo	<u><i>Thamnocalamus spathiflorus</i></u>
9	Tetepati	<i>Artemisia gmelinii</i>
10	_Pakhanbed	<i>Bergenia ciliata</i>

3.3.5. Species of Medicinal and Aromatic Plants in Kunjo Area

Kunjo area is also famous for rare and endangered medicinal plants. In the upper part of Kunjo, we can harvest Yarsagumba , Nirmansi, Lauth Salla, and Padamchal. The following are the major species in the region:

Table 9: Key medicinal plants found in Kunjo area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Nirmasi	<i>Delphinium denudatum</i>
4	Chi-Chi	<i>Hippophae salicifolia</i>
5	Padamchal	<i>Rheum australe</i>
6	Satuwa	<i>Paris polyphylla</i>
7	Ban Lasun	<i>Lilium nepalense</i>
8	Bojho	<i>Acorus calamus</i>
9	Lauth Salla	<i>Taxus baccata</i>
10	Tetepati	<i>Artemisia qmelinii</i>

3.3.6. Species of Medicinal and Aromatic Plants in Lete Area

Lete is a famous for many medicinal and aromatic plants. Lower plants of Lete is famous for Bojho , Padamchal , and Nigalo whereas Yarsagumba , Kutki , Panchaunle and Satuwa, found in the northern part of Lete. The following were the key species:

Table 10 : Major key species of Medicinal plants in Lete area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Bojho	<i>Acorus calamus</i>
4	Satuwa	<i>Paris polyphylla</i>
5	Padamchal	<i>Rheum australe</i>
6	Ban Lasun	<i>Lilium nepalense</i>
7	Chi-Chi	<i>Hippophae salicifolia</i>
8	Lauth Salla	<i>Taxus baccata</i>
9	Nigalo	<i>Thamnocalamus spathiflorus</i>

10	Panchaunle	<i>Dactylorhiza hatagirea</i>
----	------------	-------------------------------

3.3.7. Species of Medicinal and Aromatic Plants in Marpha Area

The beautiful and picturesque Marpha village is located at an altitude of 2650m in the Kali Gandaki Valley of the **lower Mustang region**. The name Marpha itself is a wonder which consists of two words “mar” meaning hard-working, and “pha” meaning people, combined to form the word - Marpha. The village is not only known for its beauty of nature but also, its beautiful culture and heritage. The homes in Marpha are made from stone and their doors and windows are sketched by cherry wood panels and sharp red lines bordering rustic white stone. The following are the key species of medicinal plants which are also the rare and endangered categories under Government of Nepal, IUCN and CITES:

Table 11: Key species of Medicinal plants in Marpha area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophularlifolia</i>
3	Sunpati	<i>Rhododendron anthopogon</i>
4	Chi-Chi	<i>Hippophae salicifolia</i>
5	Lauth Saila	<i>Taxus baccata</i>
6	Dhupi	<i>Juniperus indica</i>
7	Nirmasi	<i>Delphinium denudatum</i>
8	Padamchal	<i>Rheum australe</i>

3.3.8. Species of Medicinal and Aromatic Plants in Muktinath Area

Hindus call the site Mukti Kshetra, which literally means the “place of salvation” and it is one of the most ancient temples of the God Vishnu and the Vaishnava tradition in Nepal. The shrine is considered to be one of the eight sacred places known as Svayam Vyakta Ksetras (the other seven being Srirangam, Srimushnam, Tirupati, Naimisharanya, Totadri, Pushkar and Badrinath), as well as one of the 108 Divya Desam, or holy places of worship of Lord Vishnu. Additionally, it is also one of the 51 Shakti Pitha goddess sites. The following are the important medicinal plants/NTFPs in Muktinath area of Mustang, Nepal:

Table 12 : Key species of medicinal plants in Mustang area

SN	Local name	Scientific: name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neooicrorhiza scroohulariifolia</i>
3	Nirmashi	<i>Delohinium denudatum</i>
4	Sunpati	<i>Rhododendron anthopogon</i>
5	Padamchal	<i>Rheum australe</i>
6	Dhupi	<i>Juniperus indica</i>
7	Ban Lasun	<i>Allium wallichii</i>

8	Tora	<i>Hiooophae tibetana</i>
9	Tetepati	<i>Artemisia qmelinii</i>
10	Jatamansi	<i>Nardostach ys grandiflora</i>

3.3.9. Species of Medicinal and Aromatic Plants in Tukuche Area

Tukuche area is also equally very important area for high-value medicinal plants. Yarsagumba and Lauthsalla fall under vulnerable and endangered categories. The following were the key species in that area:

Table 13: Key Species of medicinal plants in Tukuche area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neooicrorhiza scroohulariifolia</i>
3	Chi-Chi	<i>Hinnoohae salicifolia</i>
4	Nirmasi	<i>Delphinium denudatum</i>
5	Lauth Salla	<i>Taxus baccata</i>
6	Padamchal	<i>Rheum australe</i>
7	Dhupi	<i>Juniperus indica</i>
8	Nigalo	<i>Thamnocalamus spathiflorus</i>
9	Ban Lasun	<i>Allium wallichii</i>
10	Tetepati	<i>Artemisia amelinii</i>

3.4 Key species of Medicinal and Aromatic Plants in Upper Mustang

Upper Mustang is an important source of valuable medicinal plants/NTFPs. Upper mustang is very popular for Yarsagumba collection. Now, Yarsagumba has been catagorized as vulnerable category of IUCN red list. Likewise, Chiraito is under the category of vulnerable. Government of Nepal has also prioritized Padamchal, Satuwa and Chiraito for promoting cultivation practices.

Table 14: Medicinal Plants from Upper Mustang

SN	Local Name	Scientific Name
1	Jimbu	<i>Allium hypsistum</i>
2	Kutki	<i>Neopicrohiza scrophulariifolia</i>
3	Padamchal	<i>Rheum australe</i>
4	Sunpati	<i>Rhododendron anthopogon</i>
5	Tetepati	<i>Artemisia gmelinii</i>
6	Tora	<i>Hippophae tibetana</i>
7	Yarsagumba	<i>Ophiocordyceps sinensis</i>

8	Ban Lasun	<i>Allium wallichii</i>
9	Chiraito	<i>Swertia chiraita</i>
10	Rosa	<i>Rosa sericia</i>
11	Nirmasi	<i>Delphinium denudatum</i>
12	Jatamansi	<i>Nardostachys grandiflora</i>
13	Ganja	<i>Cannabis sativa</i>

3.4.1. Species of Medicinal and Aromatic Plants Chhonhup Area

Chhonhup area is very famous for medicinal and aromatic plants. It lies in upper part of Mustang district. The following species of medicinal plants were found in Chhonhup area:

Table 15 : Key medicinal plants in Chhonhup area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neooicrorhiza scroohulariifolia</i>
3	Padamchal	<i>Rheum australe</i>
4	Sunpati	<i>Rhododendron anthopogon</i>
5	Ban Lasun	<i>Allium wallichii</i>
6	Titeoati	<i>Artemisia afnelinii</i>
7	Tora	<i>Hinnoochae tibetana</i>
8	Jimbu	<i>Allium hvnsistum</i>
9	Chiraito	<i>Swertia chiraita</i>
10	Jatamansi	<i>Nardostachys grandiflora</i>

3.4.2. Species of Medicinal and Aromatic Plants in Chhoser Area

The followings were the key species in Chhoser area:

Table 16: Key medicinal species from Chhoser area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neooicrorhiza scroohulariifolia</i>
3	Padamchal	<i>Rheum australe</i>

4	Sunpati	<i>Rhododendron anthopogon</i>
5	Ban Lasun	<i>Allium wallichii</i>
6	Jimbu	<i>Allium hvosistum</i>
7	Tora	<i>Hinnoohae tibetana</i>
8	Titeoati	<i>Artemisia amelinii</i>
9	Chiraito	<i>Swertia chiraita</i>
10	Jatamansi	<i>Nardostachys arandiflora</i>

3.4.3. Species of Medicinal and Aromatic Plants in Chhusang Area

It is located on the Upper Mustang trekking route, between Tangbe and Chele, about an hour's walk north of Tangbe. It lies at the junction of the Narshing River and the Kali Gandaki. It is surrounded by gigantic red, orange and silver gray cliffs spotted with cave dwellings. The village consists of three different hamlets: north of the Narshing river is Tangma, to the south of it is Braga, and west of Braga, towards the Kali Gandaki, is Cikyab. It is an active farming community. The followings were the key medicinal plant species in Chhusang area:

Table 17: Key species of medicinal plants from Chhusang area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Sunpati	<i>Rhododendron anthopogon</i>
3	Padamchal	<i>Rheum australe</i>
4	Kutki	<i>Neooicrorhiza scroohulariifolia</i>
5	Tora	<i>Hinnoohae tibetana</i>
6	Titeoati	<i>Artemisia amelinii</i>
7	Ban Lasun	<i>Lilium neoalense</i>
8	Jimbu	<i>Allium hvnsistum</i>
9	Bhana	<i>Cannabis sativa</i>
10	Nirmasi	<i>Delohinium denudatum</i>

3.4.4. Species of Medicinal and Aromatic Plants in Ghami Area

After crossing the steel bridge at Ghami Khola; steep uphill walk towards Choya la 3870 meters is the most difficult part of **Ghami to Tsarang** trail. From the pass you can see amazing Mountain

View including Annapurna Dhaulagiri Tukuiche, Nilgiri, Thorang peak & more etc. Ghami to Tsarang hiking pass through fairly rough terrain, perfect view point of isolated area of trans Himalayan valley. Tsarang village, medieval fort and a red Gompas are highlighted features of mustang trekking in Nepal. The followings were the major medicinal plants species in ghami area:

Table 18: Major medicinal plants species in Ghami area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neooicrorhiza scrophulariifolia</i>
3	Padamchal	<i>Rheum australe</i>
4	Sunpati	<i>Rhododendron anthopogon</i>
5	Tora	<i>Hinnoohae tibetana</i>
6	Teteoati	<i>Artemisia ame/inii</i>
7	Ban Lasun	<i>Allium wallichii</i>
8	Jimbu	<i>Allium hvnsistum</i>
9	Somlata	<i>Eohedra aerardiana</i>
10	Rosa	<i>Rosa sericea</i>

3.4.5. Species of Medicinal and Aromatic Plants in Lomanthang Area

The following key species of medicinal plants/NTFPs were found in Lo-man-thang area:

Table 19 : Medicinal plants/NTFPs from Lomanthang area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Sunpati	<i>Rhododendron anthopogon</i>
3	Kutki	<i>Neooicrorhiza scroohulariifolia</i>
4	Padamchal	<i>Rheum australe</i>
5	Tora	<i>Hiooooohae tibetana</i>
6	Titeoati	<i>Artemisia amelinii</i>
7	Jimbu	<i>Allium hvosistum</i>
8	Chiraito	<i>Swertia chiraita</i>
9	Nirmasi	<i>Delphinium denudatum</i>

3.4.6. Species of Medicinal and Aromatic Plants in Surkhang Area

Surkhang area is a highly potential for many high value medicinal plants/NTFPs. The followings were the key species of important species of medicinal plants. Howerer, Yarsagumba is the common in most parts of upper Mustang.

Table 20: Key medicinal plants in Surkhang area

SN	Local name	Scientific name
1	Yarsagumba	<i>Ophiocordyceps sinensis</i>
2	Sunpati	<i>Rhododendron anthopogon</i>
3	Padamchal	<i>Rheum australe</i>
4	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
5	Tora	<i>Hiooooohae tibetana</i>
6	Titeoati	<i>Artemisia amelinii</i>
7	Jimbu	<i>Allium hvosistum</i>
8	Chiraito	<i>Swertia chiraita</i>
9	Rosa sps	<i>Rosa sericea</i>

3.4.7. Species of Medicinal and Aromatic Plants in T-sarang Area

T-Sarang is an important area for medicinal plants. Kutki and Yarsagumba are harvested in every ear. The followings were the key species of medicinal plants in T-sarang area:

Table 21: key species of medicinal plants in T-sarang area

SN	Local name	Scientific name
1	Yarsaaumba	<i>Ophiocordyceps sinensis</i>
2	Kutki	<i>Neopicrorhiza scrophulariifolia</i>
3	Sunpati	<i>Rhododendron anthopogon</i>
4	Padamchal	<i>Rheum australe</i>
5	Tora	<i>Hiooooohae tibetana</i>
6	Jimbu	<i>Allium hvosistum</i>
7	Ban Lasun	<i>Lilium neoalense</i>
8	Titeoati	<i>Artemisia amelinii</i>
9	Somlata	<i>Ephedra aerardiana</i>
10	Rosa sp.	<i>Rosa sericea</i>

3.5 Habitat Map and Status of Endangered Medicinal and Aromatic Plants(MAPs):

3.5.1 Chiraito

Swertia chirayita

Family: Gentianaceae

English name: Gentiana chirayita

Nepali name: Chirayita

Status: Vulnerable

Distribution: 1500m-2500m altitude of temperate to sub alpine region of Nepal.

Habitat and Ecology: Chiraito is a biannual herb found on open and moist sites.

Flowering time: May-October

Fruiting time: October-December

Propagation: Chiraito can be propagated by seed, root, leaf, stem/shoot cuttings.

Uses: It is used in ordinary fever and malarial fever.

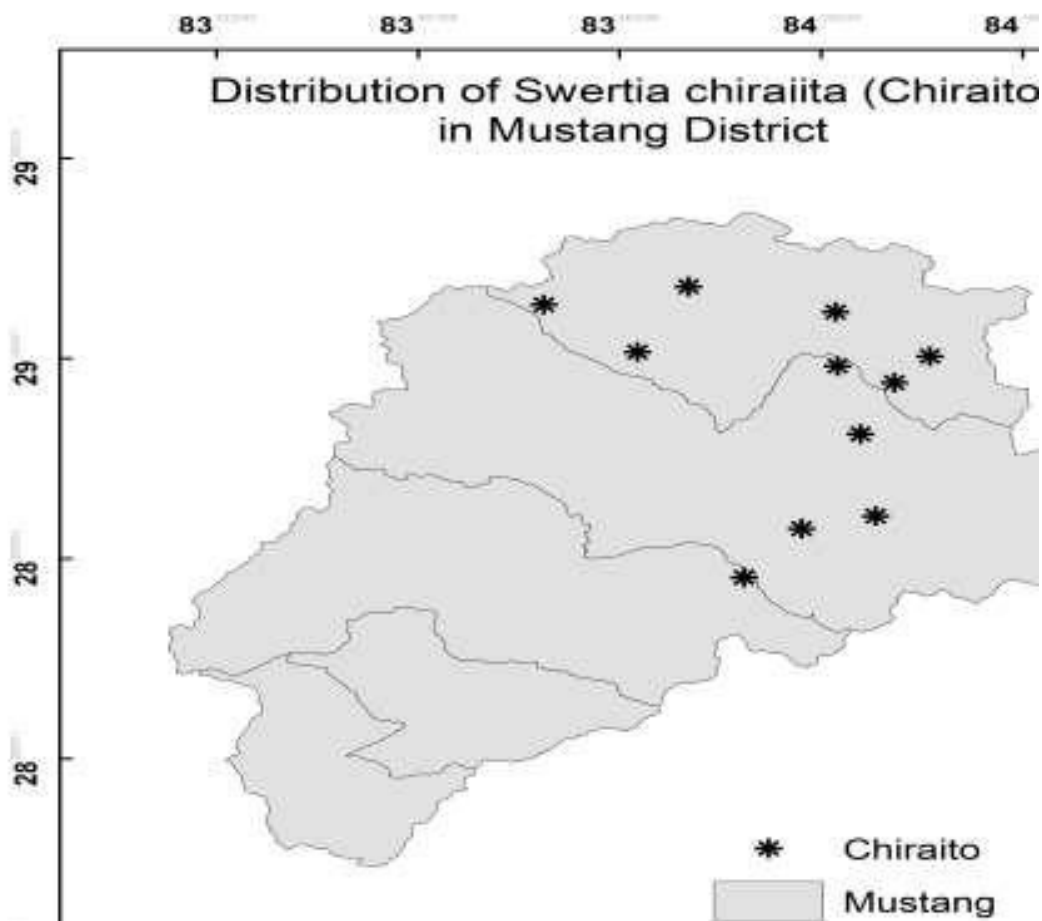


Figure 2: Chiraito distribution in Mustang

3.5.2 Pakhanbed

Berginia ciliata

Family: Saxifragaceae

English name: Rockfoil

Nepali name: Pakhanbed

Status: Commercially threatened

Distribution: Found in Western and Central Nepal; 900m-4300m altitude of the subtropical and temperate zone.

Habitat and Ecology: Perennial rhizomatous herb found on moist rock ledges and shady places.

Flowering period: March-April

Fruiting period: June-July

Uses: The drug is given in pulmonary affections, dysentery, ulcers, dysuria, spleen enlargement, cough and fever. The drug is used in folk-lore medicine against vertigo and headache. It is reported to be helpful in dissolving kidney stones.

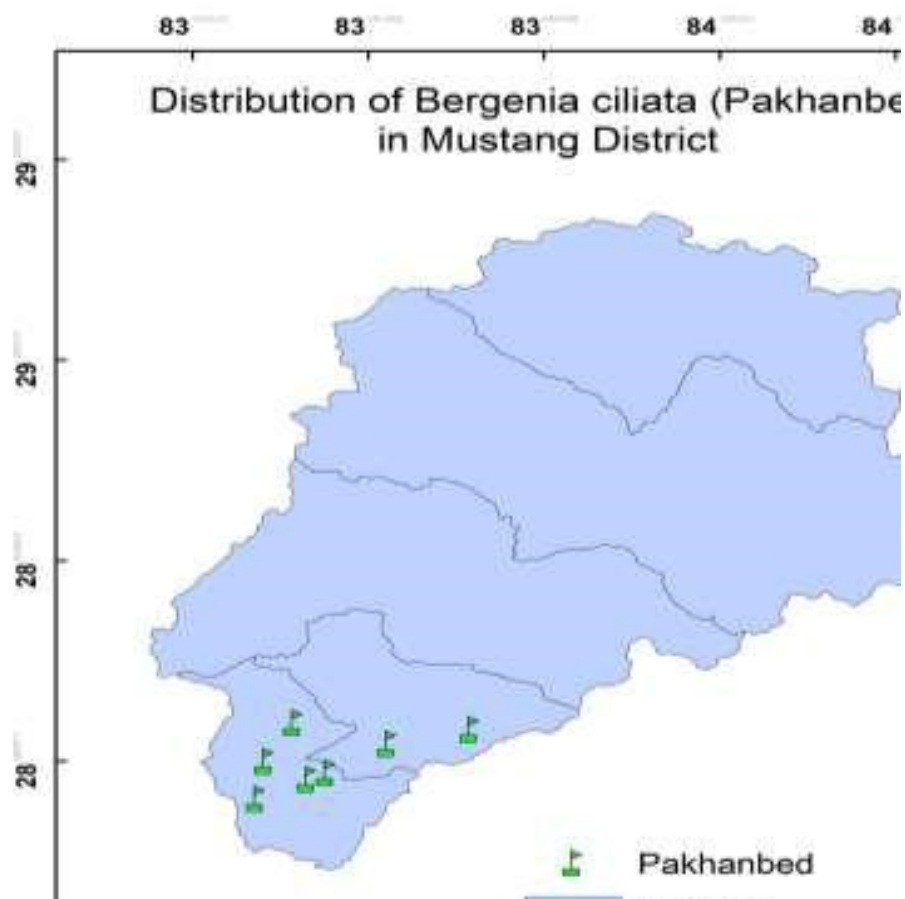


Figure 3: Habitat map of Pakhanbed

3.5.3 Panchaunle

Dactylorhiza hatagirea

Family: Orchidaceae

English: Salep

Nepali: Panchaunle

Status: Endangered

Distribution: Found in western and Central Nepal; 2400-3600m altitude of subalpine and alpine region.

Habitat and Ecology: Perennial herb with five fingered tubers found on open sloppy moist fields.

Propagation: The plant is propagated by sowing seed in nursery and from tuber also.

Flowering period: June-July

Fruiting period: August-September

Uses: Root tuber is taken as expectorant, astringent, demulcent and aphrodisiac and is highly nutritious. Root powder or paste of the rhizome is applied on cuts and wounds for speedy healing.

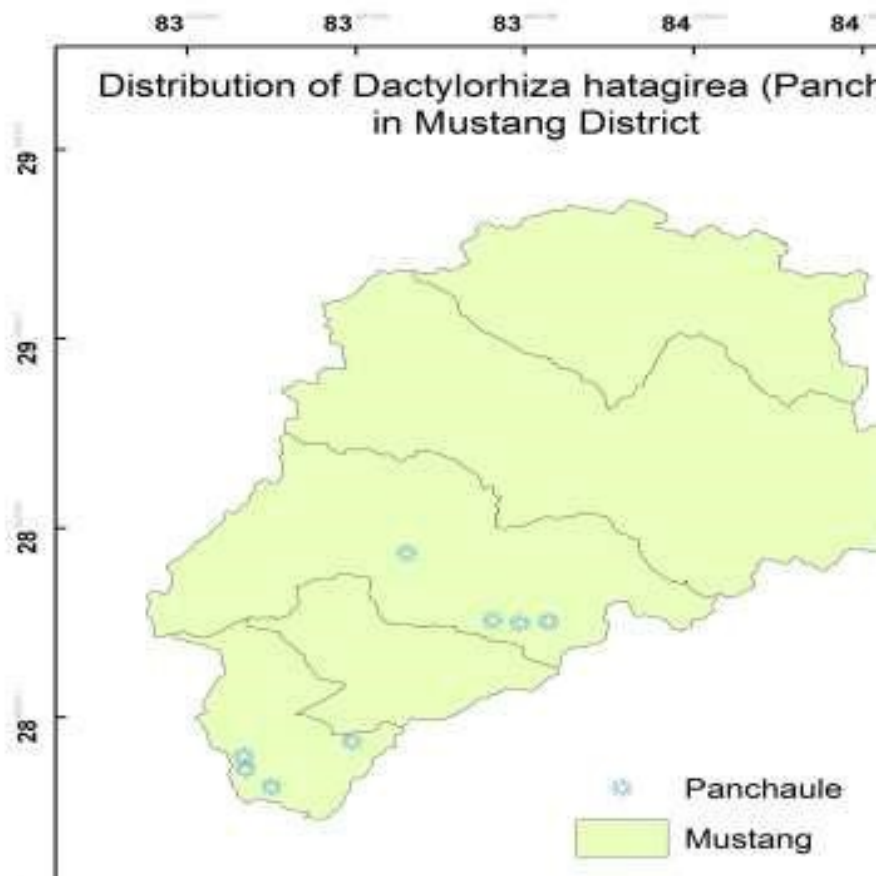


Figure 4 : Habitat map of Panchaunle

3.5.4 Jatamansi

Nardostachys grandiflora

Family: Valerianaceae

English name: Spikenard

Nepali: Jatamansi

Status: vulnerable

Distribution: Found in Western, Central, and Eastern Nepal; 3200m-5300m altitude of the alpine zone.

Habitat and ecology: An erect perennial herb found on open place, open and moist slope, and mossy rock.

Flowering period: June-August

Fruiting period: August-September

Uses: The root is used as cooling, tonic, antipyretic and alexipharmic. It helps to cure cough, biliousness, blood diseases, burning sensation, leprosy, throat troubles and ulcers and improve the complexion.

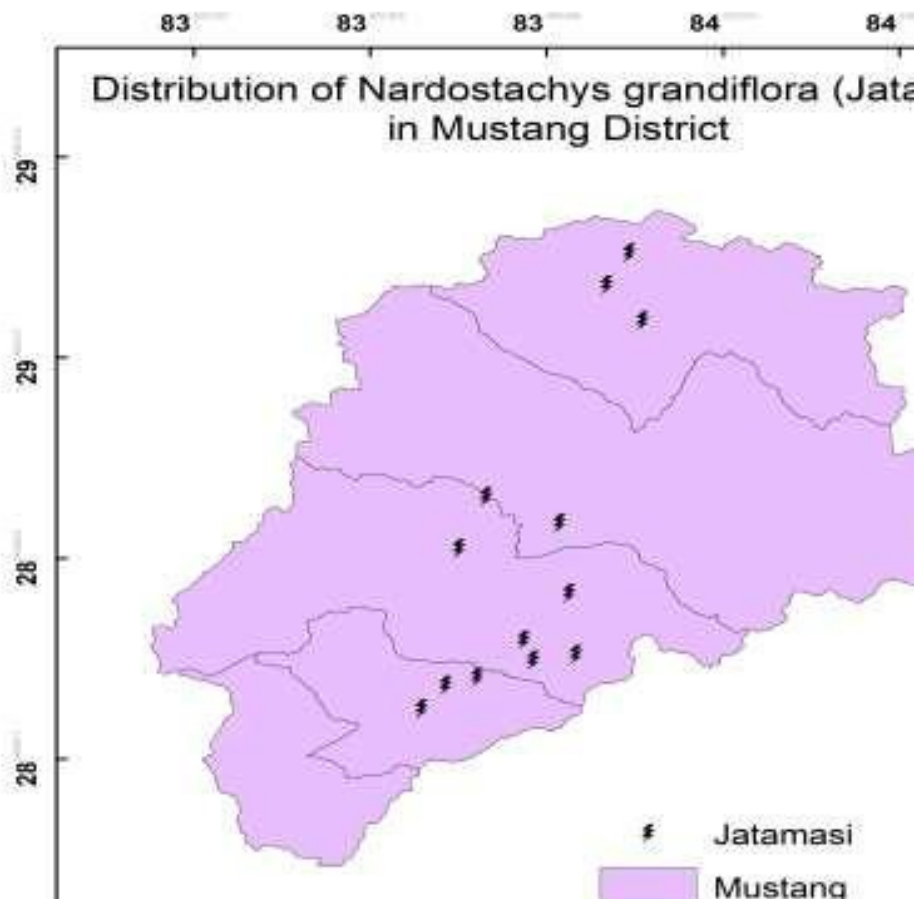


Figure 5: Habitat map of Jatamansi

3.5.5 Kutki:

Neopicrorhiza scrophulariifolia

Family: Scrophulariaceae

English name: Picrorhiza

Nepali name: Kutki

Status: Vulnerable

Distribution: Found in Western, Central and Eastern Nepal; 3500m-4800m altitude.

Habitat and Ecology: A perennial herb that grows on alpine pasture, grass and rocks and moist slope.

Propagation: The natural regeneration of Kutki takes place by seeds and rhizomes. The plant can be propagated by seeds or by division of roots.

Flowering period: May-September

Fruiting period: October-November

Uses: The root is used in fever, cough and cold, anemia, diabetes, hepatitis, leprosy, snake and scorpion bites, blood pressure etc.

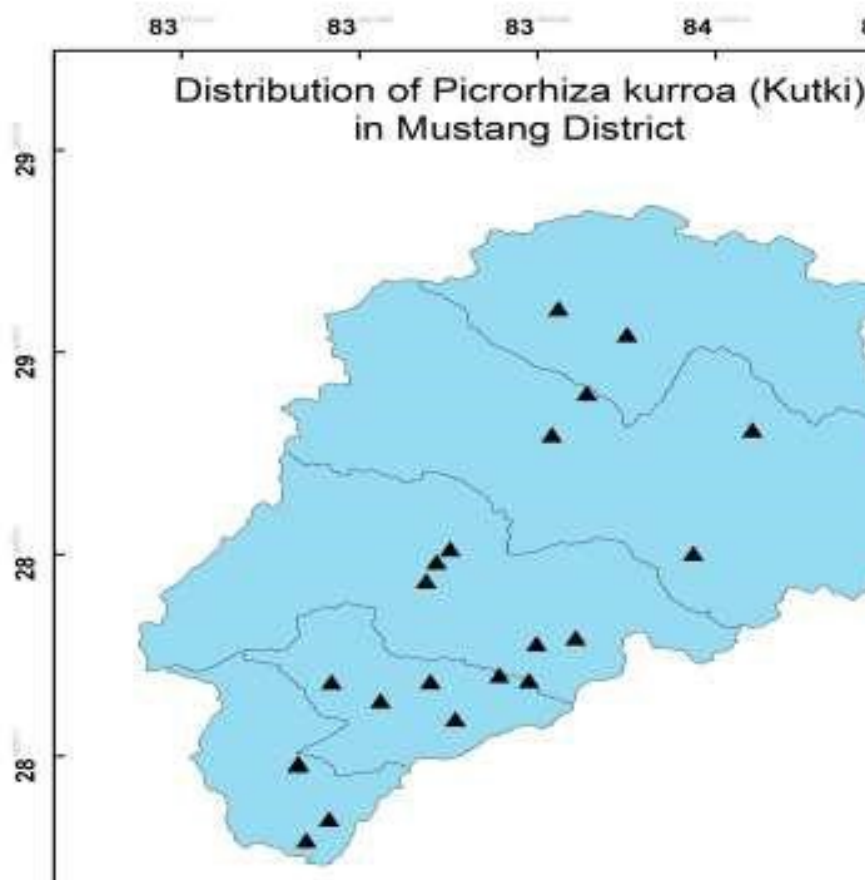


Figure 6: Habitat map of Kutki

3.5.6 Satuwa:

Paris polyphylla

Family: Liliaceae

English name: Satuwa

Nepali name: Satuwa

Status: Vulnerable

Distribution: 1800-3500m altitude

Habitat and Ecology: A perennial glabrous erect herb found on shady and cold places and inside forest.

Flowering Period: April-May

Fruiting period: June-July

Uses: The rhizome possesses anthelmintic properties and considered as a vermifuge. Its powder is taken with hot water is used as tonic. Root paste is applied as wound healing. Powder from the rhizome is used for fever and food poisoning. Root paste is also applied as an antidote to the snake bite and poisonous insects.

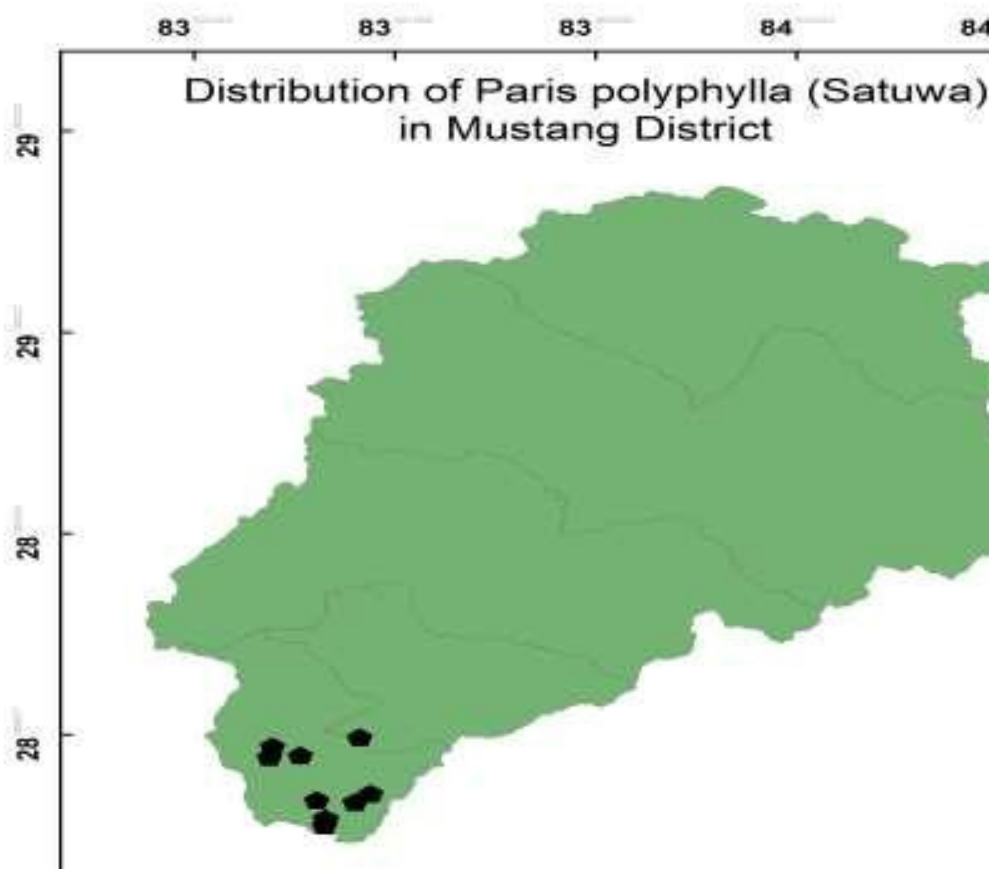


Figure 7: Habitat map of Satuwa

3.5.7 Lauth Salla:

Taxus wallichiana

Family: Taxaceae

English name: Himalayan yew

Nepali name: Lauth salla

Status: Endangered

Distribution: It is found in temperate to sub-alpine Himalayan zone between 1800m-3000m altitude.

Ecology and Habitat: An evergreen tree found on moist site.

Propagation: It is propagated by both seed and branch cutting.

Flowering period: March-May

Fruiting period: September-November

Uses: Leaves and twigs are the sources of Taxol that are used in the treatment of breast and uterus cancer. Leaves are used in asthma and bronchitis. Shoot tincture is applied for headaches, falling pulse, and diarrhea. Red juice of the bark is used as an inferior dye and staining.

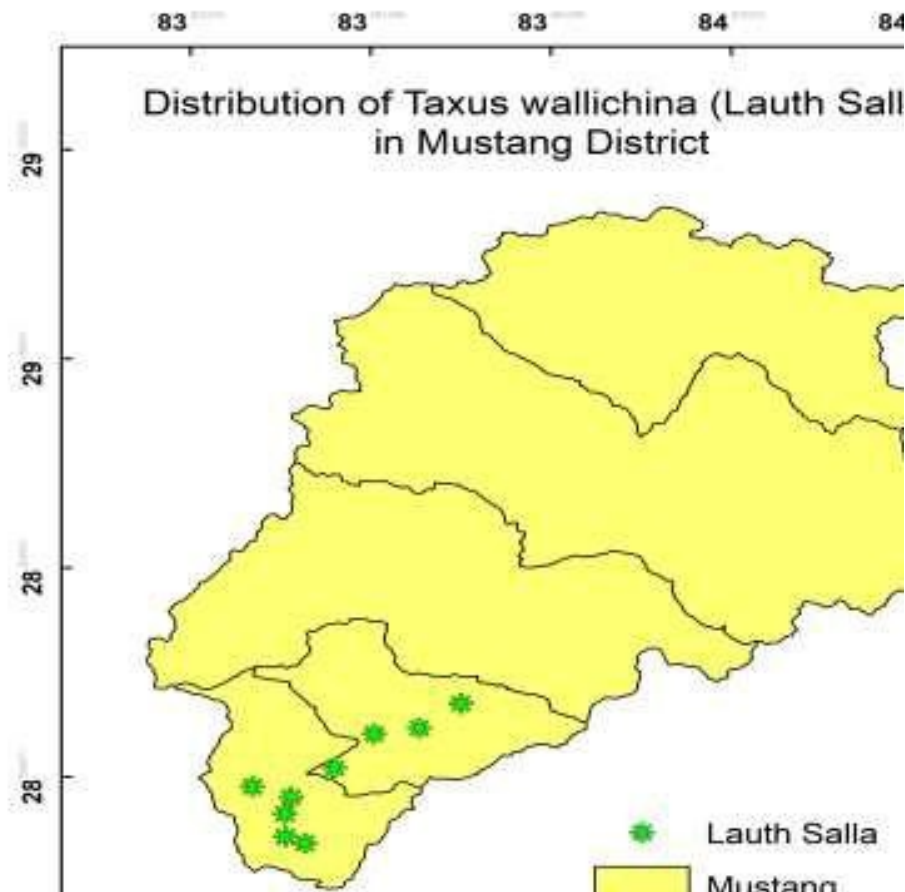


Figure 8: Habitat map of Lauth Salla

3.5.8 Yarsagumba :

Ophiocordyceps sinensis

Family: Ophiocordycipitaceae

Nepali name: Yarsagumba

English name: Caterpillar Fungus

Status: Least Concern

Distribution: It is found above 3500 m upto 5000 m. Lomanthang, Dalome, Muktinath and other lower areas of Mustang district have high presence of Yarsagumba .

Ecology and Habitat: The caterpillars prone to infection by fungus generally live 15 cm underground in alpine grass and shrub-lands. **Usable parts:** Fruiting body (Stroma)

Description: It is insect born fungus that emerges on a caterpillar during monsoon period. Worms are surviving during the monsoon. It has small spike with dark brown fructification and yellowish white stalk.

Uses: It has been traditionally used for impotence, backache, to increase sperm production and to increase blood production. It is specifically used for excess tiredness, chronic cough and asthma, debility, anemia and to build the bone marrow.

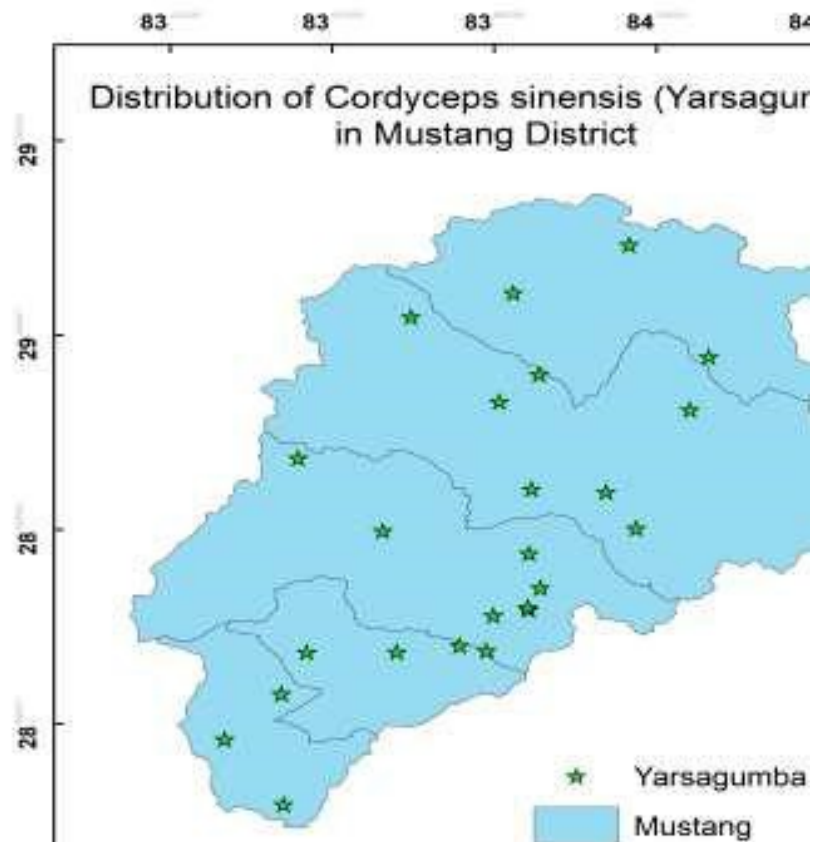


Figure 9: Habitat map of Yarsagumba

3.5.9 Padamchal:

Rheum australe

Family: Polygonaceae

Nepali name: Padamchal

English name: Himalayan Rhubarb

Distribution: It is found in upper region of Nepal above height 3200 m upto 4400 m.

Ecology and Habitat: Its habitat is distributed in rock and grasslands of mountain and high hills of Nepal.

Usable Parts: Whole plant

Flowering Period: June-July

Fruiting Period: August-September

Uses: It is used as purgative and astringent tonic. It is also used as strong laxative. Root is often used in stomach problems, cuts, wounds and muscular swellings. Shoots are used to make pickles, juice and tea and Rhizome part is used as dye locally.

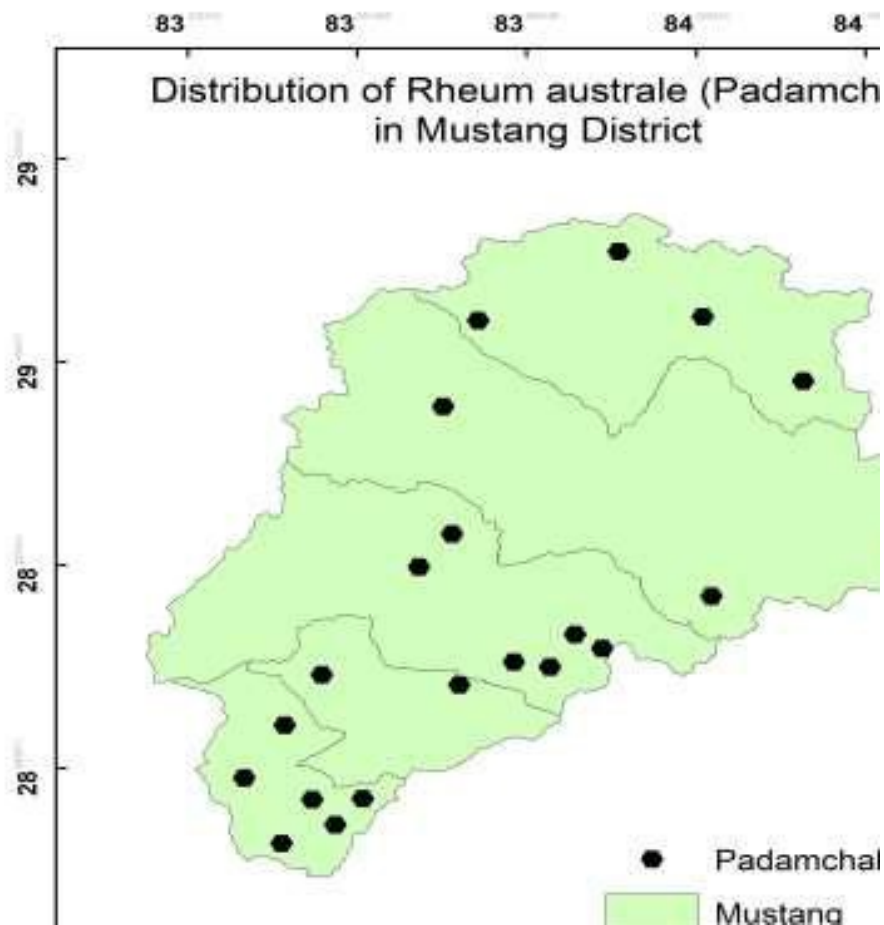


Figure 10: Habitat map of Padamchal

3.5.10 Somlata:

Ephedra gerardiana

Family: Ephedraceae

English name: Gerard's jointfir

Nepali name: Somlata

Status:

Usable parts: Above ground parts.

Habitat and ecology: It is found in the Himalayas in dry mountains and high mountain deserts.

Uses: It is often used as a stimulant, and in Ayurvedic medicine its tea is used as medicine for colds, coughs, bronchitis, asthma and arthritis. The local use of this species includes seeds and twigs used for controlling bleeding, kidney fever and hypertension.

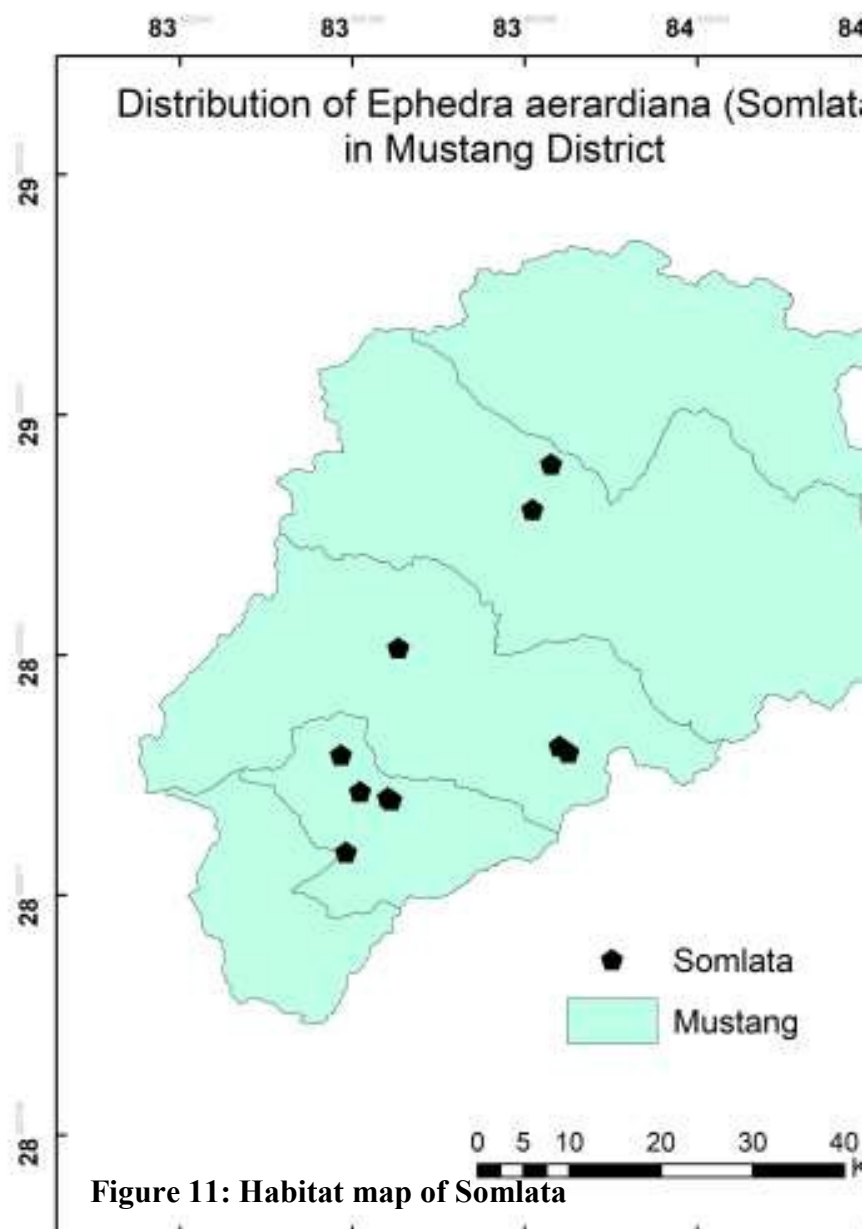


Figure 11: Habitat map of Somlata

3.5.11 Mangan:

Panax pseudo-ginseng wall

Family: Araliaceae

English name: False ginseng

Nepali name: Mangan

Status: Vulnerable

Flowering period: May-July

Distribution: The plant is reported in Eastern and Central Nepal

Habitat and ecology: Perennial herb that is cultivated in cold climatic condition.

Uses: The root possess haemostatic, tonic, hormonal and circulation promoting properties and have a beneficial effect in haematemesis, metrorrhagia, menorrhagia, post-partum haematometra, ocular congestion, bloody stools, epistaxis, rheumatism, phlegmon and contusions. Root is also effective in anemia and general debility.

3.5.12 Talis Patra:

Abies spectabilis

Family: Pinaceae

English name: Himalayan Fir

Nepali: Talis Patra or Bunge Salla

Status: Near Threatened

Distribution: Found in Central and Western Nepal between 2400m and 4400m altitude. **Habitat and ecology:** *Abies spectabilis* is the dominant tree in the forests of the central and western Himalayas, especially from c. 3,000 m to 4,000 m, with occasional occurrences on ridges below this height. It grows on cool moist sites on north facing slopes.

Use: The essential oil is obtained from the plant. The dried leaves, mixed with other ingredients, are used in making incense.

3.6 Discussion of existing causes of threats of NTFPs

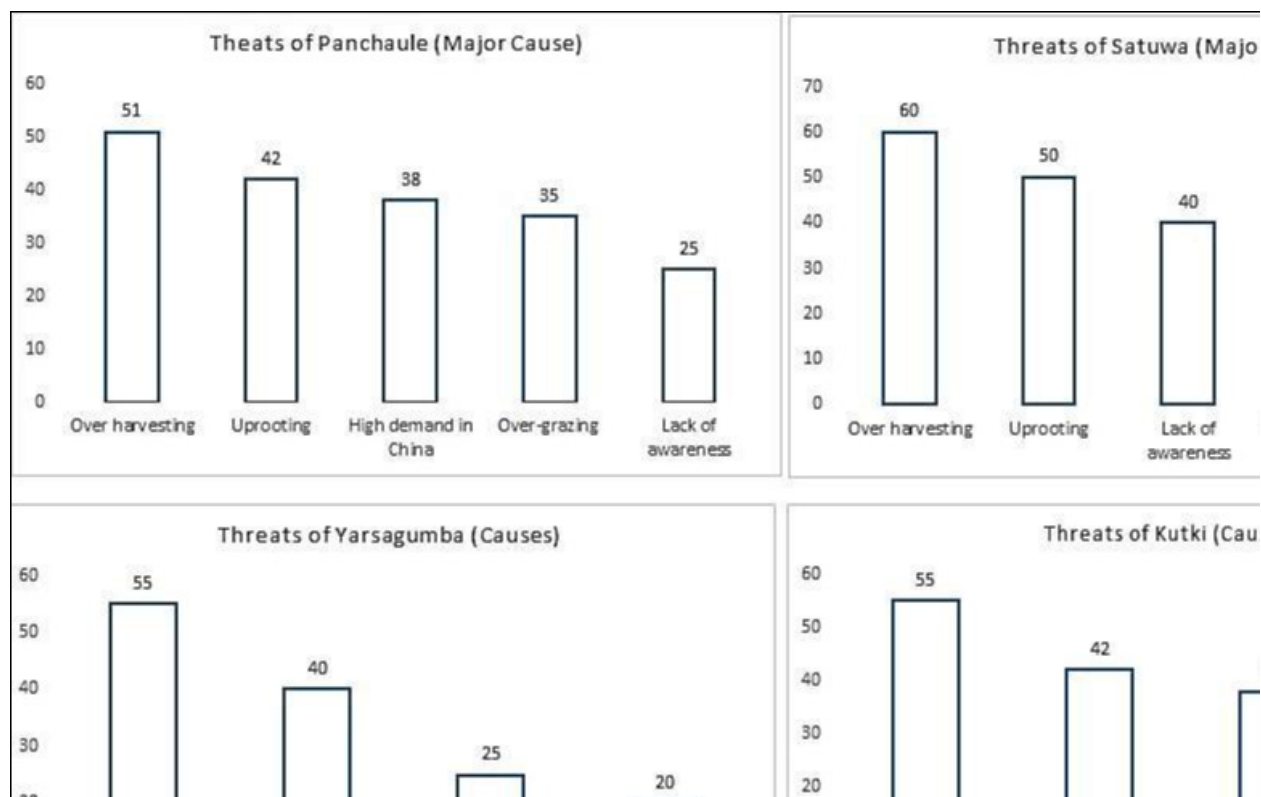


Figure 12. Cause of threats of high-value medicinal plants in Mustang, Nepal

3.6.1 Discussion

According to interview with local people. We finalized the major causes of threats to high value medicinal plants in the Mustang district of Nepal. The threat assessment was carried out with the major medicinal plants (*Panchaule*, *Kutki*, *Yarsagumba* and *Satuwa*). Altogether, we asked 300 people from Lete to Lo-man-thang areas in order to find out the real cause of threats in habitats. After analysis, we concluded that over-harvesting was the major problem in Mustang district. Due to the high market price and use value, people harvested these species for selling to Chinese brokers. The easy and reliable buyers for Mustang is China. More than 90% of medicinal plants are exported to China. The high price is also the major cause of the threat of extinction of species. Local people from Mustang often go for collection of Medicinal plants which have more market value.

The conservation awareness program for the indigenous people focusing on the value of medicinal plants is an urgent need in the study area. Among all the possible threats, overharvesting is a common problem for rare and endangered medicinal plants. Formation of youth clubs and motivating them on the conservation of endangered species of medicinal plants will be the possible program in the future so that such programs drive these species to protect in their natural habitat.

3.7 VULNERABILITY ASSESSMENT

The quantification of threats to rare and endangered medicinal plants was the major component of the study. After the checklist preparation, the next step was to find if the species were threatened or not, and if threatened, to what degree. To assess the threat status of medicinal plants, a method called rapid vulnerability assessment (RVA) was carried out for the prioritised species of MAPs. This method was developed by Cunningham (1996) and used in Bwindi National Park, Rwanda. In Nepal, it has been used by Tripathi and Schmitt (2001), Rokaya (2002) and Ghimire and Aumeeruddy-Thomas (2005). The modified RVA method was used by Wagner, Kriechbaum, and Koch (2008) for the endangerment assessment of medicinal plants from Muktinath Valley and Kali Gandaki in Central Nepal.

A total of fifteen vulnerability criteria were used for each species. For each of the eight predictors of vulnerability a score ranging from 1 to 4 (1 being low and 4 being high vulnerability) were assigned for each species. The assignment of values to a particular category was done based on vulnerability. Local users were interviewed to obtain information on plant parts used (criteria 1) and this data was validated against secondary literature. The species whose roots and rhizomes are utilized are more vulnerable as the entire plant has to be destroyed to collect these parts. Therefore, this criterion was given the highest value. Life forms (criteria 2) were assessed from secondary literature. Long-lived perennial species are considered more vulnerable because they have to rely entirely upon their underground parts for presentation and destruction of these parts can seriously affect their number and density.

Table 22: Vulnerability assessment of NTFPs

S.N.	Name of Species	Parts used	Life form	Habitat	Distribution	Local pop.	Trade	Threat	User group	Total score	Threat category
1	<i>Aconitum gammiei</i>	4	2	3	2	3	1	1	3	19	III
2	<i>Asparagus racemosus</i>	4	3	2	1	3	2	3	3	21	II
3	<i>Paris polyphylla</i>	4	3	2	3	3	4	4	3	26	I
4	<i>Neopicrorhiza scrophulariiflora</i>	4	3	2	2	3	4	4	4	26	I
5	<i>O. sinensis</i>	4	3	3	3	2	3	4	4	26	I
6	<i>Rheum australe</i>	3	3	2	2	4	1	4	3	22	II
7	<i>Rheum nobile</i>	3	3	3	3	4	0	3	2	21	II
8	<i>Rubia manjith</i>	4	2	2	3	3	2	2	3	21	II
9	<i>Swertia chirayita</i>	4	2	3	3	3	2	3	3	23	II
10	<i>Dioscorea deltoidea</i>	4	2	2	3	3	0	2	4	20	II
11	<i>Valeriana jatamansii</i>	4	3	2	2	3	1	3	3	21	II

Threat category I >25

Threat category II= 20-24

Threat category III = 15-19

Threat category IV= 5-14

During the field visit, we studied the vulnerability assessment of the traded NTFPs in the respective districts. In common sense, if the NTFPs species has the more valuable in root parts, the chances of depletion will be high in the present context. In Mustang, Satuwa (*Paris polyphylla*) was found as threatened status in the natural environment. The Nepalese government should promote cultivation practices for the categories of threats mentioned above. In the long term, domestication and cultivation are the only options to protect these species. Some species may be vulnerable in the wild, but farmers can grow NTFPs and commercialize them.

Plant-based organizations and trading companies have also focused on the maximum production of raw materials in the natural habitat. In the long run, the chances of depletion would be high if we did not harvest sustainably. Therefore, The Mustang DFO should focus on domestication and cultivation of the most valuable and locally preferable species in 12 districts. Therefore, Province must focus on root values of medicinal plant species like Yarsagumba, Panchaunle, Satuwa because the chances of depletion of these species might be very high. ***In a nutshell, major plant species are under the threats. Red categories are needed current actions for conserving in the natural habitat or promoting cultivation in ex-situ.***

3.8 Pocket area

The main aim of the pocket area of medicinal herbs/NTFPs is for managing the raw materials for the enterprises or industries. The enterprise creates thousands of job which has been linked with the livelihood of people of Mustang district. In the case of rare and endangered species, the raw materials should manage from private farmlands, not from the natural habitat. Cultivation of medicinal plants is vital for conserving species in ex-situ. The following areas of Mustang is the pocket area of high value medicinal plants, and shown in below map:

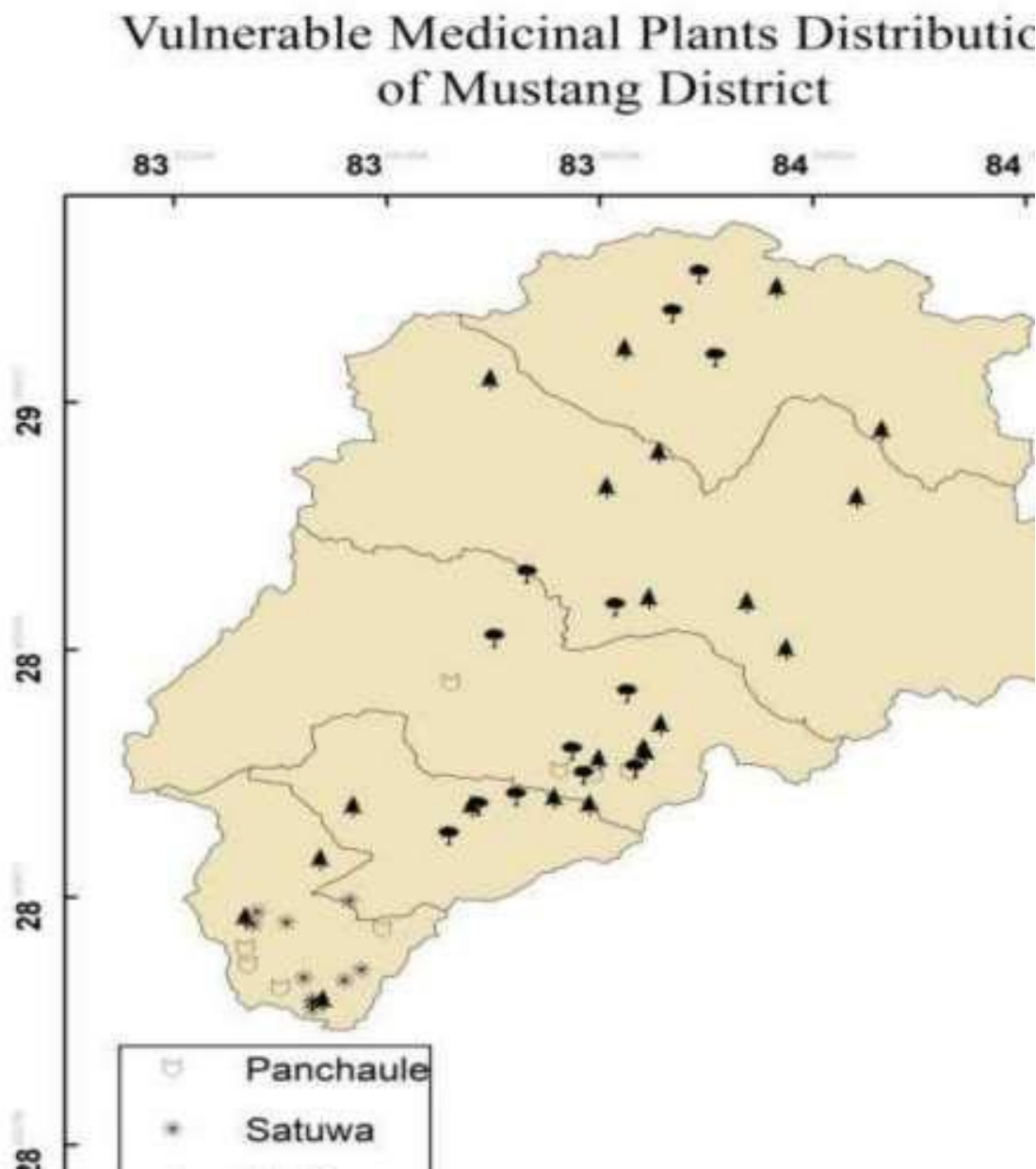


Figure 13 : Pocket area map of Mustang district, Nepal

3.9 USE VALUE, HEALTH BENEFITS AND RELATED ENTERPRISES

Name of Medicinal Herbs/ NTFPs	Uses	Health Benefits	Related enterprises	Remarks
Kutki	Edible and medicinal	It's root is used for recurring fever conditions. It also helps in reducing general weakness and fatigue and improves the vitality of the body.	Ayurvedic medicine enterprises	
Jatamansi	Edible and Medicinal	The rhizomes of the plant are used in the Ayurvedic system of medicine as a bitter tonic, stimulant, antispasmodic, and to treat hysteria, convulsions, and epilepsy. The roots has been medically used to treat insomnia and mental disorders.	Ayurvedic medicine enterprises	
Sarpaganda		It reduces blood pressure, depress activity of central nervous system and act as hypnotics. It is also used as antihypertensive and as a sedative.	Ayurvedic medicine enterprises	Endangered list of IUCN , and CITES II
Yarsagumba	Edible and Medicinal	It is considered potent at strengthening lung and kidneys, increasing energy and vitality, to increase sperm production and blood production. It is also used for excess tiredness, chronic cough and asthma, impotence, debility, anemia and to build the bone marrow.	Ayurvedic and Clinical Medicine enterprises	Vulnerable list of IUCN, and CITES II
Panchaule	Edible and Medicinal	It is used for Dysentery, Diarrhea, Chronic fever, Cough, Stomach ache, wounds, cuts, burns, fractures, general weakness and other conditions.	Ayurvedic medicine enterprise	

Somlata	Medicinal	It is used to treat asthma, bronchitis, cold, cough, allergy, rhinitis, arthritis, hay fever, sinusitis, hypotension, weight loss, heart failure and for its central nervous system stimulatory effects in the treatment of narcolepsy and depression.	Ayurvedic medicine enterprises	
Padamchal	Edible and Medicinal	It is used for digestive complaints including constipation, diarrhea, stomach pain, gastrointestinal bleeding.	Ayurvedic medicine enterprise	
Satuwa	Medicinal	It is used for fevers and headaches, burns, wounds, and many livestock related disease mainly to neutralize poisons.	Ayurvedic medicine enterprise	
Pakhanbed	Edible and Medicinal	It is used for the treatment of Gastrointestinal problems, respiratory disorders, headache, as an antidote to hookworm, toothache, etc. It is used as antiseptic.	Ayurvedic medicine(Ch yabanprash)	
Chiraito	Edible and Medicinal	It is used for fever, constipation, upset stomach, and loss of appetite, intestinal worms, skin diseases, and cancer.	Ayurvedic medicine enterprises	
Lauth Salla	Edible and Medicinal	It is a source of the chemical precursors to the anticancer drug. Their leaves, bark and trunks contain a compound called taxol, proven to inhibit the growth of new cancer cells.	Ayurvedic medicine enterprises	
Timur	Edible and Medicinal	Treatment of Dyspepsia, fever, diarrhea, diabetes, goiter, asthma, cardiac debility, cough, etc. Used as antiseptic.	Dental enterprises	
Bojho	Medicine	It is useful in hysteria and insomnia and also to reduce	Herbal medicine	

		mental stress. It is also used to cure sore throat.		
Ban Lasun	Medicine	It is used to treat dysentery, control diabetes, lower cholesterol, treat acne, and help in treating throat irritations.	Ayurvedic medicine enterprises	
Silajit	Medicine	It plays a significant role in treating conditions like dysria, glycosuria, breathing disorders, urinary disorders, kidney stones, oedema, skin diseases, piles, anemia, epilepsy, mental disorders and worm infestation.	Energy booster enterprise	

Conclusion and Recommendations

4. CONCLUSION AND RECOMMENDATION

Conclusion

Out of 86 high-valued medicinal plants species in Mustang, 15 major species are under rare and endangered categories, and they are: Panchoule (*Dactylorhiza hatagirea*), Jatamanshi (*Nardostachys grandiflora*), Kutki (*Neopicrorhiza scrophulariflora*), Satuwa (*Paris polyphylla* Smith), Laghupatra (*Podophyllum hexandrum* Royle), Louth Salla (*Taxus buccata*), Bikh (*Aconitum spicatum*), Okhar (*Juglens regia*), Sugandhawal (*Valeriana Jatamansi*), Talispatra (*Abies spectabilis*), Pakhanbed (*Bergenia ciliata*), Jhyau (*Lichen spp*), Karkati shringi (*Pistacia chinens*), Jangali painyu (*Prunus carmesina*) and Silajit were the major rare and endangered species which need to be conserved. Due to the border in Tibet, Chinese brokers directly come to villages and contact village middlemen, especially for *Ophiocordyceps sinensis* and *Peris polyphylla*. Due to high demand in the Chinese market, the chances of disappearing would be very high because of the heavy harvesting. The division forest should prepare a detailed management plan for the rare and threatened NTFPs which are found in Mustang, Nepal. Individual or species-based conservation strategies should be prepared. As a result, it helps for the long-term survival of the species in the future courses. The threats category of Kutki, Yarsagumba and Satuwa was received as (First (I)), which is needed urgent action, needed for the future courses of action. Most of the medicinal plants species fall under the threat categories (II and III).

Recommendation

- The local government, Conservation Management Committee (CMC), and local people should play a vital role in conserving rare and endangered NPTFs in their habitat.
- Division Forest Office (DFO) and Annapurna Conservation Area (ACA) should prepare the management plan including species-oriented long-term management plan for conserving this valuable and endangered species for future courses.
- Division Forest Office should initiate the cultivation of medicinal plants/NTFPs for those species which fall in endangered categories. For this, DFO initiates the interested farmer's group/women groups or other relevant groups to start up the cultivation.
- Dissemination of rare and endangered species with in district so that local people would identify about the species. Penalties system should be developed for trading or marketing of rare and endangered species.

References

- Anonymous, 2004. Mustang - The Land of Fascination. King Mahendra Trust for Nature Conservation, Jawalakhel, Kathmandu, Nepal.
- ANSAB, 1999. Forest Products Market/Enterprise Study Report. Asia Network for Sustainable and Agriculture Bioresources, Kathmandu, Nepal.
- Bhattarai S, Chaudhary RP, Taylor RSL, Ghimire SK.,2009. Biological Activities of some Nepalese Medicinal Plants used in treating bacterial infections in Human beings. Nepal Journal of Science and Technology 2009, 10:83-90.
- Bhattarai S, Chaudhary RP, Taylor RSL.,2009. The use of plants for fencing and fuelwood in Mustang District, Trans-Himalayas, Nepal. Scientific World. 7 (7): 59-63.
- Bhattarai S, Chaudhary RP.2005. Ethnobotany of wild rose in Manang district, central Nepal. Environmental Biology and Conservation 2005, 10:33-36.
- Bhattarai S, Chaudhary RP.,2006. Ethnobotany of wild Allium species in Manang district, central Nepal. Plant Archives , 6(2):471-476.
- Bhattarai, N., 1992. Medical ethnobotany in the Karnali zone , Nepal. Econ. Bot. 46, 257e261.
- Bhattarai, P.; Pandey, B.; Gautam, K.R.; Chhetri, R., 2014 . Ecology and Conservation Status of Threatened Orchid *Dactylorhiza hatagirea* (D. Don) Soo in Manaslu Conservation Area, Central Nepal. Am. J. Plant Sci.5, 3483–3491. [CrossRef]
- Bista T, Bista G.,2005 Himalayan Doctors and Healing Herbs: The Amchi Tradition and Medicinal Plants of Mustang. Mera Publications for Lo-Kunphen Mentsikhang
- Brohl M.,2006. Sustainable Use of Phytodiversity in Lower Mustang/Nepal - Concept for Laying out a Tibetan Medicinal Plant Garden.
- Chamoli, K.P.; Sharan, H. Ethno-medicinal properties of *Dactylorhiza hatagirea* in higher Himalayan villages of Rudraprayag district of Uttarakhand. J. Mt. Res. 2019, 14, 85–88.
- Chhetri HB, Gupta VNP., 2006 NTFP potential of upper Mustang - a trans- Himalayan region in western Nepal. Scientific World 2006, 4(4):38-43.
- Chhetri HB, Gupta VNP., 2007. A survey of non-timber forest products (NTFPs) in upper Mustang. Scientific World , 5(5):89-94.
- Chhetri, H.B.; Gupta, V.N.P.,2007. A survey of non-timber forest products (NTFPS) in Upper Mustang. Sci. World . 5, 89–94. [CrossRef]
- CHILDS, G. & CHOEDUP, N.,2014. Indigenous management strategies and socioeconomic impacts of Yartsa Gunbu (*Ophiocordyceps sinensis*) harvesting in Nubri and Tsum, Nepal. Himalaya, 34, 7.
- Conservation Assessment and Management Plan. Executive Summary Report of the Conservation Assessment and Management Plan (CAMP) of the Biodiversity Conservation Prioritization Project on Selected Medicinal Plants of Northern, North-Eastern and Central India. Available online: <http://msubiology.info/vesna/nauka/pillon2006.pdf> (accessed on 29 March 2014).
- Cunningham, A.B., et al., 2018. Paris in the spring: a review of the trade , conservation and opportunities in the shift from wild harvest to cultivation of Paris polyphylla (Trilliaceae). J. Ethnopharmacol. 222, 208e216.

- Gaire., D (2019). Resource assessment and marketing of caterpillar fungus (*Ophiocordyceps sinensis*) in the buffer zone of Makalu Barun National Park, Nepal. *Journal of Natural and Ayurvedic Medicine*, 3(3), 1-8.
- Ghimire SK, Sapkota IB, Oli BR, Parajuli RR., 2008. Non-timber forest products of Nepal Himalaya: database of some important species found in the mountain protected areas and surrounding regions. WWF Nepal.
- GoN., 2001. Protected Plants of Nepal: Forest regulation 1995 and its amendments. Kathmandu: Ministry of Forests and Soil Conservation, Government of Nepal. Nepal Gazette 51: 36– 43.
- GoN., 2006. Prioritized medicinal plants for economic growth in Nepal. Kathmandu, Nepal: HNCC, Department of Plant Resources; Thapathali, Nepal. p. 125. GoN., 2011. Protected Plants of Nepal: its amendments. Kathmandu, Nepal: Ministry of Forests and Soil Conservation. Nepal Gazette 60: 38–45.
- GoN., 2017. Trade statistics of medicinal plants of Nepal. Hamro Ban volume series. Kathmandu, Nepal: Ministry of Forests and Soil Conservation.
- GoN., 2011. Protected Plants of Nepal: Its amendments. Kathmandu, Nepal: Ministry of Forests and Soil Conservation. Nepal Gaz.60, 38–45.
- Gurung, K., Pyakurel, D., 2008. Resource Assessment and Non-timber Forest Products (NTFPs) Profile of Bajura District.
- Hamilton AC, Radford EA., 2007. Identification and Conservation of Important Plant Areas for Medicinal Plants in the Himalaya. Plantlife International, Salisbury, United Kingdom, and Ethnobotanical Society of Nepal, Kathmandu, Nepal.
- Huong, L.T.T., Anh, T.T.N., Yen, N.T.N., Thanh, N.T., Thin, N.N., 2012. Situation of precious and rare drug species in Thai Nguyen province. VNU J. Sci. Nat. Sci. Technol. 28, 173e194.
- International Union for Nature Conservation Nepal. National Register of Medicinal and Aromatic Plants; International Union for Nature Conservation Nepal: Kathmandu, Nepal, 2004.
- KC, M., Phoboo, S., and Jha, P.K., 2010. Ecological study of *Paris polyphylla* Sm. Ecoprint 17: 87-93.
- Khadka, C., Hammet, A., Singh, A., Balla, M. and Timilsina, Y., 2016. Ecological status and diversity indices of Panchaule (*Dactylorhiza hatagirea*) and its associates in Lete village of Mustang district, Nepal. Banko Janakari 26(1): 45-52.
- Khadka, C.; Hammet, A.; Singh, A.; Balla, M.; Timilsina, Y., 2016. Ecological status and diversity indices of Panchaule (*Dactylorhiza hatagirea*) and its associates in Lete village of Mustang district, Nepal. Banko Janakari.26, 45–52. [CrossRef]
- Kletter C, Kricchbaum M., 2001. Tibetan Medicinal Plants. Med-Pharm GmbH Scientific Publishers, Birkenwaldstr, Stuttgart, Germany .
- KMTNC., 2002. Fuel Energy in Upper Mustang: Demand, Supply and Action Plan for Management. King Mahendra Trust for Nature Conservation, Annapurna Conservation Area Project, Research report series number 9. (NEP/ 99/GEF); NEP/99/021 (TRAC) .

- KMTNC., 2004. Annual Progress Report 2003-2004. King Mahendra Trust for Nature Conservation, Annapurna Conservation Area Project, Unit Conservation Office, Lo-Manthang .
- KUNIYAL, C.P. & SUNDRIYAL, R.C. (2013) Conservation salvage of *Ophiocordyceps sinensis* collection in the Himalayan mountains is neglected. *Ecosystem Services*, 3, e40–e43.
- Kunwar RM, Nepal BK, Kshhetri HB, Rai SK, Bussmann RW., 2006. Ethnomedicine in Himalaya: a case study from Dolpa, Humla, Jumla and Mustang districts of Nepal. *Journal of Ethnobiology and Ethnomedicine*. 2: 27-10.1186/1746-4269-2-27.
- Kunwar, R.M., Adhikari, Y.P., Sharma, H.P. et al., 2020. Distribution, use, trade and conservation of Paris polyphylla Sm. in Nepal. *Global Ecology and Conservation* 23: e01081.
- Kunwar, R.M., Mahat, L., Acharya, R.P., Bussmann, R.W., 2013. Medicinal plants, traditional medicine, markets and management in far-west Nepal. *J. Ethnobiol. Ethnomed.* 9, 24.
- Kunwar, R.M., Thapa, K.P., Shrestha, R. Shrestha, P.R., Bhattarai, N.K., Tiwari, N.N. and Shrestha, K.K., 2011. Medicinal and Aromatic Plants Network (MAPs-Net) Nepal : An open access digital database. *Banko Janakari* 21: 48–50.
- Luitel, D.R., Rokaya, M.B., Timsina, B. and Münzbergová, Z., 2014. Medicinal plants used by the Tamang community in the Makawanpur district of central Nepal. *Journal of Ethnobiology and Ethnomedicine* 10(1): 1-5.
- Malla, S.B. and Shakya, P.R. (1984). Medicinal Plants. In: Majupuria, T.C. (editor), *Nepal Nature's Paradise*; White Lotus Co. Ltd. Bangkok, Thailand, pp. 261-297.
- Malla, S.B., Shakya, P.R., Rajbhandari, K.R., Bhattarai, N.K. and Subedi, M.N. (1995). Minor Forest Products of Nepal: General Status and Trade. Forest Resource Information System (FRIS) Project Paper No. 4. Report submitted to Forestry Sector Institutional Strengthening Program, Component No. 2. FRIS Project, Finnish Forest and Park Service, Ministry of Forestry and Soil Conservation, Kathmandu, Nepal.
- Manandhar NP., 1987. An ethnobotanical profile of Manang valley, Nepal. *J Econ Tax Bot*, 10:207-213.
- Meijboom, M., 2012. Guidelines for Resource Assessment and Management of Satuwa (Paris Polyphylla). Social Forestry and Extension Division, Department of Forests and Park Services, Ministry of Agriculture and Forests, Royal Government of Bhutan.
- Ministry of Environmental Protection of China, 2013. Biodiversity Red List in China-higher Plants, vol. 2013. Ministry of Environmental Protection of China, Chinese Academy of Sciences.
- Ministry of Forests and Soil Conservation, 2014. Nepal National Biodiversity Strategy and Action Plan 2014-2020. Government of Nepal
- NEPAL RASTRA BANK ., 2015. Impact of Yarsagumba on Nepalese Economy. Study report. Investigation Department, Nepal Rastra Bank, Kathmandu, Nepal.
- Noshiro S., 2008. Climatic conditions of Mustang. *Flora of Mustang, Nepal* Kodansha Scientific LTD., Tokyo Ohba H, Iokawa Yu, Sharma LR 2008, 1xii-1xiv
- Olsen, C.S. and Larsen, H.O., 2003. Alpine medicinal plant trade and Himalayan mountain Journal Pre-proof 23 livelihood strategies. *Geographic Journal* 169(3): 243–254

- Pant, S.; Tsewang, R. .,2012 . *Dactylorhiza hatagirea*: A high value medicinal orchid. J. Med. Plant Res. 6, 3522–3524.
- Paudyal MP, Rajbhandari M, Basnet P, Yahara S, Gewali MB. (2012) Quality assessment of the essential oils from *Nardostachys jatamansi* (D. Don) DC and *Nardostachys chinensis* Batal obtained from Kathmandu valley market. Scientific World, 10, 13-16.
- Pohle P.,1990. Useful Plants of Manang District: A Contribution to the Ethnobotany of the Nepal-Himalaya. Franz Steiner Verlag Wiesbaden GMBH, Stuttgart .
- Popli, D.,2017 Elicitation of *Dactylorhin*–E and Studying Anti-Cancerous Potential of *Dactylorhiza hatagirea* (D. Don). Master's Dissertation, Biotechnology, Jaypee University of Information and Technology, Wagnaghat, India,
- Pyakurel, D., Bhattarai, I. and Smith-hall, C., 2018. Patterns of change : The dynamics of medicinal plant trade in far-western Nepal. Journal of Ethnopharmacology 224: 323–334.
- Pyakurel, D., Sharma, I.B., Ghimire, S.K., 2017. Trade and conservation of medicinal and aromatic plants in western Nepal. Bot. Orient. 11, 27e37
- Pyakurel, D., Smith-Hall, C., Sharma-Bhattarai, I. and Ghimire, S.K., 2019. Trade and conservation of Nepalese medicinal plants, fungi and lichen. Economic Botany 73(4): 505– 521.
- Raskoti, B.B. The Orchids of Nepal; Bhakta Bahadur Raskoti and Rita Ale: Kathmandu, Nepal, 2009.
- Samant, S.S.; Dhar, U.; Rawal, R.S. (Eds.), 2001. Himalayan Medicinal Plants-Potential and Prospects; Gyanodaya Prakashan: Nainital, India.
- Shrestha TB, Joshi RM.,1996. Rare, Endemic and Endangered Plants of Nepal. WWF Nepal Program, Kathmandu, Nepal .
- Shrestha, B.; Kindlmann, P.; Jnawali, S.R.,2012. Interactions between the Himalayan tahr, livestock and snow leopards in the Sagarmatha National Park. In Himalayan Biodiversity in the Changing World; Kindlmann, P., Ed.; Springer: Dordrecht, The Netherlands. pp. 115–145.
- Shrestha, K.K., Tiwari, N.N. and Ghimire, S.K. (2000). MAPDON- Medicinal and Aromatic Plant Database of Nepal. In: Proceeding of Nepal-Japan Joint Symposium on Conservation and Utilization of Himalayan Medicinal Plant Resources; Organized by Society for the Conservation and Development of Medicinal Plant Resources, Japan and Department of Plant Resources, Kathmandu from Nov. 6-11, 2000, Nepal; pp. 53-74.
- Shrestha, N. and Shrestha K.K., 2013. Vulnerability assessment of high-valued medicinal plants in Langtang National Park, Central Nepal. Biodiversity 13:24-36. 10.1080/14888386.2012.666715.
- SHRESTHA, U.B. & BAWA, K.S., 2014. Economic contribution of Chinese caterpillar fungus to the livelihoods of mountain communities in Nepal. Biological Conservation.177,194-202.
- Singh UM, Gupta V, Rao VP, Sengar RS, Yadav MK. (2013) A review on biological activities and conservation of endangered medicinal herb *Nardostachys jatamansi*. International Journal of Medicinal and Aromatic Plants, 3, 113-124.
- Tanaka K, Komatsu K. (2008) Comparative study on volatile components of *Nardostachys rhizome*. Journal of Natural Medicines, 62, 112- 116.

- Thakur, M.; Dixit, V.K., 2007 . Aphrodisiac Activity of *Dactylorhiza hatagirea* (D. Don) Soo in Male Albino Rats. Evid. Based Complementary Altern. Med. 2007, 4, 29–31. [CrossRef] [PubMed]
- THAPA, B.B., PANTHI, S., RA I, R.K., SHRESTHA, U.B., ARYAL, A., SHRESTHA, S. & SHRESTHA, B., 2014 An assessment of Yarsagumba (*Ophiocordyceps s sinensis*) collection in Dhorpatan hunting reserve, Nepal. Journal of Mountain Science, 11, 555–562.
- Tiwari, N.N., Poudel, R.C and Uprety, Y. (2004). Study on Domestic Market of Medicinal and Aromatic Plants (MAPs) in Kathmandu Valley. Winrock International BDS/MaPs Bukhundole, Lalitpur.
- Uprety, Y., Asselin, H., Boon, E.K., Yadav, S., Shrestha, K.K., 2010. Indigenous use and bio-efficacy of medicinal plants in the Rasuwa District, Central Nepal. J. Ethnobiol. Ethnomed. 6, 3.
- Ved, D., Kinhal, G., Ravikumar, K., Vijaya-Shankar, R., Harisadan, K., 2005. Conservation Assessment and Management prioritization for wild medicinal plants of North-East India. Med. Plant Conserv. 11, 40e44.
- WANGCHUK, S., NORBU, N. & SHERUB, N., 2012. Impacts of *Ophiocordyceps sinensis* Collection on Livelihoods and Alpine Ecosystems in Bhutan as Ascertained from Questionnaire Survey of *Ophiocordyceps sinensis* Collectors. Royal Government of Bhutan, UWICE Press, Bumthang, Bhutan.
- WOODHOUSE, E., MCGOWAN, P. & MILNER-GULLAND, E.J., 2014. Fungal gold and firewood on the Tibetan plateau: examining access to diverse ecosystem provisioning services within a rural community. Oryx, 48, 30–38.
- Yamaji S, Komatsu K, Tani T, Namba T. (1999) Pharmacognostical studies on the Tibetan crude drugs , “sPangs-spos”, Chinese “Gansongxiang”, and Ayurvedic “Jatamansi”, derived from the plants of genus *Nardostachys*. Nature Medicine, 53, 61-71.
- Zhou, L., Wu, J., Wang, S., 2003. Low-temperature stratification strategies and growth regulators for rapid induction of *Paris polyphylla* var. *yunnanensis* seed germination. Plant Growth Regul. 41, 179e183.

Some photographs



NTPF inventor in Jharkot, Mustang



Focus Group Discussion in Lete, Mustang



Recording of medicinal plants (Way to Lomanthang)



Collecting Yarsagumba in the study area, Mustang

ANNEX